GEOTECHNICAL INVESTIGATION REPORT

FOR PROPOSED PLAN CHANGE

Turners Road & Spencerville Road, Spencerville, Christchurch

Client: LMM Investments Ltd
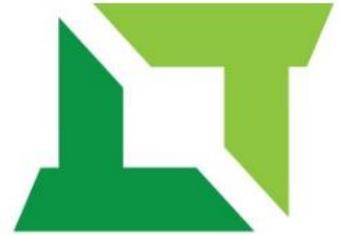
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Revision:	B
Client:	**LMM Investments Ltd**
Project Reference:	LTC24362
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LMM Investments Ltd	15 May 2025	Revision B (PDF)
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Executive Summary:

Project	Address	Turners Road & Spencerville Road, Spencerville, Christchurch
	Consenting Authority	Christchurch City Council
	Proposed Development	Land zoning plan change
	MBIE Technical Category	N/A - Rural and Unmapped
	Mapped Liquefaction Vulnerability	Possible
Preliminary Liquefaction Analysis & Site Assessment	Modelled vertical land settlement (SLSA)	<5mm to 20mm (TC2)
	Modelled vertical land settlement (SLSB)	5mm to 40mm (TC2)
	Modelled vertical land settlement (ULS)	15mm to 70mm (TC2)
	Global lateral movement category	Minor (0mm to 100mm at ULS, TC2)
	Lateral stretch category	Minor (0mm to 100mm at ULS, TC2)
	Provisional Technical Category and Liquefaction Vulnerability	TC2, Medium
	Site Subsoil Classification	Class D - Deep or Soft Soil Sites
	Geotechnical Hazard Assessment	Flood Management Area, Subsidence/slippage hazard as per TC2
	Groundwater Depth	Between 0.22m and 1.95m below ground level, with a median groundwater depth of 1.0m.

Figure 1: Aerial photograph of investigation site

(Source: Canterbury Maps. Image captured 11 February 2025)

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Appendices:

1.0   Introduction & Scope of Work

LandTech Consulting Ltd (LandTech) were engaged by Davie Lovell-Smith Ltd on behalf of LMM Investments Ltd (the Client) to carry out a geotechnical investigation at Turners Road & Spencerville Road, Spencerville, Christchurch (the Site). The geotechnical investigation and report are intended to support our client's application for a Plan Change to change the current zoning of the land to a mix of Residential and Commercial.

This geotechnical report summarises the findings of our investigation and analysis, which were conducted as per the brief given to us by our client and carried out in accordance with MBIE and Ministry for the Environment guidance documents[1][2]. This report includes our evaluation of ground conditions and assessment of potential geohazards for the site. This report may be relied upon by the Christchurch City Council (CCC) for corresponding resource consent applications.

Our scope of works for the geotechnical investigation and reporting for the site included the following:

- Calibrated desktop assessment,
- Field investigation (i.e., site walkover, deep geotechnical investigations),
- Liquefaction and s106 assessments and;
- Provision of this geotechnical report.

2.0   Site Description

The site is located at Turners Road & Spencerville Road, Spencerville, Christchurch, approximately 12km northeast of Christchurch Central. According to LINZ [3], the site comprises several Lots, legally described as:

- Part Lot 2 DP 5889
- Part Lot 30 DP 2773
- Lot 29 DP 2773
- Lots 1 & 2 DP 4047
- Lots 1, 2, 3 and 4 DP 76333

The combined total site area is 1,592,506m^2. The site is shown on Figure 1 (above) and the LandTech *Test Location Plan*, Drawing No. LTC24362 / 1 (attached in Appendix A).

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[1] *MBIE Canterbury Residential Rebuild Guidance documents*. Accessed via Repairing and rebuilding houses affected by the Canterbury earthquakes | Building Performance

[2] Planning and engineering guidance for potentially liquefaction-prone land: Resource Management Act and Building Act aspects | Ministry for the Environment

[3] https://data.linz.govt.nz/, accessed 4 February 2025

The near-level site is surrounded by rural properties, with Spencerville Road and Turners Road located to the north and west respectively. The Styx River runs along the sites southeast and southern most boundaries. All Lots currently contained within 'the site' are being utilised as farmland/pasture and/or lifestyle blocks.

3.0   Proposed Development

We are in receipt of a development concept plan prepared by Davie Lovell-Smith titled: Whisper Creek Project, Proposed Subdivision of Part Lot 2 DP 5889, Part Lot 30 DP 2773, Lot 29 DP 2773, & Lots 1 & 2 DP 4047 dated December 2024. The drawing indicates it is proposed to develop approximately half of the site into a residential and commercial subdivision with the eastern part of the site to be reserved for a wetland and recreational area as shown in Figure 2.

Figure 2 : Development concept plan

4.0   Area Geology

We have reviewed the geomorphological[4] and geological[5,6] maps of the area. The geomorphic source indicates the western portion of the site is located within coastal sand dunes while the eastern portion of the site, near the Styx River, is in an incised river channel. The geological sources indicate the site is underlain by Holocene aged Dune Deposits to the west and Holocene Alluvial Deposits to the east.

Dune Deposits generally comprise fine to medium grained wind deposited sand layers. Layers of silt and organics associated with back dune deposits can also exist in isolated locations. Due to the depositional environment the characteristics of Dune Deposits can vary widely over small distances. These variations include both horizontal and vertical differences in both soil particle size distribution and degree of consolidation.

Alluvial Deposits generally comprise interbedded horizons of fine to coarse-grained sand and silt, as well as layers of cohesive clay and peat. Layers of rounded to sub-rounded, gravel to cobble sized greywacke particles can also be present. Due to their depositional environment the characteristics of Alluvial Deposits can vary widely over short distances. These variations can include vertical and/or horizontal differences in both soil and/or particle size distribution and degree of soil consolidation.

The geotechnical properties of Dune and Alluvial Deposits depend on a number of variable factors, including soil composition, level of consolidation, particle size distribution, and organic content. The presence or absence of groundwater can also affect local soil behaviour characteristics. Due to this variability, during seismic events alluvium can be prone to differential settlement, liquefaction and, near river systems, significant lateral spreading.

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[4] *Geomorphological Map of Christchurch and Eastern Canterbury,* Beeg, Junes & Barrell (2015). Accessed via Christchurch Liquefaction Viewer, https://canterburymaps.govt.nz/map?webmap=ea5f9f0ad09b4192a481f2c76aa91907 on 5 February 2025.
[5] *Geology of the Christchurch Urban Area,* Brown and Weeber (1992) Accessed via Canterbury Maps, https://canterburymaps.govt.nz/ on 5 February 2025.
[6] *GNS Geological Unit QMAP*, GNS Science. Accessed via New Zealand Geology Web Map, https://data.gns.cri.nz/geology/ on 5 February 2025.

5.0   Geological Data Review

For the purpose of our investigation, we reviewed available data from the following sources (accessed on 5 February 2025):

- The Christchurch City Council (CCC) District Plan[7];
- The CCC Floor Level Map[8];
- The CCC Coastal Hazards Map[9];
- Environment Canterbury (ECan) map viewer[10];
- The ECan Listed Land Use Register (LLUR)[11]; and
- The New Zealand Geotechnical Database (NZGD)[12].

A summary of the findings of our data review, the results of which have contributed to our geotechnical assessment, model, and recommendations for the site.

- The CCC District Plan webservice shows that the site is located within an area categorised as a *Liquefaction Management Area* and *Flood Management Area.*

- The *Christchurch Liquefaction Vulnerability* study by Tonkin & Taylor, July 2020, presents liquefaction vulnerability categories for Christchurch City. Figure 4.14 of the report shows the site is located within a liquefaction vulnerability area of possible. This indicates there is a greater than 15% probability that liquefaction induced ground damage will be minor to moderate (or greater) for a 500 year event. There is insufficient information to distinguish between the medium and high categories.

- The MBIE *Residential Foundation Technical Category Map* shows that the site is located within an area designated as N/A - Rural and Unmapped. This indicates that normal consenting procedures apply.

- The CCC district plan indicates that the area has a fixed floor level requirement; however, the CCC Floor Level map shows that a finished floor level for the site has not yet been assessed. We recommend contacting CCC to determine the required floor level for the site prior to starting construction/earthworks.

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[7] https://districtplan.ccc.govt.nz/
[8] https://ccc.govt.nz/services/water-and-drainage
[9] https://ccc.govt.nz/environment/coast/coastalhazards
[10] http://canterburymaps.govt.nz/
[11] https://llur.ecan.govt.nz/
[12] http://www.nzgd.org.nz/

- The CCC Coastal Hazard map shows that the site does not fall within the current mapped coastal erosion hazard zone, however, the site is mapped within the coastal inundation hazard zone. The proposed development area of the site is predicted to have up to 50cm to 100cm of inundation depth during a 100-year ARI event with 60cm of sea level rise

- The ECan LLUR contains records of historical HAIL activities taking place at the site. The recorded activity is bulk storage of pesticides and landfill activities on the site. We recommend contacting a contamination specialist to conduct an assessment.

- The digitised 1856 Black Maps[13] indicate that the property and surrounding area was mapped as Sand Hills and surface water, with the western part of the site mapped as swamp consistent with the local environmental conditions.

- We have referred to historical aerial photography for the area[14], which indicates that the site has remained in its current state since the earliest available aerial photography from the 1940's.

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[13] Accessed via Canterbury Maps, https://ecan.maps.arcgis.com/home/item.html?id=c5f7d946b8fb43ce80fd3441cde5b78e
[14] Accessed via Canterbury Maps, https://canterburymaps.govt.nz/map?webmap=7d0dc64208474b4c976b90ccc6ce9ae7

5.1   Existing Geotechnical Data

The *New Zealand Geotechnical Database*[15] (NZGD) and the *Canterbury Maps ECan Wells and Bores* open data layer[16] shows that geotechnical testing and well borehole data is available for the site and within close proximity to the site. The locations of the tests utilised in our assessment are marked on the LandTech *Test Location Plan*, Drawing No. LTC24362 / 1 (attached in Appendix A). The details of each test are as follows:

- Cone Penetration Test (CPT_32129), drilled to a target depth of 14.92m by McMillan Drilling Ltd on 15 March 2013.
- Cone Penetration Test (CPT_ 103991), drilled to a target depth of 10.10m by Geotechnics Ltd on 09 October 2017.
- Cone Penetration Test (CPT_ 103992), drilled to a target depth of 10.03m by Geotechnics Ltd on 09 October 2017.
- Cone Penetration Test (CPT_ 103993), drilled to a target depth of 10.22m by Geotechnics Ltd on 09 October 2017.
- Cone Penetration Test (CPT_ 103994), drilled to a target depth of 10.06m by Geotechnics Ltd on 09 October 2017.
- Cone Penetration Test (CPT_ 103995), drilled to a target depth of 10.06m by Geotechnics Ltd on 09 October 2017.
- Cone Penetration Test (CPT_ 103996), drilled to a target depth of 10.18m by Geotechnics Ltd on 09 October 2017.
- Cone Penetration Test (CPT_ 103997), drilled to a target depth of 9.98m by Geotechnics Ltd on 09 October 2017.
- Well Borehole BW24/0163, drilled by Clemence Drilling Contractors to a depth of 36.60m on 30 May 2014.
- Well Borehole BX24/1324, drilled by East Coast Drilling to a depth of 33.0m on 15 February 2016.
- Well Borehole BW24/0163, drilled by Clemence Drilling Contractors to a depth of 36.60m on 30 May 2014.
- Well Borehole M35/1264, drilled by McMillan Drilling Ltd to a depth of 34.09m on 1 July 1968.
- Well Borehole M35/1265, drilled by A M Bisley & Co to a depth of 30.20m on 21 June 1966.
- Well Borehole M35/10558, drilled by McMillan Drilling Ltd to a depth of 86.9m on 20 July 2009.
- Well Borehole M35/18143, drilled by McMillan Drilling Ltd to a depth of 6.25m on 16 October 2009.
- Well Borehole M35/18144, drilled by McMillan Drilling Ltd to a depth of 6.0m on 16 October 2009.
- Well Borehole M35/18145, drilled by McMillan Drilling Ltd to a depth of 6.10m on 16 October 2009.

The well borehole logs generally indicate the site is underlain by sands and silts overlying gravels at a depth of approximately 25m below ground level. A copy of the well logs is included in Appendix B.

The data from the CPT's analysed in our assessment are generally consistent with the well borehole data summarised above. The results show that the recorded CPT cone resistance, Q_c values within the upper 10m to 15m below ground level were generally between 5MPa and 30MPa, generally increasing with depth, indicating predominantly dense sand and interbedded thin lenses of silt. The CPT logs are attached in Appendix B.

6.0   Field Investigation

The field investigation for the site took place on 29 January 2025 and comprised the following components:

- Detailed site inspection.
- Three Cone Penetration Tests (CPTs).

The approximate test locations[17] are indicated on the LandTech *Test Location Plan*, Drawing No. LTC24362 / 1 (attached in Appendix A).

CPT tests were carried out by LandTech technical staff using a Pagani TG63-150 CPT rig. The results of this testing are attached in Appendix C.

7.0   Subsurface Conditions

The ground conditions over the majority of the site interpreted from the on-site CPT testing, correlated with the available existing data, comprise a layer of topsoil overlying sand-like dilative material with interbedded clay-like transitional material overlying gravels at depths of approximately 20.0m below ground level.

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[17] Field tests and sections were located using a hand-held GPS unit and a measuring tape without survey control and are therefore approximate only.

7.1   Groundwater

Groundwater was encountered at a depth of 1.7m below ground level within CPT03 on the day of our site investigation. Groundwater was not measured within CPT01 or CPT02 due to shallow hole collapse.

Water level depths recorded on the onsite well borehole and CPT logs sourced from NZGD and ECan database indicate that groundwater levels range between 0.22m and 1.95m below ground level, with a median groundwater depth of 1.0m. The groundwater in the area is prone to seasonal fluctuations and local groundwater levels may also vary with rainfall levels over shorter time intervals.

The GNS Science Median Water Table Elevations, Depths to Water Table (25m – grid DEM) layer (accessed via the NZGD), shows that the groundwater level at the proposed development portion of the site varies between 1.0m and 4.0m below average ground level. The proposed wetland/recreation area marked on the development concept is shown to have a higher median water table depth of between 0.0m and 1.0m, with a median depth to groundwater of 0.5m.

Figure 3 : GNS Science Median Water Table Elevations, Depths to Water Table (25m – grid DEM)
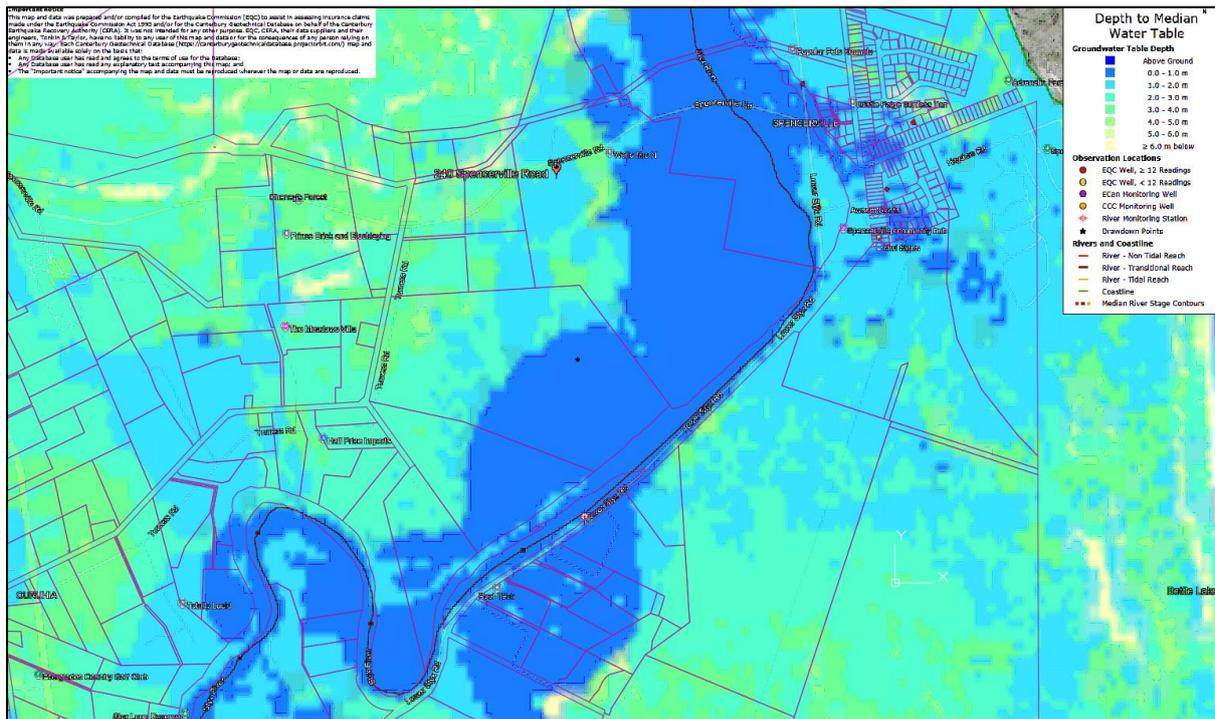
7.2   Site Seismicity

For the purpose of applying the requirements of NZS 1170.5:2004, the site subsoil is considered Class D - Deep or Soft Soil Sites. This classification is based on our estimation that the depth of soils Static Settlement

8.0   Liquefaction Analysis

We have analysed the CPT data discussed above for liquefaction in Model Earthquake Events. The analysis has been carried out using proprietary software[18] Geologismiki CLiq Version 3. Liquefaction settlement and land damage potential on the site has been calculated for the three model earthquake events specified in MBIE/NZGS *Module 3 - Earthquake geotechnical engineering practice* (November 2021)[19], based on a methodology adapted from the same source. Our analysis was carried out using groundwater conditions based on the groundwater depths measured on site. The conditions used for each of our analyses are listed below.

The model conditions are given below:

- *Service Limit State A* (SLSA); where M_w = 7.5 and PGA = 0.13g.
- *Service Limit State B* (SLSB); where M_w = 6.0 and PGA = 0.19g.
- *Ultimate Limit State* (ULS); where M_w = 7.5 and PGA = 0.35g; and
- Groundwater levels during all modelled events are set at 0.5m.

Table 1 below shows the results of our analyses; outputs are attached in Appendix C.

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[18] Geologismiki Geotechnical Software, CLiq v.3.3.1.14 – CPT Liquefaction Assessment Software
[19] *Earthquake geotechnical engineering practice Module 3: Identification, assessment and mitigation of liquefaction hazards,* MBIE and NZGS, (2021). Accessed via https://www.building.govt.nz/building-code-compliance/b-stability/b1-structure/module-3-identify-liquefaction-hazards/

Table 1: CPT Liquefaction Analysis Results

Test ID	Result	SLSA	SLSB	ULS
CPT01	Index Settlement (10.0m)	10mm	20mm	55mm
	Liquefaction Severity Number	3	5	22
	Ground Damage Category	Little to none	Little to none	Moderate
CPT02	Index Settlement (10.0m)	5mm	10mm	35mm
	Liquefaction Severity Number	1	2	12
	Ground Damage Category	Little to none	Little to none	Minor
CPT03	Index Settlement (10.0m)	<5mm	5mm	40mm
	Liquefaction Severity Number	1	1	17
	Ground Damage Category	Little to none	Little to none	Minor
CPT_32129	Index Settlement (10.0m)	10mm	20mm	70mm
	Liquefaction Severity Number	3	9	37
	Ground Damage Category	Little to none	Little to none	Moderate to Severe
CPT_103991	Index Settlement (10.0m)	<5mm	5mm	20mm
	Liquefaction Severity Number	0	4	18
	Ground Damage Category	Little to none	Little to none	Minor
CPT_103992	Index Settlement (10.0m)	<5mm	5mm	20mm
	Liquefaction Severity Number	1	1	4
	Ground Damage Category	Little to none	Little to none	Little to none
CPT_103993	Index Settlement (10.0m)	<5mm	5mm	15mm
	Liquefaction Severity Number	1	1	12
	Ground Damage Category	Little to none	Little to none	Minor
CPT_103994	Index Settlement (10.0m)	10mm	25mm	50mm
	Liquefaction Severity Number	7	22	38
	Ground Damage Category	Little to none	Moderate	Moderate to Severe
CPT_103995	Index Settlement (10.0m)	20mm	40mm	65mm
	Liquefaction Severity Number	10	23	43
	Ground Damage Category	Little to none	Moderate	Major
CPT_103996	Index Settlement (10.0m)	10mm	20mm	35mm
	Liquefaction Severity Number	6	22	29
	Ground Damage Category	Little to none	Moderate	Moderate
CPT_103997	Index Settlement (10.0m)	5mm	10mm	35mm
	Liquefaction Severity Number	1	4	19
	Ground Damage Category	Little to none	Little to none	Minor

The settlements presented in Table 1 above are to the nearest 5mm. Due to the inherent uncertainty in calculating liquefaction induced settlement, the calculated free field settlements (land settlement) are indicative only. Actual settlements on site may vary from those above and do not take into account foundation influences, volume loss from surface expression, loss in bearing strength and influences from lateral spreading.

Based on the results of our quantitative liquefaction assessment of the site's model earthquake performance, we consider that up to major liquefaction-induced land damage is possible during future ULS earthquakes, and that up to moderate land damage is likely to occur during SLS earthquakes. This indicates that a liquefaction vulnerability category of High would be applicable for the site rather than the current category of possible. However, our analyses have been conducted with a conservative groundwater level of 0.5m, which may be able to be refined via additional geotechnical investigations and groundwater monitoring at the subdivision design stage. This may then possibly return a lower liquefaction vulnerability of medium for certain parts of the site based on local subsoil and groundwater conditions.

Based on the results of the model liquefaction analysis the proposed development area of the site should be considered to have a provisional land classification of TC2, with modelled index settlements of less than 50mm predicted at SLS for the upper 10m below ground surface, and less than 100mm within the same depth interval predicted at ULS. It should be noted that a more detailed liquefaction assessment should be undertaken during subdivision consenting stages to confirm the Technical Category is relevant to all areas of the site.

Based on the proposed development area being located 200m away from any major watercourses the site is considered to fall within the minor category of both Global Lateral Movement (0mm to 100mm at ULS) and Lateral Stretch (0mm to 100mm at ULS).

9.0   Assessment Against RMA Section 106

As per the requirements of Section 106 of the Resource Management Act (RMA) (2017), we have undertaken a high-level assessment of the significant geotechnical hazards that may affect the site.

9.1   Erosion

The development portion of the site is not considered to be subject to active erosion, and is unlikely to accelerate, worsen, or result in erosion over a 100 year timeline.

9.2   Falling Debris

No elevated land exists in close proximity to the site; therefore, the risk of rock fall or land slippage occurring on the site is considered negligible.

9.3   Subsidence

Based on our assessment, the development portion of the site is considered prone to liquefaction-induced subsidence in accordance with TC2 criteria however, pockets of higher susceptibility may be present. These risks can be mitigated during subdivision development and/or building development stages.

9.4   Slippage

The proposed development area of the site is considered prone to lateral spreading (i.e., slippage) in accordance with TC2 criteria.

9.5   Inundation

According to the Christchurch City Council floor level website (referenced in Section 5.0), the site is located within a flood management area, however according to the CCC website floor level assessments for the site are incomplete.

The site is considered likely to be inundated with liquefaction ejecta following future large earthquake events.

10.0   Development Considerations

Ground improvement at the subdivision earthworks stage may be considered necessary, as there is potential for some areas of the site to be susceptible to natural hazards that would require such works to be undertaken. However, a majority of the site is unlikely to need ground improvement on account of our preliminary TC2 classification, subject to more detailed geotechnical investigations and assessment at the subdivision design stage.

All earthworks on the site are to be carried out in accordance with the requirements of *NZS 4431:2022 Engineered Fill Construction for Lightweight Structures*. All unsuitable materials (i.e., non-engineered fill, vegetation, tree roots/stumps, topsoil, organics, detritus material, demolished building foundations, and decommissioned services and their associated backfilled trenches) are to be stripped away from areas of earthworks and stockpiled clear of the operational area or carted off-site.

Preliminarily, TC2 type foundations are considered geotechnically feasible for NZS:3604 compliant structures, subject to building-specific geotechnical investigations to assess the available bearing capacity, post subdivision development.

It is noted that this report is limited to a geotechnical assessment. Advice related to other development requirements (such as roading infrastructure, pavements, services, stormwater management and contaminated land) should be sought from appropriately qualified personnel.

11.0   Limitations

This geotechnical report has been prepared for our Client for the purposes of supporting the proposed Plan Change of the subject site outlined. LandTech accepts no responsibility for the validity, appropriateness, sufficiency or consequences of the Client using this report for purposes other than for the purpose intended.

