

## DISTRICT PLAN REVIEW

# Proposed Waimakariri District Plan - Submission

Clause 6 of Schedule 1, Resource Management Act 1991

### Submitter details

(Our preferred methods of corresponding with you are by **email** and **phone**).

Full name: B and A Stokes

Email address: office@rgmc.co.nz and bjalstokes@gmail.com

Phone (Mobile): 021363497 / 0272274514 Phone (Landline): \_\_\_\_\_

Postal Address: PO Box 2551, Christchurch Post Code: \_\_\_\_\_

Physical address: 130 Gressons Road Post Code: \_\_\_\_\_

(if different from above)

Please select one of the two options below:

☒ I **could not** gain an advantage in trade competition through this submission (go to Submission details, you do not need to complete the rest of this section)

☐ I **could** gain an advantage in trade competition through this submission (please complete the rest of this section before continuing to Submission details)

Please select one of the two options below:

☐ I **am** directly affected by an effect of the subject matter of the submission that:

A) Adversely affects the environment; and

B) Does not relate to trade competition or the effect of trade competition.

☐ I **am not** directly affected by an effect of the subject matter of the submission that:

A) Adversely affects the environment; and

B) Does not relate to trade competition or the effect of trade competition.

## Submission details

The specific provisions of the proposal that my submission relates to are as follows: *(please give details)*

The Rural Lifestyle Zone proposed for our property at Mandeville, and statements of Plan objectives and policies for the rural residential area and the Large Lot Residential Zone. Please refer to the attached reports for full details of the property, the matters covered by the submission, and the reasons. The attached reports are set out at the end of the submission.

-  
-

My submission is that: *(state in summary the Proposed Plan chapter subject and provision of your submission. Clearly indicate whether you support or oppose the specific provisions or wish to have amendments made, giving reasons) (please include additional pages as necessary)*

The zoning of the subject property should be changed to Large Lot Residential Zone together with amendments to statements of objectives and policy, plus the adoption of an Outline Development Plan, to enable the development and subdivision of the property for rural-residential purposes. Please refer to the attached reports for further details, and an explanation of the reasons for this submission.

I/we have included **7 additional pages plus nine attachments**.

I/we seek the following decision from the Waimakariri District Council: *(give precise details, use additional pages if required)*

That the submission be accepted in full and given effect to as follows:

1. **Zoning** – Amend the zoning of the property from Rural Lifestyle Zone to Large Lot Residential Zone.
2. **Outline Development Plan** – Adopt and include in the District Plan the ODP attached as part of this submission (refer Appendix 8), together with any amendments that may be identified as desirable during the submission hearing process.
3. **Policy** – UFD-P3, the policy on identification and extension of Large Lot Residential Zone areas. This submission supports Policy UFD-P3, Part 2 which enables a new LLR Zone development to be included in the District Plan that has been included in the Rural Residential Development Strategy or the District Plan Review as notified. The request for re-zoning in this submission is consistent with this policy.
4. **Objective for Subdivision Design – SUB-01** – This submission supports objective SUB-01 in principle, but seeks a small amendment to recognize that rural residential is a desirable housing choice and part of a flexible and diverse housing market, and which should be included in the subdivision design objectives. The decision sought is to amend objective SUB-01, item 2, to read:  
*“2. Consolidates urban and rural residential development and maintains rural character except where required for, and identified by the District Council, for urban or rural residential development.”*
5. **Objectives and Policies for Outline Development Plans** – This submission supports the approach to the preparation and use of ODP's and specifically:
  - **SUB-P6**, criteria for ODP's
  - **RESZ-P12**, policy for the use of ODP's
  - **LLRZ – P5**, policy to ensure that in the Large Lot Residential Zone an ODP is developed in accordance with SUB-P6 and incorporated in the District Plan.

## Submission at the Hearing

- ☒ I/we wish to speak in support of my/our submission
- ☐ I/we do not wish to speak in support of my/our submission
- ☒ If others make a similar further submission, I/we will consider presenting a joint case with them at the hearing

## Signature

*Of submitters or person authorised to sign on behalf of submitter(s)*

Signature: 

Date 23 November 2021

*(If you are making your submission electronically, a signature is not required)*

## Important Information

1. The Council must receive this submission before the closing date and time for submissions.
2. Please note that submissions are public. Your name and submission will be included in papers that are available to the media and public. Your submission will only be used for the purpose of the District Plan review process.
3. Only those submitters who indicate they wish to speak at the hearing will be emailed a copy of the planning officers report (please ensure you include an email address on this submission form).

If you are a person who could gain an advantage in trade competition through the submission, your right to make a submission may be limited by clause 6(4) of Part 1 of Schedule 1 of the Resource Management Act 1991.

Please note that your submission (or part of your submission) may be struck out if the authority is satisfied that at least 1 of the following applies to the submission (or part of the submission):

- It is frivolous or vexatious
- It discloses no reasonable or relevant case
- It would be an abuse of the hearing process to allow the submission (or the part) to be taken further
- It contains offensive language
- It is supported only by material that purports to be independent expert evidence, but has been prepared by a person who is not independent or who does not have sufficient specialised knowledge or skill to give expert advice on the matter.

**Send your submission to:**  
Proposed District Plan Submission  
Waimakariri District Council  
Private Bag 1005, Rangiora 7440

**Email to:** [developmentplanning@wmk.govt.nz](mailto:developmentplanning@wmk.govt.nz)

**Phone:** 0800 965 468 (0800WMKGOV)

**You can also deliver this submission form to one our service centres:**

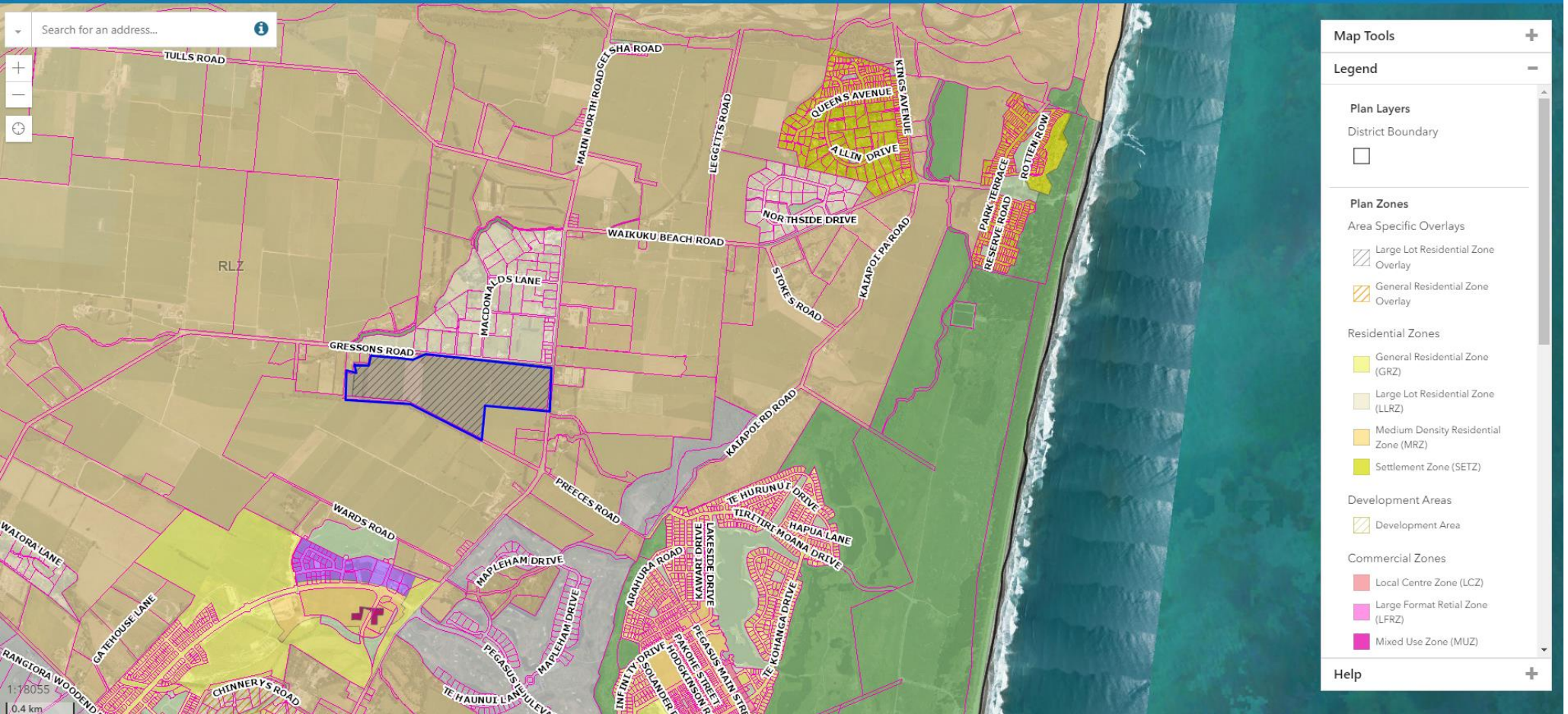
**Rangiora Service Centre:** 215 High Street, Rangiora

**Kaiapoi Service Centre:** Ruataniwha Kaiapoi Civic Centre, 176 Williams Street, Kaiapoi

**Oxford Service Centre:** 34 Main Street, Oxford

**Submissions close 5pm, Friday 26 November 2021**

**Please refer to the Council website [waimakariri.govt.nz](http://waimakariri.govt.nz) for further updates**



Site



**SUBMISSION ON**  
**PROPOSED DISTRICT PLAN**  
**WAIMAKARIRI DISTRICT COUNCIL**

To: District Plan Submissions  
Waimakariri District Council  
Private Bag 1005  
Rangiora 7440

Submission by: B and A Stokes  
130 Gressons Road  
Waikuku

Contact details: Email: B and A Stokes [bjalstokes@gmail.com](mailto:bjalstokes@gmail.com)  
McCracken & Associates [office@rgmc.co.nz](mailto:office@rgmc.co.nz)

Hearing of Submission: The submitters do wish to be heard in support of their submission

---

**Introduction**

1. The submitters are the owners of the land at 81 Gressons Road and 1375 Main North Road in Waikuku being an area of approximately 30ha. The land is generally located at the intersection of and with frontage to the Main North Road (west side – 300m) and Gressons Road (south side – 1km) and faces an area of Residential 4B zoning on the north side of Gressons Road. The submitters land was previously identified as suitable or a preferred area for Rural-Residential development in the 2010 Rural Residential Development Plan (Refer Appendix 1) and the party submitted on that Plan (Appendix 2).
2. The submitters have been involved in extensive consultation with and the provision of information to the District Council from around 2011. Much of the information and the background reports prepared for the submitters in respect of the subject land since the 2010 Rural-Residential Development Plan form part of the supporting

information to this submission, but it is relevant to note that the submitters held pre-application meetings with the District Council on:

- 5 December 2011
- 3 October 2013
- 17 December 2013
- 30 May 2014
- 26 June 2014

There had been a delay in processing matters since that time in that it took several years to sort out and settle an area of adjoining land subject to an adverse possession procedure. That is now resolved and the new title attached (Refer Appendix 3).

### **The WDC Draft Rural-Residential Development Strategy (RRS)**

3. The RRS consultation document (March 2019) sets out that its purpose is to provide a framework for the future provision of land to be zoned for rural-residential purposes.
4. The submitters have noted the overall comments and assessment in respect of the current Rural-Residential Areas and were the developers of the Rural-Residential development at Waikuku Beach. In addition the submitters are familiar with the two current rural-residential zones (Residential 4A and 4B) provided for in the District Plan and have referenced Part 2 of the Draft Growth Strategy – “Direction for Growth” which identified the subject land (Gressons Road) as a Secondary Growth Area, while at the same time appearing to support (in principle) the expansion of further rural-residential growth to the south of the existing Residential 4B settlement including the subject land at Waikuku, to quote:

***Taking into account these various constraints and opportunities, further rural residential growth is proposed to the south of the existing Residential 4B settlement, as shown in Figure 12.***

- *This area is relatively free from localised flood hazard,*
- *It also allows a great level of integration with the existing settlement via Gressons Road,*
- *It is acknowledge the proposed growth direction is within a Silent File Area Indicating the presence of significant wahi tapu or wahi taonga somewhere in the area. Therefore, consultation with Nagai Tuahuriri is particularly important in order to identify the effects of the activity and to avoid, remedy or mitigate, and*

- *Close proximity to Woodend and Pegasus.*

5. The submitters support that outcome and would note that they have extensive experience of consultation and implementation of the processes and protocols to address matters of importance to Ngai Tuahariri through their development at Waikuku beach and will initiate consultation with the iwi in respect of the subject land.

### **The land**

6. The land is generally located at 81 Gressons Road and 1375 Main North Road Waikuku. The detail in respect of the land is set out in the report submitted to the Council by the submitters in August 2013 – Request to the Planning Advisory Group, Northside Country Ltd and attached as Appendix 4. That referred;

- That the land was identified in the Rural-Residential Development Plan as suitable for rural-residential development,
- That the Regional Policy Statement required rural –residential activity to amongst other matters, take place in accordance with an adopted rural-residential development strategy prepared by the TDA (Policy 6.3.4) and to be accompanied by an outline development plan (Policy 6.3.9.(b),
- That consultation took place with the NZTA and all access would be from Gressons Road,
- That the RPS required Rural-Residential development to be located so it can be economically provided with a reticulated system and it is noted reticulated systems operate at Waikuku Beach and the opportunity exists to connect to these at (Kings Avenue/Waikuku Beach Road),
- That stormwater management can be provided,
- That the land is not at risk of flooding,
- That a comprehensive Geotechnical report has been completed,
- That a preliminary infrastructure servicing report has been prepared,
- That a ground contamination assessment has been undertaken,
- That previous issues regarding a private road (pt RS1235) which connected Gressons Road to McDonald Lane at the north end of the settlement have been resolved (Refer Appendix 3), and
- That it is acknowledged that the locality is of significance to the local iwi and that the necessary consultation and investigation are required.

### **Regional Policy Statement**

7. Regard has been had to the RPS and the manner by which it addresses Rural-Residential impacts and development. In particular issue 6.1.5 refers:

*Rural residential development, if unconstrained, has the potential to change the character of rural areas and to create adverse effects on established rural, farming (including agricultural research farms) and quarrying activities through revers sensitivity. It also can result in dispersed settlement patterns, and inefficient forms of development and provision of services.*

8. In addition Policy 6.3.3, Development in accordance with Outline Development Plans require that development within any rural residential area is to occur as set out in the policy and will be achieved namely (as relevant) by including:

- Roading network,
- Stormwater treatment,
- Resources (historical, cultural),
- Pedestrian connections,
- Infrastructure required, and
- Natural hazards

9. All of these matters are or can be addressed through the background reports and Outline Development Plan (Appendix 8).

10. Finally, Policy 6.3.9, Rural-Residential development refers;

2. *The location must be outside the greenfield priority areas for development and existing urban areas;*
3. *All subdivision and development must be located so that it can be economically provided with a reticulated sewer and water supply integrated with a publicly owned system, and appropriate stormwater treatment and disposal;*
4. *Legal and physical access is provided to a sealed road, but not directly to a road defined in the relevant district plan as a Strategic or Arterial Road, or as a State highway under the Government Roding Powers Act 1989;*
5. *The location and design of any proposed rural residential development shall:*
  - a. *avoid noise sensitive activities occurring within the 50 dBA Ldn air noise contour surrounding Christchurch International Airport so as not to compromise the future efficient operation of Christchurch International Airport or the health, well-being and amenity of people;*
  - b. *avoid the groundwater protection zone for Christchurch City's drinking water;*
  - c. *avoid land between the primary and secondary stop banks south of the Waimakariri River;*



- d. *avoid land required to protect the landscape character of the Port Hills;*
  - e. *.not compromise the operational capacity of the Burnham Military Camp, West Melton Military Training Area or Rangiora Airfield;*
  - f. *support existing or upgraded community infrastructure and provide for good access to emergency services;*
  - g. *avoid significant reverse sensitivity effects with adjacent rural activities, including quarrying and agricultural research farms, or strategic infrastructure;*
  - h. *avoid significant natural hazard areas including steep or unstable land;*
  - i. *avoid significant adverse ecological effects, and support the protection and enhancement of ecological values;*
  - j. *support the protection and enhancement of ancestral land, water sites, wāhi tapu and wāhi taonga of Ngāi Tahu;*
  - k. *where adjacent to or in close proximity to an existing urban or rural residential area, be able to be integrated into or consolidated with the existing settlement; and*
  - l. *avoid adverse effects on existing surface water quality.*
6. *An outline development plan is prepared which sets out an integrated design for subdivision and land use, and provides for the long-term maintenance of rural residential character.*
  7. *A rural residential development area shall not be regarded as in transition to full urban development.*

Development of the subject land for Rural-Residential activity can satisfy these matters.

### **The Rural-Residential Strategy**

11. Apart from the list of strengths in support for the Gressons Road land, the strategy report identifies a number of constraints. In summary it is concluded that all of these can or have already been addressed:

- *Silent File Area SF017 Pekapeka to the south,*  
Consultation initiated
- *Within a Liquefaction Susceptibility Area,*  
Refer Geotech report attached,
- *Potential for coastal hazard issues including ground water level rise associated with sea level rise. There is no issue (Refer attached report),*
- *Largely surrounded by versatile soils, except for a small portion to the northeast,*  
Soil quality is good but has in significant part been dependent on irrigation.
- *Low soil drainage to the west,*  
This is not concluded to be an issue (Refer TSG report, March 2010, and Geotechnical report – attached).

**APPENDIX 1**

**RURAL-RESIDENTIAL DEVELOPMENT PLAN (2010)**



**Legend**

- Preferred Development Location
- Household Yield: 65
- Existing Residential Zoning (Residential 4B)
- Ashley River 500 Year Flood Breakout (0.2% AEP)

**PREFERRED RURAL RESIDENTIAL DISTRIBUTION RECOMMENDED DECISIONS ON SUBMISSIONS**

WAIKUKU

**WAIMAKARIRI DISTRICT COUNCIL**  
technical services

FILE No: RESIDENTIAL DISTRIBUTION	SCALE 1:15000
PLAN No: 2995	SHEET 04
	ISSUE A

- *Council Localised Flood Hazard Modelling and Environment Canterbury's Ashley River Breakout Flood Modelling shows some medium to high flood hazard to the north and northwest of the existing Residential 4B area, and Refer Geotech report attached)*

### **Summary**

12. The land is physically well situated for rural-residential purposes with viable service connections available. The land has been assessed in terms of ground conditions and ground contamination and there are no geotechnical or soil quality matters which would prelude development as proposed.
13. The land can be accessed from Gressons Road (both road and potentially, individual lots) and as such there will be no impact on State Highway No 1. The opportunity exists to enhance the intersection of SHN1 and Gressons Road through the development of the site.
14. The land is accessible to a range of community facilities and amenities which would benefit from and be supported by development of the subject land.
15. The submitters thank the Council for its consideration of this submission.

The submitters support the inclusion or identification of the subject land for rural-residential purposes (Large Lot Residential) in the Proposed District Plan.

B and A Stokes  
K McCracken



---

Email: [bjalstokes@gmail.com](mailto:bjalstokes@gmail.com)

Phone: 03 - 3127678



## **ATTACHMENTS:**

Appendix 1	Rural-Residential Development Plan (2010)
Appendix 2	Submission on the 2010 RR Development Plan
Appendix 3	Copy of new title
Appendix 4	Request to the Planning Advisory Group – 21 Aug 2013
Appendix 5	Geotechnical Report for the proposed subdivision – 2020
Appendix 6	Ground Contamination Assessment – 2020
Appendix 7	Infrastructure Servicing Assessment – 2020
Appendix 8	Outline Development Plan
Appendix 9	Extract – Waimakariri Rural-Residential Development Strategy

## **APPENDIX 2**

### **SUBMISSION ON THE 2010 RR DEVELOPMENT PLAN**

## **DRAFT RURAL RESIDENTIAL DEVELOPMENT PLAN**

**Submission From:** BJ & AL Stokes  
1333 Main North Road  
Waikuku RD1  
Kaiapoi 7691

**Presented at hearing:** Wednesday 24<sup>th</sup> March 2010

My name is Brian Stokes and this is my wife Anne. We are dairy farmers at Waikuku where my family has been farming for a number of generations. We have had a close involvement with the Waikuku Community (list) and remain involved on issues dealing with water management (?) in the area.

We are the owners of 30 hectares (approximately) of land south of Gressons Road and to the west of State Highway One that has been identified as part of an area suitable for rural residential development at Waikuku village. This land is currently part of our dairy farm operation.

Our submission is to give general support to the Council strategy and to note that we have no objection to any other land in the vicinity being so identified. We note this because as farmers it is important that any land identified recognizes both the viability of the farming community but also the opportunity some locations may provide for rural residential use.

We believe identifying land as suitable for rural residential development at Waikuku Village is appropriate for the following reasons:-

1. The areas identified are unlikely to undermine the economic viability of farming activities.
2. The provision of services i.e. internal roading, reticulated services etc will be relatively straightforward and may in fact benefit from some additional activity.
3. Good access to rural residential development in this area can be provided away from the the State Highway.
4. Upgrading of the existing septic tanks and private wells of Waikuku Village to a fully reticulated service could be more economically achieved with some additional development.

5. The existing Waikuku Village already has a number of community services e.g. shop/service station, school, café etc and therefore the addition of rural residential activity will enhance and support a more sustainable community.
6. Land in the area generally has good north facing aspect and lends itself to creating a good rural residential character.
7. There are very few physical constraints to the development in this area.

We are currently (for the last two years) working through a rural residential proposal at Waikuku Beach. In that proposal we have worked closely with the local community and understand the issues that arise around rural residential activity and support the Draft Rural Residential Development Plan for the Waikuku Village area



### **APPENDIX 3**

#### **COPY OF NEW TITLE**



**RECORD OF TITLE  
UNDER LAND TRANSFER ACT 2017  
FREEHOLD**

**Guaranteed Search Copy issued under Section 60 of the Land  
Transfer Act 2017**



*R. W. Muir*  
Registrar-General  
of Land

Identifier **637372**  
Land Registration District **Canterbury**  
Date Issued 17 May 2016

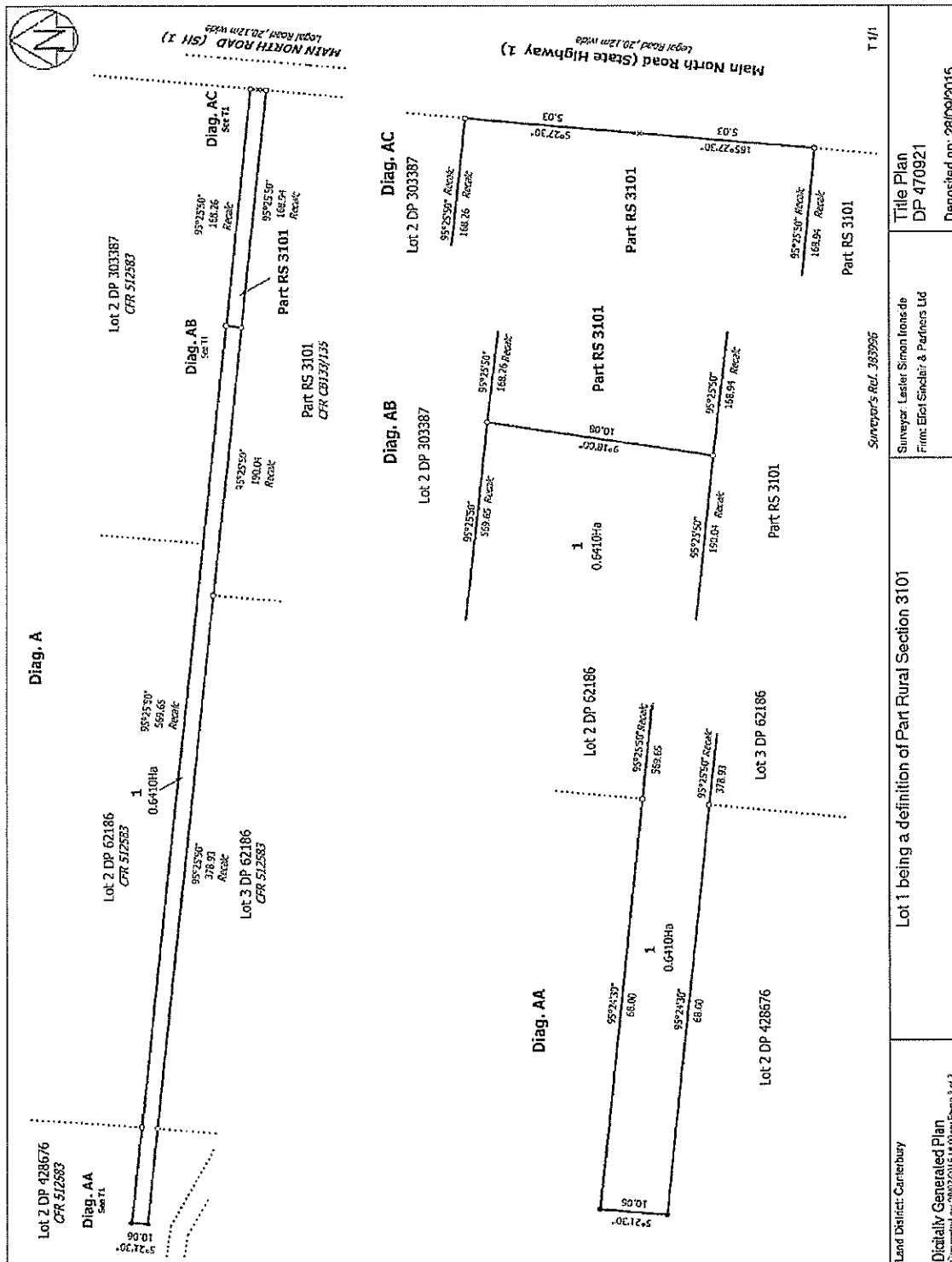
---

Estate Fee Simple  
Area 6410 square metres more or less  
Legal Description Lot 1 Deposited Plan 470921

Registered Owners  
Brian James Stokes and Anne Lois Stokes

---

Interests



## **APPENDIX 4**

### **REQUEST TO THE PLANNING ADVISORY GROUP – 21 AUG 2013**

## 81 Gressons Road & 1375 Main North Road, Waikuku

Request to the Planning Advisory Group



Northside Country Ltd

**Eliot Sinclair**  
surveyors | engineers | planners

# REQUEST TO THE PLANNING ADVISORY GROUP

81 Gressons Road & 1375 Main North Road, Waikuku

Northside Country Ltd

		20 Troup Drive   Tower Junction   Christchurch 8149 PO Box 9339   New Zealand   03 379 4014
<b>QUALITY CONTROL CERTIFICATE</b> All relevant information is identified, has been reviewed and is approved for release.		
Prepared by:	 Paul Thompson Resource Management Planner	
Directed and approved for release by:	 Bruce Sinclair Registered Professional Surveyor Director	
Date:	21 August 2013	
Reference:	350494	
Status:	Final	
Distribution:	1 copy 1 copy File copy	P G Harris Northside Country Eliot Sinclair & Partners Ltd.

**Limitations**

This report has been prepared Northside Country, according to their instructions, for the particular objectives described in the report. The information contained in the report should not be used by anyone else or for any other purposes.

## Table of Contents

1	Introduction .....	2
2	Site Description .....	2
3	Proposal .....	3
4	Relevant Considerations.....	3
4.1	Planning.....	3
4.2	Access .....	3
4.3	Mains Water & Wastewater .....	4
4.4	Electricity & Telecommunications .....	4
4.5	Stormwater Management .....	4
4.6	Natural Hazards .....	4
4.7	Soil Health .....	5
4.8	Ecology.....	5
4.9	Local Amenity .....	5
4.10	Cultural Values.....	5
5	The Planning Advisory Group .....	6
6	Conclusion .....	6
	Appendix A: District Planning Maps .....	7
	Appendix B: Concept Plan.....	8
	Appendix C: Rural Residential Development Plan - Waikuku.....	9
	Appendix D: District Plan Zone requirements.....	10



## 1 INTRODUCTION

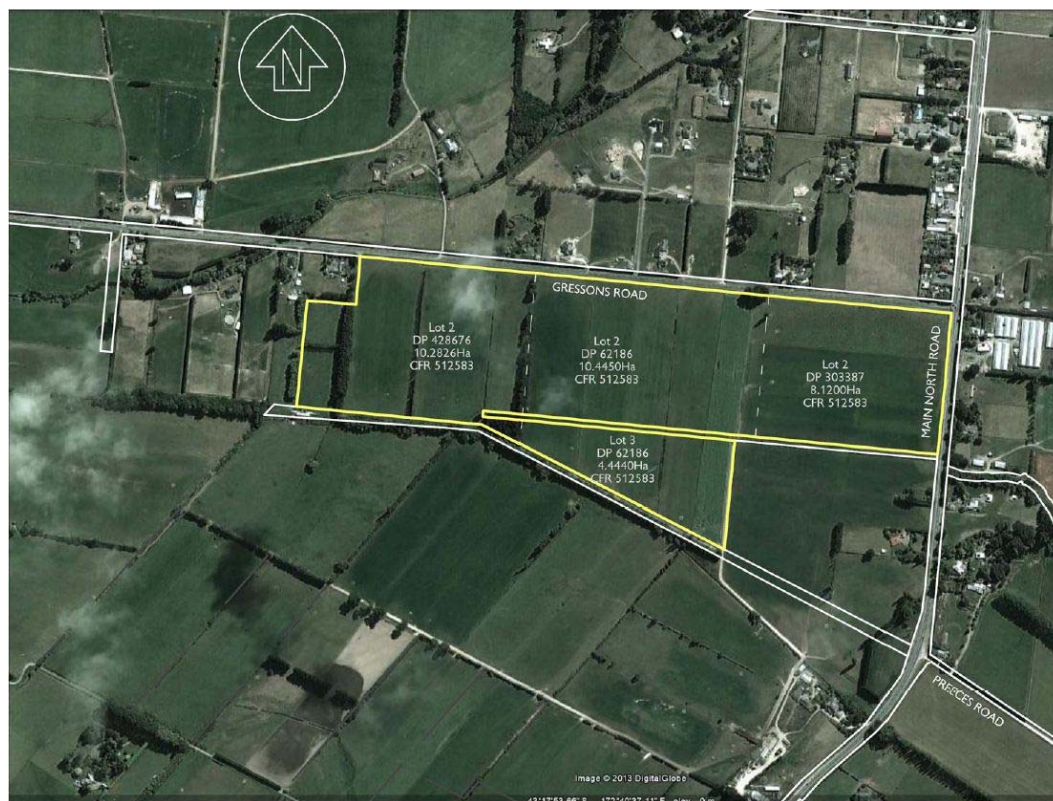
1. This is a request to the Project Advisory Group for comments in connection with proposed rural-residential development on land at 81 Gressons Road and 1375 Main North Road, Waikuku.
2. This document provides a preliminary assessment of the constraints and opportunities of the subject land to facilitate discussion and assist in the identification of issues to the Council. Specific questions to the Project Advisory Group are located at the end of this report.

## 2 SITE DESCRIPTION

3. The subject land is described as;

Physical Address	Legal Description & Computer Freehold Register	Area (ha)
81 Gressons Road	Lot 2 DP 428676 held in CFR 512583	10.2826
-	Lot 2 DP 62186 held in CFR 512583	10.4450
-	Lot 3 DP 62186 held in CFR 512583	4.4440
1375 Main North Road	Lot 2 DP 303387 held in CFR 512583	8.1200
		<b>33.2916</b>

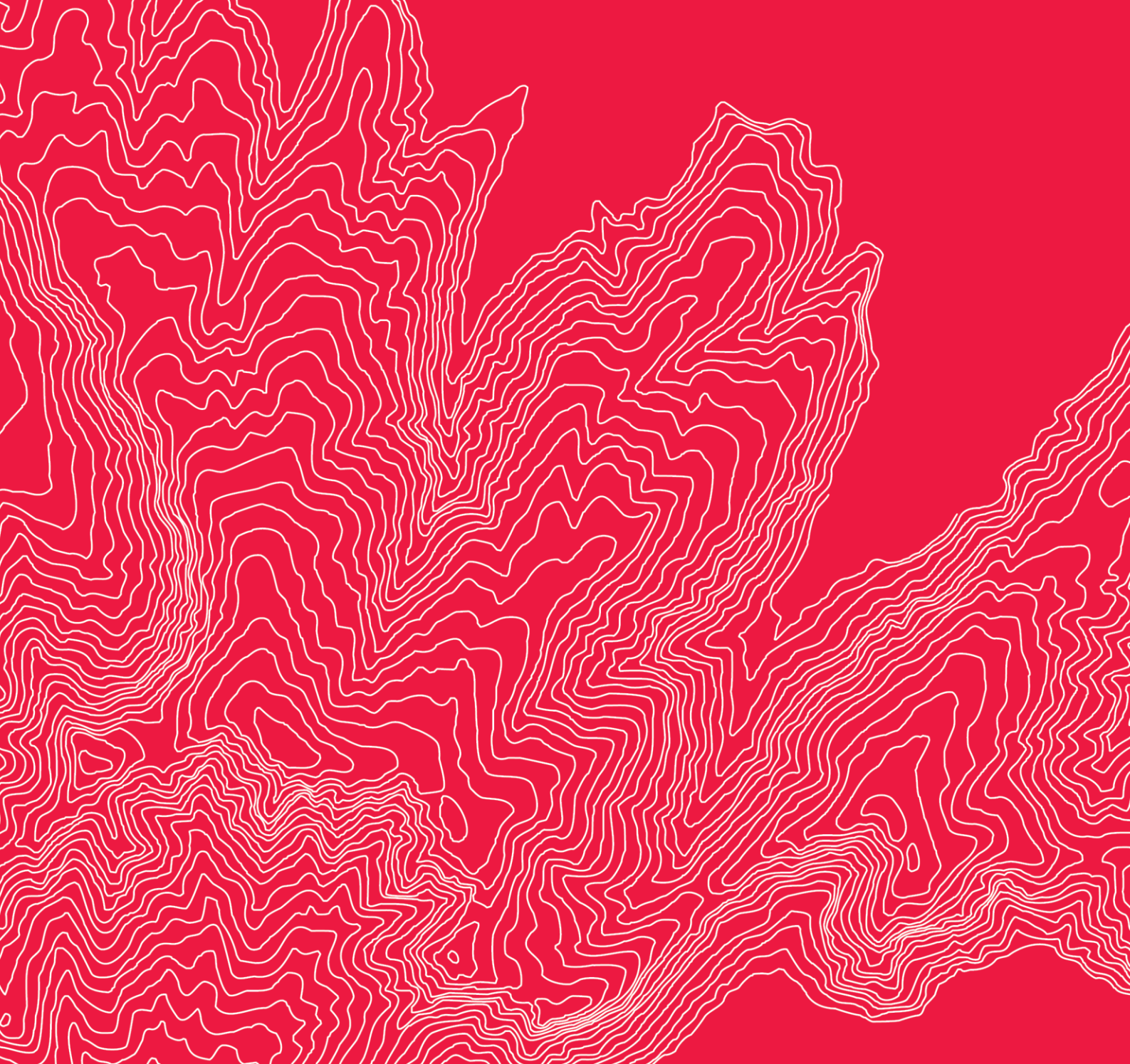
**Photo 1:** Location Plan





## **APPENDIX 5**

### **GEOTECHNICAL REPORT FOR THE PROPOSED SUBDIVISION – 2020**



# Geotechnical Report

**81 Gressons Road and 1375 Main North  
Road, Waikuku**

Prepared for Northside Country  
350494

**eliot  
sinclair**

# Geotechnical Report

81 Gressons Road and 1375 Main North Road, Waikuku



Prepared for Northside Country

350494

## Quality Control Certificate

Eliot Sinclair & Partners Limited

eliotsinclair.co.nz

Action	Name	Signature	Date
Prepared by:	Jeffrey Fleming Geotechnical Engineering Technician NZDE Civil MEngNZ		27 November 2020
Directed and approved for release by:	John Aramowicz Director, Civil/Geotechnical Engineer BE(Hons), CMEngNZ, CPEng, IntPE(NZ)		27 November 2020
Status:	Final		
Release date:	27 November 2020		
Reference no:	350494		
Distributed to:	Northside Country		

## Limitations

*This report has been prepared for Northside Country according to their instructions and for the particular objectives described in this report. The information contained in this report should not be used by anyone else or for any other purposes.*

## Contents

<b>1. Introduction</b>	<b>1</b>
<b>2. Scope of Work</b>	<b>1</b>
<b>3. Disclaimer</b>	<b>1</b>
<b>4. Rezoning Proposal</b>	<b>2</b>
<b>5. Site Description</b>	<b>2</b>
5.1. Engineering Geology	2
5.2. Existing bore hole data	3
5.3. Topography	4
5.4. Drainage	4
5.5. Vegetation	5
5.6. Buildings	5
5.7. 2010/2011 Canterbury Earthquakes	5
5.8. Technical Land Category	6
<b>6. Site Investigation</b>	<b>6</b>
6.1. CPTu Testing	6
6.2. Groundwater	6
6.3. Site investigation density	7
<b>7. Liquefaction Assessment</b>	<b>7</b>
7.1. Methodology	7
7.2. Liquefaction-Induced 'Index' Settlement	8
7.3. Liquefaction Severity Number (LSN)	9
7.4. Lateral spreading	9
<b>8. Natural Hazards</b>	<b>10</b>
8.1. Falling debris	10
8.2. Landsliding	10
8.3. Tsunami	10
8.4. Earthquake rupture	10
8.5. Inundation from the Ashley River	11
8.6. Erosion	11
8.7. Stormwater from developed site	11
8.8. Subsidence (Liquefaction)	12
<b>9. Requirements for Residential Foundations</b>	<b>12</b>
<b>10. Conclusions</b>	<b>12</b>

**Appendix A. Aerial Photo**

**Appendix B. Proposed Scheme Plan**

**Appendix C. Topographical Survey**

**Appendix D. CPTu Test Location Plan**

**Appendix E. CPTu Test Results**

## 1. Introduction

Eliot Sinclair have been engaged by Northside Country to undertake a geotechnical investigation and report at 81 Gressons Road and 1375 Main North Road to inform a proposed zone change from rural to rural-residential land use. The site is legally described as Lot 2 DP 428676, Lots 2-3 DP 62186, Lot 2 DP 303387, Lot 1 DP 470921 and Pt RS 3101.

Eliot Sinclair have previously completed a Geotechnical Report for the Proposed Subdivision dated 29 October 2012. We have carried out a further site visit on 10 November 2020 and reviewed the geotechnical data available for the site, and have updated our assessment of the liquefaction hazard at the site.

## 2. Scope of Work

The scope of work for this geotechnical assessment of the proposed zone change was;

- Review published geology,
- Review Environment Canterbury's database for nearby bore log data,
- Review of GNS Science's strong motion data for 4 September 2010 and 22 February 2011 earthquakes,
- Review the New Zealand Geotechnical Database,
- Reanalyse the 11 X cone penetration tests carried out in 2012 using the results of on-site groundwater monitoring records,
- Summarise the results of the geotechnical analysis, in this report and to provide geotechnical recommendations for the proposed rezoning.

## 3. Disclaimer

Comments made in this geotechnical report are based on a detailed site inspection undertaken in July 2012, a further site inspection on 10 November 2020, published geological and bore log information, CPTu testing, and assessment of the risk of liquefaction due to seismic shaking.

Whilst every care was taken during our investigation and interpretation of subsurface conditions, there may well be subsoil strata and features that were not detected. Additionally, on-going seismicity in the general area may lead to deterioration or additional ground settlement that could not have been anticipated at time of writing of this report.

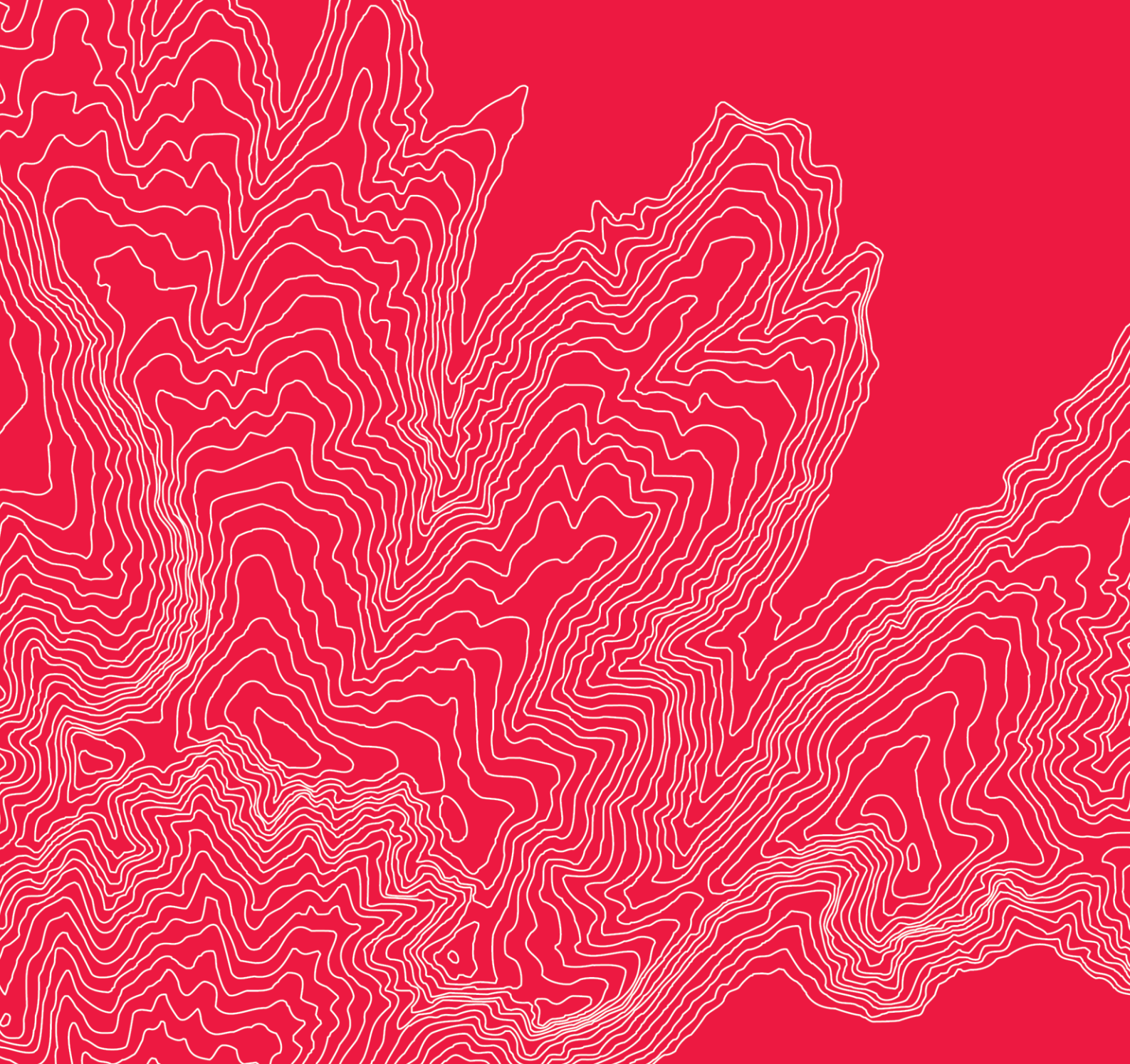
The exposure of such conditions, or occurrence of additional strong seismicity, may require a review of our recommendations.

This report has been prepared for the benefit of Northside Country, and the Waimakariri District Council. No liability is accepted by this company or any employee of this company with respect to the use of this report by any other party.

## **APPENDIX 6**

### **GROUND CONTAMINATION ASSESSMENT – 2020**





# Ground Contamination Assessment

**eliot  
sinclair**

**81 Gressons Road and 1375 Main North  
Road, Waikuku**

Prepared for Northside Country Limited

350494

## Ground Contamination Assessment

81 Gressons Road and 1375 Main North Road, Waikuku

Prepared for Northside Country Limited

350494

### Quality Control Certificate

Eliot Sinclair & Partners Limited

eliotsinclair.co.nz

Action	Name	Signature	Date
<b>Prepared by:</b>	Jeffrey Fleming Geotechnical Engineering Technician NZDE Civil		27 November 2020
<b>Reviewed by:</b>	Kristel Franklin Engineering Geologist BSc MSc (HAZM) CMEngNZ PEngGeol (1163943)		27 November 2020
<b>Directed and approved for release by:</b>	John Aramowicz Geotechnical Engineer Director BEng(Hons) Mining CMEngNZ IntPE(NZ) CPEng (1008112)		27 November 2020
<b>Status:</b>	Final		
<b>Release date:</b>	27 November 2020		
<b>Reference no:</b>	350494		
<b>Distributed to:</b>	Northside Country Limited		

### Limitations

*This report has been prepared for Northside Country Limited according to their instructions and for the particular objectives described in this report. The information contained in this report should not be used by anyone else or for any other purposes.*

## Contents

<b>1. Executive Summary</b>	<b>3</b>
<b>2. Introduction</b>	<b>4</b>
<b>3. Site Description</b>	<b>5</b>
<b>4. Site History</b>	<b>7</b>
4.1. Environment Canterbury Listed Land Use Register (LLUR)	7
4.2. Environment Canterbury Resource Consent Database	7
4.3. Waimakariri District Council Records (Property File)	8
4.4. Site Inspection and Landowner Interview	8
4.5. Historical Aerial Photographs and Satellite Images	10
<b>5. Arsenic in Groundwater</b>	<b>11</b>
<b>6. Conclusion and Recommendation</b>	<b>11</b>
<b>7. Accidental Discovery Protocol</b>	<b>12</b>
<b>8. Limitations</b>	<b>12</b>

**Appendix A. Site Plan**

**Appendix B. Site Photographs**

**Appendix C. Listed Land Use Register (LLUR)**

**Appendix D. Historical Aerial Photographs and Satellite Images**

**Appendix E. Environment Canterbury Resource Consents**

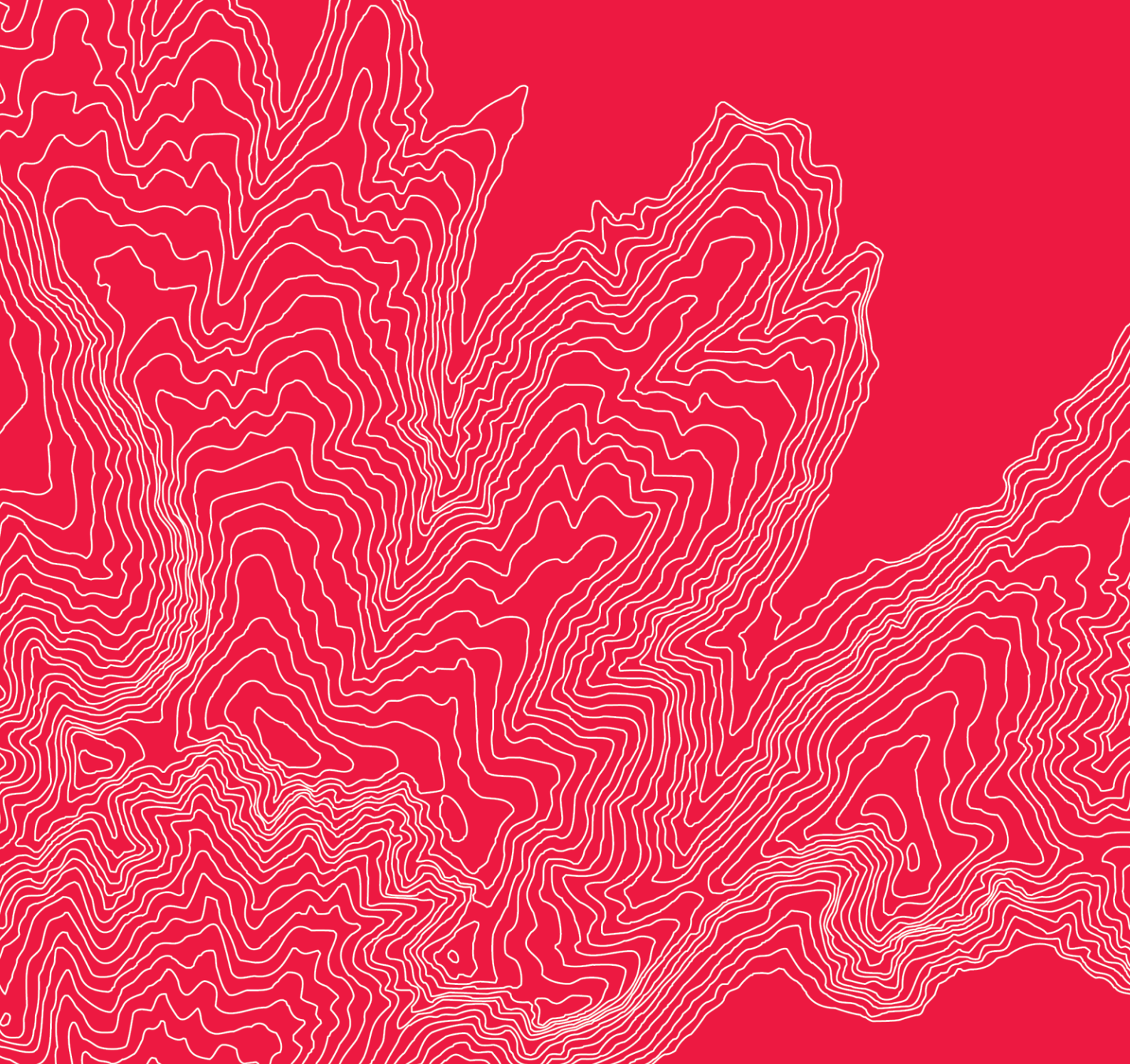
The National Environmental Standard for and Managing Contaminants in Soil to Protect Human Health (MfE 2011), and associated contaminated land management guidelines make abundant use of acronyms. Some commonly used abbreviations are:

ACM	Asbestos containing material
AST	Above ground storage tank
BAP	Benzo-alpha-pyrene
bgl	Below ground level
CCC	Christchurch City Council
CoC	Chain of Custody (Transport and Laboratory Quality Assurance), or
CoC	Contaminants of Concern
CSM	Conceptual Site Model
DSI	Detailed Site Investigation (often referred to as Phase 2)
DQO	Data Quality Objectives
ECan	Environment Canterbury Regional Council
HMs	Heavy metals screen; GC scan for Arsenic, Cadmium, Chromium, Copper, Lead, Nickel, Zinc
LLUR	Listed Land Use Register (ECan database of land with known or suspected contamination)
LWRP	Proposed Canterbury Land and Water Regional Plan (ECan 2012)
MfE	Ministry for the Environment
MMP	Monitoring and Management Plan (Phase 5)
NES(soil)	National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health. Regulations 2011.
NRRP	Natural Resources Regional Plan (Environment Canterbury 2011)
OCP	Organochlorine Pesticides
ONOP	Organophosphorus Pesticides
PAH	Polycyclic Aromatic Hydrocarbons
PEF	Potency Equivalent Factors, synonym with TEQ
PCP	Pentachlorophenol
PSI	Preliminary Site Investigation (often referred to as Phase 1)
QC/QA	Quality Control/Quality Assurance
RAP	Remedial Action Plan, often joint with a Health and Safety Plan (HSP) (Phase 3)
SCS(health)	Soil Contaminant Standard for health for inorganic substances
SPLP	Synthetic Precipitation Leaching Procedure
SVOC	Semi Volatile organic Compounds
SVR	Site Validation Report (Phase 4)

## **APPENDIX 7**

### **INFRASTRUCTURE SERVICING ASSESSMENT – 2020**





# Infrastructure Services Report

**eliot  
sinclair**

**81 Gressons Road & 1375 Main North  
Road, Waikuku**

Prepared for Northside Country Limited  
350494

## Infrastructure Services Report

81 Gressons Road & 1375 Main North Road, Waikuku

Prepared for Northside Country Limited

350494

### Quality Control Certificate

Eliot Sinclair & Partners Limited

eliotsinclair.co.nz

Action	Name	Signature	Date
Prepared by:	Edward Shaw Environmental Engineer		December 2014
	Updated by Cameron Mars Three Waters Engineer BE(Hons) Envion CMEngNZ CPEng		Updated 18 November 2020
Reviewed by:	Bruce Sinclair Surveyor/Principal BSc MS+SNZ RPSurv LCS		December 2014 Updated November 2020
Directed and approved for release by:	Bruce Sinclair Surveyor / Principal BSc MS+SNZ RPSurv LCS		December 2014 Updated November 2020
Status:	Final		
Release date:			
Reference no:	350494		
Distributed to:	Northside Country Limited		

### Limitations

*This report has been prepared for Northside Country Limited according to their instructions and for the particular objectives described in this report. The information contained in this report should not be used by anyone else or for any other purposes.*



## Contents

<b>1. Introduction</b>	<b>1</b>
<b>2. Site Description</b>	<b>1</b>
2.1. Topography and Land Use	2
2.2. Geology	2
2.3. Hydrogeology	2
2.4. Surface Water	4
<b>3. Reticulated Services</b>	<b>4</b>
3.1. Discharge of Stormwater	4
3.2. Discharge of Wastewater	6
3.3. Potable Water	8
3.4. Power	9
3.5. Telecommunication	9
<b>4. Staging</b>	<b>9</b>
<b>5. Conclusion</b>	<b>9</b>

**Appendix A. Outline Development Plan**

**Appendix B. Stormwater Calculations**

**Appendix C. Pressure Sewer Preliminary Design**

**Appendix D. Correspondence**

## 1. Introduction

Northside Country Limited have engaged Eliot Sinclair to undertake an infrastructure servicing assessment to support a plan change application at 83 Gressons Road and 1375 Main North Road, Waikuku, (the Site).

The scope of this report includes:

- a) a detailed site description relevant for reticulated servicing of the area;
- b) practicable options to service the area with regard to:
  - i) The discharge of stormwater;
  - ii) The discharge of wastewater;
  - iii) Potable water;
  - iv) Power; and
  - v) Telecommunications.

## 2. Site Description

The Site is located at the corner of Gressons Road and Main North Road (SH1) and has a gross area of approximately 34 ha (refer to Figure 1).