We have attempted to conduct a thorough investigation of the site, within the agreed scope of works. The findings and recommendations in this report are based on the results of tests at point locations; therefore, subsurface conditions could vary away from these locations and/or differ from the assumed geotechnical model. Should exposed soil conditions vary from those described herein we request to be informed so as to determine the continued applicability of our recommendations. However, as stated above, variations still may exist as soils can vary naturally across the site and due to previous human activities. LandTech has no control over and should not be held accountable for these variations.

The geotechnical investigation was confined to geotechnical aspects of the site only and did not involve an assessment for environmental contaminants. In addition, our investigation and analyses have not considered the possibility of fault rupture, which may cause deformations and displacements of the ground directly below the site. These (environmental and fault rupture) assessments are outside of the scope of our geotechnical engagement.

12.0   Conclusion

The combination of variable soil material and high groundwater means that liquefaction is the primary potential geotechnical hazard risk. TC2 land is relatively common across eastern Christchurch and there are proven and well understood land remediation and foundation design solutions available to mitigate liquefaction risk.

At a plan review stage, the key outcome is to identify if there are any significant "deal breaker' geotechnical hazard reasons that would prevent the land from being rezoned. This report does not identify any significant geotechnical hazard risks present that are so extensive as to preclude the Plan Change, especially as relates to the upper terrace development area. It is standard practice for subsequent subdivision consent processes to include provision for more detailed site investigations and if need be, land remediation through bulk earthworks. Later Building Consent processes likewise enable consideration of the suitability of specific foundation designs to ensure the chosen foundation solutions are appropriate for the underlying ground conditions. On that basis it is considered that there are no geotechnical considerations that impact on the ability to re-zone the Site.

<u>END OF REPORT</u>

APPENDIX A

LandTech Drawings

CPT_103991
CPT_103997
M35/1265
CPT_103992
CPT_103993
CPT03
BW24/0163
CPT_103995
CPT_103994
M35/10558
CPT_103996
M35/18145
M35/18143
CPT02
CPT_32129
Area Set aside for Wetlands and Recreation uses
M35/1264
M35/18144
CPT01
BX24/1324

Spencerville Road
Turners Road

North

AMENDMENTS			
DATE	REV	DESCRIPTION	
11/02/2025	A	Report Issue	

Check all dimensions and levels on site before commencing construction.

This drawing and design remains the property of LandTech Consulting Ltd. and may not be reproduced without approval and permission from LandTech Consulting Ltd.

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Test Location Plan

Turners Road & Spencerville Road
SPENCERVILLE, CHRISTCHURCH

LandTech CONSULTING

Drawing No.: LTC24362/ 1	Drawn by: MT	Date: 11/02/25
Scale: 1: 10000 (A3)	Checked by: DW	Revision: A

Filename: LTC24362 - Drawings.dwg

APPENDIX B

Deep Test Results/Logs

CPT basic interpretation plots (normalized)

Norm. cone resistance | **Norm. friction ratio** | **Nom. pore pressure ratio** | **SBTn Plot** | **Norm. Soil Behaviour Type**

SBTn plot depth annotations (Norm. Soil Behaviour Type):
- Clay
- Silty sand & sandy silt
- Sand & silty sand
- Silty sand & sandy silt
- Sand & silty sand
- Silty sand & sandy silt
- Clay & silty clay
- Sand & silty sand
- Silty sand & sandy silt
- Sand & silty sand
- Sand
- Sand & silty sand

Axis labels: Qtn | Fr (%) | Bq | Ic (Robertson 1990) | SBTn (Robertson 1990)

Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

SBTn legend

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

CLiq v.3.5.2.5 - CPT Liquefaction Assessment Software - Report created on: 12/02/2025, 11:28:09 am

Project file: C:\Users\MarkTrainor\LandTech Consulting\LandTech Consulting - Christchurch\2024\Turners Road, Spencerville - LTC24362\CPT\LTC24362 - ULS Liquefaction Analysis.clq

1

CPT basic interpretation plots (normalized)

Norm. cone resistance
Qtn

Norm. friction ratio
Fr (%)

Nom. pore pressure ratio
Bq

SBTn Plot
Ic (Robertson 1990)

Norm. Soil Behaviour Type
SBTn (Robertson 1990)

Organic soil

Sand & silty sand

Silty sand & sandy silt

Sand & silty sand

Silty sand & sandy silt

Sand & silty sand

Silty sand & sandy silt

Sand & silty sand

Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

SBTn legend

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

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2

CPT basic interpretation plots (normalized)

Norm. cone resistance

Norm. friction ratio

Nom. pore pressure ratio

SBTn Plot

Norm. Soil Behaviour Type

Depth (m)

Qtn: 0, 50, 100, 150, 200

Fr (%): 0, 2, 4, 6, 8, 10

Bq: -0.2, 0, 0.2, 0.4, 0.6, 0.8, 1

Ic (Robertson 1990): 1, 2, 3, 4

SBTn (Robertson 1990): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18

Norm. Soil Behaviour Type labels:
- Organic soil
- Sand & silty sand
- Silty sand & sandy silt
- Sand & silty sand

Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

SBTn legend

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

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3

CPT basic interpretation plots (normalized)

Norm. cone resistance — Qtn (axis 0 to 200), Depth (m) 0 to 14.5

Norm. friction ratio — Fr (%) (axis 0 to 10), Depth (m) 0 to 14.5

Nom. pore pressure ratio — Bq (axis -0.2 to 1), Depth (m) 0 to 14.5

SBTn Plot — Ic (Robertson 1990) (axis 1 to 4), Depth (m) 0 to 14.5

Norm. Soil Behaviour Type — SBTn (Robertson 1990) (axis 0 to 18), Depth (m) 0 to 14.5

Soil descriptions (right column):
- Organic soil
- Sand & silty sand
- Silty sand & sandy silt
- Clay & silty clay
- Silty sand & sandy silt
- Clay & silty clay
- Sand & silty sand
- Silty sand & sandy silt
- Sand & silty sand

Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

SBTn legend

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

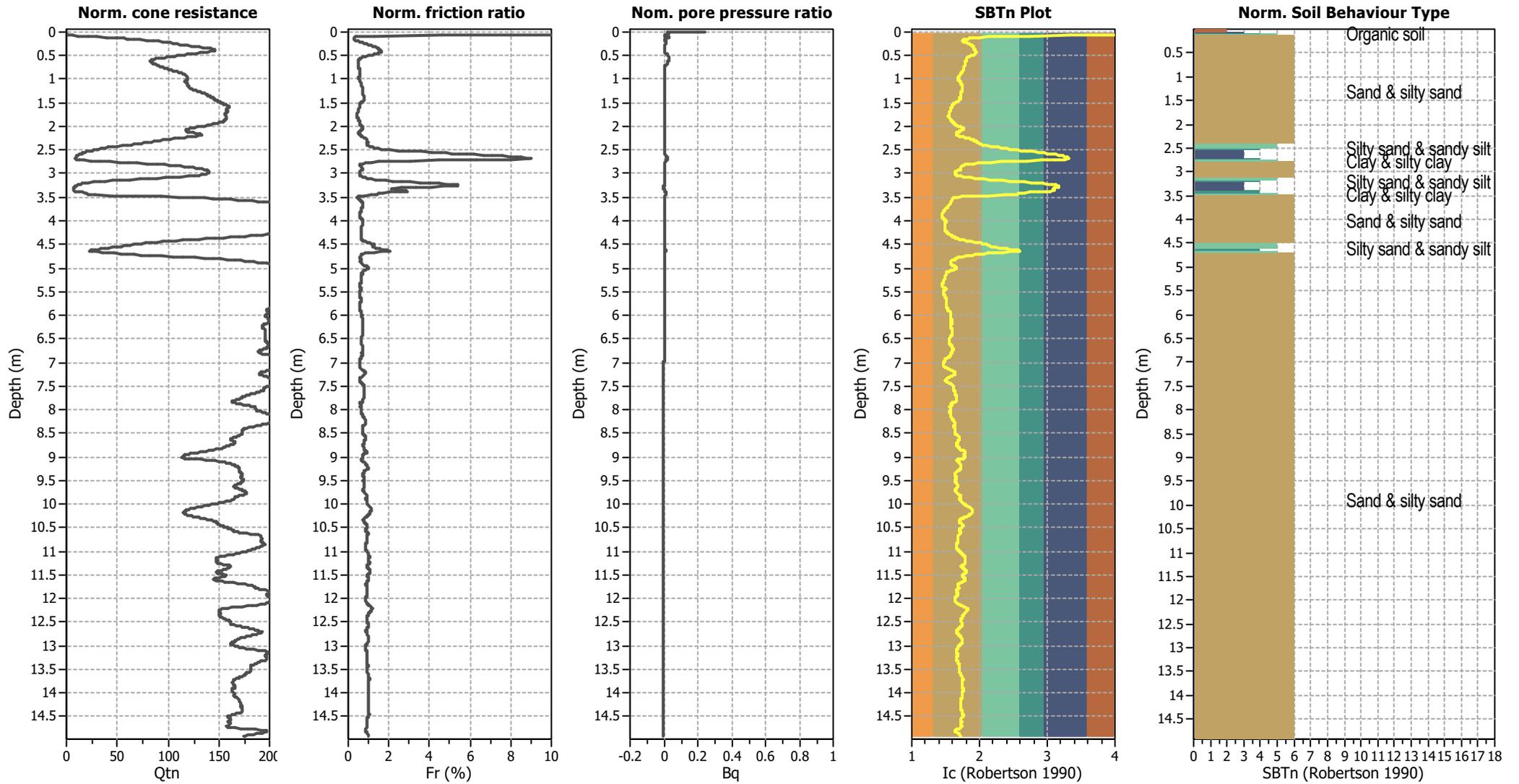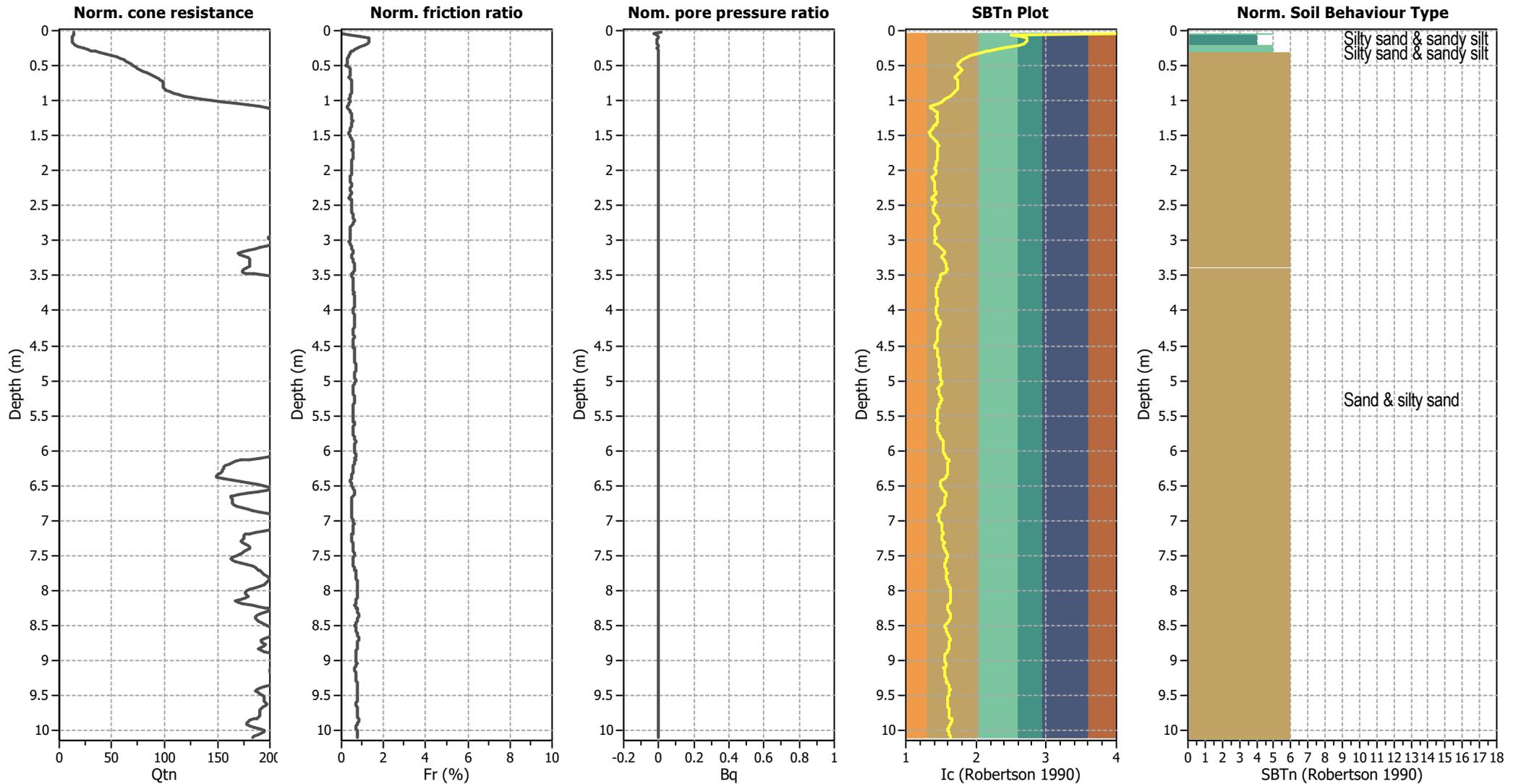# CPT basic interpretation plots (normalized)

Norm. cone resistance — Qtn (0 to 200)
Norm. friction ratio — Fr (%) (0 to 10)
Nom. pore pressure ratio — Bq (-0.2 to 1)
SBTn Plot — Ic (Robertson 1990) (1 to 4)
Norm. Soil Behaviour Type — SBTn (Robertson 1990) (0 to 18)

Silty sand & sandy silt
Silty sand & sandy silt
Sand & silty sand

Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

SBTn legend

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

CPT basic interpretation plots (normalized)

Norm. cone resistance — Qtn

Norm. friction ratio — Fr (%)

Nom. pore pressure ratio — Bq

SBTn Plot — Ic (Robertson 1990)

Norm. Soil Behaviour Type — SBTn (Robertson 1990)

Soil labels (right plot): Silty sand & sandy silt; Clay & silty clay; Sand & silty sand; Silty sand & sandy silt; Sand & silty sand

Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

SBTn legend

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

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6

CPT basic interpretation plots (normalized)

Norm. cone resistance

Norm. friction ratio

Nom. pore pressure ratio

SBTn Plot

Norm. Soil Behaviour Type

Depth (m) — Qtn (0, 50, 100, 150, 200)

Depth (m) — Fr (%) (0, 2, 4, 6, 8, 10)

Depth (m) — Bq (-0.2, 0, 0.2, 0.4, 0.6, 0.8, 1)

Depth (m) — Ic (Robertson 1990) (1, 2, 3, 4)

Depth (m) — SBTn (Robertson 1990) (0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18)

Clay & silty clay
Silty sand & sandy silt

Sand & silty sand

Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

SBTn legend

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

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7

CPT basic interpretation plots (normalized)

Norm. cone resistance	Norm. friction ratio	Nom. pore pressure ratio	SBTn Plot	Norm. Soil Behaviour Type

Norm. Soil Behaviour Type

- Silty sand & sandy silt
- Sand & silty sand
- Silty sand & sandy silt
- Sand & silty sand

Qtn — Fr (%) — Bq — Ic (Robertson 1990) — SBTn (Robertson 1990)

Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

SBTn legend

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

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8

CPT basic interpretation plots (normalized)

Norm. cone resistance

Norm. friction ratio

Nom. pore pressure ratio

SBTn Plot

Norm. Soil Behaviour Type

Silty sand & sandy silt
Silty sand & sandy silt

Sand & silty sand

Silty sand & sandy silt

Sand & silty sand

Silty sand & sandy silt
Sand & silty sand

Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

SBTn legend

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

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9

CPT basic interpretation plots (normalized)

Norm. cone resistance — Qtn (0 to 200)

Norm. friction ratio — Fr (%) (0 to 10)

Nom. pore pressure ratio — Bq (-0.2 to 1)

SBTn Plot — Ic (Robertson 1990) (1 to 4)

Norm. Soil Behaviour Type — SBTn (Robertson 1990) (0 to 18)

Soil behaviour type labels (depth descending):
- Silty sand & sandy silt
- Silty sand & sandy silt
- Sand & silty sand
- Sand
- Sand & silty sand
- Sand
- Silty sand & sandy silt
- Sand & silty sand
- Sand & silty sand

Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

SBTn legend

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

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10

CPT basic interpretation plots (normalized)

Norm. cone resistance — Qtn (axis 0, 50, 100, 150, 200)

Norm. friction ratio — Fr (%) (axis 0, 2, 4, 6, 8, 10)

Nom. pore pressure ratio — Bq (axis -0.2, 0, 0.2, 0.4, 0.6, 0.8, 1)

SBTn Plot — Ic (Robertson 1990) (axis 1, 2, 3, 4)

Norm. Soil Behaviour Type — SBTn (Robertson 1990) (axis 0–18)

Soil behaviour labels (right plot):
- Silty sand & sandy silt
- Sand
- Silty sand & sandy silt
- Sand & silty sand
- Sand
- Sand
- Sand & silty sand

Input parameters and analysis data

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

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

Fill weight:	N/A
Transition detect. applied:	No
K_σ applied:	Yes
Clay like behavior applied:	Sands only
Limit depth applied:	Yes
Limit depth:	10.00 m

SBTn legend

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

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Borelog for well BW24/0163

Grid Reference (NZTM): 1573752 mE, 5190738 mN
Location Accuracy: 50 - 300m
Ground Level Altitude: 4.0 m +MSD Accuracy: < 2.5 m
Driller: Clemence Drilling Contractors
Drill Method: Rotary/Percussion
Borelog Depth: 36.6 m   Drill Date: 30-May-2014

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha

Scale(m)	Water Level	Depth(m)		Full Drillers Description	Formation Code
	0.65			SAND (0.06 - 2 MM).	
	0.65				
5		4.40m		Black CLAY with minor peat.	
10					
15					
20					
25					
		26.60m		Yellow clayey GRAVEL (2 - 60 MM).	
30					
		32.50m		GRAVEL (2 - 60 MM). Saturated (water-bearing).	
35		36.60m			

Borelog for well BX24/1324

Grid Reference (NZTM): 1573431 mE, 5189871 mN
Location Accuracy: 10 - 50m
Ground Level Altitude: 3.6 m +MSD Accuracy: < 2.5 m
Driller: East Coast Drilling
Drill Method: Air Rotary
Borelog Depth: 33.0 m   Drill Date: 15-Feb-2016

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha

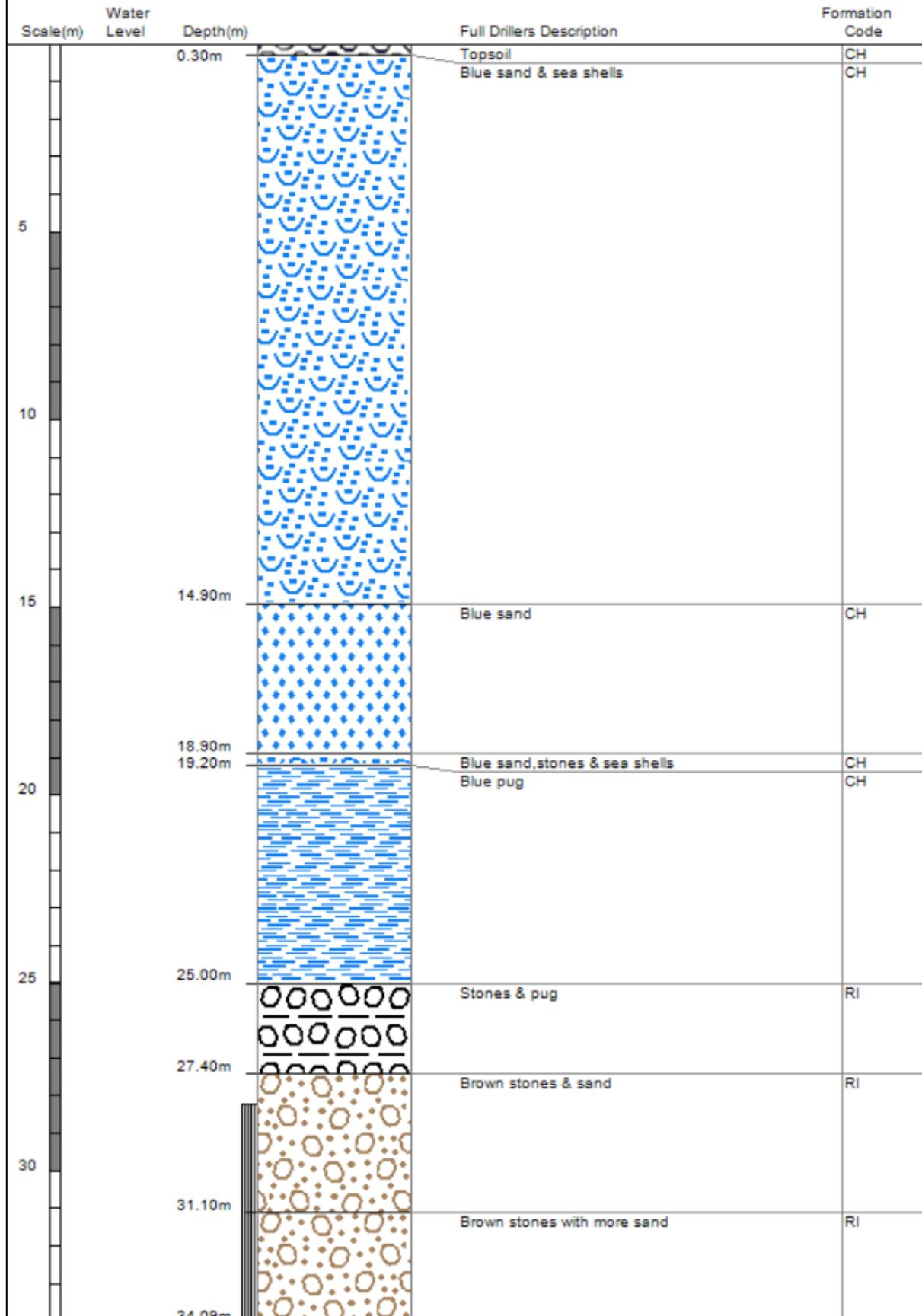| Scale(m)	Water Level	Depth(m)		Full Drillers Description	Formation Code
	1.40	0.50m		Brown TOPSOIL. Unsaturated (dry or moist).	
	1.40	2.00m		Brown CLAY. Unsaturated (dry or moist).	
		3.00m		Brown SAND (0.06 - 2 MM). Unsaturated (dry or moist).	
		4.00m		Grey SAND (0.06 - 2 MM). Unsaturated (dry or moist).	
5				Grey clayey SAND (0.06 - 2 MM). Unsaturated (dry or moist).	
10					
		12.00m		Grey SAND (0.06 - 2 MM). Unsaturated (dry or moist).	
15					
		17.00m		Grey CLAY. Unsaturated (dry or moist).	
20					
25		25.00m		Brown clayey GRAVEL (2 - 60 MM). Unsaturated (dry or moist).	
		28.00m		Light brown GRAVEL (2 - 60 MM) with some sand. Saturated (water-bearing).	
30					
		33.00m			

Borelog for well M35/1264

Grid Reference (NZTM): 1573728 mE, 5190034 mN
Location Accuracy: 50 - 300m
Ground Level Altitude: 3.7 m +MSD Accuracy: < 2.5 m
Driller: McMillan Drilling Ltd
Drill Method: Cable Tool
Borelog Depth: 34.1 m   Drill Date: 01-Jul-1962

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha

Scale(m)	Water Level	Depth(m)		Full Drillers Description	Formation Code
		0.30m		Topsoil	CH
				Blue sand & sea shells	CH
5					
10					
15		14.90m		Blue sand	CH
		18.90m			
20		19.20m		Blue sand,stones & sea shells	CH
				Blue pug	CH
25		25.00m		Stones & pug	RI
		27.40m		Brown stones & sand	RI
30		31.10m		Brown stones with more sand	RI
		34.09m			