**Figure 1: Site Location (yellow outline)**

The Site comprises the land at 81 Gressons Road and 1375 Main North Road, Waikuku and two adjoining parcels with no street address. The full legal description is given in the Private Plan Change Request document.

**APPENDIX 8**

**OUTLINE DEVELOPMENT PLAN**



## LEGEND

- OUTLINE DEVELOPMENT PLAN AREA
- EXISTING ROAD
- LOCAL ROAD
- PROPOSED ROAD DESIGN
- POSSIBLE FUTURE ROAD
- PEDESTRIAN CYCLEWAY ACCESS
- OPEN DRAINAGE
- STORMWATER TREATMENT AREA

Designed	Name	Project Title		Project No.	Set No.	Sht No.	Rev.
Drawn	Bob Greening	Northside Country		350494	C5	1	-
Design Review	Paul Thompson	81 Gressons Rd / 1372 Main Nth RD					
Approved	Paul Thompson	Outline Development Plan					
		Northside Country					
		Drawing Title					
		Date					
		Date					
		Date					
		Date					
		Drawing Status					
		Scales					
		1:6000 [A4]					
		DRAFT					

**Eliot Sinclair**  
surveyors | engineers | planners

If re-zoned to the Residential 4A Zone the Site has the potential to yield approximately 57 lots. The Outline Development Plan (ODP) is included in Appendix A.

## **2.1. Topography and Land Use**

The Site comprises generally flat topography, with a slight fall down towards the southeast. The majority of the site is vegetated with grass and used for grazing cattle. Several shelterbelts (mostly poplars and eucalypts) separate the four principal land parcels. A section of the Site along the southern boundary is planted in pine. There is a disused well shed on the land at 81 Gressons Road and a derelict hay barn at the southwest corner of the Site. The Environment Canterbury (ECan) GIS database shows two wells (M35/4266 and M35/4277) located to the north of the site. The ECan well cards indicate that the wells are disused and this was confirmed by site inspection. There is no ECan consent associated with either well.

## **2.2. Geology**

The Geological Nuclear Science (GNS) geological map of Christchurch indicates most of the site is underlain by 'Grey river alluvium comprising gravel, sand and silt in active floodplains'.

The geotechnical report to support the proposed plan change prepared by Eliot Sinclair, found that the soil types encountered in the upper layers were generally consistent across the site. The eleven cone penetration test (CPTu) results generally indicated the presence of interbedded sand, sandy silts, and silty clays throughout the profile. The testing met practical refusal at between 2.6 to 20 m depth across the site, most likely on a dense sand or sandy gravel.

From the CPTu test results it appears that there is a layer of sandy gravel located around 2-4 m below ground level across the site, roughly in a southwest-northeast orientation. It is likely that this is an historic paeleochannel, with overbank deposits to the northwest and southeast.

Well logs from ECan's GIS database were also reviewed and confirm the interbedded nature of the soils.

Well M35/6353, located on the western boundary of Pt Lot DP 57114 encountered 'sandy silt' to 4 m, 'grey pug with some vegetation' to 12.5 m, 'sand' to 15 m overlying 'sandy gravel' to at least 16 m depth where the well terminated.

Well M35/7340, located approximately 25 m north of the site along Gressons Road, encountered 'clay' to 3 m, multiple layers of 'pug' and 'gravel' to 14.3 m, 'pug and sea shells' to 20 m overlying gravels to at least 23 m depth where the well terminated.

Well M35/7197, located approximately 355 m west of Lot 1 DP 62186 encountered 'claybound' and 'sandy gravels' to 5 m, 'sandy pug with gravels' to 21 m, 'black clay' to 25 m overlying 'gravel' to at least 41 m depth below ground level.

Well M35/6176, located approximately 22 m from the southern boundary along Main North Road (SH1), encountered 'clay' to 3 m, 'sand & some small gravels' to 14 m, 'peat' to 20 m, overlying 'gravels' to at least 23 m depth below ground level where the well was terminated. Well logs are included in Appendix B.

## **2.3. Hydrogeology**

The ECan GIS database (2020) indicates that the shallow groundwater underlying the Site is within an unconfined or semiconfined aquifer over the northeast part of the Site and the coastal confined gravel aquifer to the southwest. The GIS indicates that the regional groundwater flow is in an easterly direction.

Seven standpipes have been installed across the Site and groundwater levels were monitored on a monthly basis between June 2013 and October 2017. Figure 2 shows the standpipe locations and Table 1 provides an analysis of the groundwater monitoring data.



**Figure 2: Groundwater Monitoring Standpipe Locations**

**Table 1: Ground Water Monitoring Data (groundwater depth in metres below ground level, (m bgl))**

Standpipes	1	2	3	4	5	6	7
Highest (m bgl)	0.04	0.01	0.18	0.02	0.15	0.31	0.04
Lowest (m bgl)	1.72	1.93	0.97	1.73	2.41	1.70	2.35
Average (m bgl)	0.97	0.96	0.62	0.88	1.70	1.29	1.17
Median (m bgl)	1.04	0.91	0.63	0.80	1.88	1.38	1.34
15%ile (m bgl)	0.49	0.36	0.37	0.46	1.25	0.99	0.32
85%ile (m bgl)	1.37	1.68	0.91	1.43	2.01	1.52	1.93

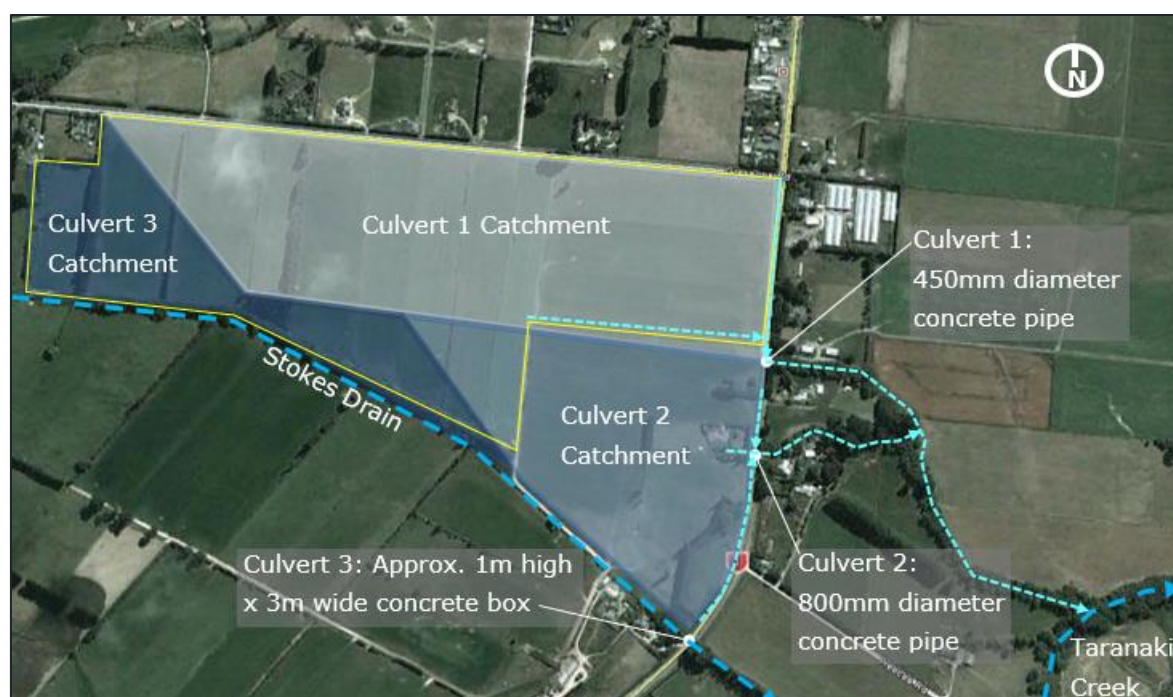
The groundwater depth across the Site fluctuates seasonally and generally the highest level was recorded in the western monitoring wells. Potentially, the highest groundwater monitoring data (shown in row 1 of the above table) is not accurate and there may have been water (or rainfall) infiltration into the standpipes giving a false result. It was noted that during some monitoring periods, especially after rainfall some wells indicated a groundwater near the surface while other suggested it was 1 m bgl. It is considered that the 15<sup>th</sup> and 85<sup>th</sup> percentile groundwater records should be used for groundwater depth measurements. The average annual groundwater depth across the full site is 1.10 m bgl.



## 2.4. Surface Water

The northern and eastern parts of the Site drain to a 450 mm diameter culvert beneath Main North Road via private drains along the eastern and southeastern boundaries of the site. The south and west of the site drain to Stokes Drain, which is conveyed beneath Main North Road in a box culvert measuring approximately 3 m wide by 1 m deep. A small area at the approximate centre of the Site drains with the land between the south east boundary of the Site and Main North Road to an 800 mm diameter culvert beneath the road.

The approximate catchment areas and the location of the culverts are shown in Figure 3.



**Figure 3. Drainage Plan (Background image: Google Maps, January 2014)**

Both Stokes Drain and the unnamed private drains are tributaries of Taranaki Creek. Taranaki Creek in turn discharges to the Ashley River mouth.

ECan's GIS database shows the Taranaki Creek catchment extends for approximately 11 km upstream of the Ashley River mouth. Assuming a stream velocity of 0.5 m/s (WWDG Table 21-4) would give a time of concentration at the confluence with the Ashley River of approximately 6 hours.

## 3. Reticulated Services

The following discussion on servicing the Site is based on information provided by WDC in their engineering code of practice, the District Plan and direct correspondence with members of WDC as well as ECan's Regional Plans, Christchurch City Council's Waterways Wetlands and Drainage Guide (WWDG) and private correspondence with other service suppliers.

### 3.1. Discharge of Stormwater

#### 3.1.1. Stormwater Conveyance, Treatment and Attenuation

The site is not serviced by a reticulated stormwater system and the depth of groundwater at less than 1 m makes the Site unsuitable for large-scale disposal of stormwater to ground via soakage.



## **APPENDIX 9**

### **EXTRACT – WAIMAKARIRI RURAL-RESIDENTIAL DEVELOPMENT STRATEGY 2019**

#### 4. Gressons Road

The Gressons Road Residential 4B area comprises approximately 53 hectares and 56 lots. It is located 3km north of Woodend and Pegasus, and 3km west of Waikuku Beach. The area is bounded by State Highway 1 / Main North Road to the east, Gressons Road to the south, and the Waikuku Stream to the north and west.

The area does not contain any community facilities or amenities, however, it is in close proximity to Woodend and Pegasus and their associated community facilities and social infrastructure.

The area is not currently connected to a reticulated wastewater network so wastewater disposal occurs via individual septic tanks. Similarly, the area is not currently connected to a reticulated water supply, which means water is sourced via individual bores. However, given the area's relatively close proximity to Woodend, Pegasus and Waikuku, connecting to these reticulated networks is possible with sufficient growth. The location is within a rated drainage area.

##### Strengths

**Overall, the Gressons Road area offers a number of strengths that support further rural residential development:**

- Close proximity to Woodend and Pegasus which have abundant community facilities and social infrastructure in place

- Close proximity to State Highway 1 providing good transport connections
- Medium soil drainage to the south and east, high soil drainage to the north
- Council Localised Flood Hazard Modelling shows only some small areas of low flood hazard surrounding the existing Residential 4B area. Areas to the south and east of the existing Residential 4B area are clear from medium to high flood hazard under Environment Canterbury's Ashley River Breakout Flood Modelling.
- Outside of identified active fault lines
- Within a rated drainage area
- No high voltage transmission lines infrastructure nearby
- No nearby mapped notable plants, vegetation and habitat sites or heritage sites.

##### Constraints

**The Gressons Road area also faces some environmental and other constraints:**

- Silent File Area SF017 Pekapeka to the south
- Within a Liquefaction Susceptibility Area
- Potential for coastal hazard issues including groundwater level rise associated with sea level rise
- Largely surrounded by versatile soils, except for a small portion to the northeast

- Low soil drainage to the west
- Council Localised Flood Hazard Modelling and Environment Canterbury's Ashley River Breakout Flood Modelling shows some medium to high flood hazard to the north and northwest of the existing Residential 4B area.

##### Growth Direction

**Taking into account these various constraints and opportunities, further rural residential growth will be enabled to the south of the existing Residential 4B settlement, as shown in Figure 10.**

This area is relatively free from localised flood hazard and avoids the potential community severance associated with State Highway 1. It also allows a greater level of integration with the existing settlement via Gressons Road. The key underlying landowner is in support of rural residential development at this site.

It is acknowledged the growth direction is within a Silent File Area indicating the presence of significant wāhi tapu or wāhi taonga somewhere in the area. Therefore, consultation with Ngāi Tūāhuriri is particularly important in order to identify effects of the activity and to avoid, remedy or mitigate those effects. It is also acknowledged that the growth direction does impact land with versatile soils.

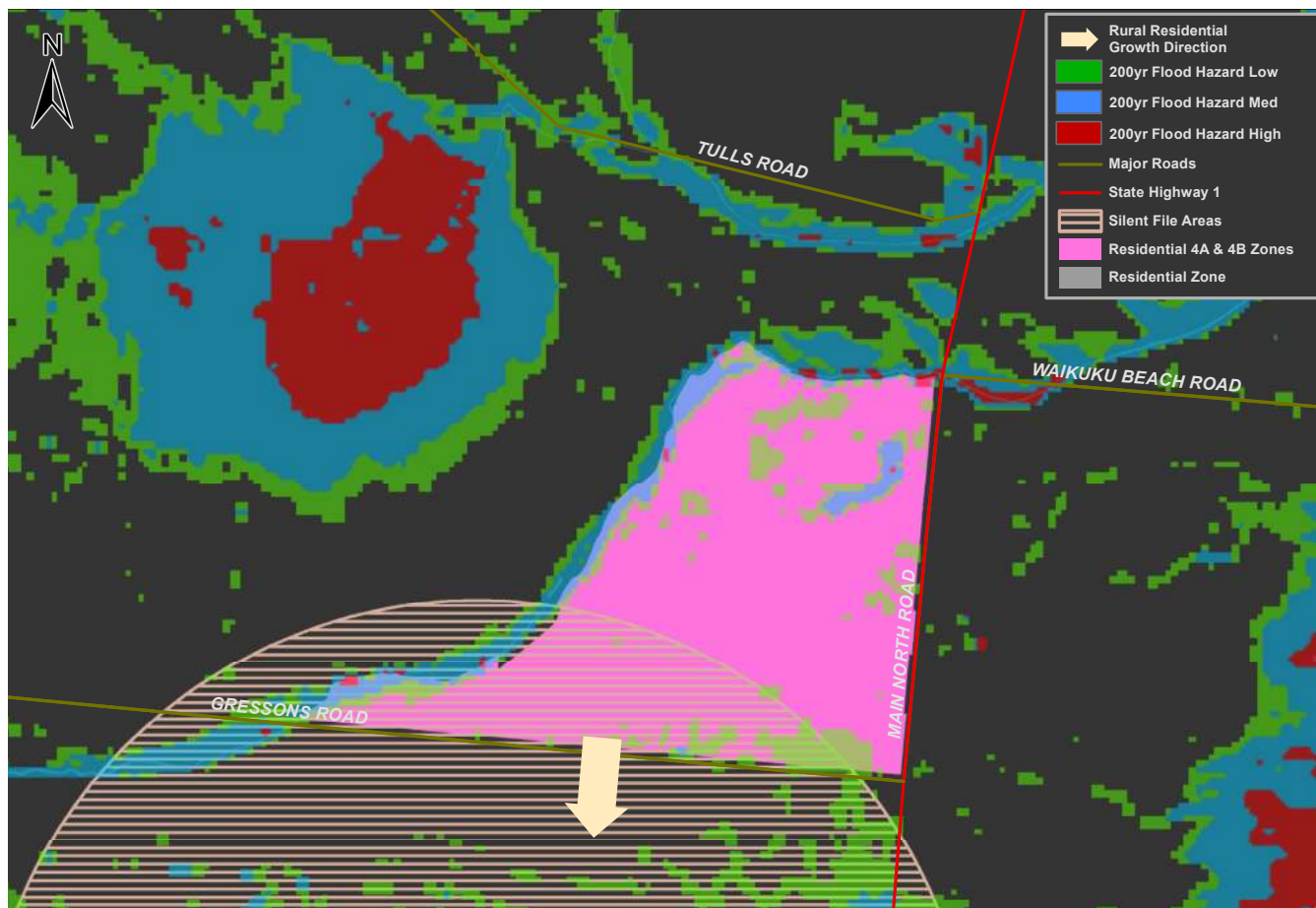


Figure 10: Gressons Road rural residential growth direction



Figure 11: Gressons Road area aerial map 2017

The Site largely drains to the 450 mm culvert beneath Main North Road or to Stokes Drain and these two drainage paths are intended to be maintained for the developed site. Each catchment will be served by a separate stormwater basin providing partial treatment and attenuation of the runoff prior to discharge.

Stormwater run-off from residential allotments and roading will be captured in roadside swales that will both treat and convey the run-off to the stormwater basins. An example calculation for a typical swale profile is included in Appendix B.

Where the catchments discharging to the swales become too large for efficient treatment to take place, the catchments will be broken up by installing sumps in the swale invert to direct flow to a piped stormwater network that will also discharge to the stormwater basins.

Sufficient area has been set aside in the ODP stormwater management areas to attenuate the run-off from a typical development of the site to residential 4A zoning to pre-development levels for all storms up to the 50 year return period 6 hour duration design event when groundwater is at its seasonally highest level.

The basins will also provide sufficient volume to satisfy the first flush requirement at a design rainfall depth of 25 mm. Calculations in Appendix B show how the provisional basin sizes were arrived at.

While the basins can be sized to capture the first flush, maintaining the 50 year 6 hour predevelopment discharge rates will only detain the first flush volume for 5-6 hours in the basins. While this is significantly less than the 24 hours stipulated in the WWDG, the basins primary purpose is attenuation as the run-off will be pre-treated in roadside swales. Any additional treatment provided by the basins can therefore be considered polishing.

Given the evidence of the shallow depth to groundwater across the site the basins are likely to have to be designed as wet basins with a permanent free water surface. The monitoring of the groundwater levels is ongoing and will be used to inform the final design of the basins at the detailed engineering design stage.

### 3.1.2. Flood Management

Figure 4, shows an overlay of the proposed subdivision plan and the Waimakariri District Council (WDC or "the Council") 200 year flood hazard map (WDC 2020). The flood hazard map incorporates the combined output of the 200 year localised rainfall, Ashley River Breakout and coastal flooding. Green shaded areas indicate a low hazard flood depth of less than 0.3 m and blue shaded areas indicate medium hazard flood depths of greater than 0.3 m. There are no high hazard flood areas within the Site (indicated by red shading).



**Figure 4. 200 Year Ashley River Floodplain Mapping (WDC, 2020)**

In general, there is isolated flooding within the proposed residential lots, indicative of water ponding due to rainfall, rather than flowing water. The main flooding impacts are to the southeast within the neighbouring land (Rt RS 3101) and within Lots 59 and 62, which have been set aside for stormwater management (e.g. stormwater basins).

It is a WDC requirement that residential lots be filled to at least the 200 year flood depth and finished floor levels be 400 mm above the flood depth (if applicable).

WDC may require the proposed development to undergo 200 year flood modelling to confirm that the Site has no adverse effects on surrounding properties. If this requirement is stipulated by Council, we recommend that it be carried out as part of the subdivision consent phase.

### 3.1.3. Conclusion

A stormwater management system incorporating swales for treatment and basins (likely to be wet ponds) for attenuation can be designed in accordance with the WWDC so that predevelopment discharge rates from the site are maintained for the developed site for events up to the 50 year 6 hour design storm.

The stormwater treatment areas and road reserves shown on the ODP allow sufficient space for the swales and basins required to provide the level of treatment and attenuation described.

WDC may require flood modelling to be carried out to confirm that the subdivision has no adverse effects on surrounding land areas during the 200 year rainfall and Ashley River Breakout. However, we do not envisage that the flood effects across the Site will present no restriction to rezoning and that the flood modelling if required be completed during the subdivision consent phase.

## 3.2. Discharge of Wastewater

The Site wastewater reticulation network will be low pressure sewer (LPS) due to the topography not allowing for gravity reticulation. Residential dwellings will have an individual pump to which effluent will drain prior to being discharged to a common rising sewer main located within the street berm. The sewer pump is located within a tank chamber allowing for approximately 24 to 48 hours of wastewater



storage. Each individual pump unit can be controlled by an IOTA OneBox control panel which allows for automation and external controlling of the pump.

The estimated average flow from the proposed 57 lots to Council's network is 39 m<sup>3</sup>/day at a peak wet weather flow rate of 4.2 L/s. However, given the proposed use of a pressurised system the peak discharge from the developed site is likely to be closer to the peak dry weather flow rate estimated as 1.1 L/s.

Eliot Sinclair consulted with WDC in 2014 and again in 2020 for confirmation of wastewater servicing requirements for the Site. In 2014 Council indicated that there is capacity available in the Pegasus Township sewerage system. The nearest point of connection to the Site would be the gravity sewer in Tiritiri Moana Drive (via Preeces and Kaiapoi Pa Roads). However, the Council's preferred point of connection would be the existing pumping station on Kawari Drive (off Tiritiri Moana Drive) due to concerns over odour generation.

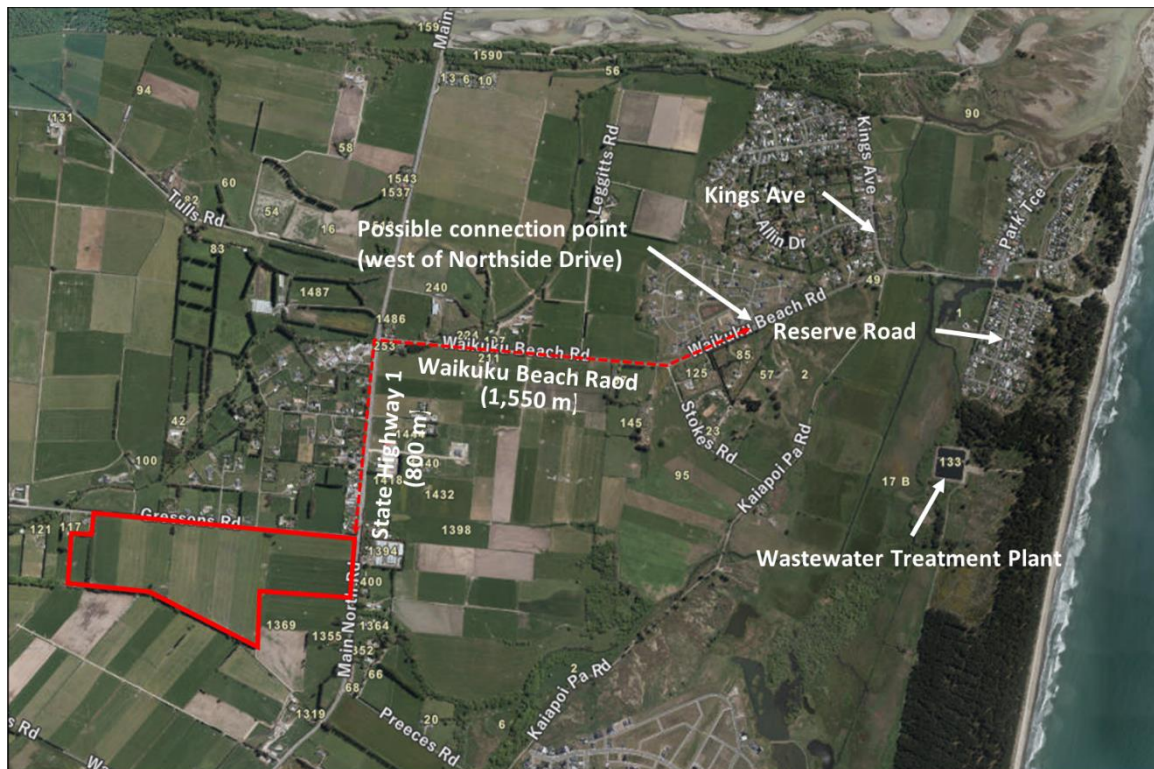
Since the initial 2014 consultation, WDC has advised (2020) that it is expected that any construction (particularly excavation) along Preeces Road and Kaiapoi Pa Road to Tiritiri Moana Drive would be strongly opposed by the local Runanga as this area is very culturally sensitive due to the location of the nearby Kaiapoi Pa.

Based on the assumption that discharging wastewater along Preeces Road would not be acceptable to local Runanga, WDC has stated that Ravenswood has limited capacity, therefore it would be more appropriate to service the development via Waikuku Beach which has capacity for the additional dry weather flow of 1.1 L/s, with the following caveats:

- There is a proposed renewal of the Kings Ave rising main (existing 100 mm diameter AC would be increased to a 125 mm), that would need to be undertaken before these connection were added.
- In conjunction with the renewal of the rising main it is possible that the Kings Ave pumps may need to be upgraded to service the Site. WDC would need to assess this requirement in more detail.
- The pumps at the Reserve Road pump station will need to be upgraded and potentially power and control as well. Potentially, there would only be an extra-over cost to the developer providing the pumps and associated components.
- There are no capacity restrictions in the Reserve Road rising main and the wastewater treatment plant.

WDC has also stated that the Site should be able to connect into the existing 110 mm diameter MPDE main just west of Northside Drive, however they will need to provide confirmation of this. If this connection was to be undertaken WDC may consider paying an extra over cost to the developer to upsize the rising main between State Highway 1 and Kings Ave to accommodate a possible future scheme extension to Waikuku township. The work under taken by PDU previously assumed that up to 96 new pressure connection in the Waikuku township could be added to the scheme in the future.

As shown in Figure 5, an 800 m length of pipe will need to be run down State Highway 1 and an additional 1,550 m down Waikuku Beach Road, up to Northside Drive.



**Figure 5: Potential Sewer Pipe Route and Distances**

Appendix C provides a concept LPS sewer design, prepared by Ecoflow in 2014. It should be noted that the design shows the discharge via Preece's Road, which is no longer feasible.

Appendix D provides the correspondence from WDC (2020).

### 3.2.1. Conclusion

The Site will be serviced by Low Pressure Sewer due to the topography not allowing for a gravity discharge. WDC has indicated that the Site will need to be serviced via Waikuku and the Reserve Road rising main and Wastewater Treatment plant have no capacity restrictions. However, Kings Road pumps may need to be upgraded and the pumps at the Reserve Road pump station will need to be upgraded and potentially the power and pump station controls.

We note, that during the design phase alternative solutions will be investigated, including the option of discharging via Preece's Road which was originally proposed by WDC in 2014.

While further assessment is required by WDC as to the extent of servicing and potential upgrade measures, we consider there are options available and wastewater servicing will not present a restriction to the rezoning of the Site.

## 3.3. Potable Water

The closest point of connection for a potable water supply to the site is the reticulated network in the Pegasus Township. During, initial Eliot Sinclair servicing investigations in 2014, WDC indicated that sufficient capacity exists to provide the site with a restricted supply. To connect to the restricted water supply each lot will be required to have its own tank and a pump to boost the supply pressure. The minimum tank size for domestic supply purposes would be 5,000 L.

Since the initial 2014 investigation, WDC has stated (2020) that water supply servicing has recently been considered and they have assessed a 315 mm diameter PE main water will be required to supply the proposed development area in Gressons Road as well as allowing for growth north of



Ravenswood, and to provide future servicing of the Waikuku township. It is expected that the Gressons Road development would only pay a portion of this cost with the remainder assumed to be funded through development contributions. WDC did not provide comment on the restricted supply to each lot, therefore until such time as WDC provides further advice it should be assumed that this is still applicable.

#### 3.3.1. Firefighting Water Supply

As the Site will be on a restricted supply hydrants installed within the Site may not be able to provide firefighting pressures and flows to SNZ PAS 4509:2008 requirements.

Hydrants installed at strategic locations within the Site would still provide limited firefighting capacity and act as a convenient location for fire tenders to re-fill.

Should firefighting pressures not be available larger tanks could be installed on each lot to provide further firefighting capacity. WDC have indicated that 25,000 L tanks have been installed in other recent subdivisions for this purpose.

#### 3.3.2. Conclusion

In summary, the secure supply of water for both domestic and firefighting purposes does not present a restriction to the rezoning of the Site.

### 3.4. Power

Mainpower has confirmed that the 11 kV overhead network in the vicinity of Gressons and Main North Road Corner has the capacity to supply the proposed subdivision. Appendix D provides the Mainpower confirmation letter.

### 3.5. Telecommunication

Chorus have confirmed that they can install fibre to the for the subdivision. Appendix D provides the Chorus confirmation email.

## 4. Staging

Any staging of the development has yet to be decided. Given the location of the stormwater treatment areas in the east of the site, it would be practical from a servicing perspective to progress any staging from east to west.

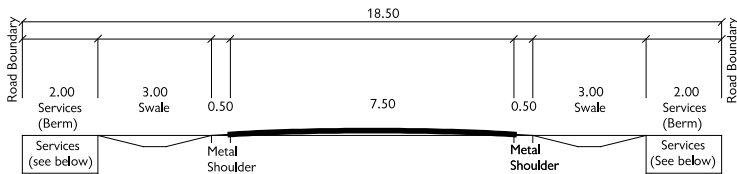
## 5. Conclusion

This report describes the site conditions that are relevant for servicing the area and has identified the following:

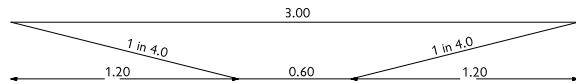
- Water supply, power and telecommunications services do not present impediments to the rezoning proposal for future residential development.
- Stormwater reticulation, treatment and attenuation do not present impediments to the rezoning.
- WDC may require 200 year flood modelling of the Site for confirmation that the development will not have adverse flooding effects on surrounding land areas. The majority of the site is not impacted by flood waters, with flooding generally limited to the southeast stormwater management zones. While the results of a flood modelling analysis cannot be predicted, the site layout and position of the stormwater management basins suggests that the development is unlikely to have any adverse effect. Should this not be the case, the stormwater basin capacities could be increased to provide additional water storage.

- WDC has indicated that an outfall will be available via Waikuku which is approximately 2.3 km away. However, we note that during the design phase an alternative outfall will be investigated (e.g. Preeces Road) to determine if there are more efficient servicing options.

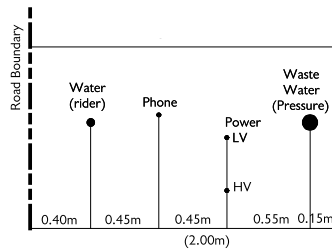
## Appendix A. Outline Development Plan



TYPICAL ROAD CROSS SECTION  
Scale 1:100



TYPICAL SWALE CROSS SECTION  
Scale 1:20



SERVICES LOCATION  
Scale 1:5

NOTES  
All roads are 18.50 metres wide.  
Piped Stormwater Easements are 2 metres wide unless shown otherwise

no.	amendment		initial	date	designed	Bob Greening	surveyed	origin of levels	Projection NZGD 2000 Circuit Mount Pleasant 2000	Scale: 1:2000 (A1) 1:4000(A3)  Date: 20/3/2014  LINZ Dec 2013 datum Lyttelton 1937 post Dec 2013	Drawing Set  350494 C4  PLOT 350494 C4 140312.DWG
	A	Lot 61 added - pedestrian access, swale moved across, note re land in LT 470921	pkg	25.6.14	manager	Bruce Sinclair	Roger Claessens	JA 87 Main North Road (SH1)			
	B	Road widened to 18.5m and revised Road Cross Section added	pkg	24.7.14	drawn	Bob Greening	surv. date	RL 6.271 LINZ Dec 2013			
	C	Stormwater amended - two ponds. Lot 58 removed	pkg	18.8.14	checked		Feb 2014				
	D	Possible Future Road added to Lot 27	pkg								
DRAFT											

Proposed Subdivision of  
81 Gressons Road and 1375 Main North Road (SH1), Waikuku  
(Lot 1 LT 470921, Lots 1 and 2 DP 428676, Lots 2 and 3 DP 62186 and Lot 2 DP 303387  
for Northside Country

**Eliot Sinclair**  
surveyors | engineers | planners

## Appendix B. Stormwater Calculations

## Volume Calculation Eastern Stormwater Basin

Composite Run off Coefficient Road Reserve:

Area (m2) = 27000

Surface	Area (m2)	C	CA
Seal	11000	0.85	9350
Shoulder	1500	0.5	750
Grass	14500	0.3	4350
	Total		14450
	C		0.54

Run off Coefficient Paddock/Garden/Reserve = 0.3

Existing Discharge (Q=CIA):

	Area (ha)	C	CA
Site Area =	24	0.3	7.2

Duration (Hours)	Return Period (Years)	Intensity (mm/hr)	Flow (m3/S)	Volume (m3)
1	5	15.3	0.31	1110.41
1	50	27.1	0.55	1966.81
3	5	8.67	0.17	1887.70
3	50	15.2	0.31	3309.47
6	5	6.03	0.12	2625.80
6	50	10.57	0.21	4602.77
12	5	4.3	0.09	3744.92
12	50	7.5	0.15	6531.84
24	5	2.93	0.06	5103.54
24	50	5.1	0.10	8883.30
48	5	1.87	0.04	6514.42
48	50	3.29	0.07	11461.20

Detention Basin Volume Calculation:

Limit developed discharge to 5yr 6hr storm (m3/s) = 0.12

Duration (Hours)	Return Period (Years)	Developed Flow (m3/s)	limited Discharge (m3/s)	Storage Volume (m3)
1	20	0.37	0.12	884.01
3	20	0.21	0.12	941.22
6	20	0.14	0.12	519.99
12	20	0.10	0.12	-745.68
24	20	0.07	0.12	-4319.50
48	20	0.04	0.12	-13015.39

6hr storage volume = 1654.24 m3  
25mm First Flush Volume = 2133.3 m3

Composite Run off Coefficient Lots:

Average lot size (m2) = 5000

Surface	Area (m2)	C	CA
Roofs	400	0.9	360
Seal	175	0.85	148.75
Gravel	175	0.5	87.5
Gardens	4250	0.3	1275
	Total		1871.25
	C		0.37

Proposed Discharge, Un-attenuated (Q=CIA):

	Area (ha)	C	CA
Lot Area =	17.8	0.37	6.7
Road Area =	2.6	0.54	1.4
Reserve =	1.6	0.3	0.5
	Total		8.5

Duration (Hours)	Return Period (Years)	Intensity (mm/hr)	Flow (m3/S)	Volume (m3)
1	5	15.3	0.37	1316.01
1	50	27.1	0.65	2330.98
3	5	8.67	0.21	2237.22
3	50	15.2	0.36	3922.24
6	5	6.03	0.14	3111.99
6	50	10.57	0.25	5455.01
12	5	4.3	0.10	4438.32
12	50	7.5	0.18	7741.26
24	5	2.93	0.07	6048.50
24	50	5.1	0.12	10528.11
48	5	1.87	0.04	7720.61
48	50	3.29	0.08	13583.33

Limit developed discharge to 50yr 6hr storm (m3/s) = 0.21

Duration (Hours)	Return Period (Years)	Developed Flow (m3/s)	limited Discharge (m3/s)	Storage Volume (m3)
1	2	0.65	0.21	1574.98
3	2	0.36	0.21	1654.24
6	2	0.25	0.21	919.01
12	2	0.18	0.21	-1330.74
24	2	0.12	0.21	-7615.89
48	2	0.08	0.21	-22704.67

**Eliot Sinclair**  
surveyors | engineers | planners

## Volume Calculation Southern Stormwater Basin

### Composite Run off Coefficient Road Reserve:

Area (m2) = 27000

Surface	Area (m2)	C	CA
Seal	11000	0.85	9350
Shoulder	1500	0.5	750
Grass	14500	0.3	4350
	Total		14450
	C		0.54

Run off Coefficient Paddock/Garden/Reserve = 0.3

### Existing Discharge (Q=CIA):

	Area (ha)	C	CA
Site Area =	9.5	0.3	2.85

Duration (Hours)	Return Period (Years)	Intensity (mm/hr)	Flow (m3/S)	Volume (m3)
1	5	15.3	0.12	439.54
1	50	27.1	0.22	778.53
3	5	8.67	0.07	747.22
3	50	15.2	0.12	1310.00
6	5	6.03	0.05	1039.38
6	50	10.57	0.08	1821.93
12	5	4.3	0.03	1482.36
12	50	7.5	0.06	2585.52
24	5	2.93	0.02	2020.15
24	50	5.1	0.04	3516.31
48	5	1.87	0.01	2578.63
48	50	3.29	0.03	4536.73

### Detention Basin Volume Calculation:

Limit developed discharge to 5yr 6hr storm (m3/s) = 0.05

Duration (Hours)	Return Period (Years)	Developed Flow (m3/s)	limited Discharge (m3/s)	Storage Volume (m3)
1	20	0.18	0.05	482.05
3	20	0.10	0.05	585.48
6	20	0.07	0.05	485.54
12	20	0.05	0.05	72.78
24	20	0.04	0.05	-1277.18
48	20	0.02	0.05	-4756.00

6hr storage volume = 1109.16 m3  
25mm First Flush Volume = 1073.2 m3

### Composite Run off Coefficient Lots:

Average lot size (m2) = 5000

Surface	Area (m2)	C	CA
Roofs	400	0.9	360
Seal	175	0.85	148.75
Gravel	175	0.5	87.5
Gardens	4250	0.3	1275
	Total		1871.25
	C		0.37

### Proposed Discharge, Un-attenuated (Q=CIA):

	Area (ha)	C	CA
Lot Area =	10.4	0.37	3.9
Road Area =	0.3	0.54	0.2
Reserve =	0.8	0.3	0.2
	Total		4.3

Duration (Hours)	Return Period (Years)	Intensity (mm/hr)	Flow (m3/S)	Volume (m3)
1	5	15.3	0.18	662.05
1	50	27.1	0.33	1172.64
3	5	8.67	0.10	1125.48
3	50	15.2	0.18	1973.16
6	5	6.03	0.07	1565.54
6	50	10.57	0.13	2744.25
12	5	4.3	0.05	2232.78
12	50	7.5	0.09	3894.39
24	5	2.93	0.04	3042.82
24	50	5.1	0.06	5296.37
48	5	1.87	0.02	3884.00
48	50	3.29	0.04	6833.35

Limit developed discharge to 50yr 6hr storm (m3/s) = 0.08

Duration (Hours)	Return Period (Years)	Developed Flow (m3/s)	limited Discharge (m3/s)	Storage Volume (m3)
1	2	0.33	0.08	884.64
3	2	0.18	0.08	1109.16
6	2	0.13	0.08	1016.25
12	2	0.09	0.08	438.39
24	2	0.06	0.08	-1615.63
48	2	0.04	0.08	-6990.65

**Eliot Sinclair**  
surveyors | engineers | planners



## Swale Sizing Calculation

### Runoff from gardens/paddocks

Total area (m2) =	30000
Less sealed surfaces (m2) =	25500
Runoff in ten mins (App 1/3)=	8500
C=	0.3
CA=	2550

### Runoff from road (say 175m)

Area (m2) =	1600
C=	0.54
CA=	864

### Runoff from sealed surfaces

Number of lots	6				SURFACE AREA
Surface	ea/lot (m2)	Area (m2)		C	CA
Roofs	400	2400	0.9		2160
Seal	175	1050	0.85		892.5
Gravel	175	1050	0.5		525
Total					3577.5

**Eliot Sinclair**  
surveyors | engineers | planners

## Swale ARC TP10 Treatment

Flow to treat is 1/3 of the 2 year 10 minute flow (Min 10mm/hr) - using  $Q = CIA$

min i =	10	mm/hr	Imp A	6991.5	m <sup>2</sup>
<b>Q =</b>	<b>19.42</b>	<b>l/s</b>			

### Water quality flow rate

for 50mm grass	
d < 75	d > 75
Manning from ARCTP10	
-1.64	0.107

### ARC TP10 Criteria

for 150mm grass	
d < 60	d > 60
Manning from ARCTP10	
0.37	0.14

Chanel bed Width	0.6	m	Pass - no wider than 2m	Chanel bed Width	0.6	m
Flow Depth	<b>0.148</b>	m	Pass - no greater than 100mm above vegetation	Flow Depth	<b>0.171</b>	m
Mannings roughness	0.107	Grassed swale	Calculated using ARCTP10	Mannings roughness	0.145	Grassed swale
Channel Slope one	0.33%	or 1: 300.03		Channel Slope one	0.3%	or 1: 300.03
Channel Side slope	25.00%	or 1: 4.00	Pass - no steeper than 1 in 3	Channel Side slope	25.0%	or 1: 4.00
		V: H				V: H
Wetted area	0.176		<div>Velocity using manings formula</div> <div><math>v = 1/n R^{2/3} S^{1/2}</math></div> <div>Where S = Slope, R = Hydraulic Radius and n = mannings roughness</div>	Wetted area	0.219	
Wetted perimeter	1.816			Wetted perimeter	2.006	
R	0.10			R	0.11	
v	0.11	m/s		v	0.09	m/s
<b>Flow</b>	<b>19.88</b>	<b>l/s</b>	Pass - no greater than 0.8m/s	<b>Flow</b>	<b>19.88</b>	<b>l/s</b>

Note: Manning values as calculated using ARC TP10 were used in establishing these velocities

Swale Length	175	m	Pass - minimum 30m	Swale Length	175	m
Residence time	<b>25.8</b>	mins	Pass - minimum 9 minutes	Residence time	<b>32.1</b>	mins

## Swale Conveyance

Time of Concentration: 30mins, Min Protection Standard Primary Infrastructure: 20% AEP

I =	22.8	mm/hr	Imp A	12091.5	m <sup>2</sup>
<b>Q =</b>	<b>76.58</b>	<b>l/s</b>			

### Min protection flow rate

for 50mm grass	
d < 75	d > 75
Manning from ARCTP10	
-5.70	0.066

### ARC TP10 Criteria

for 150mm grass	
d < 60	d > 60
Manning from ARCTP10	
0.32	0.09

Chanel bed Width	0.6	m	Pass - no wider than 2m	Chanel bed Width	0.6	m
Flow Depth	<b>0.222</b>	m	Pass - no greater than 100mm above vegetation	Flow Depth	<b>0.255</b>	m
Mannings roughness	0.066	Grassed swale	Calculated using ARCTP10	Mannings roughness	0.089	Grassed swale
Channel Slope one	0.33%	or 1: 300.03		Channel Slope one	0.3%	or 1: 300.03
Channel Side slope	25.00%	or 1: 4.00	Pass - no steeper than 1 in 3	Channel Side slope	25.0%	or 1: 4.00
		V: H				V: H
Wetted area	0.330		<div>Velocity using manings formula</div> <div><math>v = 1/n R^{2/3} S^{1/2}</math></div> <div>Where S = Slope, R = Hydraulic Radius and n = mannings roughness</div>	Wetted area	0.414	
Wetted perimeter	2.430			Wetted perimeter	2.705	
R	0.14			R	0.15	
v	0.23	m/s		v	0.19	m/s
<b>Flow</b>	<b>76.57</b>	<b>l/s</b>	Pass - no greater than 1.5m/s	<b>Flow</b>	<b>76.62</b>	<b>l/s</b>

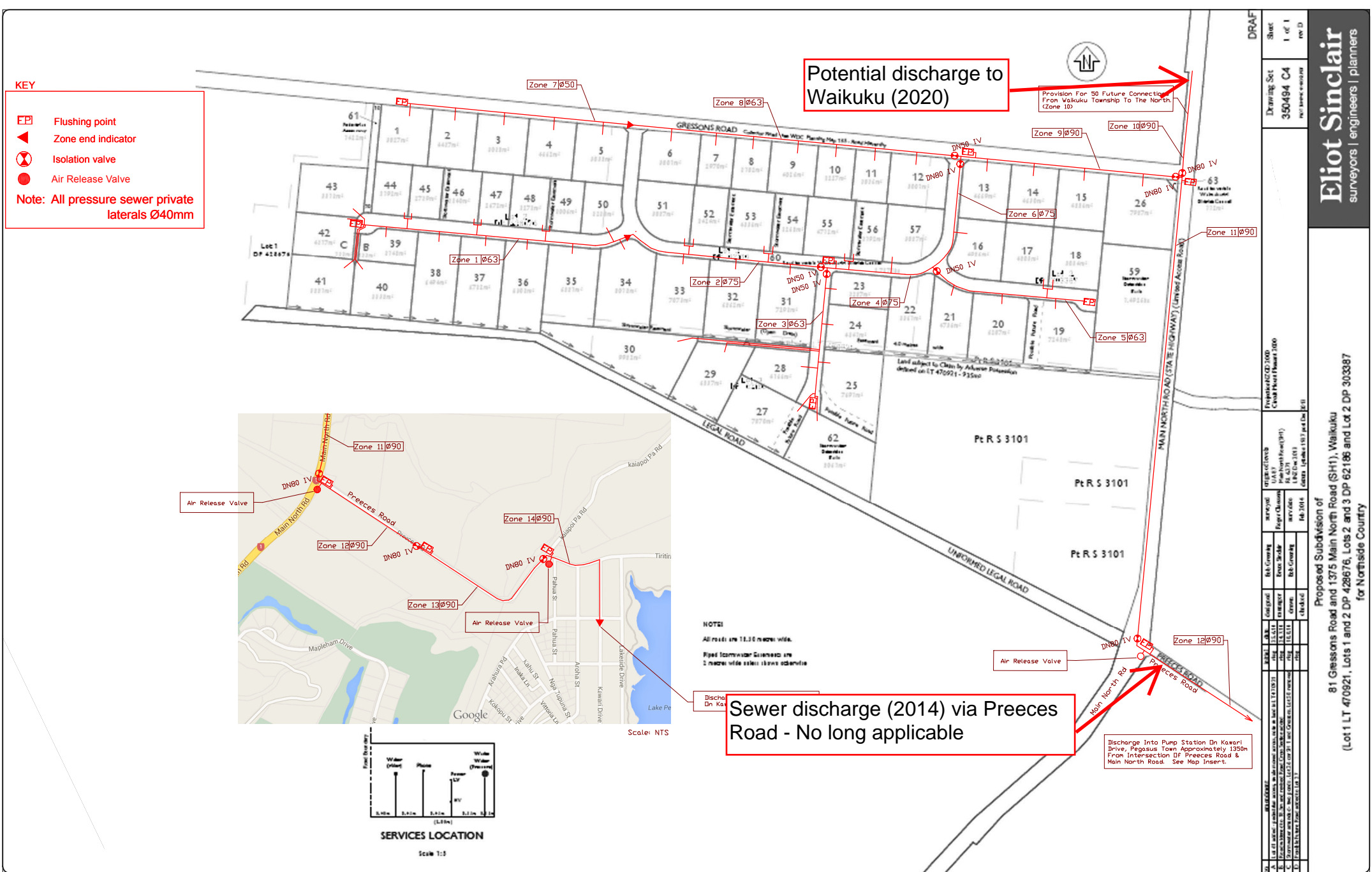
Note: Manning values as calculated using ARC TP10 were used in establishing these velocities

Swale Length	175	m	Pass - minimum 30m	Swale Length	175	m
Residence time	<b>12.6</b>	mins	Pass - minimum 9 minutes	Residence time	<b>15.8</b>	mins

Time of Concentration: 30mins, Erosion: 10% AEP									
Erosion flow rate		I =		27.36	mm/hr	Imp A	12091.5	m <sup>2</sup>	
		Q =		91.90	l/s				
		ARC TP10 Criteria							
		for 50mm grass						for 150mm grass	
		d < 75      d > 75						d < 60      d > 60	
		Manning from ARCTP10						Manning from ARCTP10	
		-6.62      0.062						0.31      0.08	
Chanel bed Width	0.6	m	Pass - no wider than 2m				Chanel bed Width	0.6	m
Flow Depth	0.234	m	Pass - no greater than 100mm above vegetation				Flow Depth	0.269	m
Mannings roughness	0.062	Grassed swale	Calculated using ARCTP10				Mannings roughness	0.084	Grassed swale
Channel Slope one	0.33%	or 1: 300.03	Pass - no steeper than 1 in 3				Channel Slope one	0.3%	or 1: 300.03
Channel Side slope	25.00%	or 1: 4.00					Channel Side slope	25.0%	or 1: 4.00
		V: H							V: H
		<div>Velocity using manings formula</div> <div><math>v = 1/n R^{2/3} S^{1/2}</math></div> <div>Where S = Slope, R = Hydraulic Radius and n = mannings roughness</div>							
Wetted area	0.360						Wetted area	0.452	
Wetted perimeter	2.532						Wetted perimeter	2.821	
R	0.14						R	0.16	
v	0.26	m/s	Pass - no greater than 1.5m/s				v	0.20	m/s
Flow	91.95	l/s					Flow	91.89	l/s
Note: Manning values as calculated using ARC TP10 were used in establishing these velocities									
Swale Length	175	m	Pass - minimum 30m				Swale Length	175	m
Residence time	11.4	mins	Pass - minimum 9 minutes				Residence time	14.3	mins

**Eliot Sinclair**  
surveyors | engineers | planners

## Appendix C. Pressure Sewer Preliminary Design



## Appendix D. Correspondence

Network Reference: MACK00022724

28/10/2020

Cameron Mars  
Eliot Sinclair  
20 Troup Drive  
Christchurch 8011

Dear Cameron,

**Re. Power Connection for Proposed Subdivision. Lot 2 DP 303387, lot 2 DP62186, Lot 2 DP 428676 and Lot 3 DP62186 Corner Gressons and Main North Road Waikuku.**

MainPower confirms that the 11kV Overhead network in the vicinity of Gressons and Main North Road Corner has the capacity to supply the proposed subdivision.

Please Note that this letter is to advise you that the MainPower NZ Ltd.'s Network has the Capacity for the Proposed subdivision.

This may not mean that there is an electrical supply to the boundary of the proposed lots.

Please do not hesitate to contact the MainPower NZ Ltd NSR Team on 03 311 8311 or [NSR@mainPower.co.nz](mailto:NSR@mainPower.co.nz) if you have any questions.

Yours faithfully



Matthew Bate  
Network Services Representative



## Cameron Mars

---

**From:** Neville Warsaw <Neville.Warsaw@Chorus.co.nz>  
**Sent:** Monday, 2 November 2020 11:00 a.m.  
**To:** Cameron Mars  
**Subject:** RE: [#350495] New Development Gressons Rd Waikuku

Hi Cameron

Thanks for your prompt reply.

Yes Chorus can supply a fibre solution to service this development.  
If and when you decide to proceed then please make the appropriate request to Chorus to provide the service.

For your planning purposed an desk top estimate to provide service would be in the range \$95-\$140k depend on the developer is doing in Gressons Rd.

Cheers,

**Neville Warsaw | Network Planner**

**CHORUS** | T +6439667497 | M +64274852920

---

**From:** Cameron Mars <cameron.mars@eliotsinclair.co.nz>  
**Sent:** Monday, 2 November 2020 10:02 AM  
**To:** Neville Warsaw <Neville.Warsaw@Chorus.co.nz>  
**Subject:** RE: [#350495] New Development Gressons Rd Waikuku

Hi Neville,

Thanks for the email.

No we aren't after costs at this stage, rather we are just wanting confirmation that chorus can supply telecommunications to the site.  
We discussed this block of land with Chorus back in 2014 and it was confirmed that fibre could be installed. However, the project was then put on hold until just recently; given the time frame since our last correspondence, we thought it prudent just to get a second confirmation.

Thanks



**Cameron Mars**

**3 WATERS ENGINEER**

**BE(Hons) Environ CMEngNZ IntPE(NZ) CPEng**

Christchurch | Rangiora

Queenstown | Hokitika | Nelson

**eliotsinclair.co.nz**  

*Caution: This email (including any attachments) may contain confidential and privileged information. If you have received it in error, please 1) notify the sender by return email (or telephone) and then delete this email, together with all attachments and your reply and 2) do not act on this email in any other way. Please visit [eliotsinclair.co.nz/](http://eliotsinclair.co.nz/) email disclaimer for other important information concerning this message. Thank you.*

---

**From:** Neville Warsaw <[Neville.Warsaw@Chorus.co.nz](mailto:Neville.Warsaw@Chorus.co.nz)>

**Sent:** Monday, 2 November 2020 9:49 a.m.

**To:** Cameron Mars <[cameron.mars@eliotsinclair.co.nz](mailto:cameron.mars@eliotsinclair.co.nz)>

**Subject:** RE: New Development Gressons Rd Waikuku

Hi

You Company has requested Chorus to supply a cost to reticulate 57 lots in Gressons Rd Waikuku.

To enable us to provide a cost I would like to know if you will be opening a trench along Gressons Rd to provide services to the 16 lots that face Gressons Rd.

If you are not, then Chorus will have to provide this trench..

Cheers,

**Neville Warsaw | Network Planner**

**CHORUS** | **T** +6439667497 | **M** +64274852920

**From:** [consumer@chorus-online.co.nz](mailto:consumer@chorus-online.co.nz) <[consumer@chorus-online.co.nz](mailto:consumer@chorus-online.co.nz)>

**Sent:** Tuesday, 27 October 2020 5:25 PM

## Cameron Mars

---

**From:** Gary Stevenson <gary.stevenson@wmk.govt.nz>  
**Sent:** Tuesday, 24 November 2020 11:25 a.m.  
**To:** Cameron Mars  
**Cc:** Bruce Sinclair; Gavin Hutchison; Chris Bacon; Subdivision Eng  
**Subject:** RE: [#350494] Water and Wastewater - 81 Gressons Road 34 ha Subdivision

Hi Cameron,

I have had a response from Chris Bacon, but I've gone back with further questions to give you a more complete picture where I can. Chris is currently on leave.

This aside, I can offer the following:

There would be capacity for an additional 1.1 L/s in the Waikuku Beach scheme with caveats:

- There is a proposed renewal of the Kings Ave rising main (existing 100mm AC to 125mm) that would need to be undertaken before these connections were added.
- In conjunction with the renewal of the rising main it's possible the Kings Ave pumps may need to be upgraded to service this subdivision. We would need to examine this in more detail.
- The pumps at the Reserve Road pump station will need to be upgraded and potentially power and controls also. It's likely that there would only be an extra-over cost to the developer providing the pumps and associated components.
- That there are no capacity restrictions in the Reserve Road rising main and the wastewater treatment plant.