Borelog for well M35/1265

Grid Reference (NZTM): 1574398 mE, 5191184 mN
Location Accuracy: 50 - 300m
Ground Level Altitude: 1.7 m +MSD Accuracy: < 2.5 m
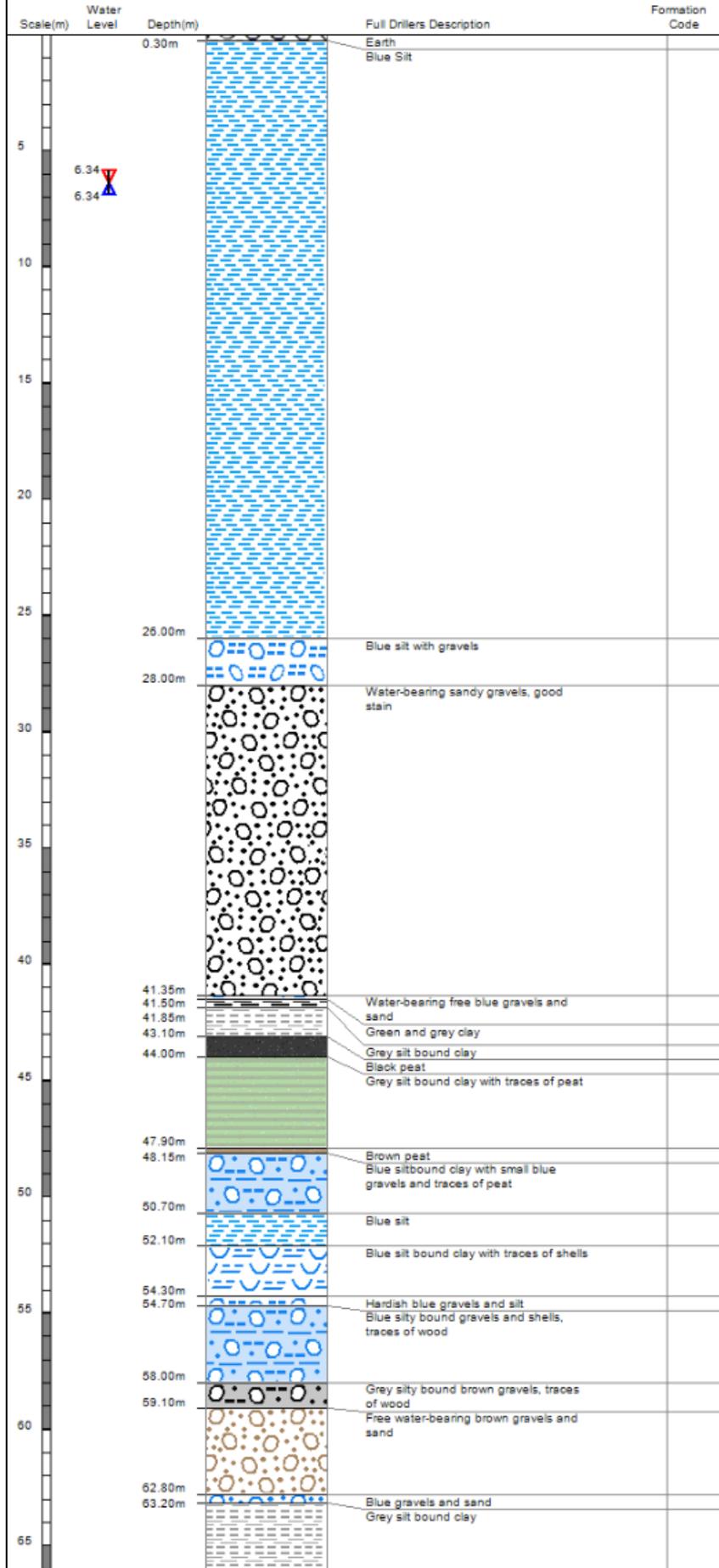Driller: A M Bisley & Co
Drill Method: Cable Tool
Borelog Depth: 30.2 m   Drill Date: 21-Jun-1966

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha

Scale(m)	Water Level	Depth(m)	Full Drillers Description	Formation Code
		0.50m	Topsoil	CH
			Grey sand	CH
5				
10				
15		15.20m		
			Grey sand & shells	CH
		18.00m		
			Grey sand,Grey gravel & shells	CH
20		20.10m		
		21.00m	Grey clay	CH
		21.29m	Grey sand,shells	CH
			Grey clay	CH
25		25.60m		
		26.20m	Clay,peat,gravel	CH
			Brown/Grey gravel,sand	RI
30		30.20m		

Borelog for well M35/10558

Grid Reference (NZTM): 1574808 mE, 5190764 mN
Location Accuracy: 10 - 50m
Ground Level Altitude: 1.5 m +MSD Accuracy: < 2.5 m
Driller: McMillan Drilling Ltd
Drill Method: Rotary/Percussion
Borelog Depth: 86.9 m   Drill Date: 20-Jul-2009

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha

Scale(m)	Water Level	Depth(m)		Full Drillers Description	Formation Code
		0.30m		Earth	
				Blue Silt	
	6.34				
	6.34				
		26.00m		Blue silt with gravels	
		28.00m		Water-bearing sandy gravels, good stain	
		41.35m			
		41.50m		Water-bearing free blue gravels and sand	
		41.85m			
		43.10m		Green and grey clay	
		44.00m		Grey silt bound clay	
				Black peat	
				Grey silt bound clay with traces of peat	
		47.90m			
		48.15m		Brown peat	
				Blue siltbound clay with small blue gravels and traces of peat	
		50.70m		Blue silt	
		52.10m		Blue silt bound clay with traces of shells	
		54.30m		Hardish blue gravels and silt	
		54.70m		Blue silty bound gravels and shells, traces of wood	
		58.00m		Grey silty bound brown gravels, traces of wood	
		59.10m		Free water-bearing brown gravels and sand	
		62.80m			
		63.20m		Blue gravels and sand	
				Grey silt bound clay	

Borelog for well M35/18143

Grid Reference (NZTM): 1574623 mE, 5190527 mN
Location Accuracy: 10 - 50m
Ground Level Altitude: 1.4 m +MSD Accuracy: < 2.5 m
Driller: McMillan Drilling Ltd
Drill Method: Push Tube
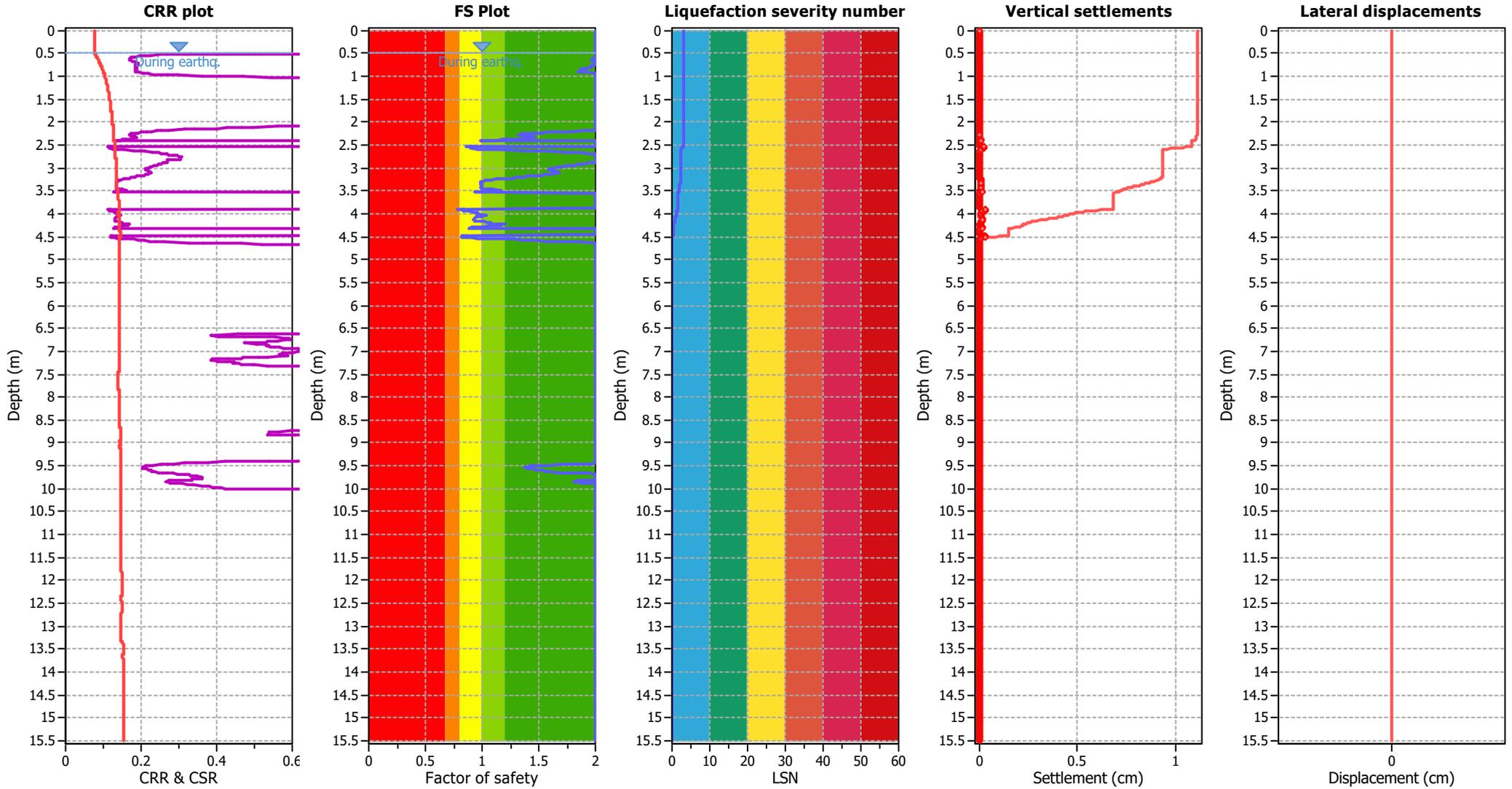Borelog Depth: 6.3 m   Drill Date: 16-Oct-2009

Scale(m)	Water Level	Depth(m)		Full Drillers Description	Formation Code
1	1.00 / 1.00	1.20m		Silty sand, brown, dry	
		1.70m		Silty sand, grey (moist)	
2		2.40m		Silt, grey (west)	
3				Silty Sand, grey (moist)	
4					
5					
6		6.25m			

Borelog for well M35/18144

Grid Reference (NZTM): 1574273 mE, 5190240 mN
Location Accuracy: 10 - 50m
Ground Level Altitude: 0.8 m +MSD Accuracy: < 2.5 m
Driller: McMillan Drilling Ltd
Drill Method: Push Tube
Borelog Depth: 6.0 m   Drill Date: 16-Oct-2009

Scale(m)	Water Level	Depth(m)		Full Drillers Description	Formation Code
	0.04			Silty clay, damp	
1		0.70m			
		1.00m		Clay, grey	
				Sandy silt, grey (wet)	
2		1.80m			
3				Silty sand, grey (moist)	
4					
5		4.50m		Sand, grey (very moist)	
		6.00m			

Borelog for well M35/18145

Grid Reference (NZTM): 1573733 mE, 5190451 mN
Location Accuracy: 10 - 50m
Ground Level Altitude: 3.9 m +MSD Accuracy: < 2.5 m
Driller: McMillan Drilling Ltd
Drill Method: Push Tube
Borelog Depth: 6.1 m   Drill Date: 16-Oct-2009

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha

Scale(m)	Water Level	Depth(m)	Full Drillers Description	Formation Code
			Top soil, dark brown	
		0.30m		
			Silty sand, brown, damp	
		0.80m		
1			Silty sand, grey, moist	
2	2.06 / 2.06			
3				
		3.20m		
		3.40m	Silty peat (damp)	
			Silty sand, grey, moist	
4				
5		5.20m		
			Sandy silt, grey, almost wet	
6		6.10m		

APPENDIX C

Model Earthquake Liquefaction Analysis Outputs

Liquefaction analysis overall plots

| CRR plot | FS Plot | Liquefaction severity number | Vertical settlements | Lateral displacements |

Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

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

LSN color scheme
- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

CLiq v.3.5.2.5 - CPT Liquefaction Assessment Software - Report created on: 11/02/2025, 2:23:18 pm

Project file: C:\Users\MarkTrainor\LandTech Consulting\LandTech Consulting - Christchurch\2024\Turners Road, Spencerville - LTC24362\CPT\LTC24362 - SLSA Liquefaction Analysis.clq

1

Liquefaction analysis overall plots

CRR plot — CRR & CSR vs Depth (m)
FS Plot — Factor of safety vs Depth (m)
Liquefaction severity number — LSN vs Depth (m)
Vertical settlements — Settlement (cm) vs Depth (m)
Lateral displacements — Displacement (cm) vs Depth (m)

Input parameters and analysis data

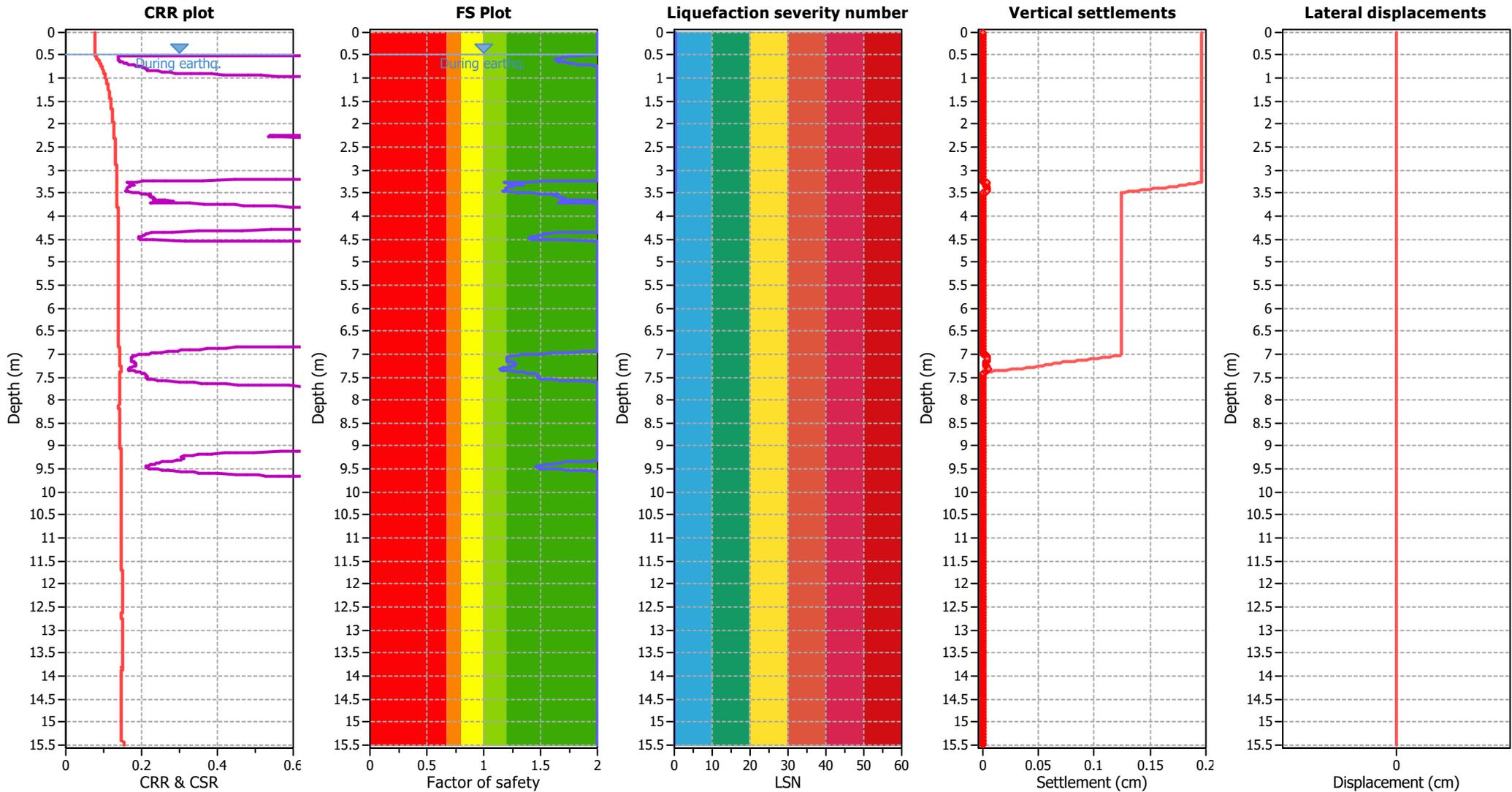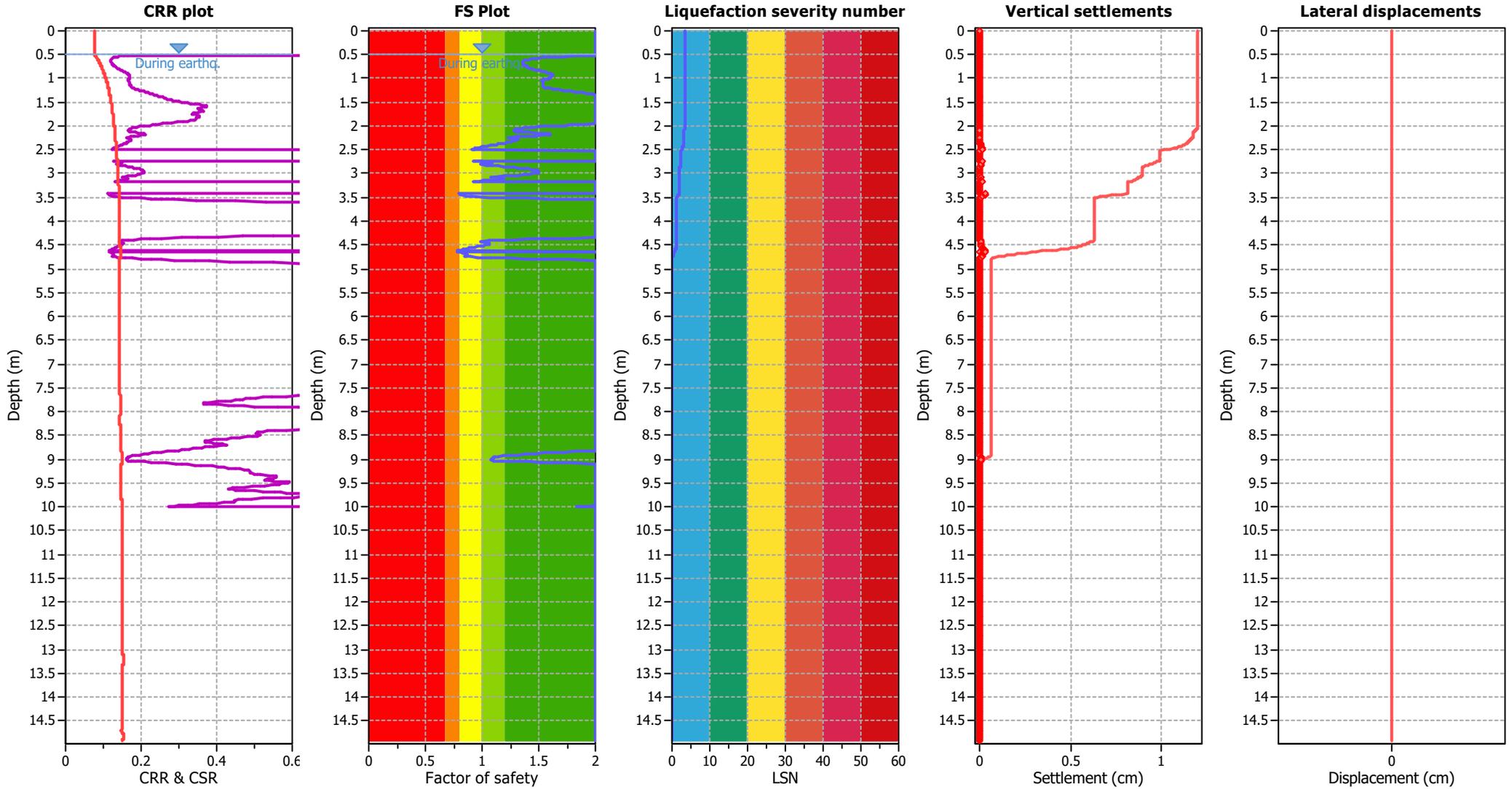|					
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

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

LSN color scheme
- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

CLiq v.3.5.2.5 - CPT Liquefaction Assessment Software - Report created on: 11/02/2025, 2:23:18 pm
Project file: C:\Users\MarkTrainor\LandTech Consulting\LandTech Consulting - Christchurch\2024\Turners Road, Spencerville - LTC24362\CPT\LTC24362 - SLSA Liquefaction Analysis.clq

2

Liquefaction analysis overall plots

CRR plot | **FS Plot** | **Liquefaction severity number** | **Vertical settlements** | **Lateral displacements**

Input parameters and analysis data

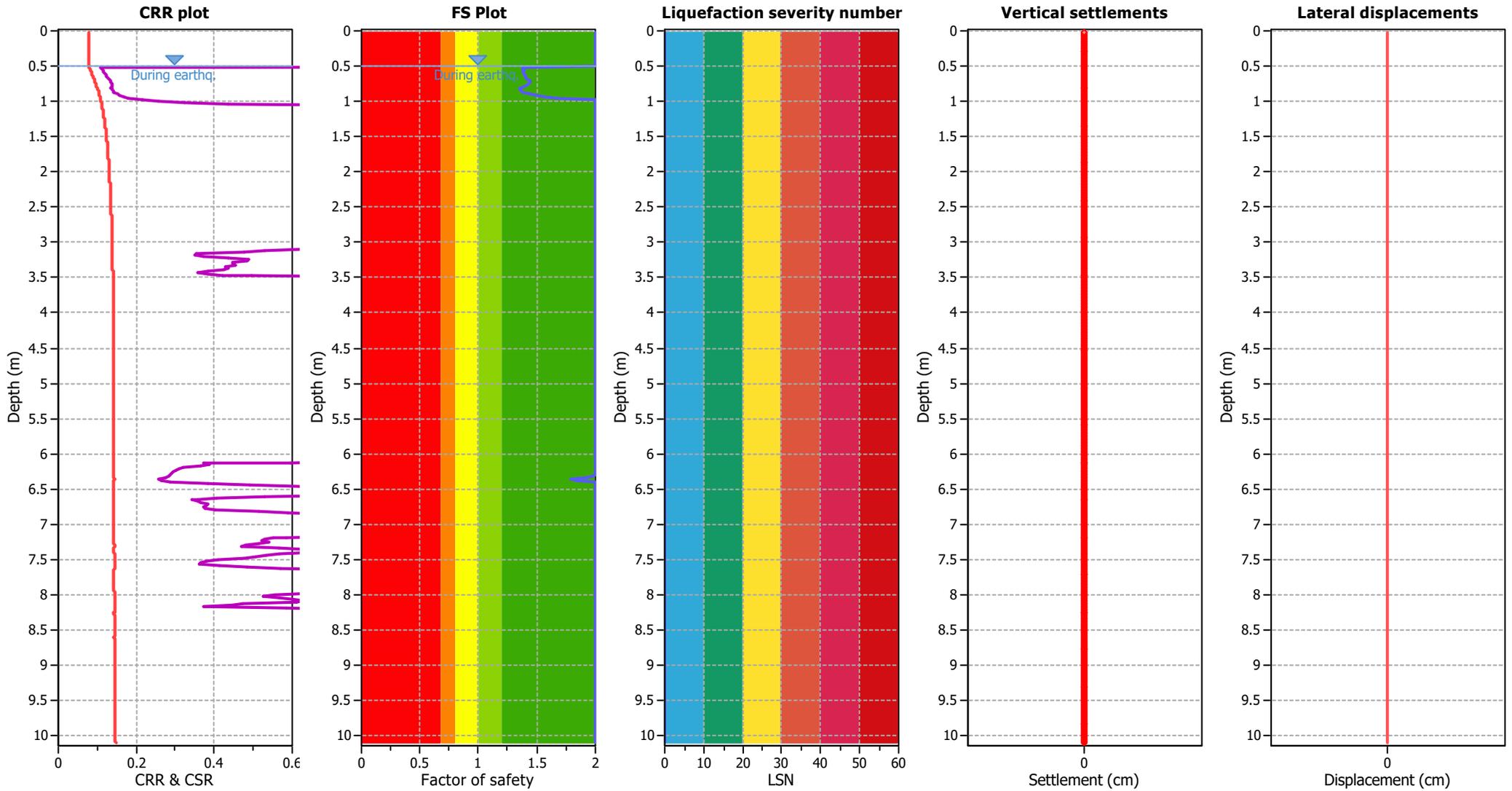|					
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

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

LSN color scheme
- ■ Severe damage
- ■ Major expression of liquefaction
- ■ Moderate to severe exp. of liquefaction
- ■ Moderate expression of liquefaction
- ■ Minor expression of liquefaction
- ■ Little to no expression of liquefaction

CLiq v.3.5.2.5 - CPT Liquefaction Assessment Software - Report created on: 11/02/2025, 2:23:19 pm

Project file: C:\Users\MarkTrainor\LandTech Consulting\LandTech Consulting - Christchurch\2024\Turners Road, Spencerville - LTC24362\CPT\LTC24362 - SLSA Liquefaction Analysis.clq

3

Liquefaction analysis overall plots

Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

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

LSN color scheme
- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

CLiq v.3.5.2.5 - CPT Liquefaction Assessment Software - Report created on: 11/02/2025, 2:23:19 pm

4

Project file: C:\Users\MarkTrainor\LandTech Consulting\LandTech Consulting - Christchurch\2024\Turners Road, Spencerville - LTC24362\CPT\LTC24362 - SLSA Liquefaction Analysis.clq