The development should be able to connect into the existing 110mm MPDE main just west of Northside Drive, however we need to confirm that.

Following on from the above, if this connection was to be undertaken the Council may consider paying an extra over cost to the developer to upsize the rising main between State Highway One and Kings Ave to accommodate a possible future scheme extension to Waikuku township. The work undertaken by PDU previously assumed that up to 96 new pressure connections in the Waikuku township could be added to the scheme in the future.

Given the relatively small upgrades required to the Waikuku Beach scheme to accommodate the extra connections we believe IOTA will not be an option.

Cheers,

**Gary Stevenson** | Development Manager

Project Delivery Unit

Phone: 0800 965 468 (0800 WMK GOV)

Mobile: 021 480 833



**From:** Cameron Mars <cameron.mars@eliotsinclair.co.nz>

**Sent:** Wednesday, November 18, 2020 6:30 PM

**To:** Subdivision Eng <subdivisioneng@wmk.govt.nz>

**Cc:** Gary Stevenson <gary.stevenson@wmk.govt.nz>; Bruce Sinclair <BES@eliotsinclair.co.nz>

**Subject:** RE: [#350494] Water and Wastewater - 81 Gressons Road 34 ha Subdivision

**[THIS EMAIL IS FROM AN EXTERNAL SOURCE]** DO NOT CLICK links or attachments unless you recognise the sender email address and know the content is safe.

Dear Sir/Madam,

Gary Stevenson has forwarded on the email below relating to water/wastewater servicing for a 34 ha subdivision at 81 Gressons Road and 1375 Main North Road.

The email states wastewater servicing is only possible if our client can secure a pipeline route along Preeces/Kaiapoi Pa Roads (which the email indicates local Runanga are not likely to accept), however, the last paragraph says that Ravenswood has limited capacity but that we could discharge via Waikuku Beach which has some spare capacity available.

Could WDC please provide how much spare capacity Waikuku has, previous Eliot Sinclair reporting indicates our clients development low pressure sewer will have a dry weather flow rate of around 1.1 L/s. Also, if Ravenswood or Waikuku do have limited capacity, would installing IOTA OneBox controllers be a viable solution to limit the discharge to off-peak periods, thereby allowing the development more certainty of a discharge pathway?

Is Council able to provide any certainty that this development can discharge its wastewater to any existing infrastructure in the future?

Regards



**Cameron Mars**

**3 WATERS ENGINEER**

**BE(Hons) Environ CMEngNZ IntPE(NZ) CPEng**

Christchurch | Rangiora

Queenstown | Hokitika | Nelson

**eliotsinclair.co.nz**  

*Caution: This email (including any attachments) may contain confidential and privileged information. If you have received it in error, please 1) notify the sender by return email (or telephone) and then delete this email, together with all attachments and your reply and 2) do not act on this email in any other way. Please visit [eliotsinclair.co.nz/](http://eliotsinclair.co.nz/) email disclaimer for other important information concerning this message. Thank you.*

---

**From:** Gary Stevenson <[gary.stevenson@wmk.govt.nz](mailto:gary.stevenson@wmk.govt.nz)>

**Sent:** Monday, 16 November 2020 11:46 a.m.

**To:** Cameron Mars <[cameron.mars@eliotsinclair.co.nz](mailto:cameron.mars@eliotsinclair.co.nz)>

**Cc:** Subdivision Eng <[subdivisioneng@wmk.govt.nz](mailto:subdivisioneng@wmk.govt.nz)>

**Subject:** RE: [#350494] Water and Wastewater - 81 Gressons Road 34 ha Subdivision

Hi Cameron,

Apologies for the delay.

As per your email below servicing is possible but only if you could secure a pipeline route along Preeces Road and Kaiapoi Pa Road to Tiritiri Moana Drive.

It is expected that any construction (particularly excavation) along this road corridor would be strongly opposed by the local Runanga as this area is very culturally sensitive due to the location of the nearby Kaiapoi Pa. For this reason we have assumed that any future servicing for this development would need to be along SH1 to the Pegasus Roundabout.

Water supply servicing has recently been considered and we have assessed a 315mm PE main would be required to supply the proposed development area in Gressons Road as well as allowing for growth north of Ravenswood and to provide future servicing of the Waikuku township. It is expected that the Gressons Road development would only pay a portion of this cost with the remainder assumed to be funded through DC's.

Wastewater has not been reassessed assuming the pipeline corridor along Preeces Road is unavailable. It is likely this would need further assessment as the pressure main servicing Ravenswood has limited capacity and it may make more sense servicing this development via Waikuku Beach which has some spare capacity available.

I hope this helps.

Cheers

**Gary Stevenson** | Development Manager

Project Delivery Unit

Phone: 0800 965 468 (0800 WMK GOV)

Mobile: 021 480 833



**From:** Cameron Mars <[cameron.mars@eliotsinclair.co.nz](mailto:cameron.mars@eliotsinclair.co.nz)>

**Sent:** Tuesday, November 3, 2020 6:45 PM

**To:** Gary Stevenson <[gary.stevenson@wmk.govt.nz](mailto:gary.stevenson@wmk.govt.nz)>

**Subject:** RE: [#350494] Water and Wastewater - 81 Gressons Road 34 ha Subdivision

[THIS EMAIL IS FROM AN EXTERNAL SOURCE] DO NOT CLICK links or attachments unless you recognise the sender email address and know the content is safe.

Hi Gary,

Thanks for the update, also thanks for providing the email, I asked around the office for the correct WDC email and everyone suggested I just email you..... I'll pass on the email to the rest of our team for future reference.

Cheers



**Cameron Mars**

**3 WATERS ENGINEER**

**BE(Hons) Environ CEngNZ IntPE(NZ) CPEng**

Christchurch | Rangiora

Queenstown | Hokitika | Nelson

[eliotsinclair.co.nz](http://eliotsinclair.co.nz)  



*Caution: This email (including any attachments) may contain confidential and privileged information. If you have received it in error, please 1) notify the sender by return email (or telephone) and then delete this email, together with all attachments and your reply and 2) do not act on this email in any other way. Please visit [eliotsinclair.co.nz/](http://eliotsinclair.co.nz/) email disclaimer for other important information concerning this message. Thank you.*

---

**From:** Gary Stevenson <[gary.stevenson@wmk.govt.nz](mailto:gary.stevenson@wmk.govt.nz)>  
**Sent:** Tuesday, 3 November 2020 10:59 a.m.  
**To:** Cameron Mars <[cameron.mars@eliotsinclair.co.nz](mailto:cameron.mars@eliotsinclair.co.nz)>  
**Cc:** Subdivision Eng <[subdivisioneng@wmk.govt.nz](mailto:subdivisioneng@wmk.govt.nz)>  
**Subject:** RE: [#350494] Water and Wastewater - 81 Gressons Road 34 ha Subdivision

Hi Cameron,

I have forwarded your email to relevant asset managers for their review. Hope to get back to you in the next couple of days.

Can you please email [subdivisioneng@wmk.govt.nz](mailto:subdivisioneng@wmk.govt.nz) with these enquiries in future please.

Thanks

**Gary Stevenson** | Development Manager

Project Delivery Unit

Phone: 0800 965 468 (0800 WMK GOV)

Mobile: 021 480 833



---

**From:** Cameron Mars <[cameron.mars@eliotsinclair.co.nz](mailto:cameron.mars@eliotsinclair.co.nz)>  
**Sent:** Wednesday, October 28, 2020 9:50 AM  
**To:** Gary Stevenson <[gary.stevenson@wmk.govt.nz](mailto:gary.stevenson@wmk.govt.nz)>  
**Cc:** Gavin Hutchison <[Gavin.Hutchison@wmk.govt.nz](mailto:Gavin.Hutchison@wmk.govt.nz)>  
**Subject:** [#350494] Water and Wastewater - 81 Gressons Road 34 ha Subdivision

**[THIS EMAIL IS FROM AN EXTERNAL SOURCE]** DO NOT CLICK links or attachments unless you recognise the sender email address and know the content is safe.

Hi Gary,

We are carrying out a water supply and wastewater servicing review for a 34 ha (57 Lot) proposed residential subdivision, located at 81 Gressons Road & 1375 Main North Road, Waikuku. The land area of interest is shown in the picture below. We have discussed the site previously with WDC back in 2014; however, would like to revisit the servicing of the site for confirmation, given the timeframe since our last review of the area. Previous correspondence with WDC indicated the servicing requirements I've briefly summarised below. Could Council please provide an update or confirm if our 2014 reporting is still accurate.

#### **Wastewater**

In 2014 WDC indicated capacity was available in the Pegasus Township sewerage system to accept the discharge from the development. The nearest point of connection was the gravity sewer in Tiritiri Moana Drive, however, Council's preferred point of connection was the pump station on Kawari Drive due to concerns over odour generation. Low Pressure Sewer would be used due to topography not being suitable for a gravity system. Our original report indicates that Ecoflow have carried out a concept design, the estimated average flow to Council's network is 39 m<sup>3</sup>/day at a peak dry weather flow rate of 1.1 L/s.

#### **Water Supply**

Point of supply would be from Pegasus Township and in 2014 WDC indicated that sufficient capacity exists to provide the site with a restricted supply and that they may extend the supply to service the existing Waikuku Township. To connect to the restricted supply each lot will be required to have its own tank and pump to boost the supply pressure. The minimum tank size for domestic supply purposes would be 5,000 L. Potentially, these tank sizes might need to be increased to 25,000 L should firefighting pressures not be available.



Regards



**Cameron Mars**

**3 WATERS ENGINEER**

**BE(Hons) Environ CMEngNZ IntPE(NZ) CPEng**

Christchurch | Rangiora

Queenstown | Hokitika | Nelson

[eliotsinclair.co.nz](http://eliotsinclair.co.nz)



TCDD	2,3,7,8-Tetrachlorodibenzo-p-dioxin, persistent carcinogenic pollutant of 2,4,5-T; was widely used in forestry as defoliant (herbicide) in the 1950s-1960s.
TCLP	Toxicity Characteristic Leaching Procedure
TEQ	Toxic Equivalent
TLB	True left bank (of a river, as seen in the direction of flow)
TRB	True right bank (opposite the TLB)
UST	Underground storage tank

## 1. Executive Summary

This report comprises a ground contamination assessment for land at 81 Gressons and 1375 Main North Road in Waikuku, North Canterbury, and has been prepared to inform a proposed zone change from rural to residential land use.

This report is a Preliminary Site Investigation (PSI), prepared in accordance with the National Environmental Standard (NES), which ensures that potential contamination from recent or historical HAIL<sup>1</sup> activities is identified and assessed at the time of development and, if necessary, remediated to make the land safe for the intended use. Eliot Sinclair carried out an initial assessment and reporting for the site in December 2013 and have subsequently carried out a further site visit and desk study in November 2020.

The PSI is based on:

- A site walkover and interview with the site owner in September 2013 and November 2020,
- Investigation of a high-resolution aerial photograph from 1942, 1963, 1976, 1980, 1984, 2000 and satellite images from 2005 and 2013 to 2019,
- A search of Waimakariri District Council's property file,
- A search of Environment Canterbury's Listed Land Use Register (LLUR), and Resource Consent Database.

Most of the land has been in the ownership of Mr and Mrs Stokes since 1991 with other areas acquired between 2002 and 2003. The historical land use comprised cattle and sheep grazing, and barley cropping. The current land use is pastoral; i.e. Mr and Mrs Stokes currently use the land to graze dairy cattle (presently 400 cows/140 ha; i.e. approx. 3 cows/ha).

Farm chemicals are stored and formulated off-site, and site investigations did not reveal any farm pits, livestock dips or spray race operations, change in the natural contour of the land from excavation or fill, discoloured soils, or stressed vegetation. Apart from a historical disused well shed at 81 Gressons Road with an electric well and a historical hay shed at the southern boundary, there are no other buildings or structures on the land or, according to the owner, have been on the land.

Other than three small burn pads, no other historical or current activities have been identified during the site investigation and interview with the owner, the investigation of aerial photographs, the search of the property file, LLUR and Resource Consent Database that might have led to intentional or accidental release of hazardous substances. Consequently, acknowledging the three burn pads will need to be removed or remediated before subdivision, this preliminary site investigation concludes that it is unlikely that HAIL activities have taken place or are taking place on the land. On this basis, it is considered that it is "highly unlikely" that ground contamination is present that exceeds the NES soil contaminant standards for residential land use.

---

<sup>1</sup> Hazardous Activities and Industries List, published by the Ministry for the Environment (MfE, 2011).

A tabular summary of the ground contamination assessment is provided in Table 1.

Table 1. Summary of Ground Contamination Assessment.

<b>Site Addresses</b>	81 Gressons Road, 1375 Main North Road and three parcels in between without associated street address in Waikuku, North Canterbury
<b>Local Authority</b>	Waimakariri District Council
<b>Resource consents</b>	Two expired water take consents, no discharge consents, no hazardous storage consents
<b>Legal Description</b>	Lot 2 DP 428676, Lot 2 DP 62186, Lot 2 DP 303387, Lot 3 DP 62186, Lot 1 DP 470921; all on certificate of title 512583; Pt RS 3101 (paper road, 0.7852 ha)
<b>Area</b>	34.0768 hectares
<b>Owner/occupier</b>	Brian & Anne Stokes, and unknown (paper road)
<b>Current land use</b>	Pastoral (dairy cattle grazing), shelterbelts
<b>Proposed land use</b>	Residential
<b>LLUR ID</b>	None
<b>HAIL</b>	None

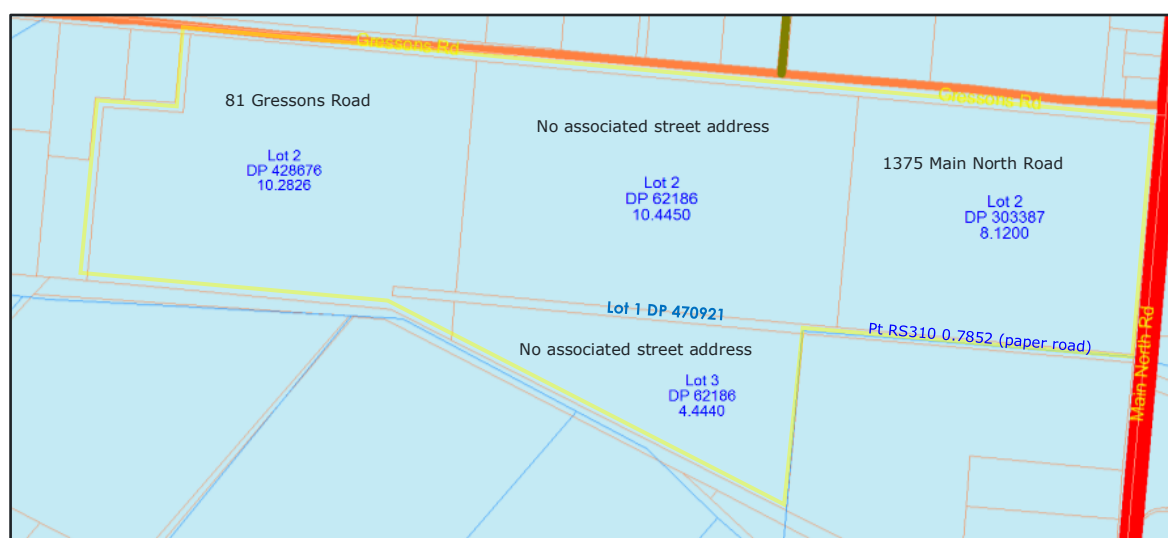


Figure 1 Site plan with Legal Description, source Qmap.

## 2. Introduction

Mr and Mrs Stokes have engaged Eliot Sinclair to undertake a ground contamination assessment of 34.0768 hectares at 1375 Main North Road (SH1) and 83 Gressons Road in Waikuku, North Canterbury.

The investigation has been carried out to inform a proposed zone change from rural to residential land use.

The report has been prepared in accordance with the National Environmental Standard (NESSoil<sup>2</sup>) and MfE's Contaminated Land Management Guidelines 1-5<sup>3</sup>. This ensures that potential contamination from recent or historical HAIL<sup>4</sup> activities is identified and assessed at the time of development and, if necessary, remediated to make the land safe for human use.

<sup>2</sup> Resource Management; National Environmental Standard (NES) for Assessing and Managing Contaminants in Soil to Protect Human Health; Regulations 2011/361.

<sup>3</sup> Ministry for the Environment (2004, 2006, 2011) Contaminated Land Management Guidelines Vol. 1-5.

<sup>4</sup> Hazardous Activities and Industries List, published by the Ministry for the Environment (MfE, 2011).



The scope of this report comprises:

- A description of the site and its surrounding environment to support a conceptual site model,
- Review of the Listed Land Use Register and Resource Consent Database from Environment Canterbury,
- Review of available information from the property file from the Waimakariri District Council,
- Review of a historical aerial photograph and a recent satellite images,
- A Site investigation and interview with the site owner,
- Conclusion and recommendations.

### 3. Site Description

The site is bordered by State Highway 1 at the southern fringes of the Waikuku settlement and Gressons Road. The site comprises five land parcels at 81 Gressons Road and 1375 Main North Road (SH1), and three parcels between without street addresses. Site plans are appended in Appendix A.

Legal Description: The legal description, associated street address, area and owner of the land area summarised in **Table 2**.

**Table 2. Legal description of the site.**

Lot	Title	Owner	Street Address	Area [ha]
Lot 2 DP 428676	512583	B&A Stokes	81 Gressons Rd	10.2826
Lot 2 DP 62186	512583	B&A Stokes	No street address associated	10.4450
Lot 2 DP 303387	512583	B&A Stokes	1375 Main North Road (SH1)	8.1200
Lot 3 DP 62186	512583	B&A Stokes	No street address associated	4.4440
Lot 1 DP 470921	512583	B&A Stokes	No street address associated	0.6410
Pt RS 3101	-	-	(paper road)	0.7852
			<b>Total</b>	<b>34.7178</b>

**Topography:** The land is classified as 'flat'<sup>5</sup> and has no significant topographical features. The lowest elevation of the site is approximately 5m asl (metres above sea level) in the north-eastern corner near SH1 (Main North Road). From there the land gently rises to approximately 10m asl towards the western boundary. This results in an average gradient of 1:240.

**Surface Water:** The nearest surface water is located in an open drain along the southern boundary of the site, which are part of the Stokes Drain catchment. No water quality management unit has been allocated to the drains in the proposed Land and Water Regional Plan. Waikuku Stream flows approximately 100m north of the site in a north-to east direction.

<sup>5</sup> LandCare Research soil classification / slope classes

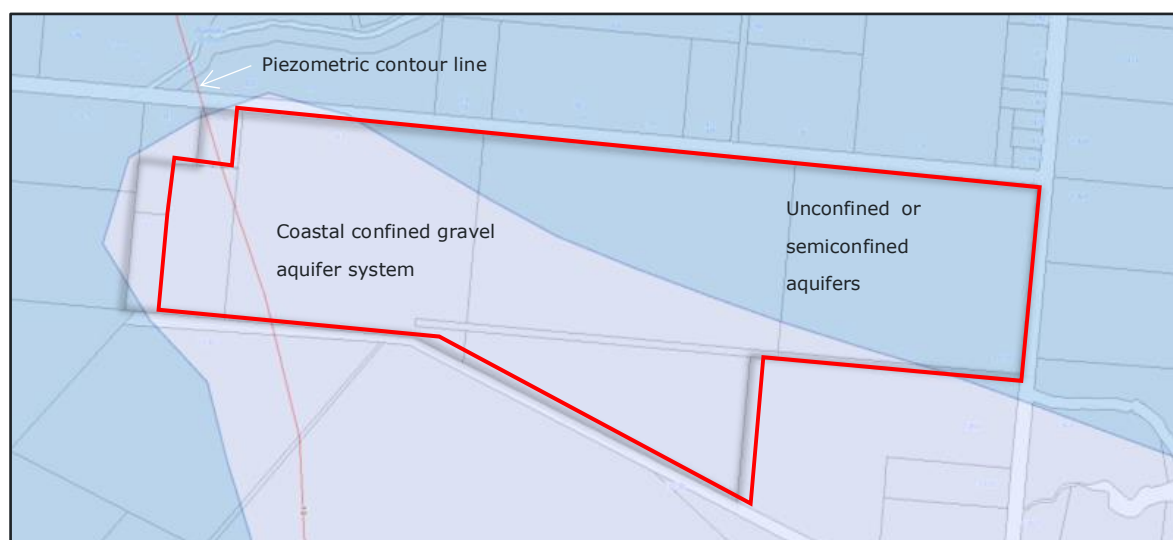
**Land Use:** Most of the area is currently held in pasture (i.e. irrigated and fertilised) and grazed by cattle. Several shelterbelts (mostly poplars and eucalypts) which previously separated the four principal land parcels have been removed since our 2012/13 site inspection. A poplar shelter belt still remains at the western end of Lot 2 DP 428676. A small area near the southern boundary was previously a pine plantation but was felled during 2015/2016.

**Soils and Underlying Geology:** The soil of the three blocks closest to Gressons Road is described as Wakanui Deep Silt Loam<sup>6</sup>. Landcare Research classifies the soil as 'imperfectly drained' (drainage class 3 out of 5<sup>7</sup>). The triangular shaped parcel along the southern boundary (Lot 3 DP 62186) has poorly drained Temuka Deep Silt Loam (drainage class 4 out of 5).

The underlying geology comprises alluvial deposits of silts and sandy gravels over sandy gravels.

**Groundwater:** Groundwater under the southwestern portion of the site is within the Coastal Confined Gravel Aquifer System. Groundwater under the north-eastern part of the site is assumed to be unconfined or semiconfined (Figure 2).

Seven piezometers were placed evenly across the site by Eliot Sinclair staff in July 2013 and monitored monthly until October 2017. Results indicate that groundwater can increase to around 1m to 2m below ground level seasonally around 1m to 2m below ground level and at or near the existing ground level and in winter and spring conditions.



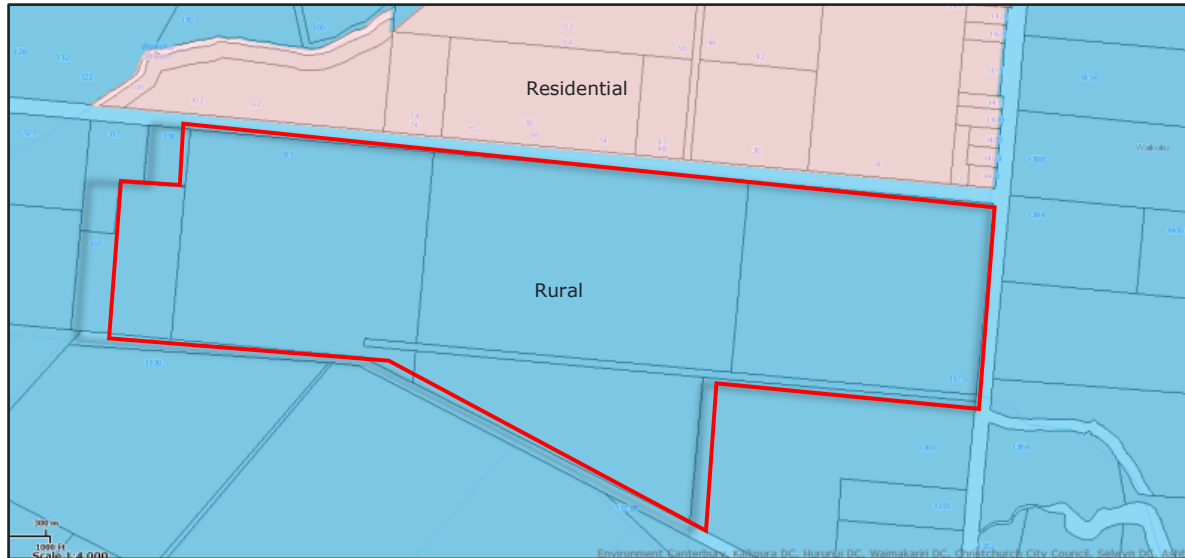
**Figure 2** Approximate extent of groundwater systems under the site.

**Waimakariri District Plan Zoning:** The current zoning of the site is 'Rural'. The zoning of the adjacent land north of Gressons Road is zoned 'Residential'. The adjacent land to the west, south and east is zoned 'Rural' (Figure 3). The proposed zoning for the site is for residential land use.

<sup>6</sup> ECan GIS

<sup>7</sup> LandCare Research Soil Drainage Classes

Class 1: well drained, Class 2: moderately well drained, Class 3: imperfectly drained, Class 4: poorly drained, Class 5: very poorly drained.



**Figure 3 Waimakariri District Plan zoning of the site.**

## 4. Site History

### 4.1. Environment Canterbury Listed Land Use Register (LLUR)

A search of Environment Canterbury's Listed Land Use Register (LLUR) has been undertaken. The LLUR is a database containing all known contaminated and potentially contaminated sites in Canterbury.

Environment Canterbury states that there are currently no known or anticipated HAIL activities on the site or within the area of enquiry. This does not necessarily mean that contamination has never occurred, or is not currently occurring. However, it confirms that no past or present sources of contamination are known and recorded.

The LLUR statements are appended in Appendix C.

**Conclusion:** Neither the site nor any of the surrounding land is recorded on Environment Canterbury's Listed Land Use Register.

### 4.2. Environment Canterbury Resource Consent Database

Environment Canterbury's resource consent database indicates two resource consents on the site, referring to the historical installation of a well and a surface water take. The well has been disused long time ago, and the consent for the surface water take expired in 1997.

No discharge consents, or consents for above or below ground storage of hazardous substances are recorded on Environment Canterbury's resource consent database.

Further details of the two expired resource consents on the site is appended in Appendix E.

**Conclusion:** Environment Canterbury's Resource Consent Database does not raise any specific concern about potential contamination from current or past consented activities.

### 4.3. Waimakariri District Council Records (Property File)

The property files held in the Waimakariri District Council were inspected on 26 September 2013. The files relate to several parcels that are not part of the site and include consent applications documents and approvals granted by the Council under the Building Act, and other information such as:

- Application forms,
- Construction details of a dairy shed and milk room,
- Project information memorandums (PIMs),
- Groundwater testing undertaken by Environment Canterbury. Wells M35/8110 (near the southern boundary of the site), M35/8759 (1.7km NE), M35/1160 (570m S of the site) and M35/4227 (1.7km E of the site) were found to have arsenic levels that are above NZ Drinking Water Standards; however, the water is considered safe for stockwater use.
- Most of the information contained in the property files relates to buildings that are on other land beyond the site.
- Our discussions with the landowner confirm no further consent applications have been made for the site since our review of the property file in 2013.

**Conclusion:** The property files do not raise any concerns about contamination of the site.

### 4.4. Site Inspection and Landowner Interview

- The site was inspected on 26 September 2013 and 10 November 2020 with the objective of identifying potential contaminants listed on MfE's Hazardous Activities and Industries List (HAIL<sup>8</sup>) such as:
- Above ground storage tanks/underground storage tanks (AST/UST) for fuel, chemicals or liquid waste,
- Storage, formulation and disposal of herbicides/pesticides,
- Sheep dips or spray races including remnants of it,
- Fibrous material potentially containing asbestos in deteriorated condition,
- Soils that are discoloured (stained e.g. with hydrocarbons or bleached),
- Soil mounds or excavations; change in natural contours of the land,
- Deposits of refuse, drums, canisters etc., historical landfills,
- Vegetation that is disturbed, stressed or discoloured,
- Any other activity that might have led to intentional or accidental release of a hazardous substance in sufficient quantity that it could be a risk to human health or the environment.

Photographs taken during the site investigations in September 2013 and November 2020 are in Appendix B.

An interview with the existing landowners, Mr and Mrs Stokes, was conducted during Eliot Sinclair's site inspection on 26 September 2013.

The information from the site inspection and interview is summarised as follows:

- Mr and Mrs Stokes have owned parts of the site since 1991 and further acquired the remainder in 2002/2003.
- The land is used to graze dairy cattle.
- Fonterra's milk screening programme did not detect organochlorine pesticides in the milk.

---

<sup>8</sup> Ministry for the Environment 2011. Hazardous Activities and Industries List (HAIL).

- A derelict well shed near Gressons Road (constructed of timber and corrugated iron) contains remnants of an electric well. The shed and well are disused. A hay storage shed was located near the paper road along the paper road/southern boundary of the site. According to the owner, no other structures have been erected on the site.
- No soil mounds, or excavations, or change in the natural contours of the land were identified.
- No other activity that might have led to contamination has been identified.

A follow up interview with Mr Stokes was conducted on the 9 November 2020.

The information from the interview is summarised as follows:

- Irrigation lines were installed on site for the centre pivot irrigation systems in 2015.
- Further irrigation trenches were excavated in 2020 to the Centre Pivot Irrigator at the east end of the site on Lot 2 DP303387.
- Wood and vegetation was stock piled at the southeast corner of Lot 2 DP 428676.
- Evidence of burn pads was observed during our site inspection. These were located at the east and western end of Lot 2 DP 428676 and are in the areas where some of the shelter belts were removed. Soil has been mounded up over the burn pads and further timber and vegetation has been placed over these areas including partially burnt logs and stumps. Soil sample were taken from each burn pad and analysed with an XRF (X-ray Fluorescence) to determine the elemental composition of the soil.

The soil sample taken from the burn pad at the eastern end of Lot 2 DP428676 was found to have concentrations of Arsenic between 22 to 40 mg/kg and is above the NES (2011) rural residential standard of 17mg/kg. The area of the burn pad is around 5m x 5m.

Soil samples taken from the burn pad at the western end of Lot 2 DP 428676 were found to have concentrations of Arsenic below 17mg/kg.

The wood and vegetation stock piled at the southeast corner of Lot 2 DP 428676 may also be covering a burn pad, however, no evidence of burnt wood was located in this area during our inspection.

These areas should be remediated as a condition of subdivision.

**Conclusion:** Other than the small burn pads, the site investigation did not raise any other concerns about persistent ground contamination of the site. The burn pads should be removed or remediated before subdivision of the site, however, this should not prevent the rezoning of the site to rural-residential.

#### 4.5. Historical Aerial Photographs and Satellite Images

A historical aerial photograph from 15 May 1963 has been obtained from New Zealand Aerial Mapping Ltd. Historical aerial photography has also been obtained from Retrolens for 1942, 1976, 1980, 1984, 2000, as summarised in Table 3. In addition, recent satellite images from 2005 and 2013 to 2019 have been analysed.

Key features are identified on the 2005, 2013 and 2019 satellite images in Attachment D.

The analysis of the historical photos and recent satellite images are summarised in Table 3.

**Conclusion:** The historical aerial photo from 1963 confirms that no buildings or structures were established on the site apart from the well shed near Gressons Road and the hay storage shed at the paper road along the southern boundary. No excavation or fill or other land use is visible that raises concerns about persistent ground contamination.

**Table 3. Summary of information from historical aerial photographs and recent satellite images.**

Date (source)	Scale	Description
■ 6/06/1942 (Retrolens)	1:16000	<ul style="list-style-type: none"> <li>■ The entire site is either cropped or grazed (sheep/cattle).</li> <li>■ Farming activity can be seen on Lot 2 DP 62186 and Lot 2 DP 303387.</li> </ul>
■ 15/05/1963 (NZAM)	1:16,000	<ul style="list-style-type: none"> <li>■ The entire site is either cropped or grazed (sheep/cattle).</li> <li>■ No excavation or fill is visible.</li> <li>■ Watering troughs are located at the northern boundary along Gressons Road.</li> <li>■ A hay shed is located near the paper road at the southern boundary. The shed is shown in Photo 3 in Attachment D. An electric well shed is located at 81 Gressons Road.</li> <li>■ No further structures or land uses are visible.</li> </ul>
■ 1/10/1976 (Retrolens)	1:50,000	<ul style="list-style-type: none"> <li>■ The hay shed located near the paper road at the southern boundary is no longer there.</li> <li>■ No further significant changes in land use are visible.</li> </ul>
■ 1/02/1980 (Retrolens)	1:25,000	<ul style="list-style-type: none"> <li>■ No further significant changes in land use are visible.</li> </ul>
■ 28/09/1984 (Retrolens)	1:25,000	<ul style="list-style-type: none"> <li>■ No further significant changes in land use are visible.</li> </ul>
■ 5/12/2000 (Retrolens)	1:50,000	<ul style="list-style-type: none"> <li>■ No further significant changes in land use are visible.</li> </ul>
■ 22/04/2005 (Google)	n/a	<ul style="list-style-type: none"> <li>■ Several watering troughs are established throughout the site.</li> <li>■ The block at 1375 Main North Road is newly sown; the remaining area is grazed.</li> <li>■ The disused power pole and pump shed remains at 81 Gressons Road.</li> <li>■ No further built structures or earthworks are visible.</li> </ul>
■ 17/02/2013	n/a	<ul style="list-style-type: none"> <li>■ No further significant changes in land use are visible.</li> </ul>

(Google)		
■ 1/11/2015	n/a	<ul style="list-style-type: none"> <li>■ Centre Pivot irrigation system starting to be installed.</li> <li>■ Trees removed west end of Lot 2 DP 428676.</li> </ul>
■ 23/7/2016	n/a	<ul style="list-style-type: none"> <li>■ Centre Pivot irrigation system visible</li> <li>■ Trees removed at southeast end and east end of Lot 2 DP 428676.</li> </ul>
■ 2/2/2017	n/a	<ul style="list-style-type: none"> <li>■ No further significant changes in land use are visible.</li> </ul>
■ 16/1/2018	n/a	<ul style="list-style-type: none"> <li>■ No further significant changes in land use are visible.</li> </ul>
■ 19/1/2019	n/a	<ul style="list-style-type: none"> <li>■ Three Centre Pivot irrigation systems visible on site.</li> <li>■ Two burn pads visible, plus stock pile of wood.</li> <li>■ No further significant changes in land use are visible.</li> </ul>

## 5. Arsenic in Groundwater

The property file held by the Waimakariri District Council identifies that elevated arsenic levels can be present in the groundwater of coastal and near coastal areas of the Canterbury Plains. While the concentration of Arsenic is generally low, in some cases the concentration exceeds the maximum allowable value (MAV) of 0.01mg As/l. The highest concentrations of arsenic are generally found in groundwater from the first confined aquifer (Riccarton Gravels) at a depth of approximately 20m, but groundwater from some wells screened in the second aquifer (Linwood Gravels) at a depth of approximately 40m has also shown elevated arsenic levels.

The arsenic is associated with buried swamp deposits and is derived from the degradation of organic matter. This consumes dissolved oxygen and leads to anoxic (reduced) conditions in groundwater, which can lead to naturally elevated concentrations of iron, manganese, arsenic and/or hydrogen sulphide.

Groundwater containing naturally occurring concentrations of arsenic that are above NZ Drinking Water Standards should not be used for potable water.

## 6. Conclusion and Recommendation

The investigations undertaken in this report have not raised any concerns about ground contamination sources and/or indicators such as farm chemicals (they are stored and formulated off-site), farm pits, livestock dip or spray races, changes in the natural contour of the land from excavation or filling, discoloured soils, or stressed vegetation. Apart from a historical hay shed that was removed before 1976, and a well shed at 81 Gressons Road with a disused electric well, no buildings or other structures have been, or are, on the site.

This Preliminary Site Investigation concludes that on the balance of probabilities, it is unlikely that HAIL activities have taken place, or are taking place on the site<sup>9</sup>. It is accepted that there are two burn pads that contain concentrations of Arsenic, with results that exceed the NES threshold for rural residential land. These areas are small and will be removed or remediated before subdivision. On this basis, it is considered highly unlikely that ground contamination from past or current activities will exceed the NES soil contaminant standards for the proposed rural residential land use.

<sup>9</sup> Including the migration and intentional or accidental release of hazardous substances from adjacent land in sufficient quantity that it could be a risk to human health or the environment.



## 7. Accidental Discovery Protocol

If any of the following materials are encountered during any future earthworks, such as:

- Stained or odorous soil (e.g. black, green, grey; or smells of rotting organic material, petroleum hydrocarbons or solvents)
- Slag, ash, charcoal
- Rubbish comprising putrescible waste, or hardfill
- Potential asbestos containing-material (for example fragments from cement fibre sheets, or loose fibres from insulation, etc.)

Then we recommend:

- i) Excavation and earthworks cease, the site secured to stop people entering the area where potential contamination was encountered, and then:
- ii) Contact a contaminated land specialist for further advice. If required, **Eliot Sinclair (03) 379 4014** can inspect the area, assess the material determine if it is contaminated or hazardous, and then determine a practical course of action.

This report does not relieve contractors and landowners of their responsibilities under the Health and Safety at Work Act 2015.

## 8. Limitations

The comments made in this report are based on a desktop review and site walkover inspections on 26 October 2013 and 10 November 2020. It is possible these may not provide a complete or accurate assessment of the entire site. As a result, Eliot Sinclair provides this information on the basis that it does not guarantee that the information is complete or without error and accepts no liability for any inaccuracy in, or omission from, this information.

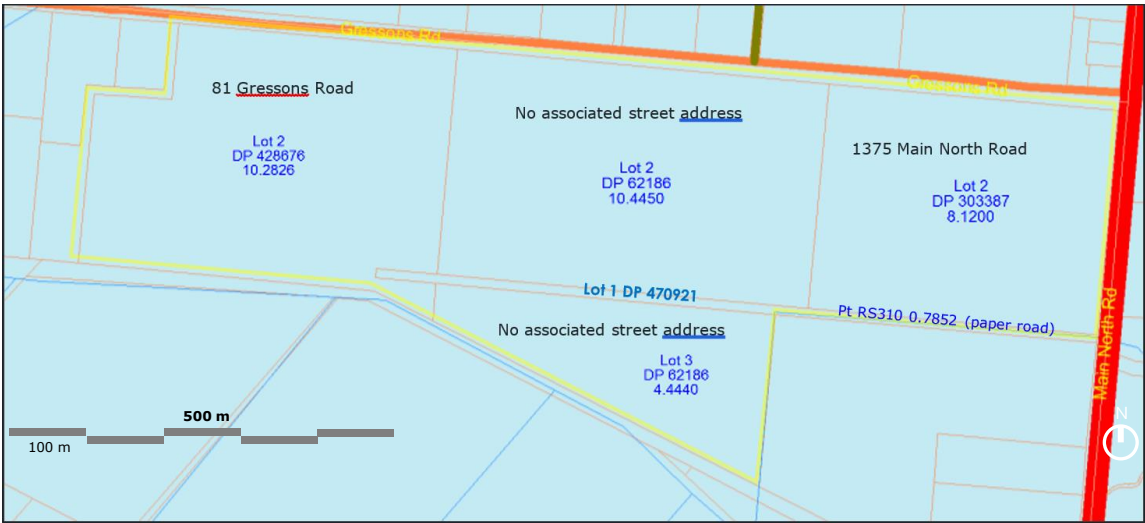
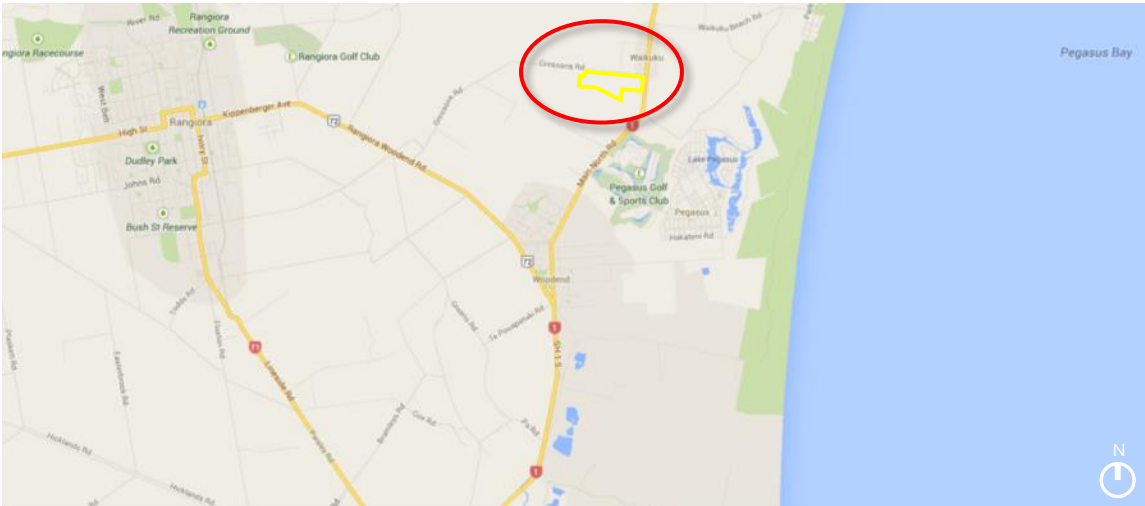
All reasonable effort has been made to ensure that the conclusions drawn in this report are correct at the time of reporting. However, the activities described on the HAIL may change in the future as knowledge about potentially hazardous activities develops over time.

It is possible there may be unidentified subsoil conditions that are not obvious from the information obtained by our investigations and site inspection, and that differ from the conclusions of this report. Should unusual geotechnical conditions be encountered during future earthworks such as historical uncontrolled fill materials, then Eliot Sinclair should be advised. They can review any new information and to advise if the recommendations of this report are still valid.

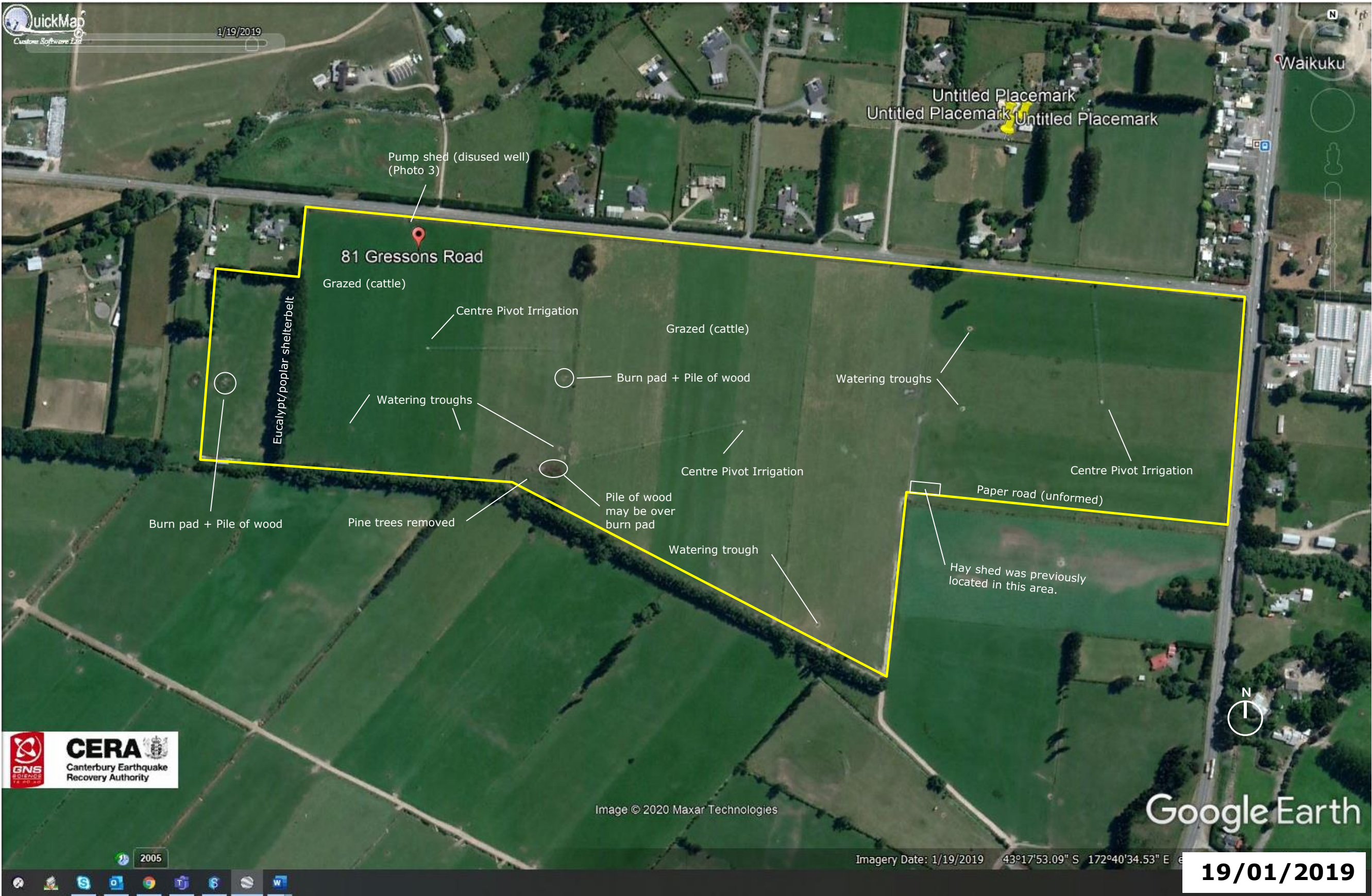
This report has been prepared for the benefit of Waimakariri District Council. No liability is accepted by this company or any employee of this company with respect to the use of this report by any other party or for any other purpose other than what is stated in our scope of work.

This report does not relieve contractors of their responsibilities under the Health and Safety at Work Act 2015. Site conditions relevant to construction works should be assessed by contractors who can make their own interpretation of the factual data provided.

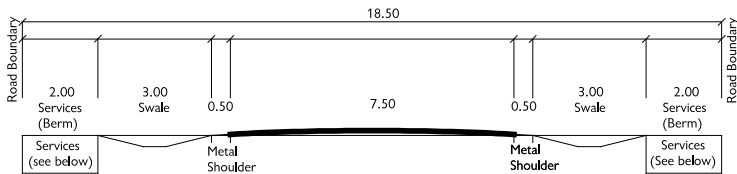
Appendix A: Site Plan



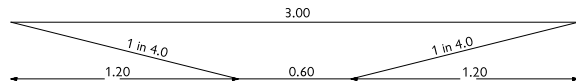




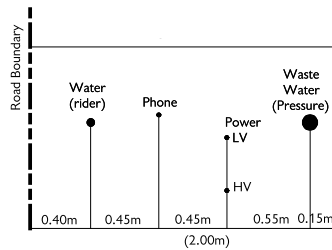




TYPICAL ROAD CROSS SECTION  
Scale 1:100



TYPICAL SWALE CROSS SECTION  
Scale 1:20



SERVICES LOCATION  
Scale 1:5

NOTES  
All roads are 18.50 metres wide.  
Piped Stormwater Easements are 2 metres wide unless shown otherwise

no.	amendment	initial	date	designed	Bob Greening	surveyed	origin of levels	Projection NZGD 2000 Circuit Mount Pleasant 2000	Scale: 1:2000 (A1) 1:4000(A3)	Drawing Set	Sheet
	A Lot 61 added - pedestrian access, swale moved across, note re land in LT 470921	rkg	25.6.14	manager	Bruce Sinclair	Roger Claessens	JA 87 Main North Road (SH1)		350494 C4	350494 C4	1 of 1
	B Road widened to 18.5m and revised Road Cross Section added	rkg	24.7.14	drawn	Bob Greening	surv. date	RL 6.271 LINZ Dec 2013				rev D
	C Stormwater amended - two ponds - Lot 26 and Gressons - Lot 58 removed	rkg	18.8.14	checked		Feb 2014	datum Lyttelton 1937 post Dec 2013		Date: 20/3/2014		
D Possible Future Road added to Lot 27											

Proposed Subdivision of  
81 Gressons Road and 1375 Main North Road (SH1), Waikuku  
(Lot 1 LT 470921, Lots 1 and 2 DP 428676, Lots 2 and 3 DP 62186 and Lot 2 DP 303387  
for Northside Country

**Eliot Sinclair**  
surveyors | engineers | planners

## Appendix B: Site Photographs (taken on 26/09/2013)



Photo 1. View across the site looking west.



Photo 2. View across the site looking southeast towards Main North Road (SH1).





Photo 3. Power pole and disused well shed at 81 Gressons Road (looking south).

## Site Photographs (taken on 10/11/2020)

Photo 4. Power pole and disused well shed at 81 Gressons Road (looking east).







Photo 5. 81 Gressons Road (looking west).



Photo 6. 1375 Main Road and 81 Gressons Road (looking west)

## Appendix C: Listed Land Use Register (LLUR)

### Search of Listed Land Use Register 18 September 2013

81 Gressons Road



Customer Services  
P. 03 353 9007 or 0800 324 636  
PO Box 345  
Christchurch 8140  
P. 03 365 3828  
F. 03 365 3194  
E. [ecinfo@ecan.govt.nz](mailto:ecinfo@ecan.govt.nz)  
[www.ecan.govt.nz](http://www.ecan.govt.nz)

Dear Sir/Madam

Thank you for submitting your property enquiry in regards to our Listed Land Use Register (LLUR) which holds information about sites that have been used, or are currently used for activities which have the potential to have caused contamination.

The LLUR statement provided indicates the location of the land parcel(s) you enquired about and provides information regarding any LLUR sites within a radius specified in the statement of this land.

Please note that if a property is not currently entered on the LLUR, it does not mean that an activity with the potential to cause contamination has never occurred, or is not currently occurring there. The LLUR is not complete, and new sites are regularly being added as we receive information and conduct our own investigations into current and historic land uses.

The LLUR only contains information held by Environment Canterbury in relation to contaminated or potentially contaminated land; other information relevant to potential contamination may be held in other files (for example consent and enforcement files).

If your enquiry relates to a farm property, please note that many current and past activities undertaken on farms may not be listed on the LLUR. Activities such as the storage, formulation and disposal of pesticides, offal pits, foot rot troughs, animal dips and underground or above ground fuel tanks have the potential to cause contamination.

Please contact and Environment Canterbury Contaminated Sites Officer if you wish to discuss the contents of the LLUR statement, or if you require additional information. For any other information regarding this land please contact Environment Canterbury Customer Services.

Yours sincerely

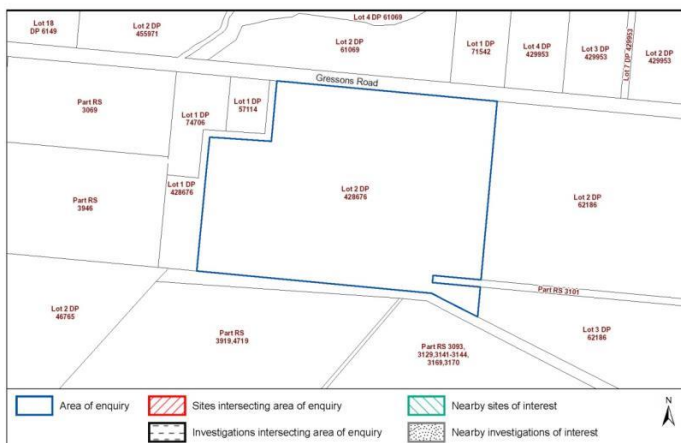
**Contaminated Sites Team**

**Statement from the Listed Land Use Register**



PO Box 345, Christchurch  
General enquiries: 03 365 3828  
Fax: 03 365 3194  
Email: [ecinfo@ecan.govt.nz](mailto:ecinfo@ecan.govt.nz)  
Customer services: 03 353 9007  
or: 0800 EC INFO (0800 324 636)  
Website: [www.ecan.govt.nz](http://www.ecan.govt.nz)

**Date:** 18 September 2013  
**Land Parcels:** • Lot 2 DP 428676 **Valuation No(s):**



**Summary of sites:**

There are no sites associated with the area of enquiry.

Please note that the above table represents a summary of sites intersecting the area of enquiry within a 50m buffer.

For further information from Environment Canterbury, contact the Contaminated Sites Officer and refer to enquiry number 20647.

**Disclaimer:**

*The enclosed information is derived from Environment Canterbury's Listed Land Use Register and is made available to you under the Local Government Official Information and Meetings Act 1987 and Environment Canterbury's Contaminated Land Information Management Strategy (ECan 2009).*

*This information reflects Environment Canterbury's current understanding of this site, which is based only on the information thus far obtained by it and held on record concerning this site. It is released only as a copy of those records and is not intended to provide a full, complete or totally accurate assessment of the site. As a result, Environment Canterbury is not in a position to warrant that the information is complete or without error and accepts no liability for any inaccuracy in, or omission from, this information.*

*Any person receiving and using this information is bound by the provisions of the Privacy Act 1993.*

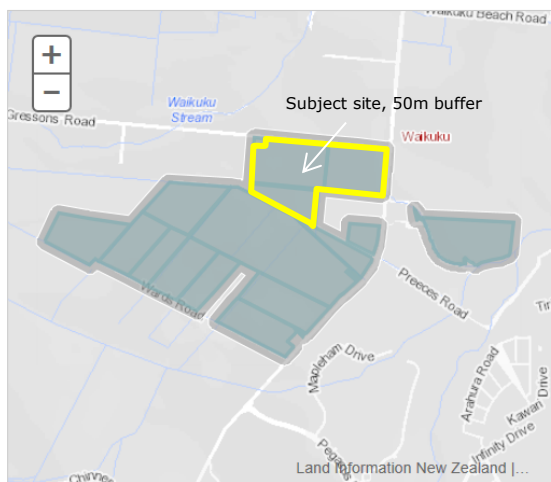
1375 Main North Road and Parcels without Street Address

Multiple parcels (including subject site); none of the parcels is recorded on LLUR.

## Listed Land Use Register



[Home](#) [Advice & Info](#) [Services](#) [Our Responsibilities](#) [News & Notices](#) [Get Involved](#) [About Us](#)



### Type your Street Address or Legal Description

1375 Main North Road, Saltwater Creek-Waimakariri R, Hur

(having trouble finding your address? [more info here](#) ...)

[Overview](#) [FAQs](#)

### What is the Listed Land Use Register (LLUR)?

The LLUR is a land use database that Environment Canterbury uses to manage information about land that is, or has been, associated with the use, storage or disposal of hazardous substances.

We need the LLUR to help us manage information about sites that have had hazardous activities or industries on them. By managing this information, we can then help you to manage any potential risks to your health or the environment that the site may pose from exposure to contaminants.