Liquefaction analysis overall plots

Input parameters and analysis data

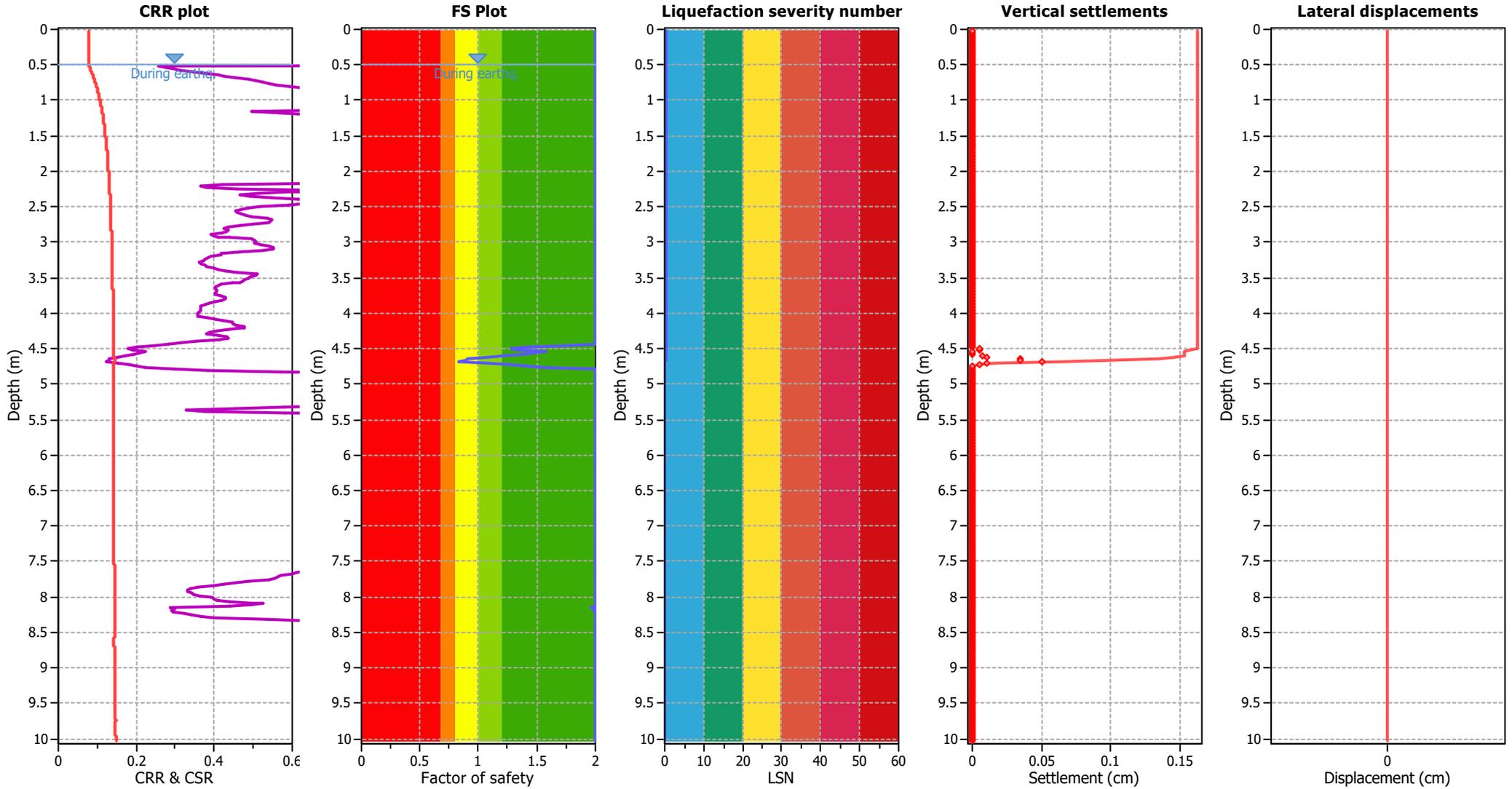|					
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

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

LSN color scheme
- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

CLiq v.3.5.2.5 - CPT Liquefaction Assessment Software - Report created on: 11/02/2025, 2:23:20 pm
Project file: C:\Users\MarkTrainor\LandTech Consulting\LandTech Consulting - Christchurch\2024\Turners Road, Spencerville - LTC24362\CPT\LTC24362 - SLSA Liquefaction Analysis.clq

5

Liquefaction analysis overall plots

CRR plot — CRR & CSR
FS Plot — Factor of safety
Liquefaction severity number — LSN
Vertical settlements — Settlement (cm)
Lateral displacements — Displacement (cm)

During earthq.

Input parameters and analysis data

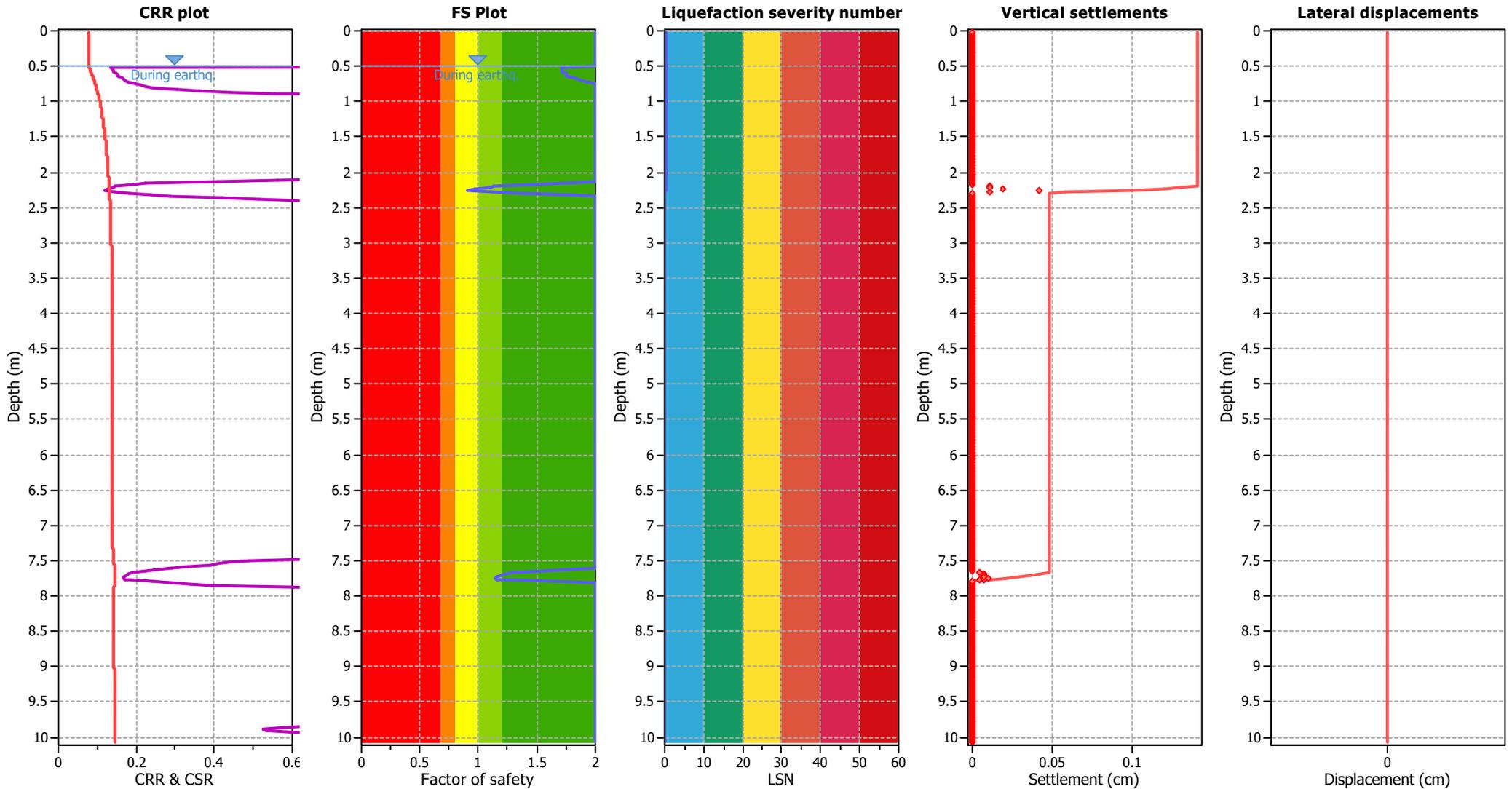|					
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

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

LSN color scheme
- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

CLiq v.3.5.2.5 - CPT Liquefaction Assessment Software - Report created on: 11/02/2025, 2:23:20 pm
Project file: C:\Users\MarkTrainor\LandTech Consulting\LandTech Consulting - Christchurch\2024\Turners Road, Spencerville - LTC24362\CPT\LTC24362 - SLSA Liquefaction Analysis.clq

6

Liquefaction analysis overall plots

CRR plot — CRR & CSR

FS Plot — Factor of safety

Liquefaction severity number — LSN

Vertical settlements — Settlement (cm)

Lateral displacements — Displacement (cm)

Input parameters and analysis data

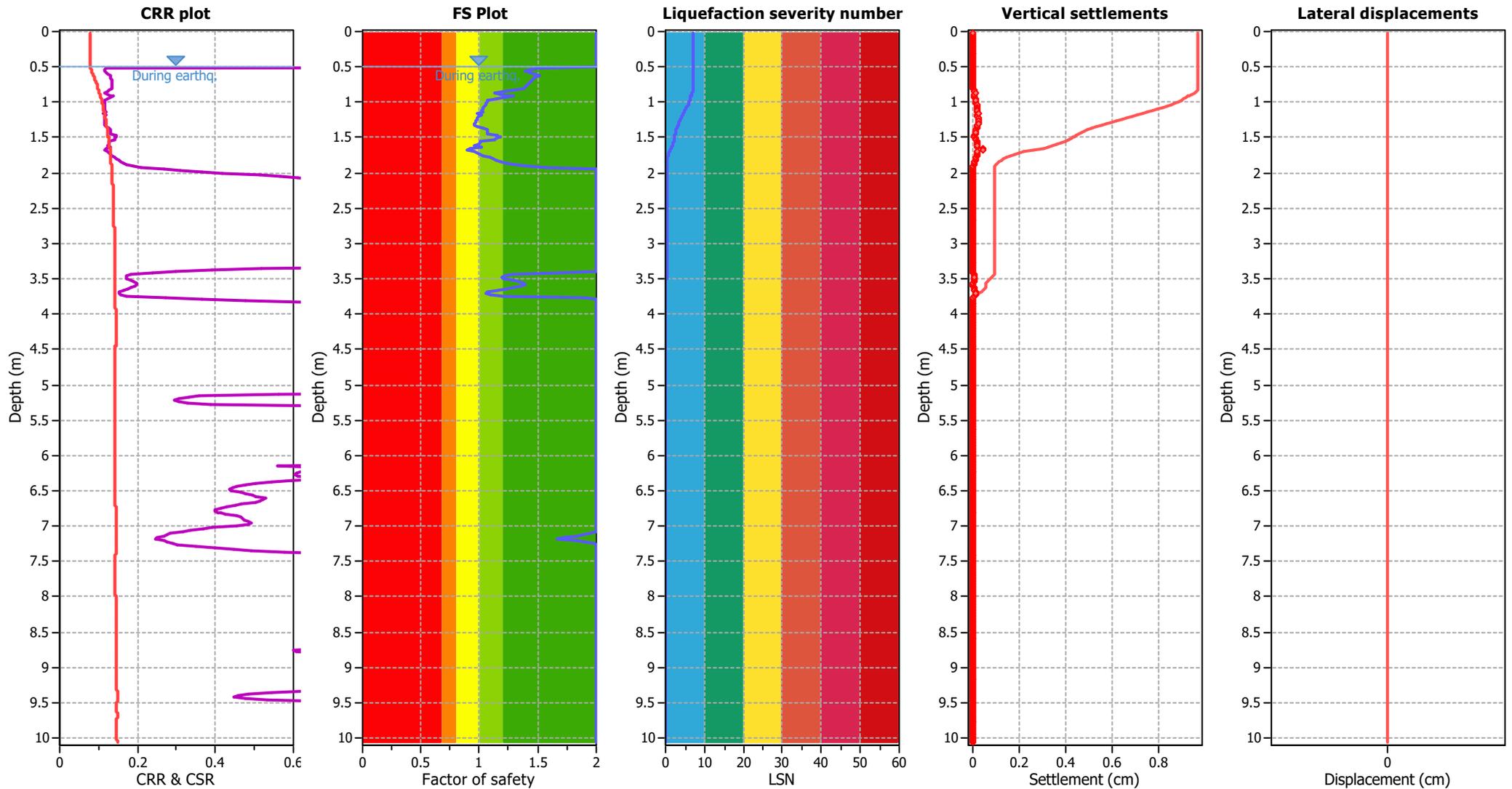|					
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

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

LSN color scheme
- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

CLiq v.3.5.2.5 - CPT Liquefaction Assessment Software - Report created on: 11/02/2025, 2:23:20 pm

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Project file: C:\Users\MarkTrainor\LandTech Consulting\LandTech Consulting - Christchurch\2024\Turners Road, Spencerville - LTC24362\CPT\LTC24362 - SLSA Liquefaction Analysis.clq

Liquefaction analysis overall plots

CRR plot — CRR & CSR (0 to 0.6), Depth (m) 0 to 10

FS Plot — Factor of safety (0 to 2), Depth (m) 0 to 10

Liquefaction severity number — LSN (0 to 60), Depth (m) 0 to 10

Vertical settlements — Settlement (cm) (0 to 0.8), Depth (m) 0 to 10

Lateral displacements — Displacement (cm), Depth (m) 0 to 10

During earthq. (shown on CRR plot and FS Plot)

Input parameters and analysis data

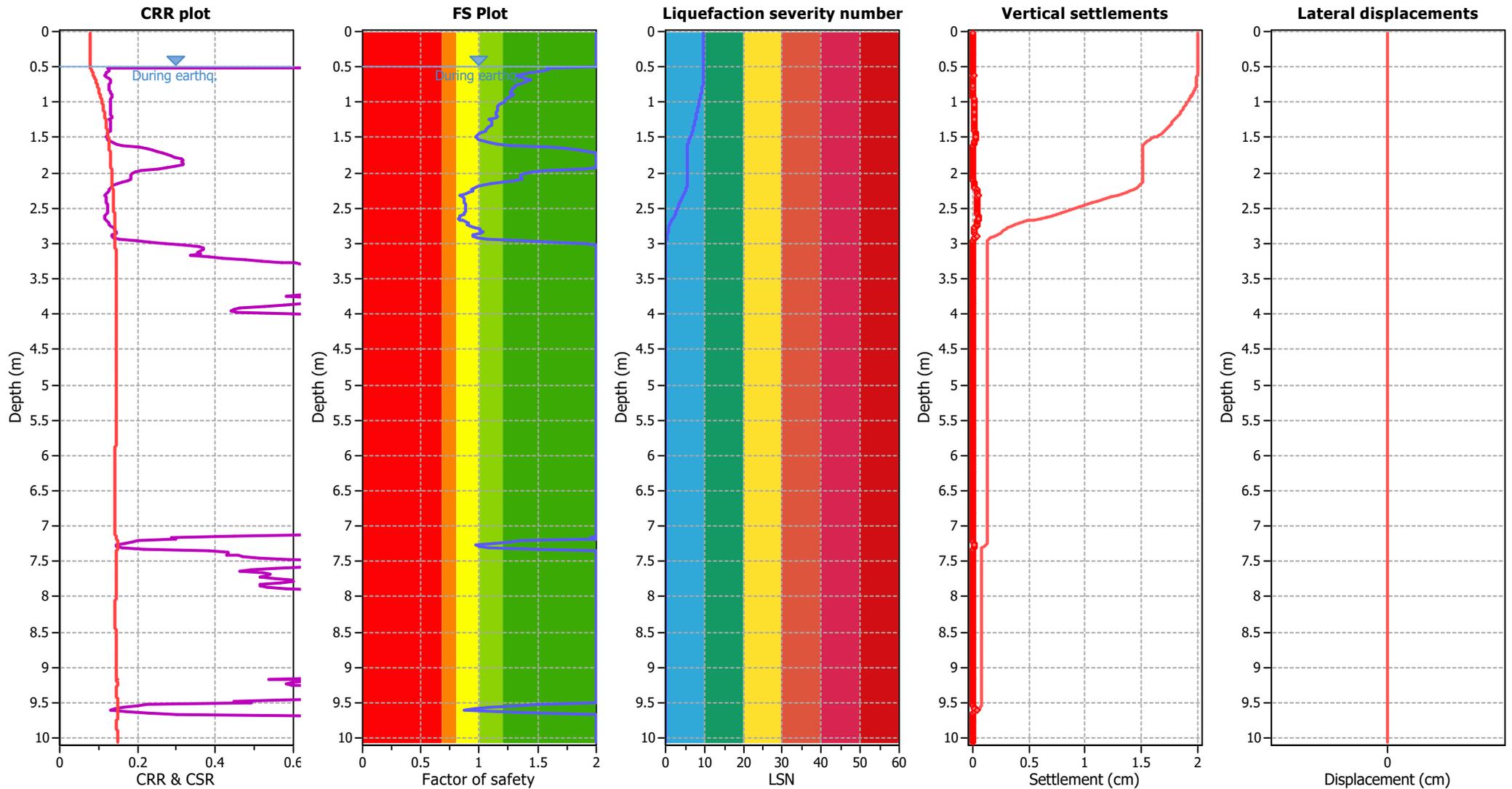|					
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

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

LSN color scheme
- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

CLiq v.3.5.2.5 - CPT Liquefaction Assessment Software - Report created on: 11/02/2025, 2:23:21 pm

8

Project file: C:\Users\MarkTrainor\LandTech Consulting\LandTech Consulting - Christchurch\2024\Turners Road, Spencerville - LTC24362\CPT\LTC24362 - SLSA Liquefaction Analysis.clq

Liquefaction analysis overall plots

CRR plot — CRR & CSR (Depth vs 0 to 0.6)

FS Plot — Factor of safety (Depth vs 0 to 2)

Liquefaction severity number — LSN (Depth vs 0 to 60)

Vertical settlements — Settlement (cm) (Depth vs 0 to 2)

Lateral displacements — Displacement (cm) (Depth vs 0)

Input parameters and analysis data

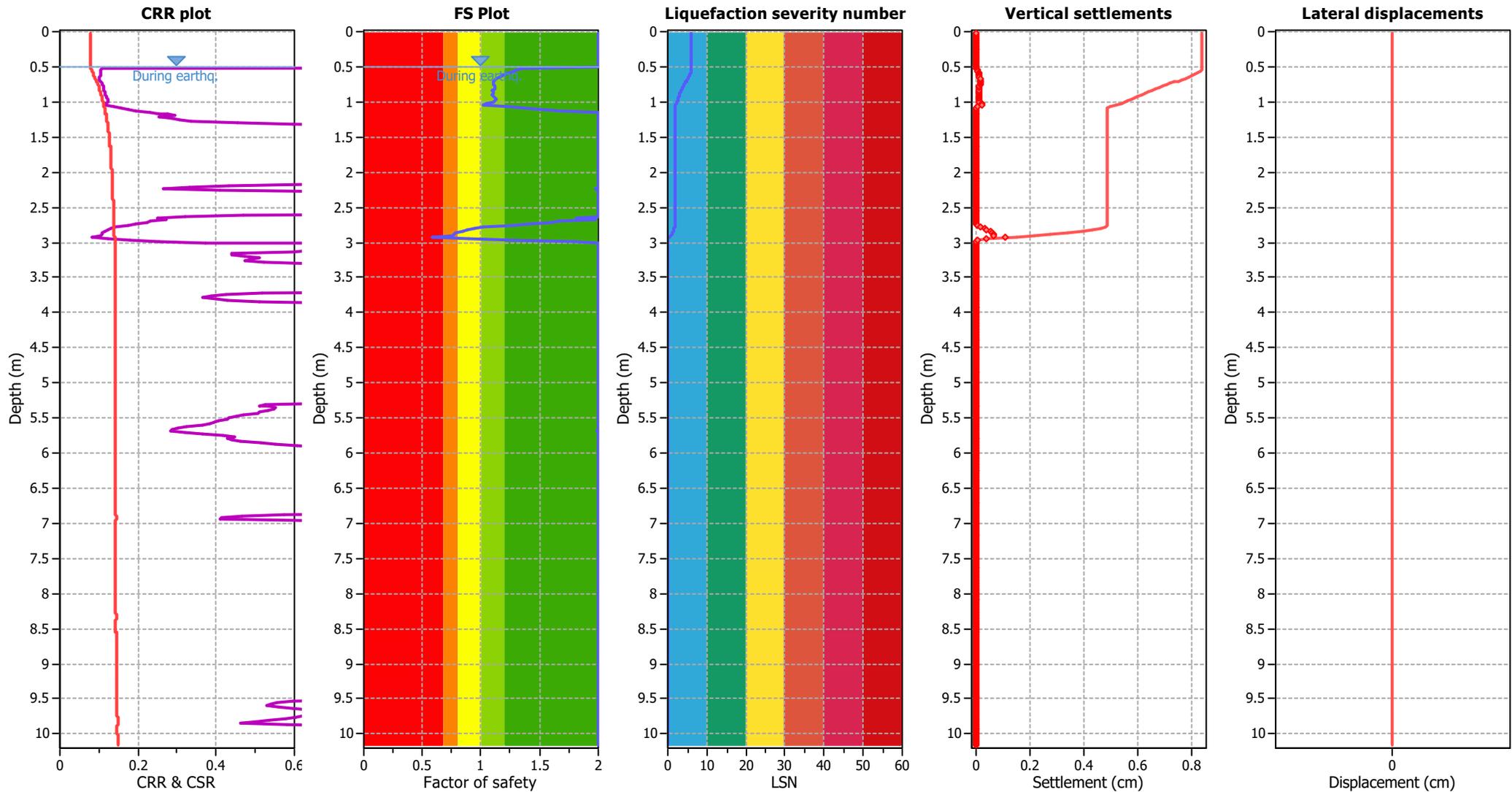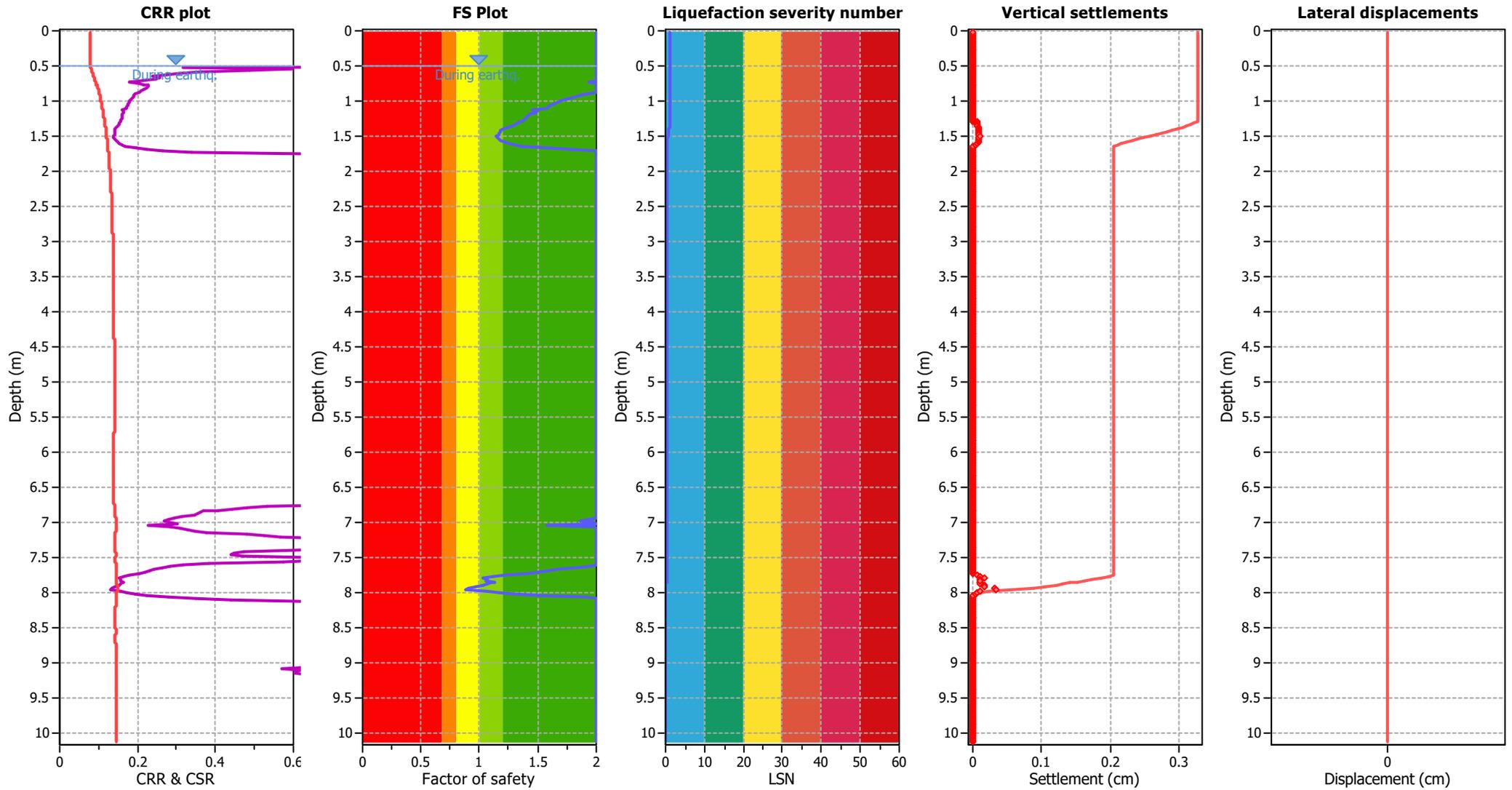|					
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