[View LLUR Brochure](#)

We need the LLUR to help us manage the risk posed by hazardous sites to your health and the environment.

Section 30 of the Resource Management Act (RMA) requires Environment Canterbury to collect and manage information about potentially contaminated sites. To do this, we follow guidelines from the Ministry for the Environment (MfE). The information we collect




Search of Listed Land Use Register 10 November 2020

Listed Land Use Register (LLUR)

Search

Lot 2 DP 428676

(Having trouble finding your address?)



OVERVIEW FINDING YOUR ADDRESS SEARCH SUMMARY

Thank you for your enquiry.

The Listed Land Use Register does not currently have any information about a Hazardous Activities and Industries List site on this land parcel.

If you would like a property statement, please fill in your details below.

Records Found

No records found.

Property Search Results


	Legal Description	Titles	Valuation No	
1323 Main North Road (Sh1) (Wnd-Amb)				
1	Lot 2 DP 428676	512583	2159170000	

Listed Land Use Register (LLUR)

Search

Lot 2 DP 62186

(Having trouble finding your address?)



OVERVIEW FINDING YOUR ADDRESS SEARCH SUMMARY

Thank you for your enquiry.

The Listed Land Use Register does not currently have any information about a Hazardous Activities and Industries List site on this land parcel.

If you would like a property statement, please fill in your details below.

Records Found

No records found.

Property Search Results

	Legal Description	Titles	Valuation No	
1323 Main North Road (Sh1) (Wnd-Amb)				
1	Lot 2 DP 62186	512583	2159170000	

Search of Listed Land Use Register 10 November 2020


Listed Land Use Register (LLUR)

Search

Lot 2 DP 303387

Q

(Having trouble finding your address?)



OVERVIEW FINDING YOUR ADDRESS SEARCH SUMMARY

Thank you for your enquiry.

The Listed Land Use Register does not currently have any information about a Hazardous Activities and Industries List site on this land parcel.

If you would like a property statement, please fill in your details below.

Records Found

No records found.

Property Search Results

	Legal Description	Titles	Valuation No	
1323 Main North Road (Sh1) (Wnd-Amb)				
1	Lot 2 DP 303387	512583	2159170000	

Listed Land Use Register (LLUR)

Search


Lot 3 DP 62186

+

−

Map

Having trouble finding your address?



OVERVIEW FINDING YOUR ADDRESS SEARCH SUMMARY

Thank you for your enquiry.

The Listed Land Use Register does not currently have any information about a Hazardous Activities and Industries List site on this land parcel.

If you would like a property statement, please fill in your details below.

Records Found

No records found.

Property Search Results

	Legal Description	Titles	Valuation No	✕
1323 Main North Road (Sh1) (Wnd-Amb)				
1	Lot 3 DP 62186	512583	2159170000	✕

Listed Land Use Register (LLUR)

Search


Street Address or Legal Description

+

−

Map

Having trouble finding your address?



OVERVIEW FINDING YOUR ADDRESS SEARCH SUMMARY

Thank you for your enquiry.

The Listed Land Use Register does not currently have any information about a Hazardous Activities and Industries List site on this land parcel.

If you would like a property statement, please fill in your details below.

Records Found

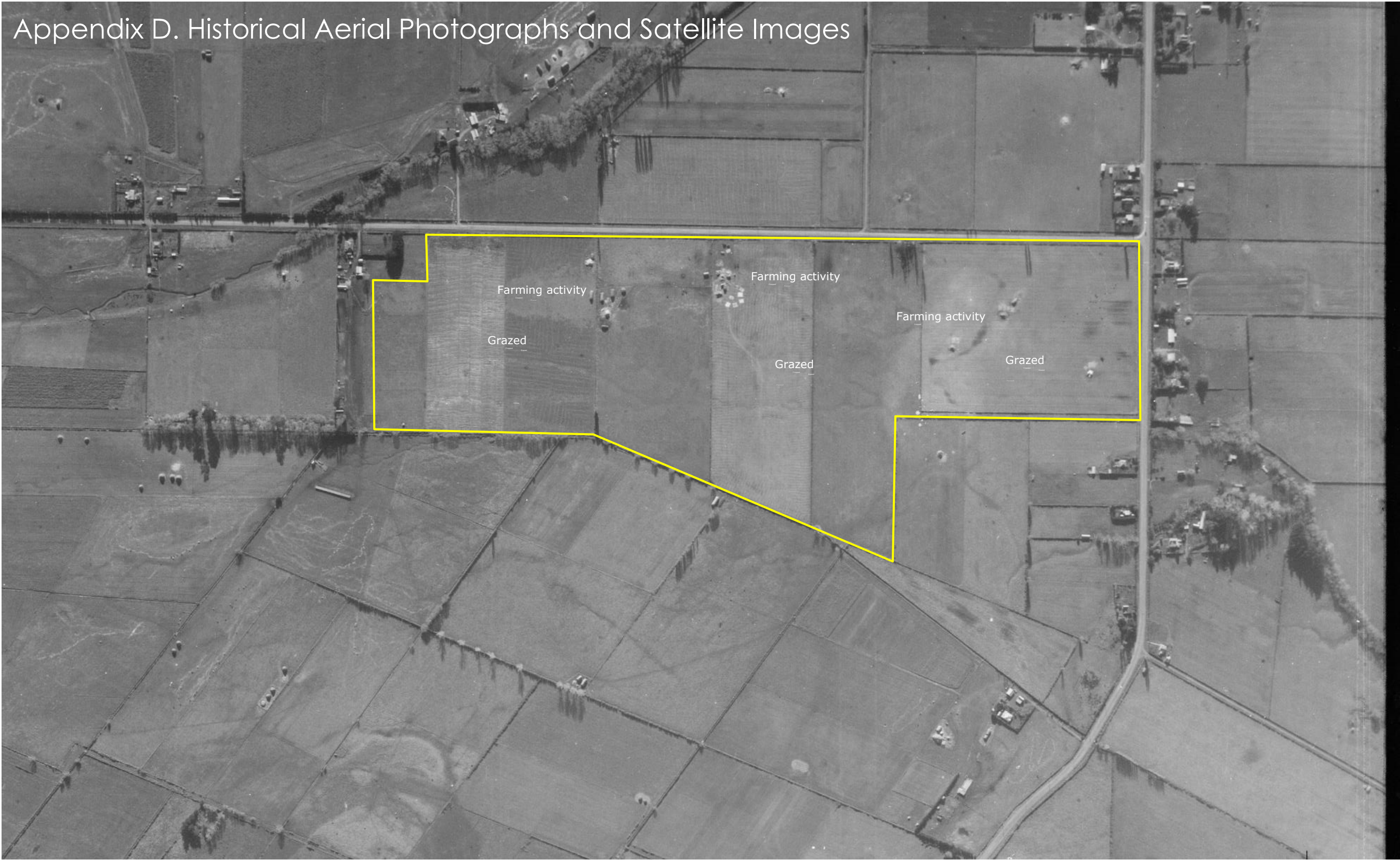
No records found.

Property Search Results

	Legal Description	Titles	Valuation No	✕
1323 Main North Road (Sh1) (Wnd-Amb)				
1	Lot 1 DP 470921	637372	2159170000	✕

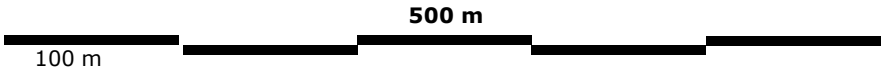


Appendix D. Historical Aerial Photographs and Satellite Images



6/06/1942





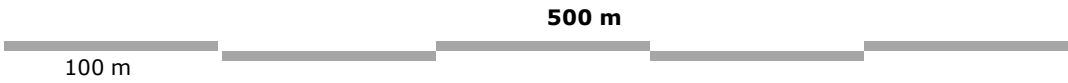
15/05/1963





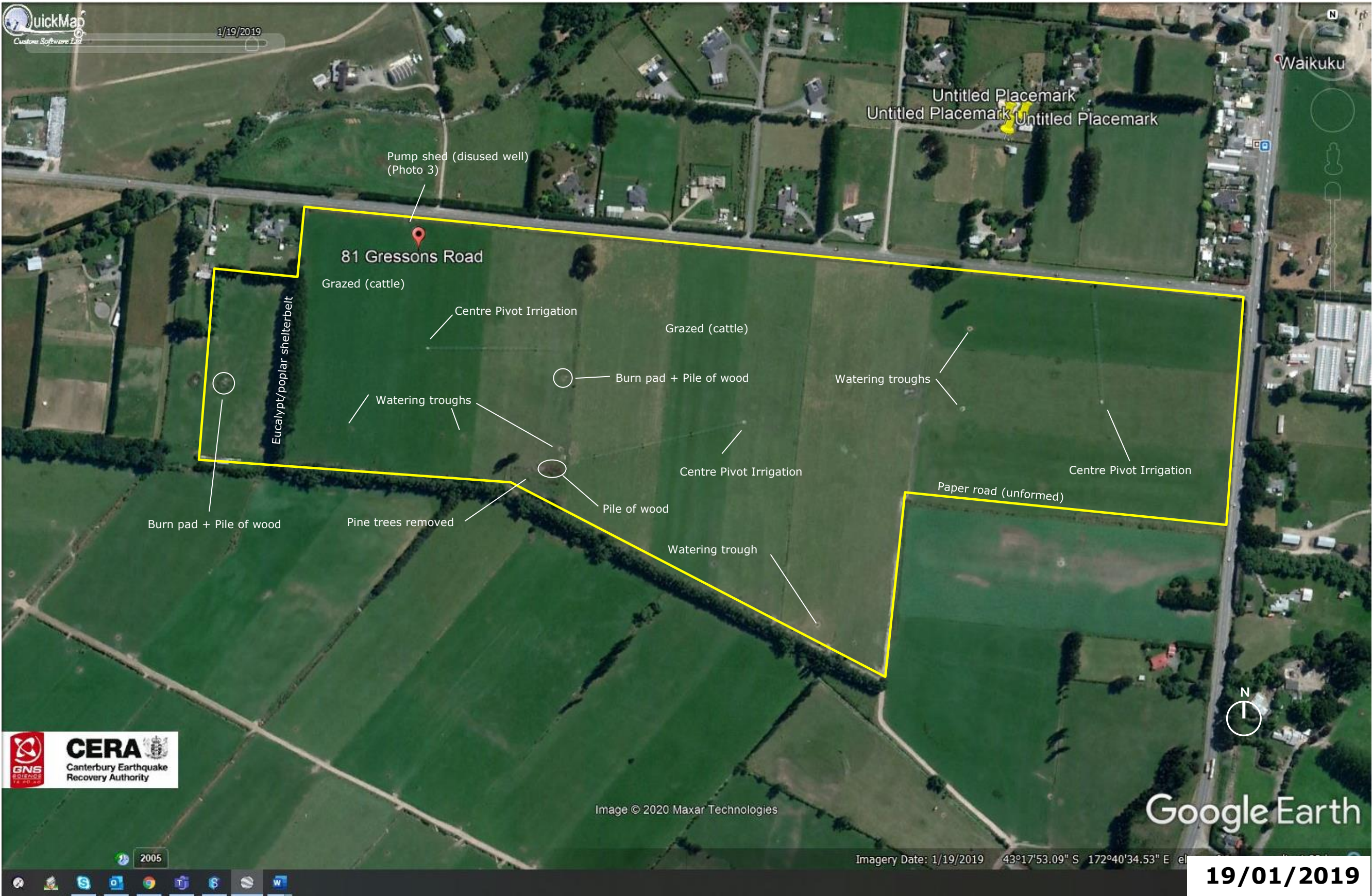
22/04/2005





17/02/2013







## Appendix E: Environment Canterbury Resource Consents



On the subject site:

- 1) Well M35/4266: 51mm well in pump shed. Well card status: 'Not used', updated in May 2016. No associated water permit. No dates in wellcard.
- 2) NCY880160: Surface water take. Expired in 1997.

Notes:

- 1) No discharge consents, above ground or below ground of hazardous storage consented.

## 4. Rezoning Proposal

The site is legally described as Lot 2 DP 428676, Lot 2 DP 62186, Lot 2 DP 303387, Lot 3 DP 62186, Lot 1 DP 470921 and Pt RS 3101 (paper road, 0.7852 ha) and totals approximately 34.2 hectares.

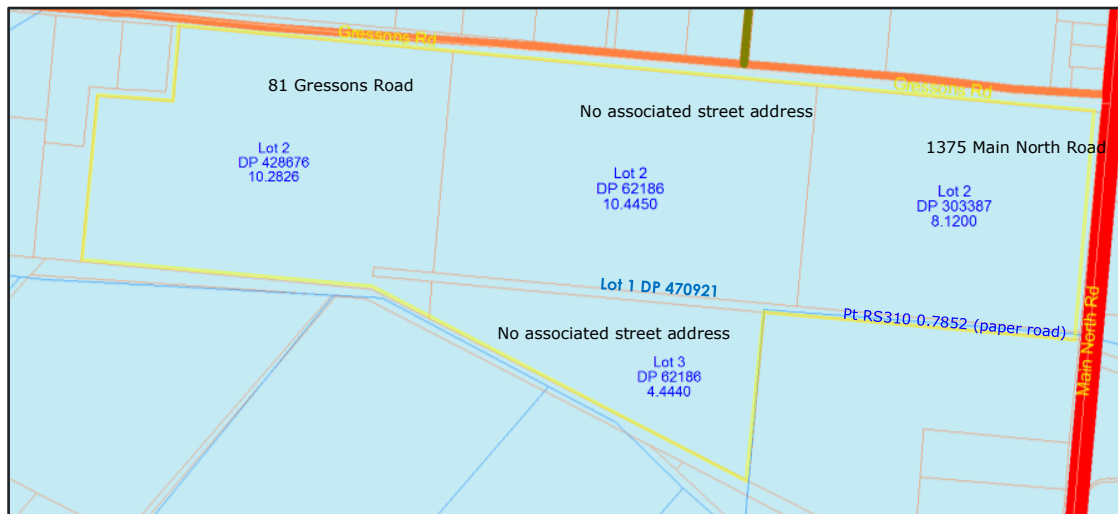


Figure 1: Site location plan (Source LINZ database)

It is proposed to rezone the site situated on the corner of Gressons Road and Main North Road, Waikuku, from rural to rural-residential land use.

Refer to Appendix A and Appendix B.

## 5. Site Description

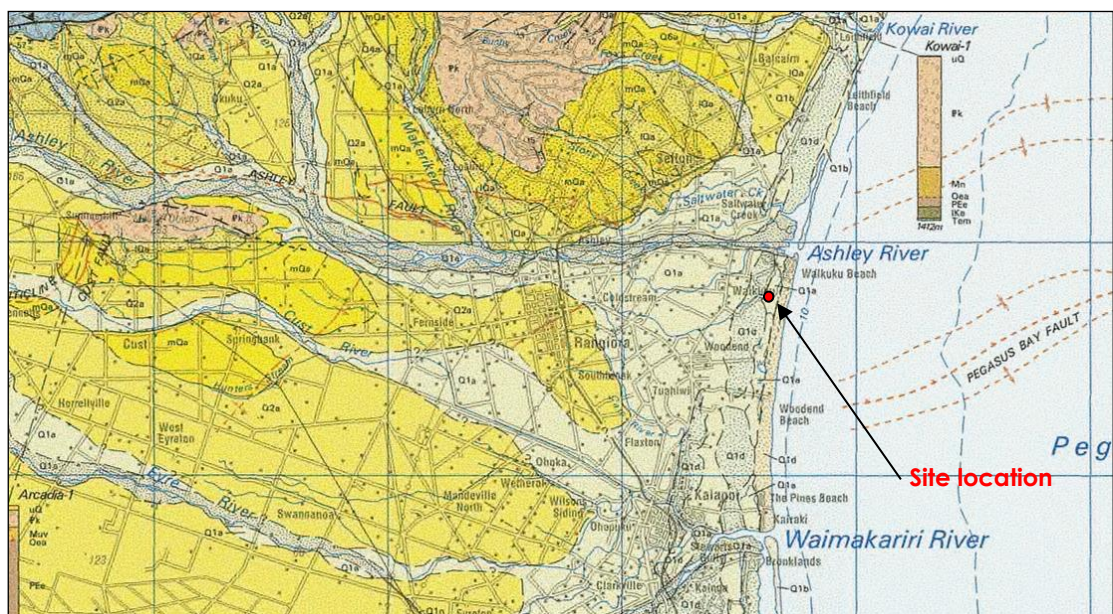
### 5.1. Engineering Geology

GNS's geological map<sup>1</sup> notes the site being underlain by 'Grey river alluvium comprising gravel, sand and silt in active floodplains'.

*'The vast expanse of the Canterbury Plains comprises coalesced floodplains. Large parts of the plains are abandoned braided river floodplains, last occupied during the LGM (last glacial maximum)'.*

<sup>1</sup> Forsyth, P.J., Barrell, D.J.A., Jongens, R. (compilers) 2008 Geology of the Christchurch area. Scale 1:250 000. Institute of Geological & Nuclear Sciences geological map 16. 1 sheet + 67p. Lower Hutt, New Zealand. GNS Science.





**Figure 2: Geological Map of Christchurch.**

## 5.2. Existing bore hole data

Bore log records from the Environment Canterbury (ECan) GIS system were reviewed to determine typical subsoil geology of the general area.

Well M35/6353, located on the western boundary of Pt Lot DP 57114 encountered 'sandy silt' to 4m, 'grey pug with some vegetation' to 12.5m, 'sand' to 15m overlying 'sandy gravel' to at least 16m depth where the well terminated.

Well M35/7340, located approximately 25m north of the site along Gressons Road, encountered 'clay' to 3m, multiple layers of 'pug' and 'gravel' to 14.3m, 'pug and sea shells' to 20m overlying gravels to at least 23m depth where the well terminated.

Well M35/7197, located approximately 355m west of Lot 1 DP 62186 encountered 'claybound' and 'sandy gravels' to 5m, 'sandy pug with gravels' to 21m, 'black clay' to 25m overlying 'gravel' to at least 41m depth below ground level.

Well M35/6176, located approximately 22m from the southern boundary along Main North Road (SH1), encountered 'clay' to 3m, 'sand & some small gravels' to 14m, 'peat' to 20m, overlying 'gravels' to at least 23m depth below ground level where the well was terminated.



### 5.3. Topography

The site is located on the corner of Gressons Road and Main North Road. The site topography is flat.



Photograph 1: The southeast corner of the site looking west, showing the flat topography across the site. (November 2020)

### 5.4. Drainage

An open drain is located along the west and south boundaries of the site, and is piped in places.



Photograph 2: The large drain situated on the neighbouring property, south of the site. (July 2012)

## 5.5. Vegetation

The site is vegetated in grass, with shelterbelts located in the western part of the site.



**Photograph 3: The west end of the site looking northeast. (November 2020)**

## 5.6. Buildings

There are no buildings within the area of the proposed subdivision.

A residential dwelling is located at the adjacent property at the northwest corner of the site.

## 5.7. 2010/2011 Canterbury Earthquakes

The M7.1 Darfield earthquake on 04 September 2010 occurred on a previously unknown (Greendale) fault, producing peak horizontal ground accelerations of 0.21g and 0.41g at Ashley School and Kaiapoi North School respectively. Whilst the earthquake resulted in liquefaction within the soft alluvial soils predominantly across eastern Christchurch and some areas of Kaiapoi, we understand that there was no liquefaction identified areas on or around the site.

The subsequent M6.3 aftershock on 22 February 2011, located near Lyttleton/Heathcote, produced peak horizontal ground accelerations of 0.09g at Ashley School and 0.23g at Kaiapoi North School.



**Table 1 Comparison of peak horizontal ground accelerations close to site.**

<b>PGA (horizontal)</b>	<b>SLS (1/25, M7.5)</b>	<b>ULS (1/500, M7.5)</b>	<b>04 Sept 2010<sup>2</sup> (M7.1)</b>	<b>22 Feb 2011<sup>3</sup> (M6.3)</b>
Current design pga	0.13g	0.35g		
Ashley School			0.21g	0.09g
Kaiapoi North School			0.41g	0.23g

## 5.8. Technical Land Category

This site has not been classified by CERA, as it is deemed rural /NA.

The site is located within the area of "liquefaction susceptibility" shown on the Waimakariri District Council's 'Natural Hazards Liquefaction Susceptibility Map', dated 19 May 2016.

## 6. Site Investigation

### 6.1. CPTu Testing

Eleven cone penetration tests with measurement of pore water pressure (CPTu) were undertaken across the site in 2012. Refer to Appendix E.

These test results generally indicate the presence of interbedded sand, sandy silts, and silty clays throughout the profile.

CPTu testing met practical refusal at 2.6 to 20m depth across the site, most likely on a dense sand or sandy gravel. Shallow refusal at CPTu's 1, 3, 4, 7, 8, 10 and 11 is likely to have occurred within an upper layer of gravelly sand. Refer to Appendix E.

It appears that there is a layer of sandy gravel located around 2-4m below ground level across the site, roughly in a southwest-northeast orientation. It is likely that this is an historic paleochannel, with overbank deposits to the northwest and southeast.

### 6.2. Groundwater

Pore water pressure measurements at the time of the CPTu testing indicated inferred groundwater at around 3 to 4m below ground level.

Subsequent to this, Eliot Sinclair installed 7 standpipes across the site in July 2013 and then monitored ground water levels monthly between July 2013 to September 2017. Our monitoring records indicate the highest ground water level occurs in winter and spring when the ground water level rises to between 1m to 2m below ground level across the site.

<sup>2</sup> Darfield (Canterbury) earthquake strong motion data, GNS Science, 04 September 2010.

<sup>3</sup> Christchurch earthquake strong motion data, GNS Science, 22 February 2011.

Potentially, the highest groundwater monitoring data is not accurate and there may have been water (or rainfall) infiltration into the standpipes giving a false result. It was noted that during some monitoring periods, especially after rainfall some wells indicated a groundwater near the surface while other suggested it was 1 m bgl. It is considered that the 15th and 85th percentile groundwater records should be used for groundwater depth measurements. The average annual groundwater depth across the full site is 1.10 m bgl.

### **6.3. Site investigation density**

The Ministry for Business, Innovation and Employment released their 'Planning and engineering guidance for potentially liquefaction-prone land' in September 2017.

The new guidelines set out typical requirements for geotechnical investigations, assessment and reporting primarily for Plan Change and Subdivision Consent applications.

Our assessment for the site was based on a Level C detailed area-wide assessment. The guidelines suggest that between 0.1 to 4 deep ground test/investigation locations be undertaken per Ha for adequate ground characterisation for liquefaction assessments to inform planning and consenting processes. Our CPTu testing special density across the site the site is equivalent to 0.3 tests per Ha. The testing undertaken across the site included:

- Cone penetrometer testing with pore water pressure measurement at eleven (11) locations across the site, down to 2.5 to 20m depth.

We consider the results of the deep site investigation, along with supporting information from geological maps, records shown on the New Zealand Geotechnical Database, and Environment Canterbury well logs, provide sufficient evidence of the underlying ground conditions and the risk of natural hazards at this site to inform this report which advises on the geotechnical suitability of the site for rural-residential land use.

## **7. Liquefaction Assessment**

### **7.1. Methodology**

Following the most recent version of MBIE's guidelines and Supplement Issue 7, the calculation of liquefaction triggering was undertaken using the method by Boulanger and Idriss (2014)<sup>4</sup> and the estimation of post-liquefaction induced settlements using the method by Zhang et al (2002)<sup>5</sup>.

The peak ground accelerations used for liquefaction assessment were  $PGA_{6.0} = 0.19g$  and  $PGA_{7.5} = 0.13g$  for the serviceability limit state (SLS) event, and  $PGA_{7.5} = 0.35g$  for an ultimate limit state (ULS) event.

For the purpose of this assessment, the depth to groundwater for liquefaction assessment was conservatively assumed to be 1m below existing ground level.

---

<sup>4</sup> Boulanger, R. W. and Idriss, I. M. (2014). CPT and SPT based liquefaction triggering procedures (Report No. UCD/CGM-14/01), University of California, Davis, CA, 134 p.

<sup>5</sup> Zhang, G., Robertson, P. K., & Brachman, R. (2002). Estimating liquefaction induced ground settlements from CPT for level ground. Canadian geotechnical journal, 39(5): 1168-1180.

## 7.2. Liquefaction-Induced 'Index' Settlement

Liquefaction-induced 'index' settlements were calculated using CLiq<sup>6</sup> software, with the results summarised in table 2. The vertical 'index' settlements were calculated using the method by Zhang et al (2002) using the four basic CPT parameters (depth, cone tip resistance, skin friction and pore water pressure). Reported settlements are 'index' values that indicate relative susceptibility to liquefaction and free-field ground surface settlement.

The analysis indicates that in an SLS earthquake event the silty sands and sands typically located between around 3 to 6m bgl would liquefy, but the near-surface clay and silty clay-like soils would generally not liquefy. In a ULS earthquake the clay silts and sands between 1m to 10m bgl are expected to liquefy at various depths.

Where CPTu testing met practical refusal at shallow depth, estimation of liquefaction risk and settlements will not have taken the presence of deeper soil layers into account.

Please refer to the CPT data, Liquefaction Analysis and the Summary of Liquefaction Hazard in Appendix E.

Test No.	Depth of CPTu test	Results of liquefaction analysis (mm)						Assessed Technical land Category
		SLS1 (M6.0, 0.19g)		SLS2 (M7.5, 0.13g)		ULS (M7.5, 0.35g)		
		Index	LSN	Index	LSN	Index	LSN	
CPTu01	3.9m*	3	1	2	1	7	4	TC1
CPTu02	14.7m	66	22	43	10	101	38	TC2
CPTu03	12.7m	55	12	42	8	76	20	TC2
CPTu04	2.4m*	3	2	1	1	10	7	TC1
CPTu05	20.0m	39	12	28	7	58	23	TC2
CPTu06	18.0m	56	17	41	10	63	21	TC2
CPTu07	4.3m*	10	6	4	2	19	11	TC1
CPTu08	3.2m	1	1	0	1	2	2	TC1
CPTu09	18.1m	79	18	67	12	94	24	TC2
CPTu10	4.0m*	5	3	3	1	13	8	TC1
CPTu11	2.6m*	6	5	1	1	26	18	TC1

**Table 2 - Liquefaction-induced 'index' settlement (mm) – Limited to the upper 10m of soils.**

<sup>6</sup> CLiq (version 2.2.0.37). (2006). Computer software. Serres, Greece: GeoLogismiki.

\*CPT testing terminated prematurely and did not reach 10m bgl, therefore these values may not completely reflect the geotechnical conditions that exist deeper down.

### 7.3. Liquefaction Severity Number (LSN)

The liquefaction severity number (LSN) is a parameter developed to reflect the more damaging effects of shallow liquefaction on residential land and shallow foundations<sup>7</sup>. Calculation of the LSN is limited to 10m bgl. The estimated LSN values are summarised in Table 3.

**Table 3: Maximum LSN**

Event	Typical Maximum LSN Assessed for CPT 1-11	Predominant performance
SLS	10 - 20	'Minor expression of liquefaction'
ULS	20 - 30	'Moderate expression of liquefaction'

#### 7.3.1. Serviceability limit state, SLS

LSN values of between 0 to 20 were calculated, which suggest only minor expression of liquefaction would occur in an SLS event. This is consistent with either TC1 or TC2 land.