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

LSN color scheme
- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

CLiq v.3.5.2.5 - CPT Liquefaction Assessment Software - Report created on: 11/02/2025, 2:23:21 pm

9

Project file: C:\Users\MarkTrainor\LandTech Consulting\LandTech Consulting - Christchurch\2024\Turners Road, Spencerville - LTC24362\CPT\LTC24362 - SLSA Liquefaction Analysis.clq

Liquefaction analysis overall plots

| CRR plot | FS Plot | Liquefaction severity number | Vertical settlements | Lateral displacements |

Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

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

LSN color scheme
- ■ Severe damage
- ■ Major expression of liquefaction
- ■ Moderate to severe exp. of liquefaction
- ■ Moderate expression of liquefaction
- ■ Minor expression of liquefaction
- ■ Little to no expression of liquefaction

Liquefaction analysis overall plots

CRR plot | **FS Plot** | **Liquefaction severity number** | **Vertical settlements** | **Lateral displacements**

Input parameters and analysis data

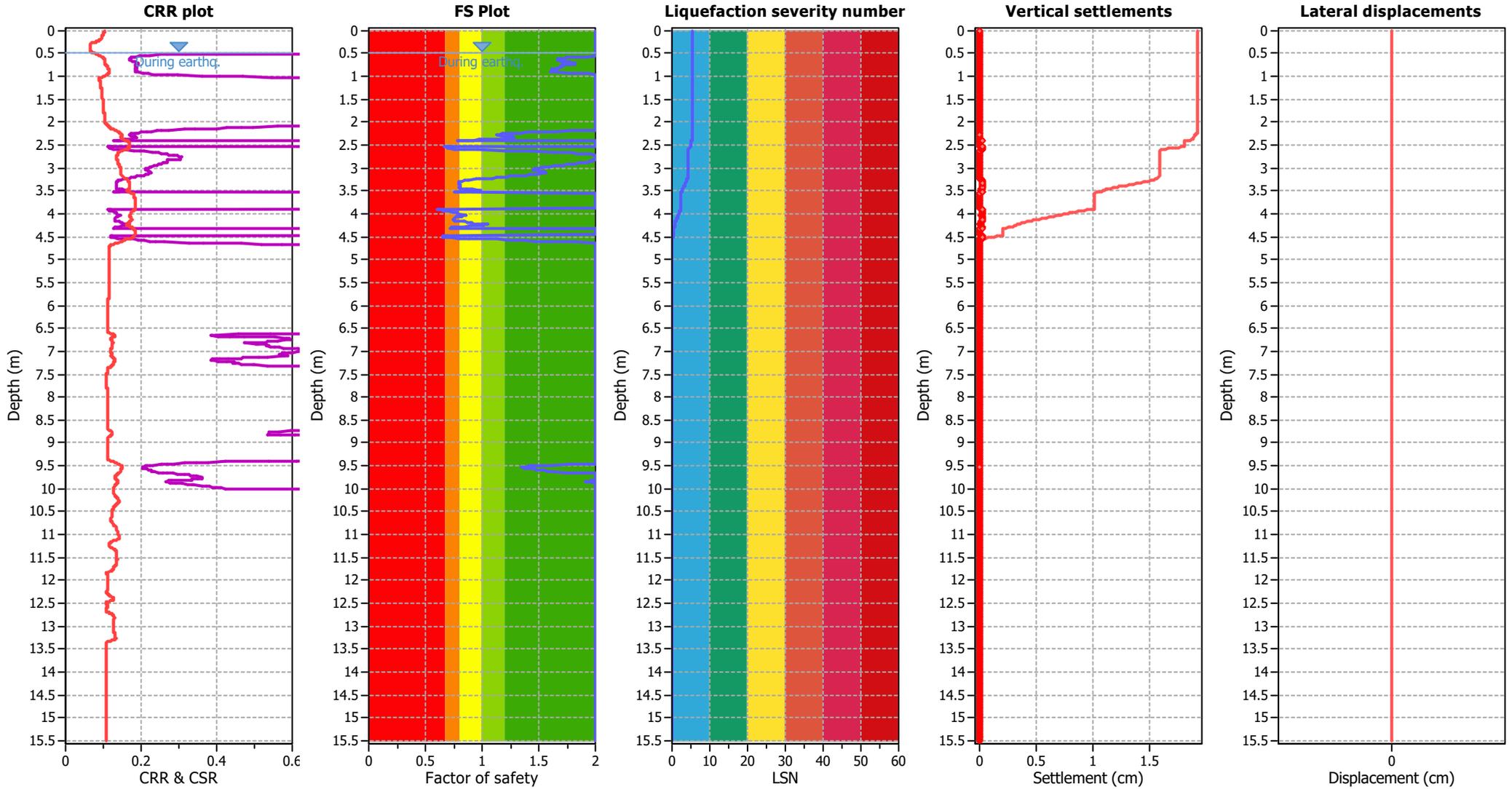|					
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

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

LSN color scheme
- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

CLiq v.3.5.2.5 - CPT Liquefaction Assessment Software - Report created on: 11/02/2025, 2:23:22 pm

11

Project file: C:\Users\MarkTrainor\LandTech Consulting\LandTech Consulting - Christchurch\2024\Turners Road, Spencerville - LTC24362\CPT\LTC24362 - SLSA Liquefaction Analysis.clq

Liquefaction analysis overall plots

CRR plot — Depth (m) vs CRR & CSR (0 to 0.6). During earthq.

FS Plot — Depth (m) vs Factor of safety (0 to 2). During earthq.

Liquefaction severity number — Depth (m) vs LSN (0 to 60)

Vertical settlements — Depth (m) vs Settlement (cm) (0 to 1.5+)

Lateral displacements — Depth (m) vs Displacement (cm)

Input parameters and analysis data

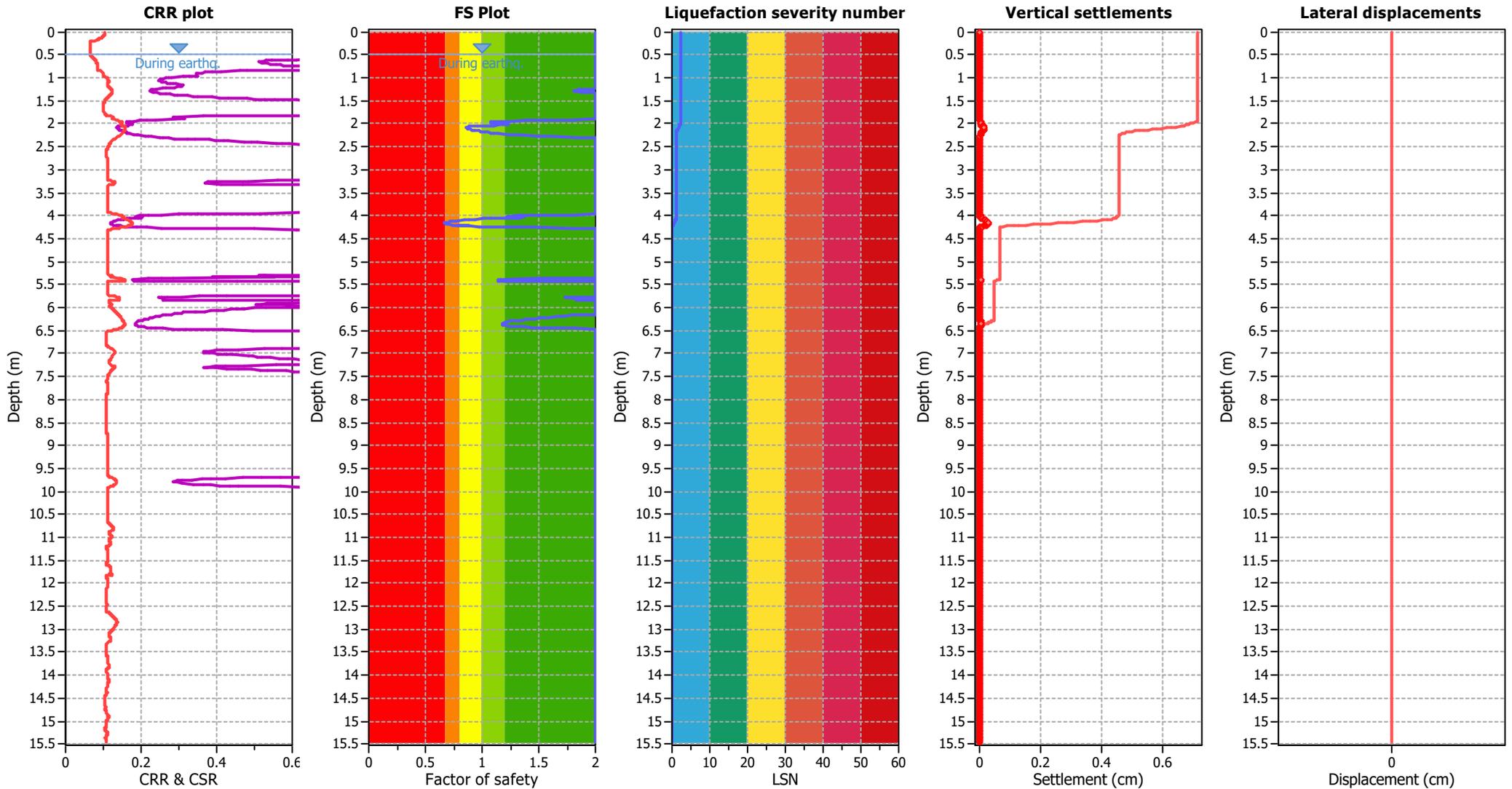|					
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

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

LSN color scheme
- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

Liquefaction analysis overall plots

CRR plot — CRR & CSR vs Depth (m)

FS Plot — Factor of safety vs Depth (m)

Liquefaction severity number — LSN vs Depth (m)

Vertical settlements — Settlement (cm) vs Depth (m)

Lateral displacements — Displacement (cm) vs Depth (m)

Input parameters and analysis data

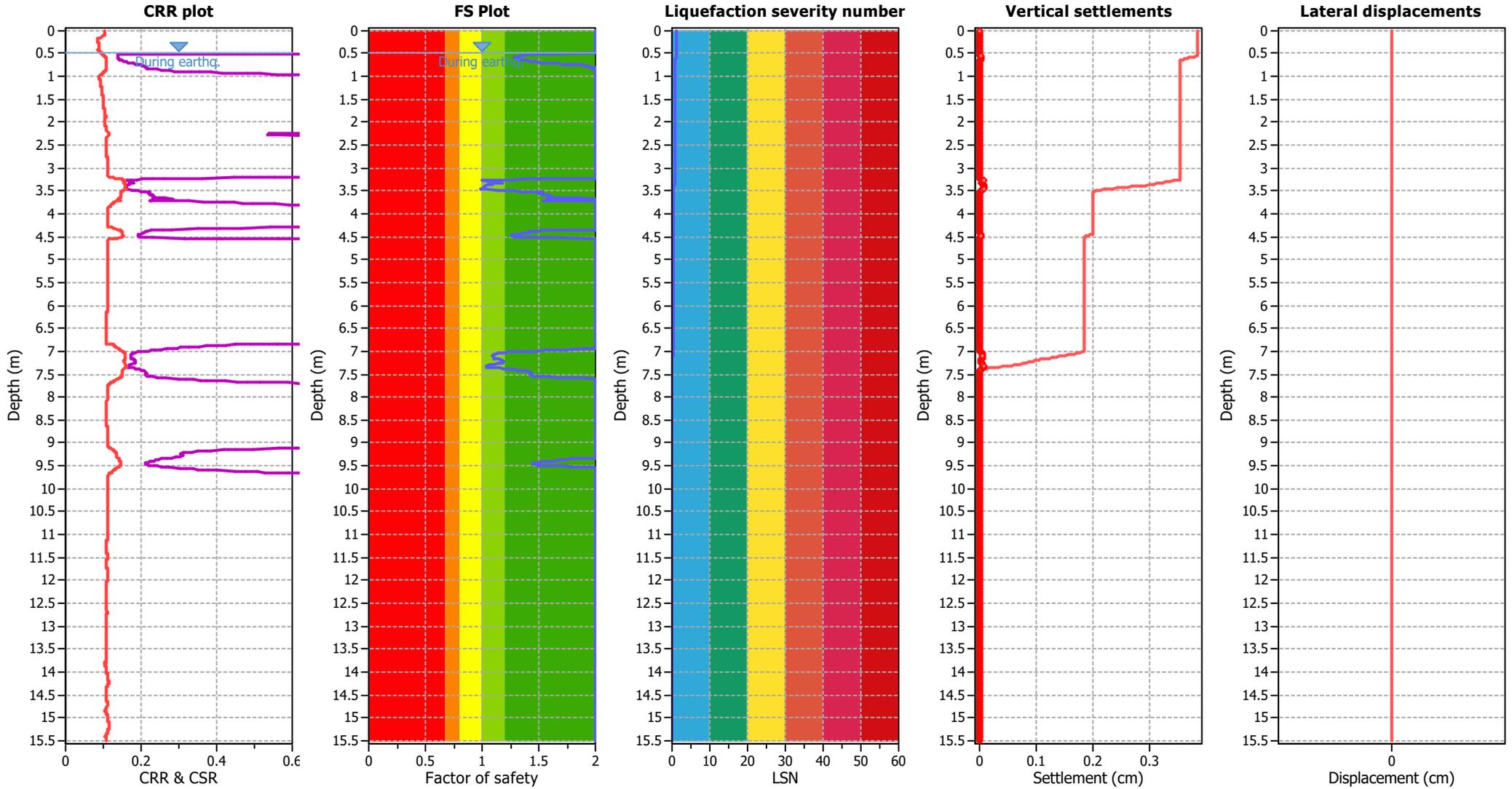|					
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

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

LSN color scheme
- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

CLiq v.3.5.2.5 - CPT Liquefaction Assessment Software - Report created on: 11/02/2025, 2:24:14 pm

2

Project file: C:\Users\MarkTrainor\LandTech Consulting\LandTech Consulting - Christchurch\2024\Turners Road, Spencerville - LTC24362\CPT\LTC24362 - SLSB Liquefaction Analysis.clq

Liquefaction analysis overall plots

CRR plot — CRR & CSR

FS Plot — Factor of safety

Liquefaction severity number — LSN

Vertical settlements — Settlement (cm)

Lateral displacements — Displacement (cm)

During earthq.

Input parameters and analysis data

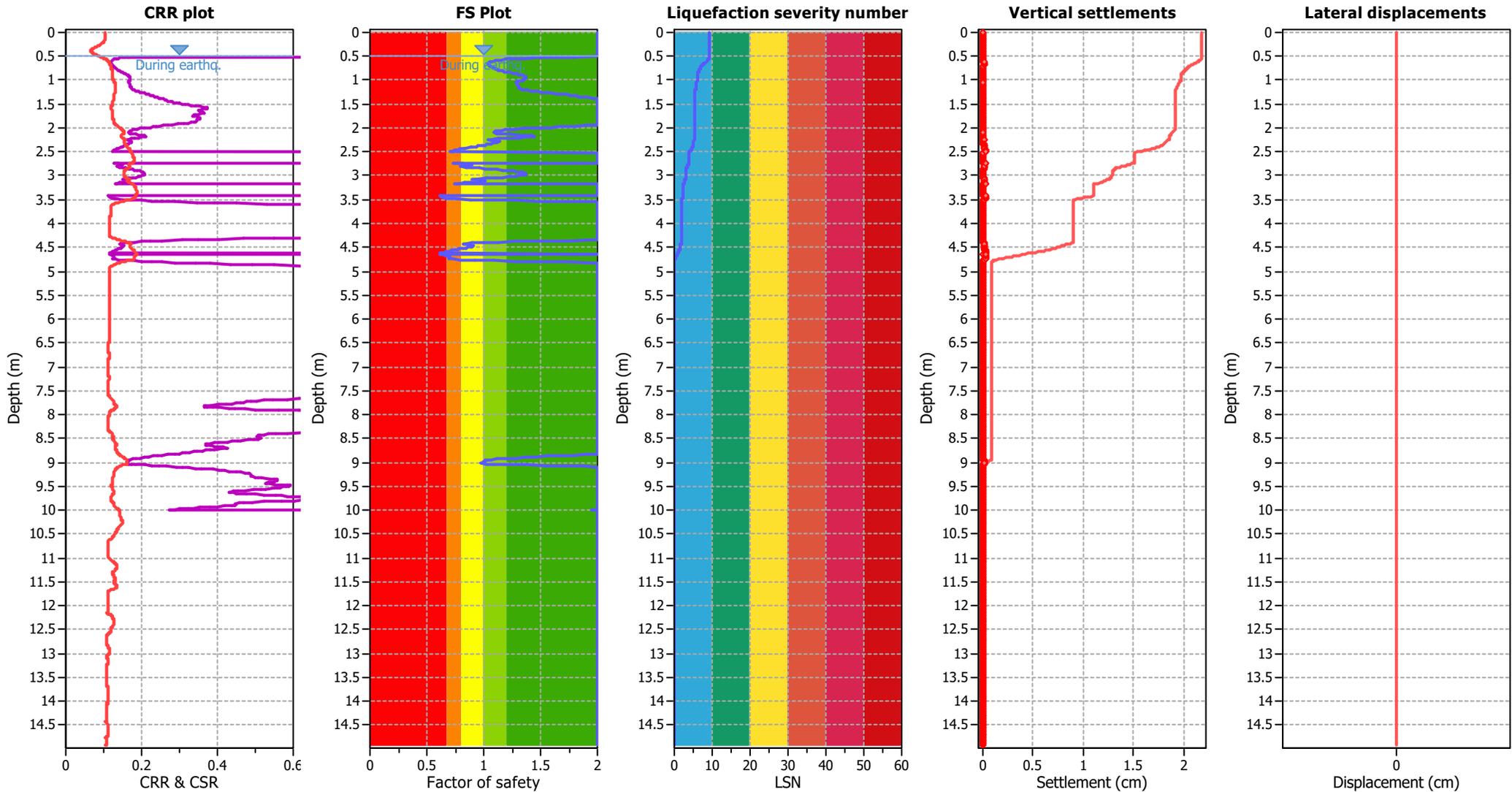|					
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

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

LSN color scheme
- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

CLiq v.3.5.2.5 - CPT Liquefaction Assessment Software - Report created on: 11/02/2025, 2:24:15 pm

3

Project file: C:\Users\MarkTrainor\LandTech Consulting\LandTech Consulting - Christchurch\2024\Turners Road, Spencerville - LTC24362\CPT\LTC24362 - SLSB Liquefaction Analysis.clq

Liquefaction analysis overall plots

CRR plot | FS Plot | Liquefaction severity number | Vertical settlements | Lateral displacements

Input parameters and analysis data

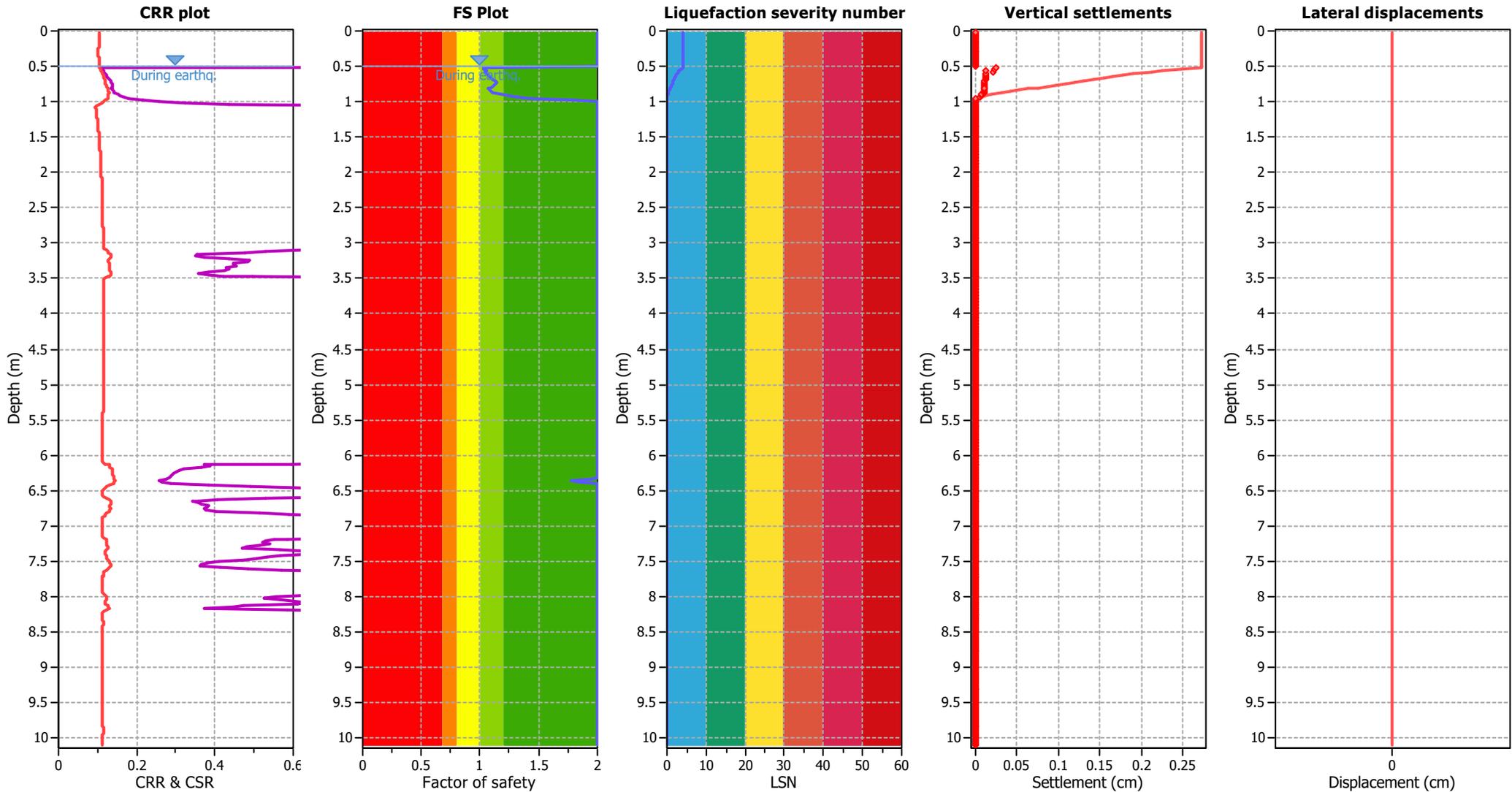|					
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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

LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

CLiq v.3.5.2.5 - CPT Liquefaction Assessment Software - Report created on: 11/02/2025, 2:24:15 pm

4

Project file: C:\Users\MarkTrainor\LandTech Consulting\LandTech Consulting - Christchurch\2024\Turners Road, Spencerville - LTC24362\CPT\LTC24362 - SLSB Liquefaction Analysis.clq

Liquefaction analysis overall plots

CRR plot — CRR & CSR
FS Plot — Factor of safety
Liquefaction severity number — LSN
Vertical settlements — Settlement (cm)
Lateral displacements — Displacement (cm)

Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m
Fines correction method:	B&I (2014)	Average results interval:	3
Points to test:	Based on Ic value	Ic cut-off value:	2.60
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT
Peak ground acceleration:	0.19	Use fill:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A

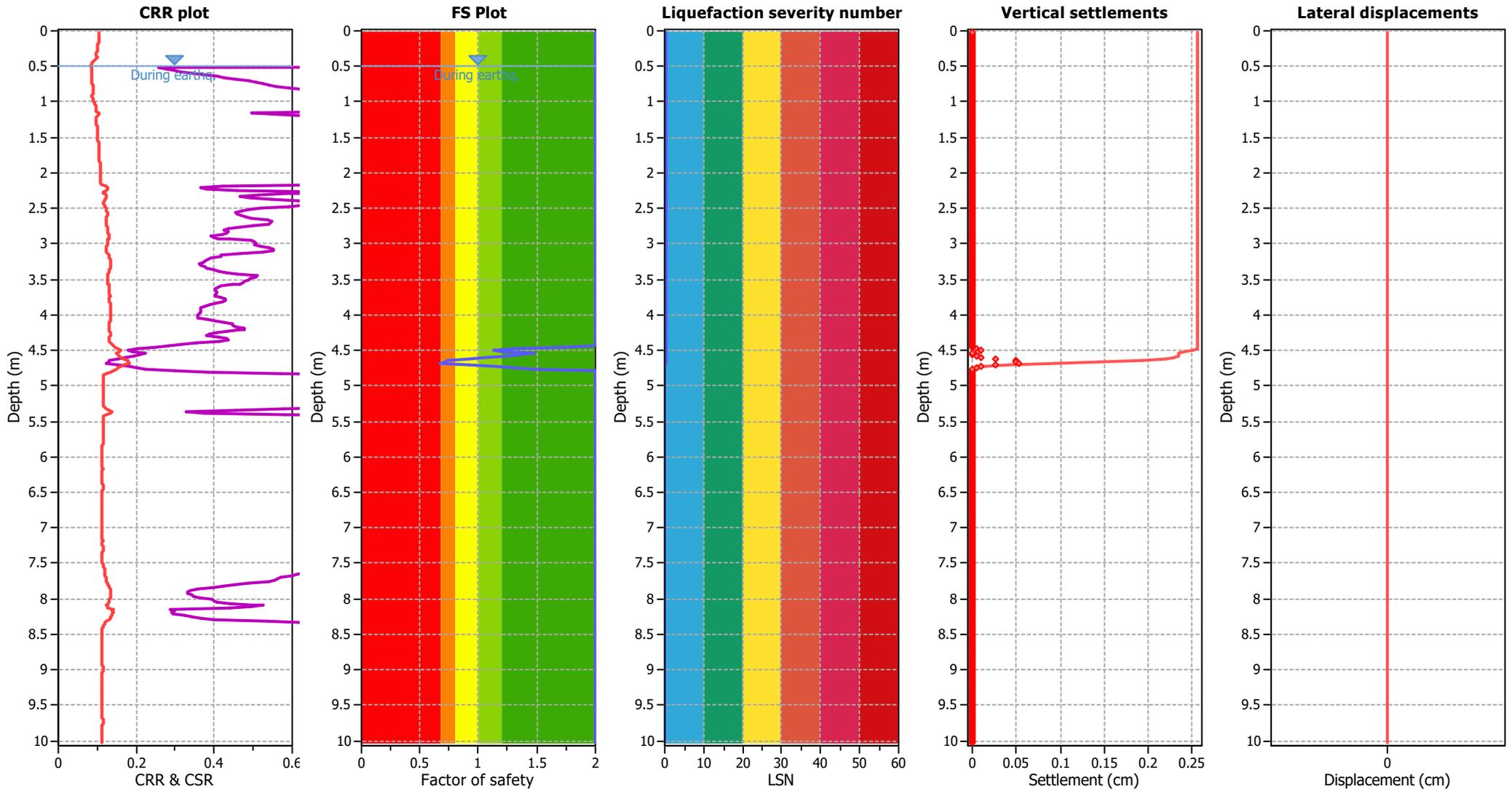|	
Fill weight:	N/A
Transition detect. applied:	No
K_σ applied:	Yes
Clay like behavior applied:	Sands only
Limit depth applied:	Yes
Limit depth:	10.00 m

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

LSN color scheme
- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

Liquefaction analysis overall plots

CRR plot — Depth (m) vs CRR & CSR

FS Plot — Depth (m) vs Factor of safety

Liquefaction severity number — Depth (m) vs LSN

Vertical settlements — Depth (m) vs Settlement (cm)

Lateral displacements — Depth (m) vs Displacement (cm)

Input parameters and analysis data

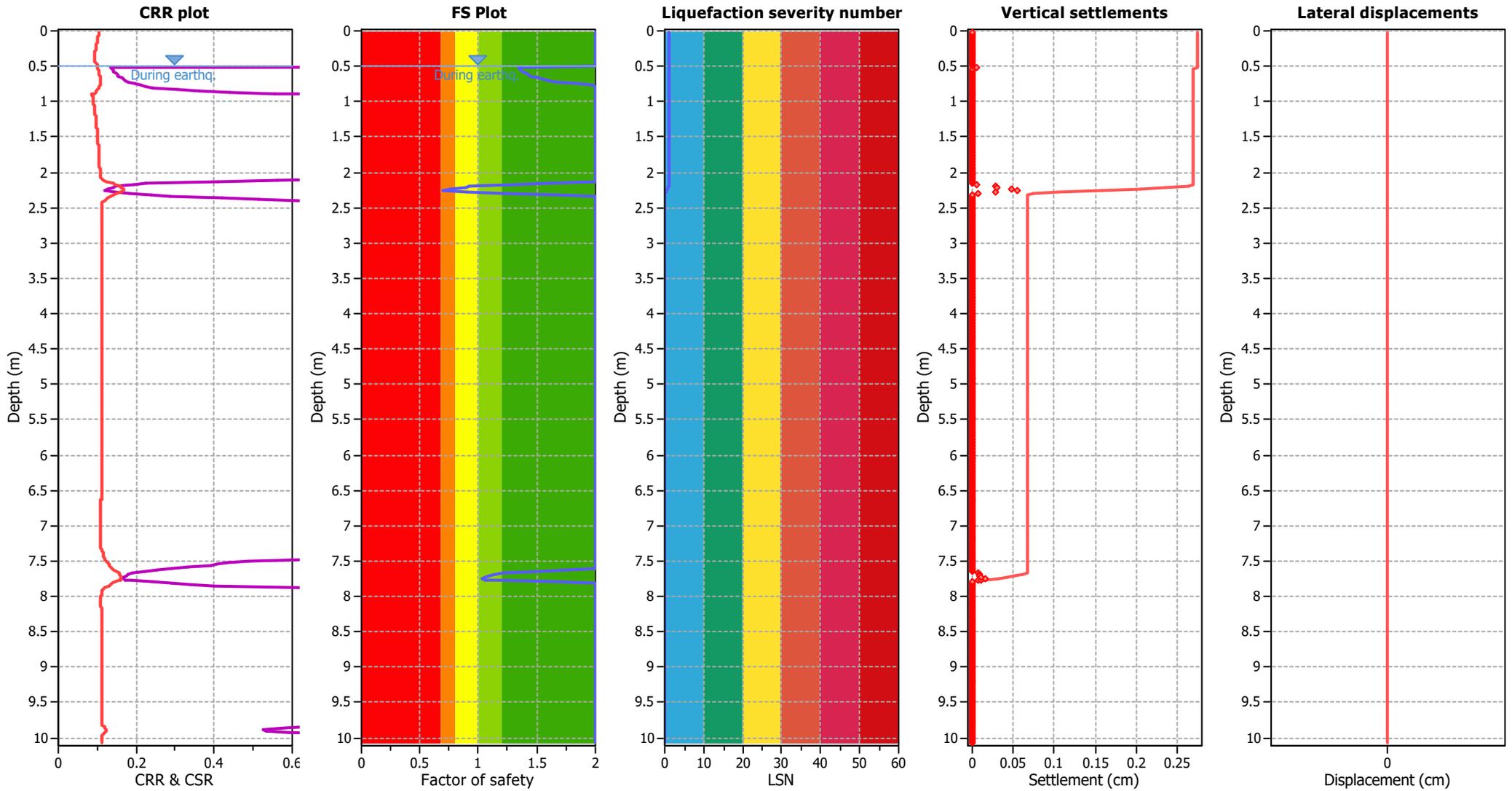|					
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

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

LSN color scheme
- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

CLiq v.3.5.2.5 - CPT Liquefaction Assessment Software - Report created on: 11/02/2025, 2:24:16 pm

6

Project file: C:\Users\MarkTrainor\LandTech Consulting\LandTech Consulting - Christchurch\2024\Turners Road, Spencerville - LTC24362\CPT\LTC24362 - SLSB Liquefaction Analysis.clq

Liquefaction analysis overall plots

CRR plot · **FS Plot** · **Liquefaction severity number** · **Vertical settlements** · **Lateral displacements**

Input parameters and analysis data

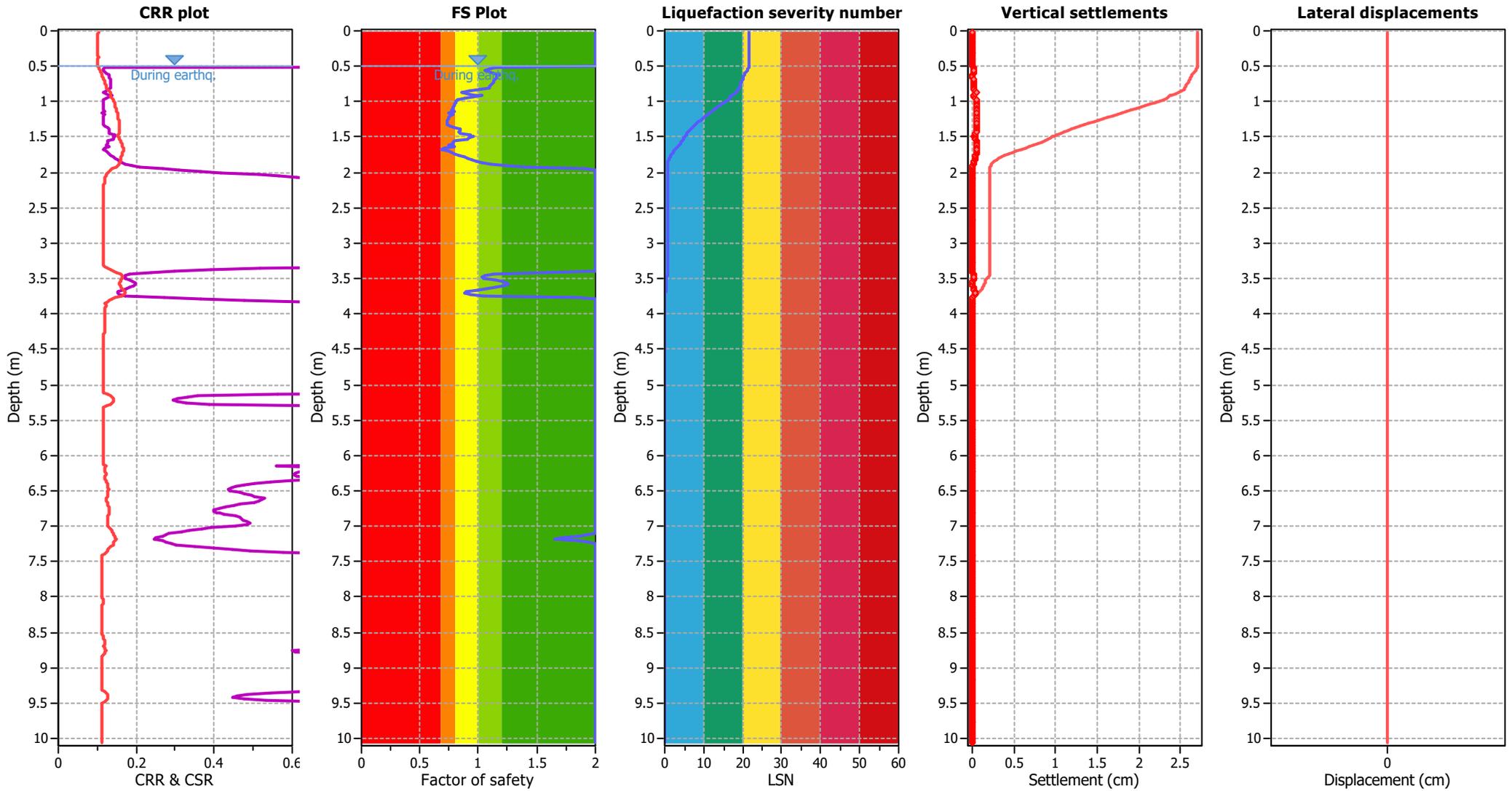|					
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

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

LSN color scheme
- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

CLiq v.3.5.2.5 - CPT Liquefaction Assessment Software - Report created on: 11/02/2025, 2:24:16 pm

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Project file: C:\Users\MarkTrainor\LandTech Consulting\LandTech Consulting - Christchurch\2024\Turners Road, Spencerville - LTC24362\CPT\LTC24362 - SLSB Liquefaction Analysis.clq

Liquefaction analysis overall plots

CRR plot — CRR & CSR

FS Plot — Factor of safety

Liquefaction severity number — LSN

Vertical settlements — Settlement (cm)

Lateral displacements — Displacement (cm)

Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m
Fines correction method:	B&I (2014)	Average results interval:	3
Points to test:	Based on Ic value	Ic cut-off value:	2.60
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT
Peak ground acceleration:	0.19	Use fill:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A

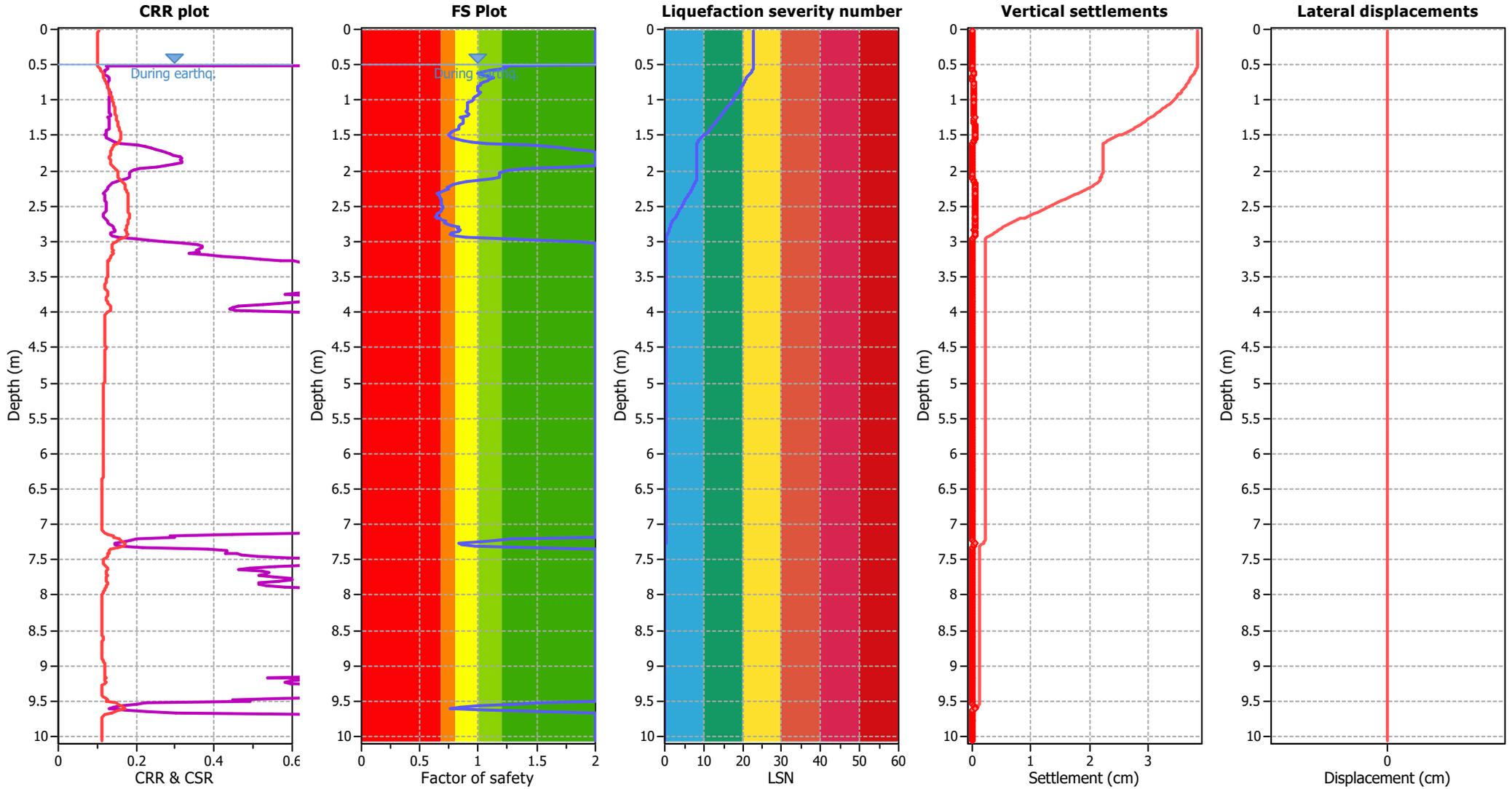|	
Fill weight:	N/A
Transition detect. applied:	No
K_σ applied:	Yes
Clay like behavior applied:	Sands only
Limit depth applied:	Yes
Limit depth:	10.00 m

F.S. color scheme
- 🟥 Almost certain it will liquefy
- 🟧 Very likely to liquefy
- 🟨 Liquefaction and no liq. are equally likely
- 🟩 Unlike to liquefy
- 🟩 Almost certain it will not liquefy

LSN color scheme
- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

CLiq v.3.5.2.5 - CPT Liquefaction Assessment Software - Report created on: 11/02/2025, 2:24:17 pm
Project file: C:\Users\MarkTrainor\LandTech Consulting\LandTech Consulting - Christchurch\2024\Turners Road, Spencerville - LTC24362\CPT\LTC24362 - SLSB Liquefaction Analysis.clq

8

Liquefaction analysis overall plots

CRR plot | **FS Plot** | **Liquefaction severity number** | **Vertical settlements** | **Lateral displacements**

Input parameters and analysis data

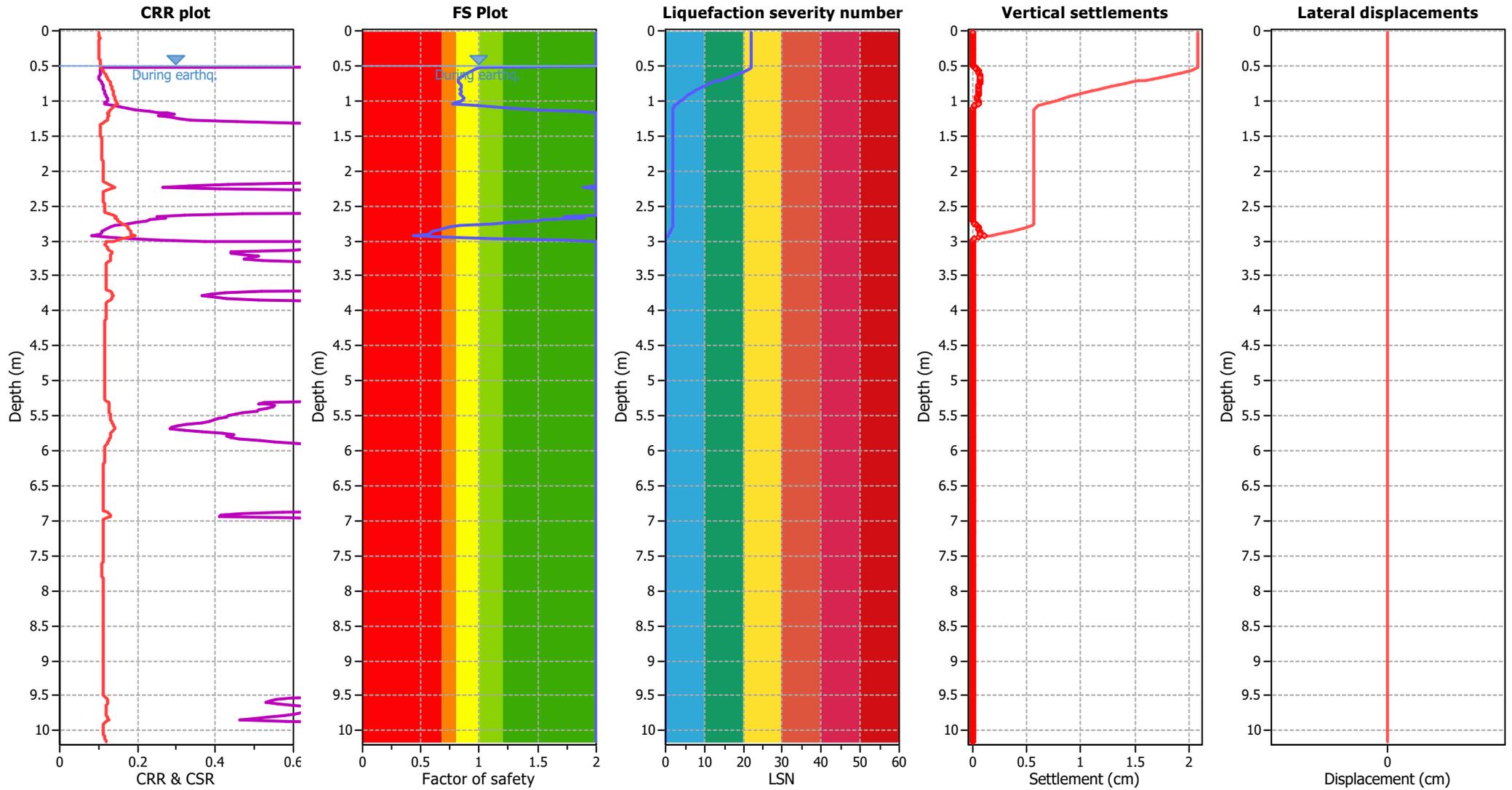|					
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

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

LSN color scheme
- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

CLiq v.3.5.2.5 - CPT Liquefaction Assessment Software - Report created on: 11/02/2025, 2:24:17 pm

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Project file: C:\Users\MarkTrainor\LandTech Consulting\LandTech Consulting - Christchurch\2024\Turners Road, Spencerville - LTC24362\CPT\LTC24362 - SLSB Liquefaction Analysis.clq

Liquefaction analysis overall plots

CRR plot — CRR & CSR vs Depth (m)

FS Plot — Factor of safety vs Depth (m)

Liquefaction severity number — LSN vs Depth (m)

Vertical settlements — Settlement (cm) vs Depth (m)

Lateral displacements — Displacement (cm) vs Depth (m)

Input parameters and analysis data

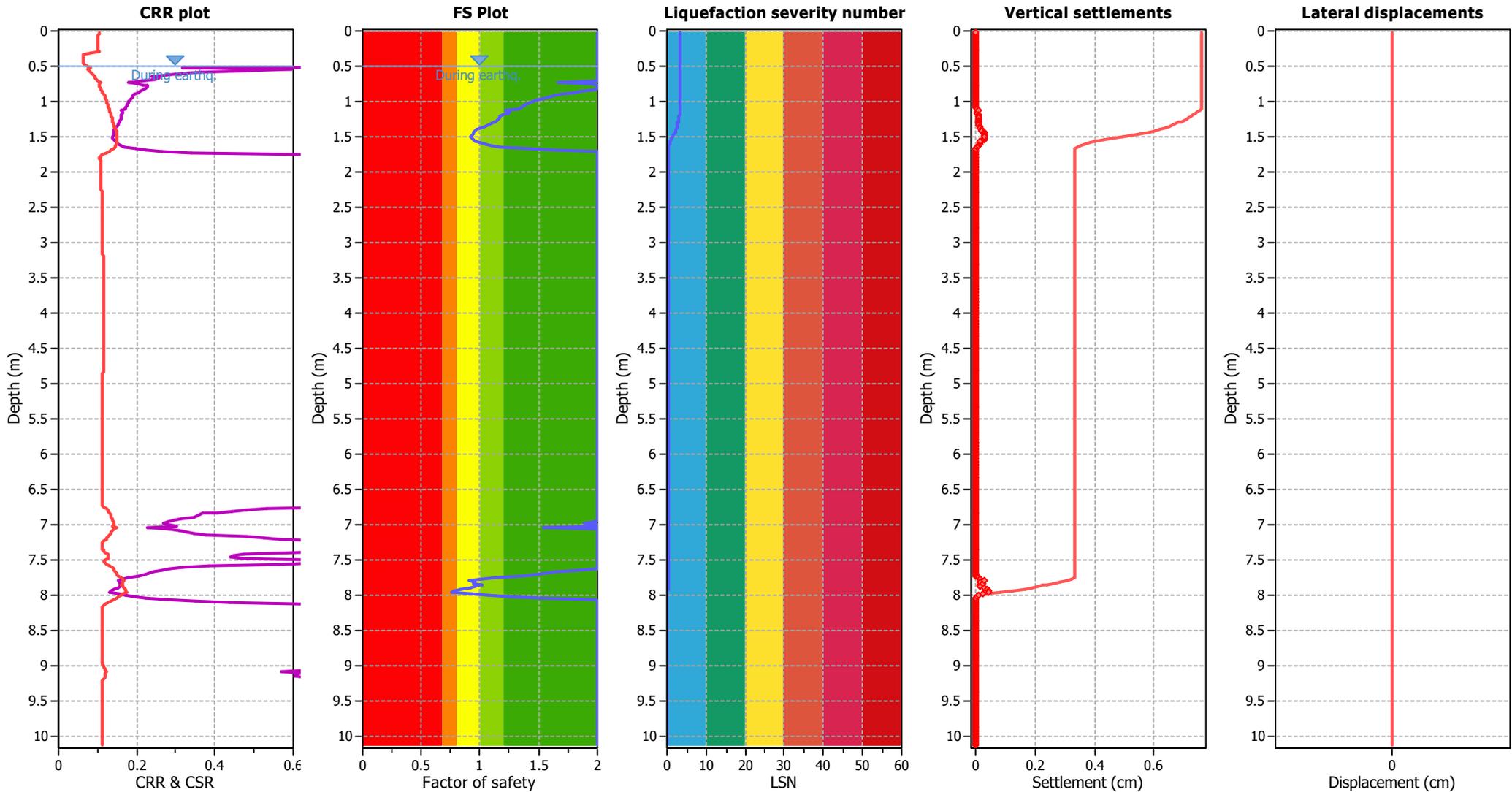|					
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

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

LSN color scheme
- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

CLiq v.3.5.2.5 - CPT Liquefaction Assessment Software - Report created on: 11/02/2025, 2:24:17 pm

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Project file: C:\Users\MarkTrainor\LandTech Consulting\LandTech Consulting - Christchurch\2024\Turners Road, Spencerville - LTC24362\CPT\LTC24362 - SLSB Liquefaction Analysis.clq

Liquefaction analysis overall plots

CRR plot — CRR & CSR

FS Plot — Factor of safety

Liquefaction severity number — LSN

Vertical settlements — Settlement (cm)

Lateral displacements — Displacement (cm)

Input parameters and analysis data

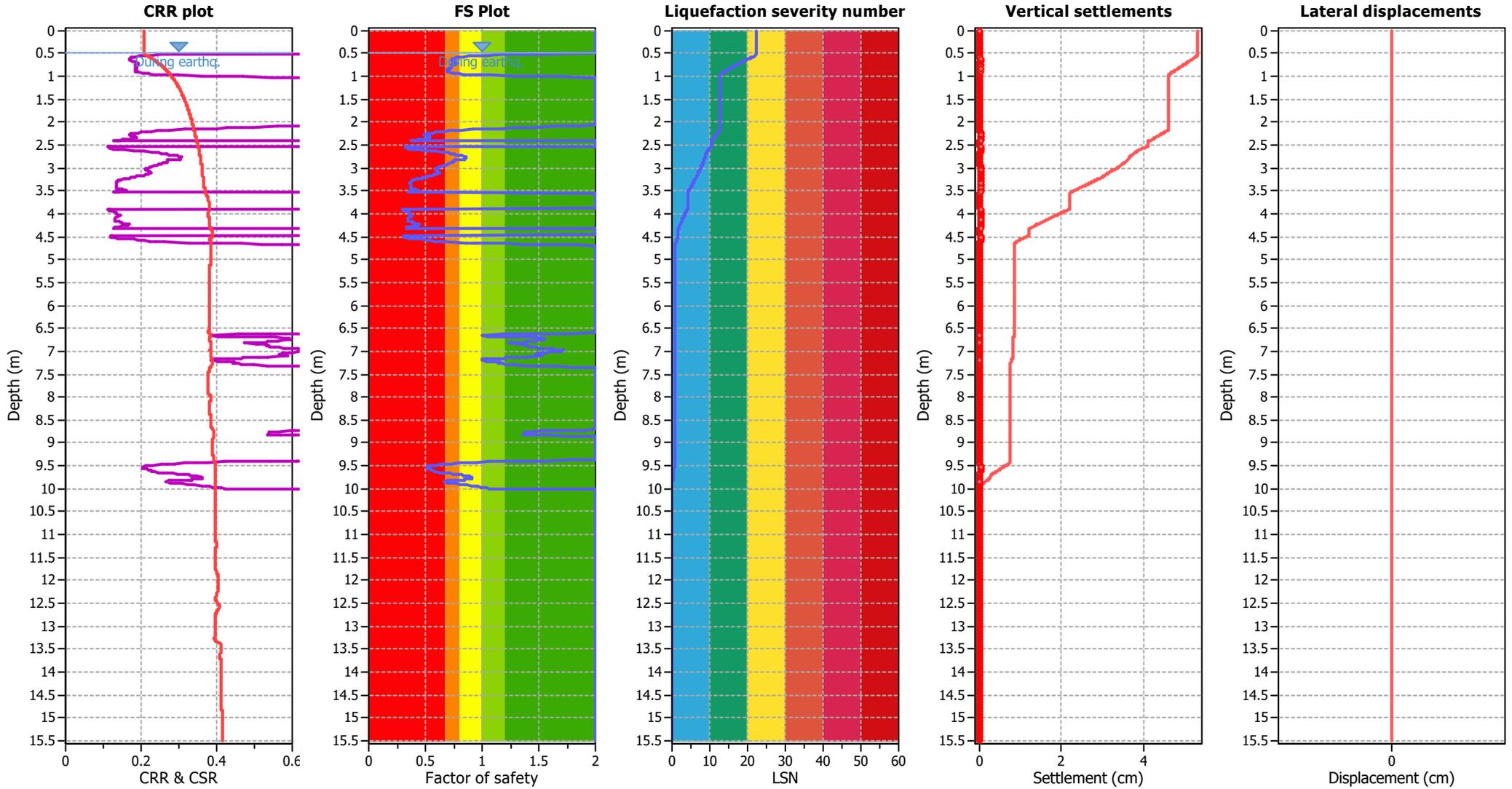|					
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

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

LSN color scheme
- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

CLiq v.3.5.2.5 - CPT Liquefaction Assessment Software - Report created on: 11/02/2025, 2:24:18 pm

11

Project file: C:\Users\MarkTrainor\LandTech Consulting\LandTech Consulting - Christchurch\2024\Turners Road, Spencerville - LTC24362\CPT\LTC24362 - SLSB Liquefaction Analysis.clq

Liquefaction analysis overall plots

CRR plot — CRR & CSR
FS Plot — Factor of safety
Liquefaction severity number — LSN
Vertical settlements — Settlement (cm)
Lateral displacements — Displacement (cm)

Input parameters and analysis data

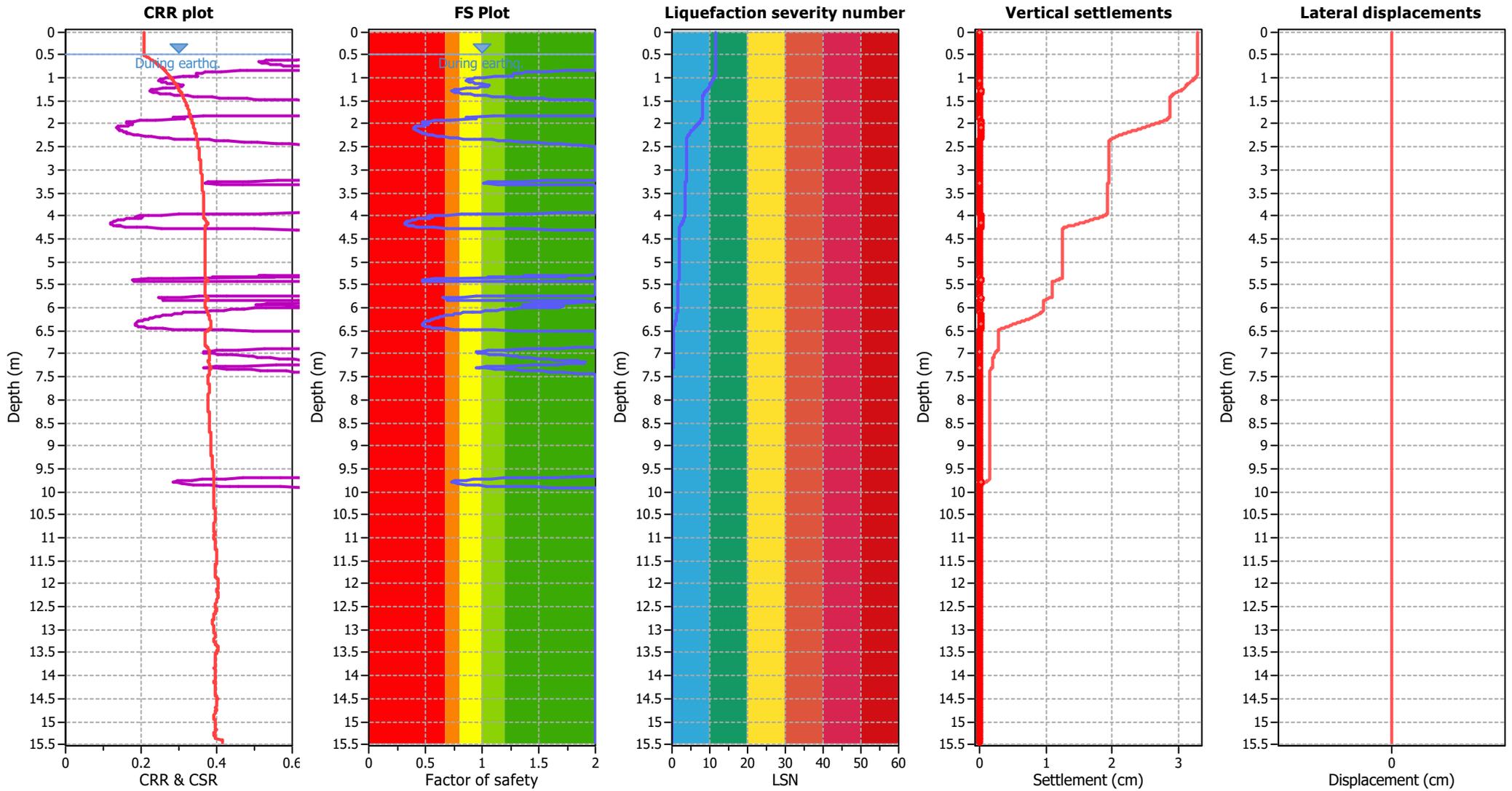|					
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

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

LSN color scheme
- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

CLiq v.3.5.2.5 - CPT Liquefaction Assessment Software - Report created on: 12/02/2025, 8:48:32 am
Project file: C:\Users\MarkTrainor\LandTech Consulting\LandTech Consulting - Christchurch\2024\Turners Road, Spencerville - LTC24362\CPT\LTC24362 - ULS Liquefaction Analysis.clq

1

Liquefaction analysis overall plots

Input parameters and analysis data

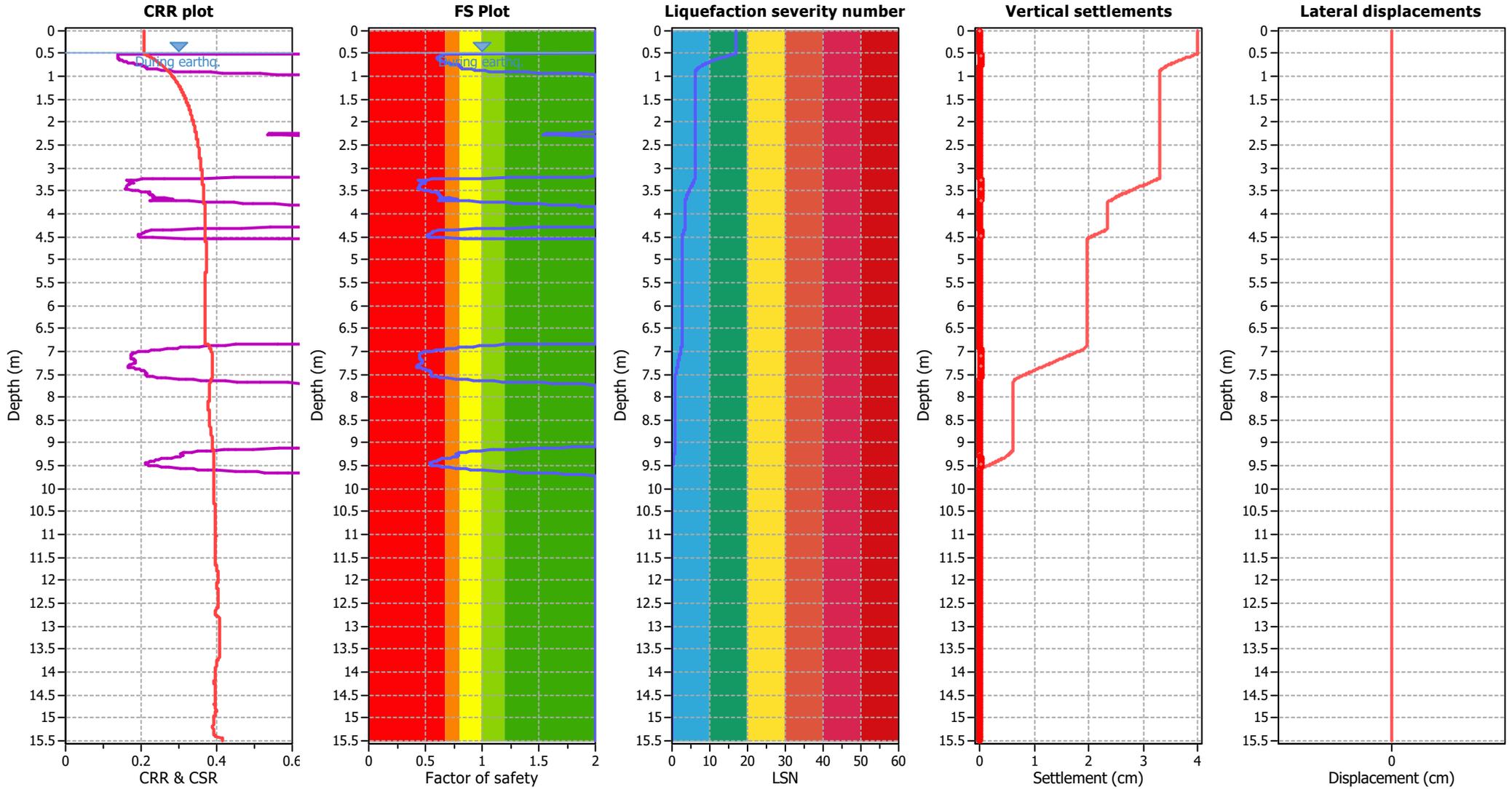|					
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

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

LSN color scheme
- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

CLiq v.3.5.2.5 - CPT Liquefaction Assessment Software - Report created on: 12/02/2025, 8:48:32 am

Project file: C:\Users\MarkTrainor\LandTech Consulting\LandTech Consulting - Christchurch\2024\Turners Road, Spencerville - LTC24362\CPT\LTC24362 - ULS Liquefaction Analysis.clq

2

Liquefaction analysis overall plots

CRR plot — CRR & CSR

FS Plot — Factor of safety

Liquefaction severity number — LSN

Vertical settlements — Settlement (cm)

Lateral displacements — Displacement (cm)

Input parameters and analysis data

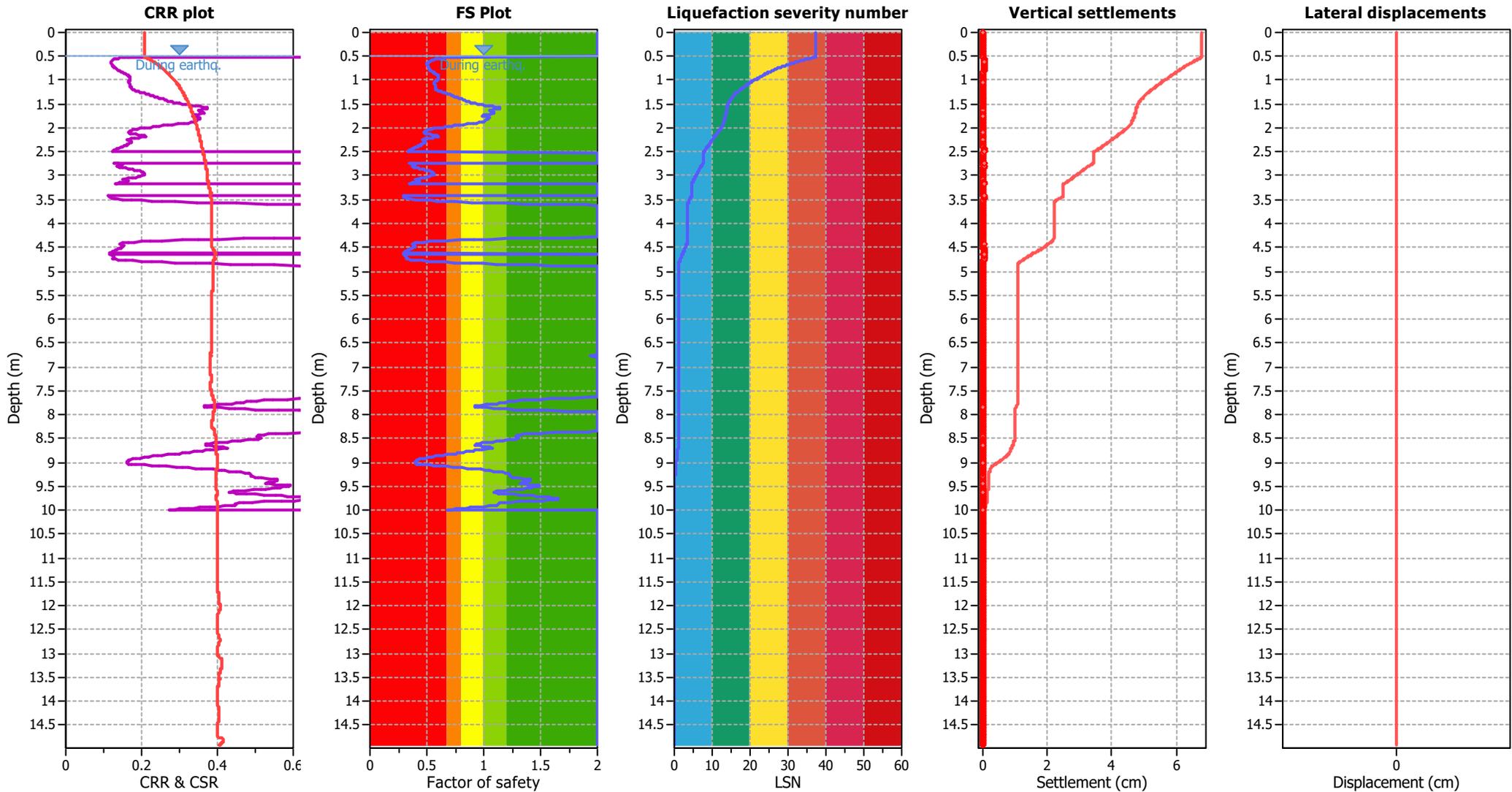|					
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

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

LSN color scheme
- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

CLiq v.3.5.2.5 - CPT Liquefaction Assessment Software - Report created on: 12/02/2025, 8:48:33 am

Project file: C:\Users\MarkTrainor\LandTech Consulting\LandTech Consulting - Christchurch\2024\Turners Road, Spencerville - LTC24362\CPT\LTC24362 - ULS Liquefaction Analysis.clq

3

Liquefaction analysis overall plots

CRR plot — CRR & CSR

FS Plot — Factor of safety

Liquefaction severity number — LSN

Vertical settlements — Settlement (cm)

Lateral displacements — Displacement (cm)

Input parameters and analysis data

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

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

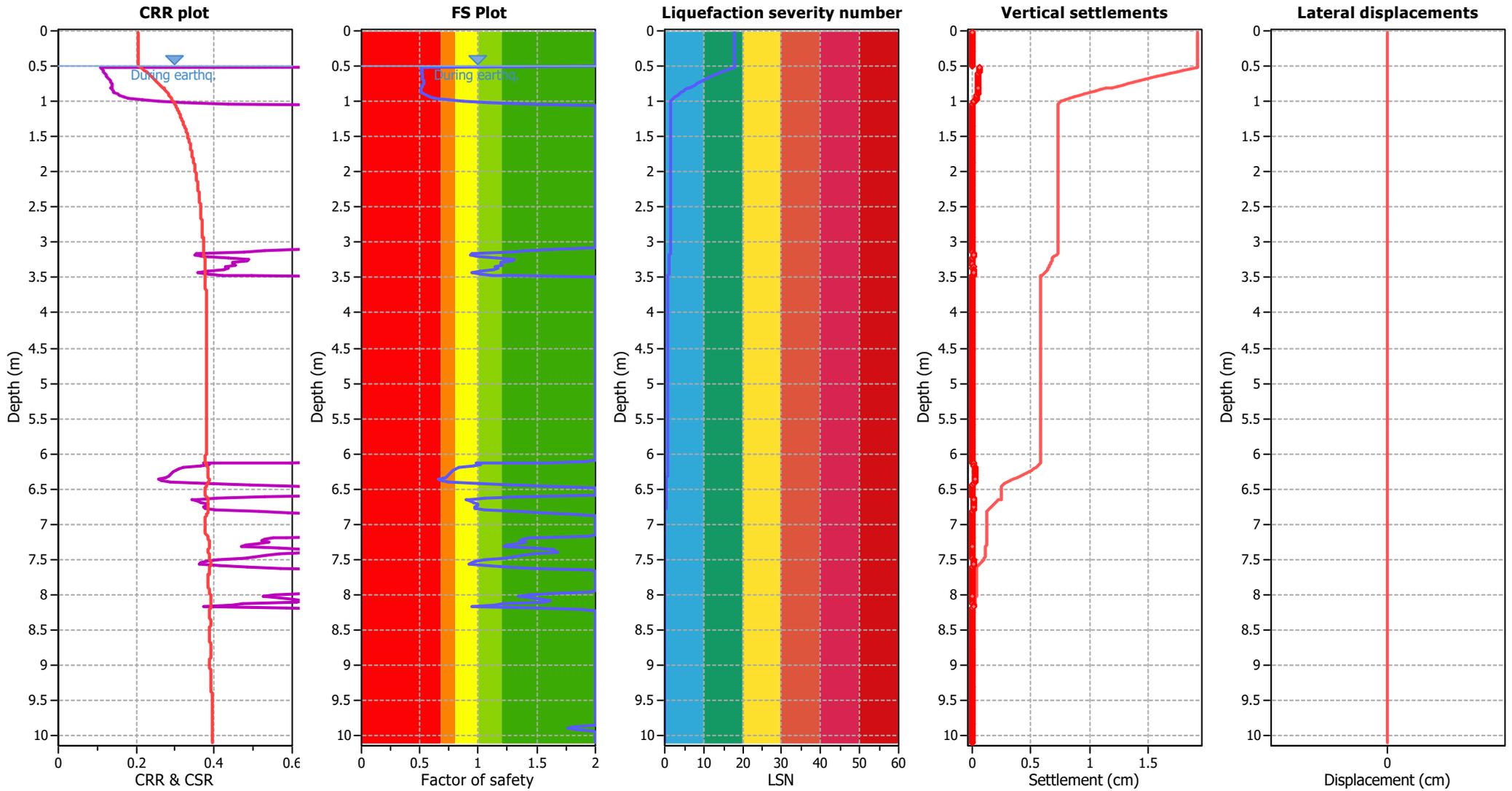|	
Fill weight:	N/A
Transition detect. applied:	No
K_σ applied:	Yes
Clay like behavior applied:	Sands only
Limit depth applied:	Yes
Limit depth:	10.00 m

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

LSN color scheme
- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

CLiq v.3.5.2.5 - CPT Liquefaction Assessment Software - Report created on: 12/02/2025, 8:48:33 am

Project file: C:\Users\MarkTrainor\LandTech Consulting\LandTech Consulting - Christchurch\2024\Turners Road, Spencerville - LTC24362\CPT\LTC24362 - ULS Liquefaction Analysis.clq

4

Liquefaction analysis overall plots

CRR plot | **FS Plot** | **Liquefaction severity number** | **Vertical settlements** | **Lateral displacements**

Input parameters and analysis data

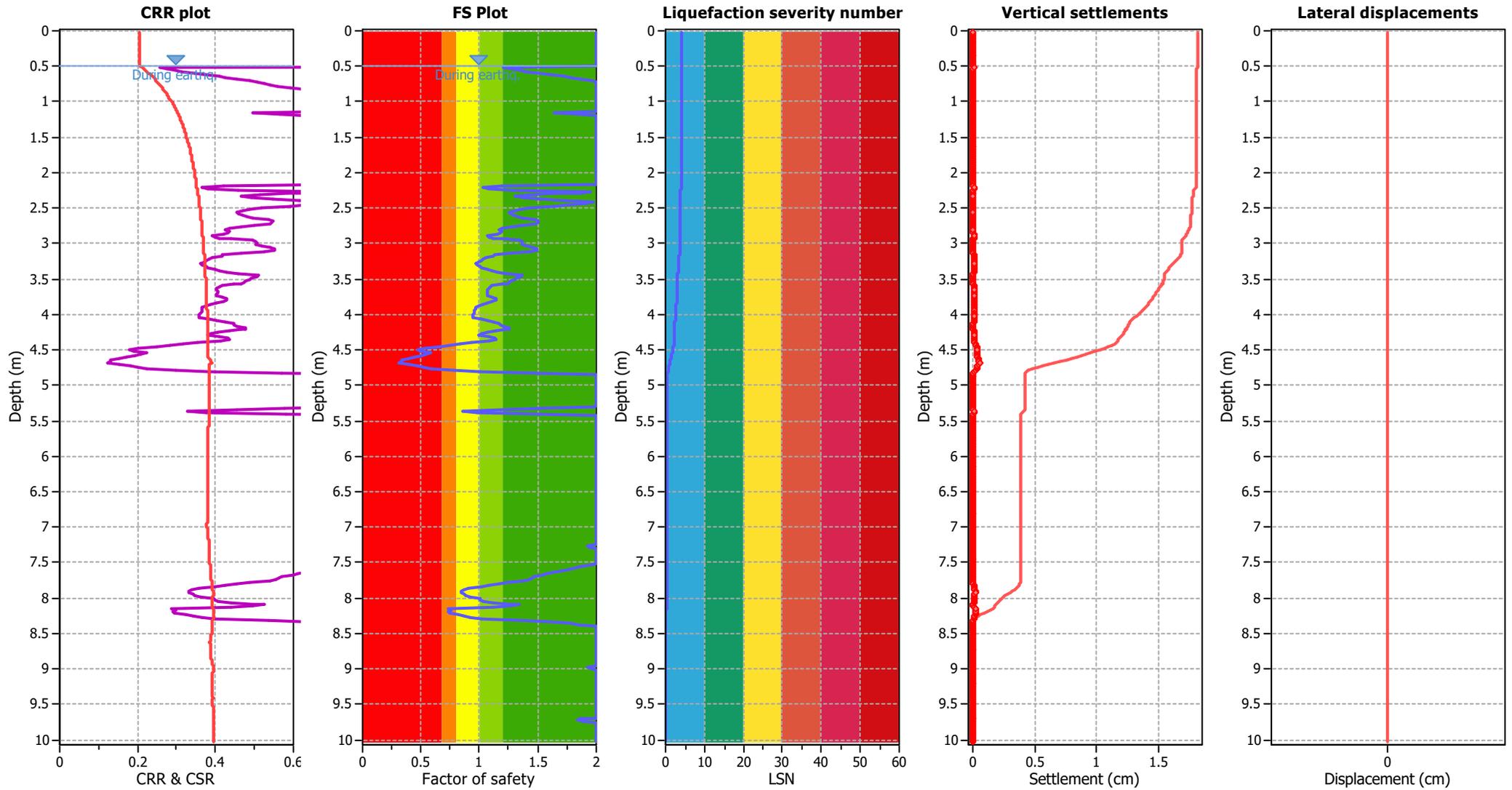|						
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A	
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No	
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes	
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only	
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes	
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m	

F.S. color scheme

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

LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

CLiq v.3.5.2.5 - CPT Liquefaction Assessment Software - Report created on: 12/02/2025, 8:48:34 am

Project file: C:\Users\MarkTrainor\LandTech Consulting\LandTech Consulting - Christchurch\2024\Turners Road, Spencerville - LTC24362\CPT\LTC24362 - ULS Liquefaction Analysis.clq

5

Liquefaction analysis overall plots

CRR plot | **FS Plot** | **Liquefaction severity number** | **Vertical settlements** | **Lateral displacements**

Input parameters and analysis data

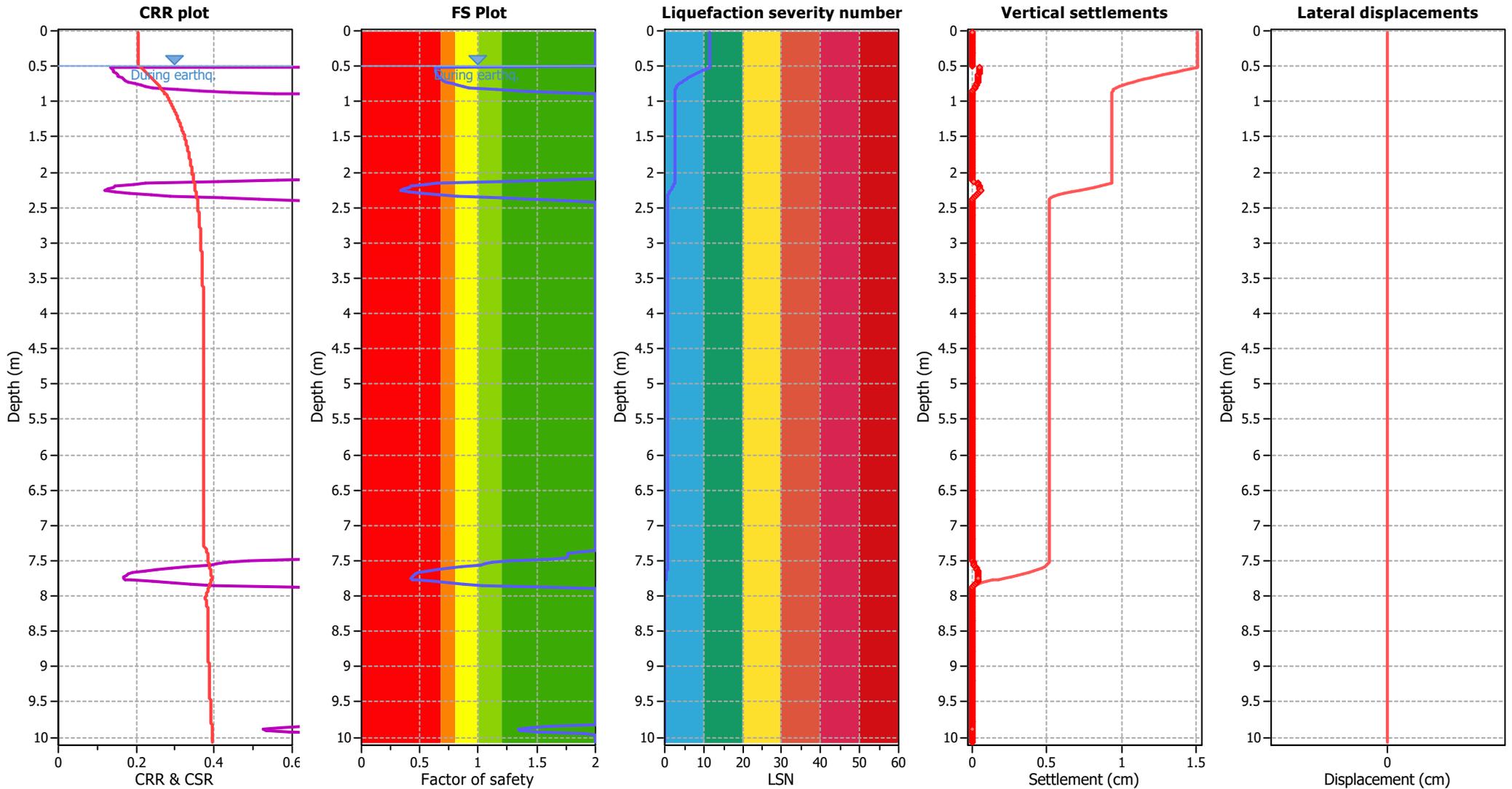|					
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

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

LSN color scheme
- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

CLiq v.3.5.2.5 - CPT Liquefaction Assessment Software - Report created on: 12/02/2025, 8:48:34 am
Project file: C:\Users\MarkTrainor\LandTech Consulting\LandTech Consulting - Christchurch\2024\Turners Road, Spencerville - LTC24362\CPT\LTC24362 - ULS Liquefaction Analysis.clq

6

Liquefaction analysis overall plots

CRR plot — CRR & CSR

FS Plot — Factor of safety

Liquefaction severity number — LSN

Vertical settlements — Settlement (cm)

Lateral displacements — Displacement (cm)

Input parameters and analysis data

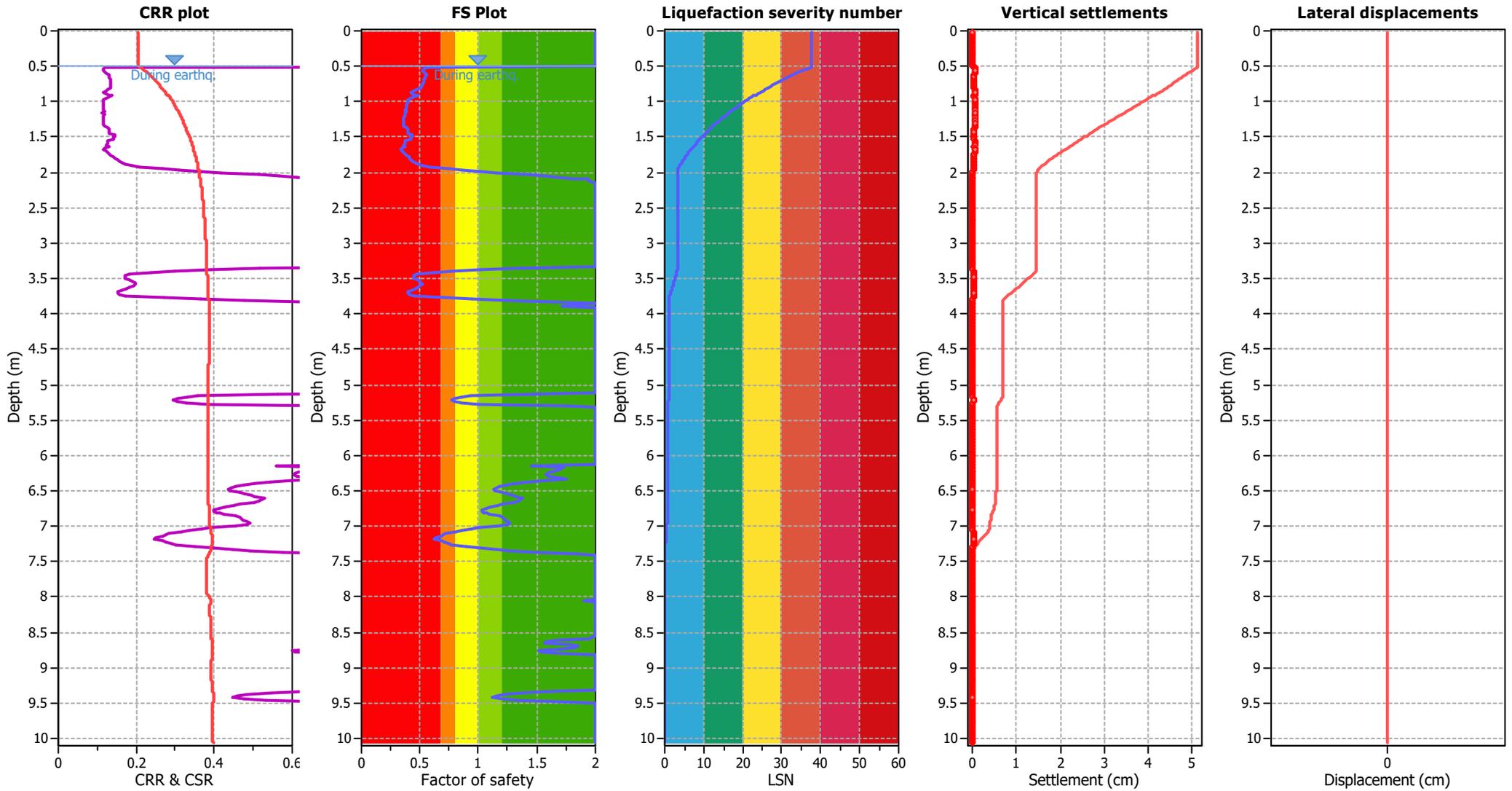|					
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

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

LSN color scheme
- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

Liquefaction analysis overall plots

CRR plot — Depth (m) vs CRR & CSR

FS Plot — Depth (m) vs Factor of safety

Liquefaction severity number — Depth (m) vs LSN

Vertical settlements — Depth (m) vs Settlement (cm)

Lateral displacements — Depth (m) vs Displacement (cm)

Input parameters and analysis data

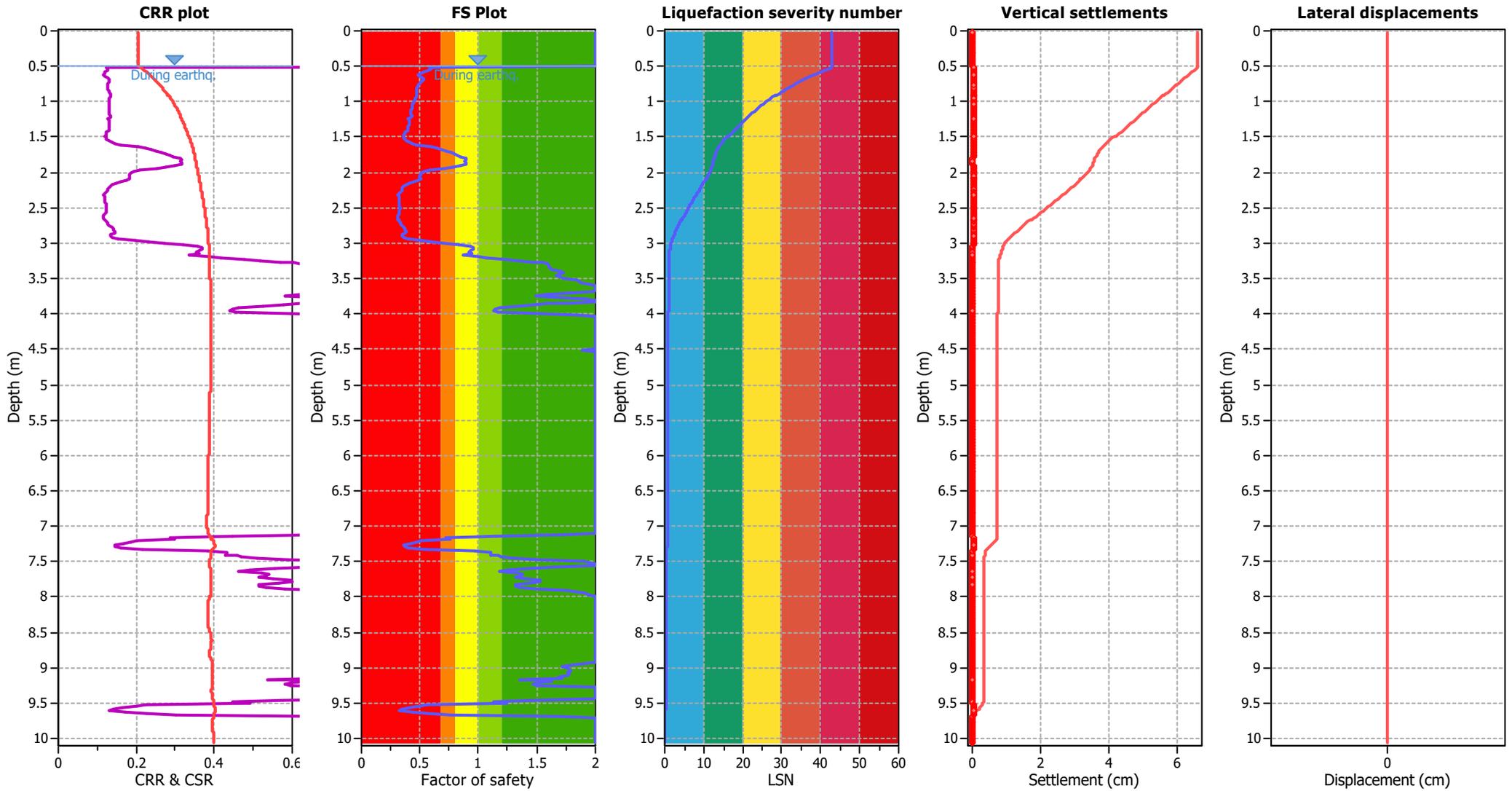|					
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

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

LSN color scheme
- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

CLiq v.3.5.2.5 - CPT Liquefaction Assessment Software - Report created on: 12/02/2025, 8:48:35 am

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Project file: C:\Users\MarkTrainor\LandTech Consulting\LandTech Consulting - Christchurch\2024\Turners Road, Spencerville - LTC24362\CPT\LTC24362 - ULS Liquefaction Analysis.clq

Liquefaction analysis overall plots

CRR plot
FS Plot
Liquefaction severity number
Vertical settlements
Lateral displacements

Input parameters and analysis data

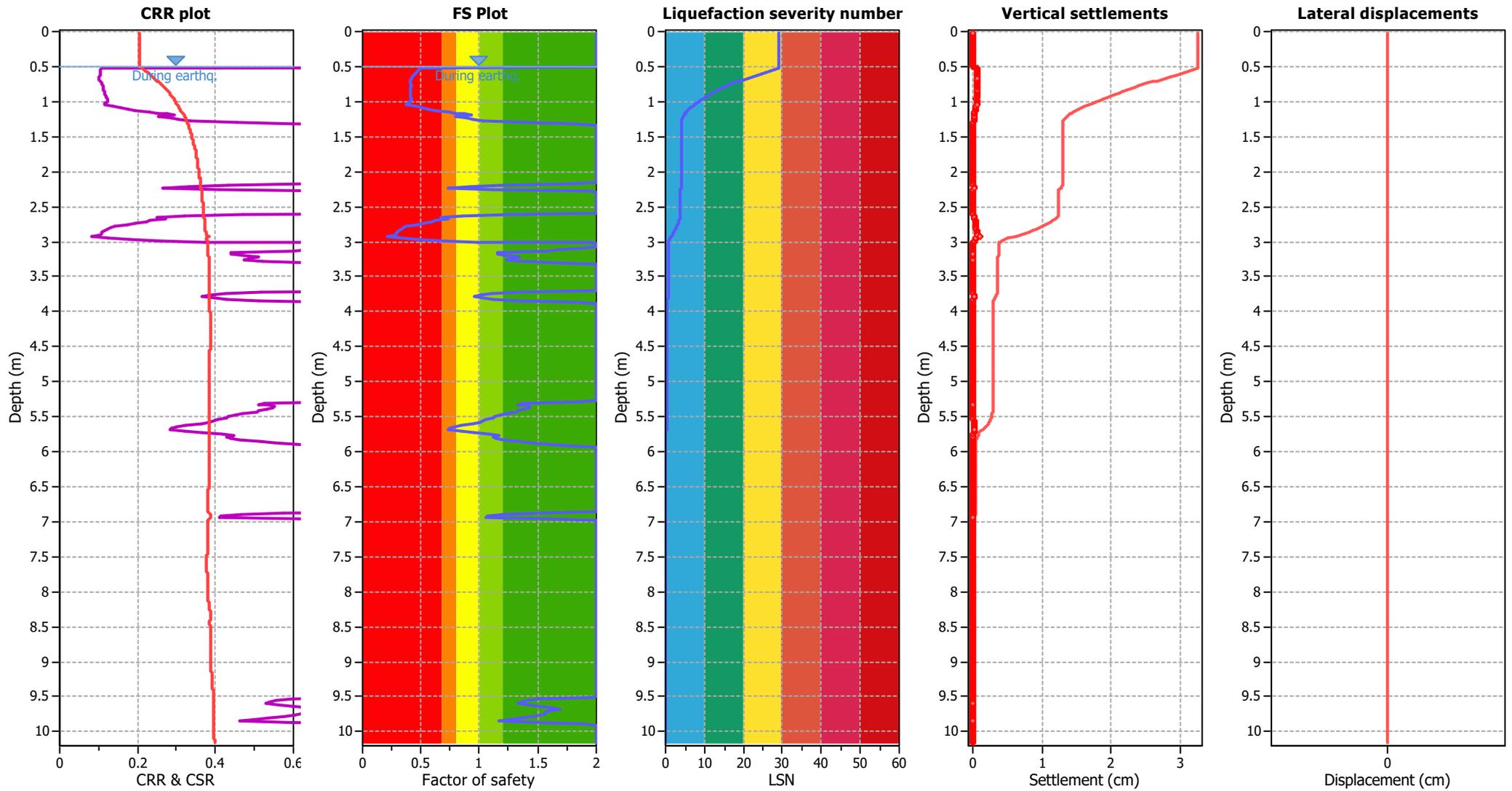|					
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
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Liquefaction analysis overall plots

CRR plot | **FS Plot** | **Liquefaction severity number** | **Vertical settlements** | **Lateral displacements**

Input parameters and analysis data

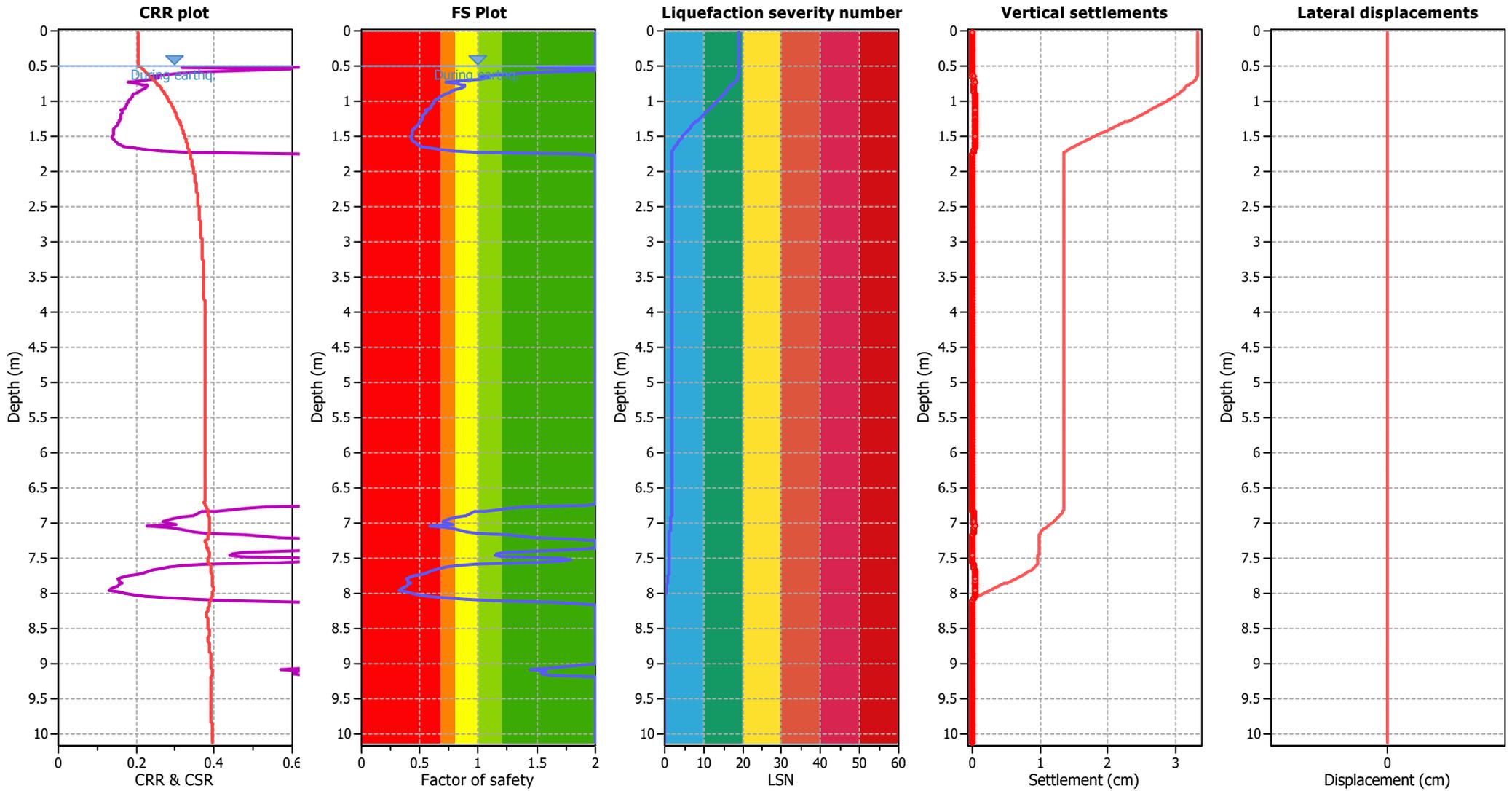|					
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
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Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
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F.S. color scheme
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- 🟧 Very likely to liquefy
- 🟨 Liquefaction and no liq. are equally likely
- 🟩 Unlike to liquefy
- 🟩 Almost certain it will not liquefy

LSN color scheme
- 🟥 Severe damage
- 🟥 Major expression of liquefaction
- 🟧 Moderate to severe exp. of liquefaction
- 🟨 Moderate expression of liquefaction
- 🟩 Minor expression of liquefaction
- 🟦 Little to no expression of liquefaction

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Liquefaction analysis overall plots

CRR plot | **FS Plot** | **Liquefaction severity number** | **Vertical settlements** | **Lateral displacements**

Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
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