#### 7.3.2. Ultimate limit state, ULS

LSN values around 20-30 were calculated for an ULS earthquake. This is consistent with TC2 land.

#### 7.3.3. Actual Damage

We did not observe any visual evidence of liquefaction or lateral spreading across the site in our July 2012 site inspection, although we note that our inspection occurred around 20 months after the September 2010 earthquake, and it is likely that any visual evidence of ground damage across the paddocks, if present, may have been obscured by grass.

There was no obvious ejection of groundwater or sediment across the site in aerial photography taken soon after the September 2010 M7.1 earthquake.

The road surface of Gressons Rd and SH1 were in relatively good condition for their age at our site visit in 2012, and we did not observe any unusual settlement, slumping or heaving of the road surface that may have indicated the occurrence of shallow liquefaction.

### 7.4. Lateral spreading

The Waikuku Stream is located around 150m north of the site. The topography of the site is flat, and there are no steep slopes or banks across the site or surrounding area. Therefore, lateral spreading in an SLS event is not likely to affect the future subdivision.

While there is an open drain along the south boundary of the site, the risk of lateral stretch to nearby building platform can be addressed by adopting TC2- type foundation systems that are designed with sufficient tensile capacity to avoid rupture if lateral spread ever occurred.

<sup>7</sup> Tonkin & Taylor's (T&T) report 'Liquefaction Vulnerability Study', February 2013, T&T Ref: 52020.0200/v1.0



## 8. Natural Hazards

### 8.1. Falling debris

The site is flat, and not close to any steep slopes, and is therefore not at risk of falling debris due to rock fall/roll.

### 8.2. Landsliding

The site is flat, and not close to any steep slopes, and therefore is not at risk of land damage due to landsliding.

### 8.3. Tsunami

The site is **not** located within a Canterbury Tsunami Evacuation Zone<sup>8</sup> *"No zone: Tsunami flooding is not expected, even in a very large tsunami"*.

### 8.4. Earthquake rupture

We have searched GNS's Active Faults database<sup>9</sup> to determine the presence of any known active faults in the general locality. The Loburn Fault is located approximately 4.5km northwest of the site. Based on available data the site is likely to be located outside the minimum 20m fault avoidance zone recommended by the Ministry for the Environment<sup>10</sup>.

While the site is not affected by active faulting, it is important to acknowledge that New Zealand is a seismically active country.

These risks are considered by various New Zealand standards, the New Zealand Building Code, various Ministry guidelines, and the Council's design standards. Providing design and construction work is undertaken in accordance with the appropriate standards and guidelines then the risk to life and property can be kept to an acceptable low level.

---

<sup>8</sup> <https://ecan.maps.arcgis.com/apps/Minimalist/index.html?appid=591062afb6b542abb247cc8d15a64855>

<sup>9</sup> <https://data.gns.cri.nz/af/>

<sup>10</sup> Planning for Development of Land on or Close to Active Faults: A Guideline to Assist Resource Management Planners in New Zealand (Published July 2003).

## 8.5. Inundation from the Ashley River

There are no topographical features that concentrate stormwater onto the site.

The 'Waimakariri District flood planning hazard management strategy Ashley River floodplain'<sup>11</sup> indicates that the site is not at risk at from the Ashley River Floodplain for a 0.5% AEP (200 year return period) event.

The Waimakariri District Natural Hazards Interactive viewer shows the site is generally at very low risk of flooding for the 1 in 200 year return period. Parts of the southeast corners of the site are at low to medium risk.

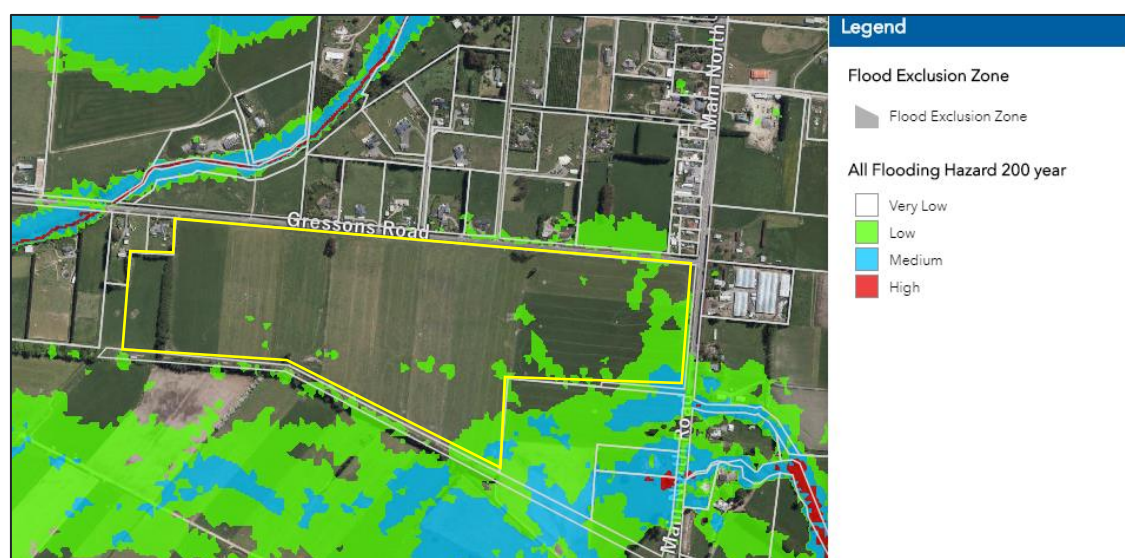


Figure 3 Waimakariri District Natural Hazards Interactive Viewer, retrieved Nov 2020.

## 8.6. Erosion

The site is flat, and there are no large watercourses or rivers close to the site. There is a small watercourse along the southern boundary, however this does not carry large flows of stormwater. Therefore, the site is not likely to be subject to erosion. Further, the site is almost entirely located outside of the area of risk of inundation from the Ashley River Floodplain, and therefore erosion is not likely.

## 8.7. Stormwater from developed site

There is no piped stormwater system along Gressons Rd or SH1.

Concentrations of roof and surface stormwater will almost certainly require onsite treatment and attenuation before discharge either to ground or an existing waterway.

We note that subdivision and future residential construction on the lots will tend to increase the rate of stormwater runoff from the site and therefore the stormwater design will need to take into account the risk of inundation to adjacent and downstream property, and provide attenuation before discharge to surface waterways.

<sup>11</sup> Waimakariri District, flood hazard Management Strategy, Ashley River Floodplain Investigation, Report No. R08/23, June 2008, Environment Canterbury.

## **8.8.      Subsidence (Liquefaction)**

Geotechnical testing and analysis indicates the site is at low risk of damage to shallow building foundations in a serviceability limit state event (7.5, 0.13g), and a moderate risk of damage to building foundations in a ultimate limit state event (M7.5, 0.35g). Refer to Section 7: Liquefaction Assessment.

Based on the calculated index settlements and LSN values, with ground water at 1 m bgl, we conclude the site should be considered equivalent to TC2.

## **9.          Requirements for Residential Foundations**

Based on our site assessment and review of geotechnical information for the site, future residential buildings located over undisturbed natural ground are likely to require TC2 foundations. Site-specific geotechnical investigation, assessment and foundation design will be required as part of the normal building consent requirements once the nature and location of the proposed buildings has been established.

## **10.        Conclusions**

Eliot Sinclair has completed a geotechnical desktop investigation, liquefaction analysis and review of relevant geotechnical, topographic data and Council records that relate to the site and wider area.

While further assessment and consideration will need to be given to inundation and the need for site specific foundation requirements for buildings. This will be part of the standard geotechnical requirements, including Section 106 of the RMA, for future subdivision consents. There are no significant geotechnical constraints that would prevent the re-zoning of the land.

In summary, in accordance with the recommendations set out in this report, we consider the site is geotechnically suitable for residential development.

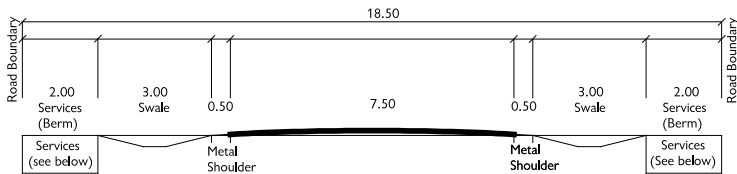
## Appendix A. Aerial Photo



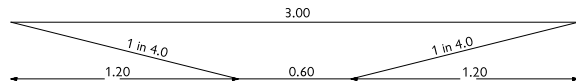
Photo 1: Aerial Photo of site and surrounding land (source: Google Earth, Image January 2019)

## Appendix B. Proposed Scheme Plan

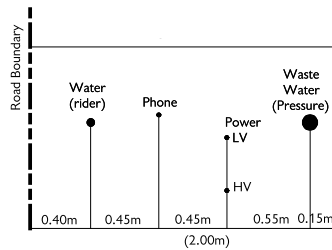




TYPICAL ROAD CROSS SECTION  
Scale 1:100



TYPICAL SWALE CROSS SECTION  
Scale 1:20



SERVICES LOCATION  
Scale 1:5

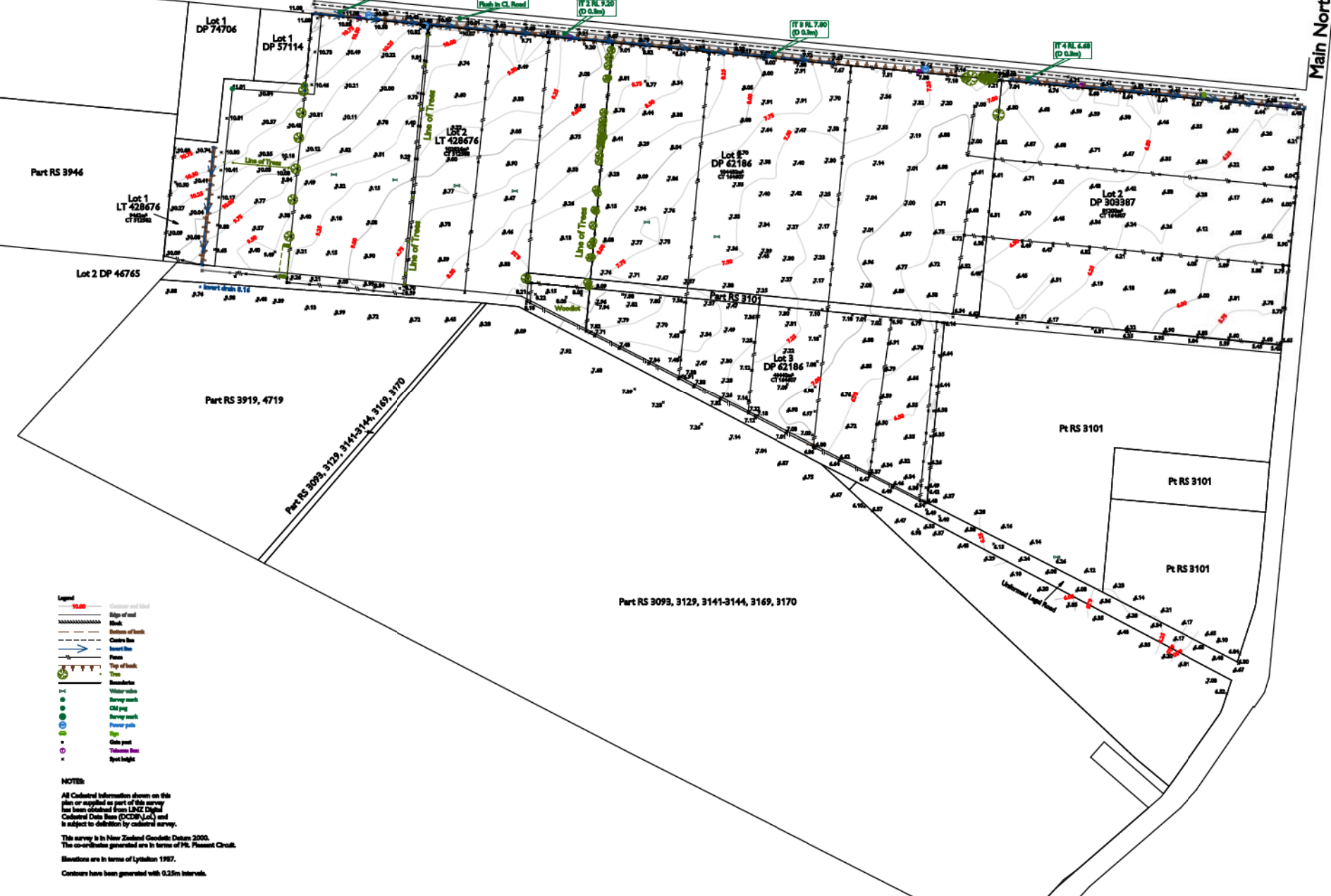
NOTES  
All roads are 18.50 metres wide.  
Piped Stormwater Easements are 2 metres wide unless shown otherwise

no.	amendment	initial	date	designed	Bob Greening	surveyed	origin of levels	Projection NZGD 2000 Circuit Mount Pleasant 2000	Scale: 1:2000 (A1) 1:4000(A3)  Date: 20/3/2014	Drawing Set 350494 C4  PLOT 350494 C4 140312.DXF	Sheet 1 of 1  rev D
	A Lot 61 added - pedestrian access, swale moved across, note re land in LT 470921	pkg	25.6.14	manager	Bruce Sinclair	Roger Claessens	UA 87				
	B Road widened to 18.5m and revised Road Cross Section added	pkg	24.7.14	drawn	Bob Greening	surv. date	Main North Road (SH1) RL 6.271 LINZ Dec 2013				
	C Stormwater amended - two ponds - Lot 26 and Gressons - Lot 58 removed	pkg	18.8.14	checked		Feb 2014	datum Lytleton 1937 post Dec 2013				
	D Possible Future Road added to Lot 27	pkg									

Proposed Subdivision of  
81 Gressons Road and 1375 Main North Road (SH1), Waikuku  
(Lot 1 LT 470921, Lots 1 and 2 DP 428676, Lots 2 and 3 DP 62186 and Lot 2 DP 303387  
for Northside Country

**Eliot Sinclair**  
surveyors | engineers | planners

## Appendix C. Topographical Survey



**NOTES:**  
All Cadastral Information shown on this plan or supplied as part of this survey has been obtained from LINZ Digital Cadastral Data Base (PCDDB) and is subject to definition by cadastral survey.  
This survey is in New Zealand Geodetic Datum 2000.  
The co-ordinates generated are in terms of Mt. Pleasant Grid.  
Elevations are in terms of Lyttelton 1957.  
Contours have been generated with 0.25m intervals.

Part RS 3093, 3129, 3141-3144, 3169, 3170

Main North Road (SH 1)

Scale: 1:2000 (A1)  
Date: 25/07/2012

**Eliot Sinclair**  
surveyors | engineers | planners

Topographical Survey of 1375 Main North Road (SH 1), 81 & 107 Gressons Road, Waikuku  
Lot 1 LT 428676, Lot 2 LT 428678, Lot 2 DP 62186, Lot 3 DP 62186, Lot 2 DP 303387  
For Mr & Mrs Stokes

**For Mr & Mrs Stokes**

[illegible]

Unit 4, 502 Warwick Road, PO Box 4597, Christchurch 8140, Phone 08 379-4014, Fax 08 345-2444, info@air.co.nz  
www.air.co.nz

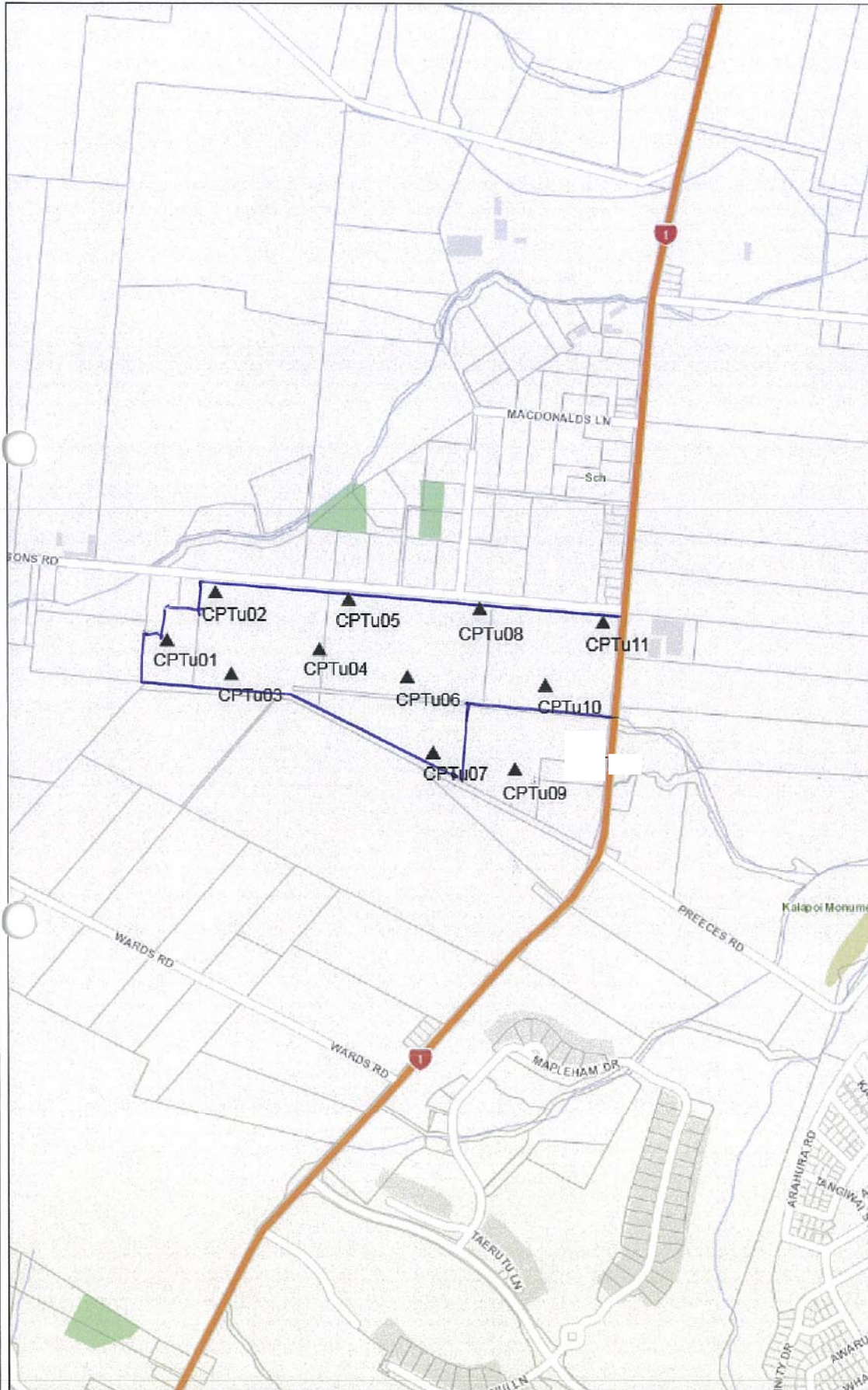
## Appendix D. CPTu Test Location Plan



# CPTu Location Map

Date Printed: 22 June 2012

Legend



This map is a user generated static output from an Internet mapping site and is for reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable.

THIS MAP IS NOT TO BE USED FOR NAVIGATION

0.4 0 0.4 Miles

Projection: NZGD\_2000\_New\_Zealand\_Transverse\_Mercator

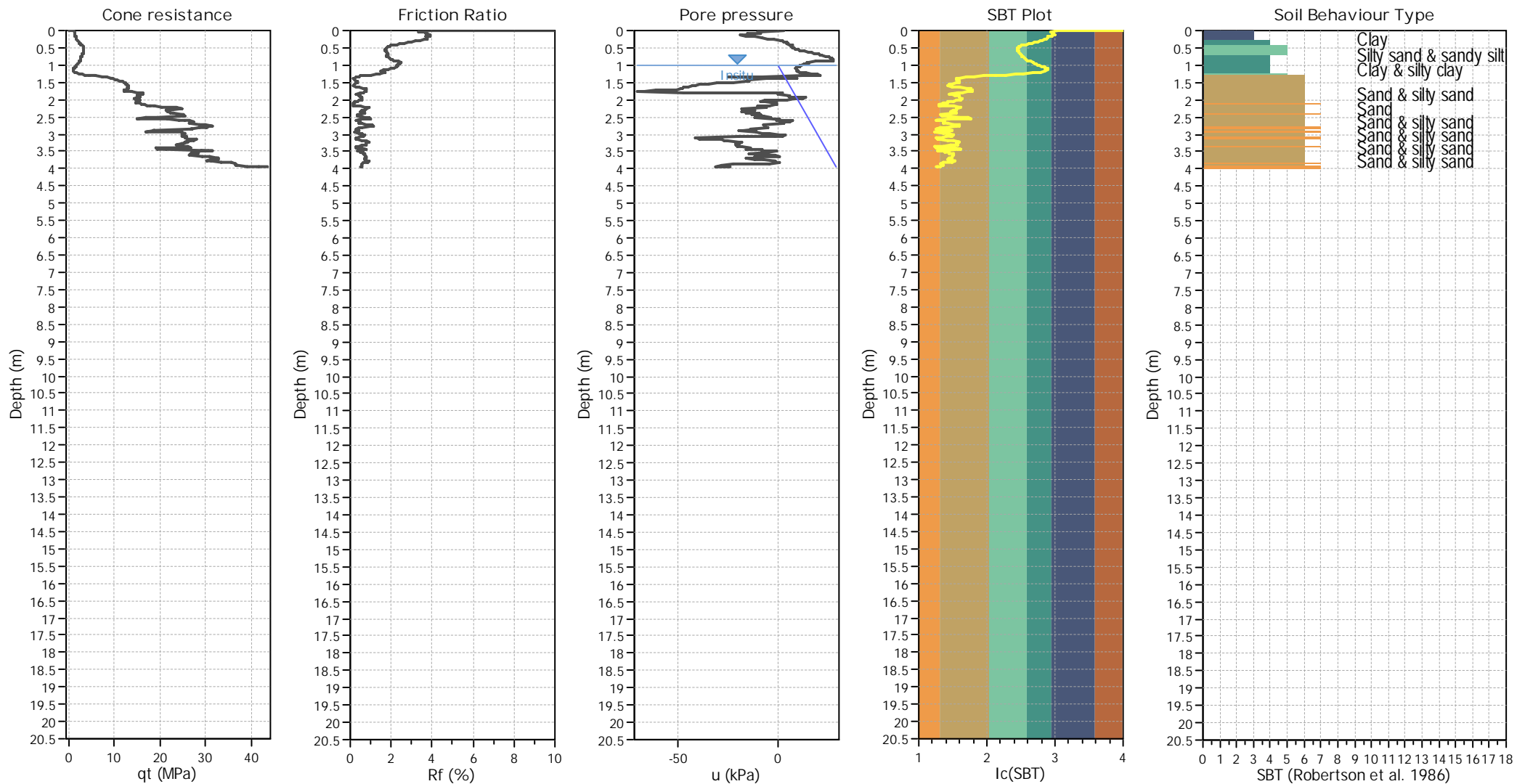
New Zealand Government



## Appendix E. CPTu Test Results

CPT basic Interpretation Plots

CPT basic interpretation plots



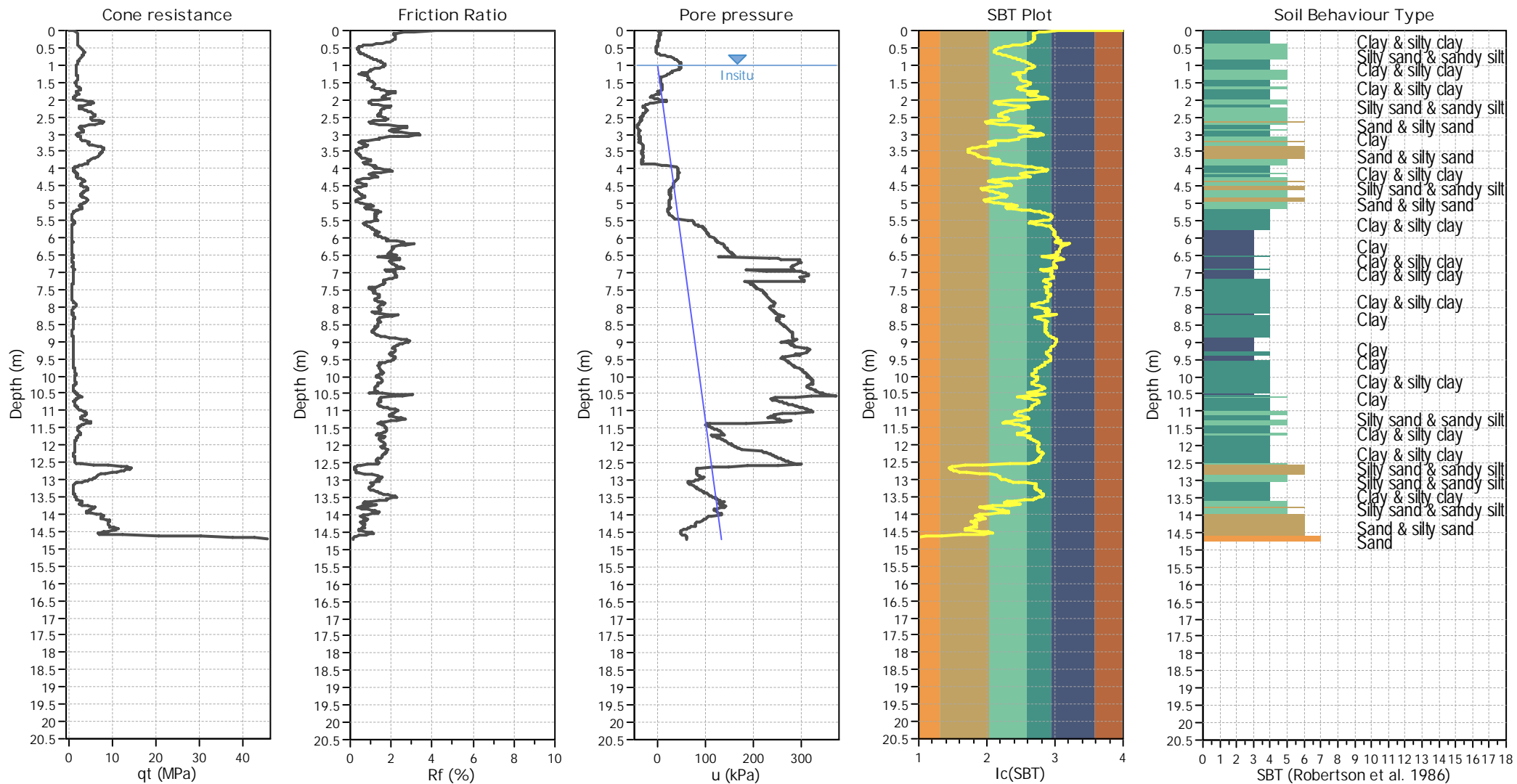
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K <sub>0</sub> applied:	Yes
Earthquake magnitude M <sub>w</sub> :	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

SBT legend

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

CPT basic interpretation plots



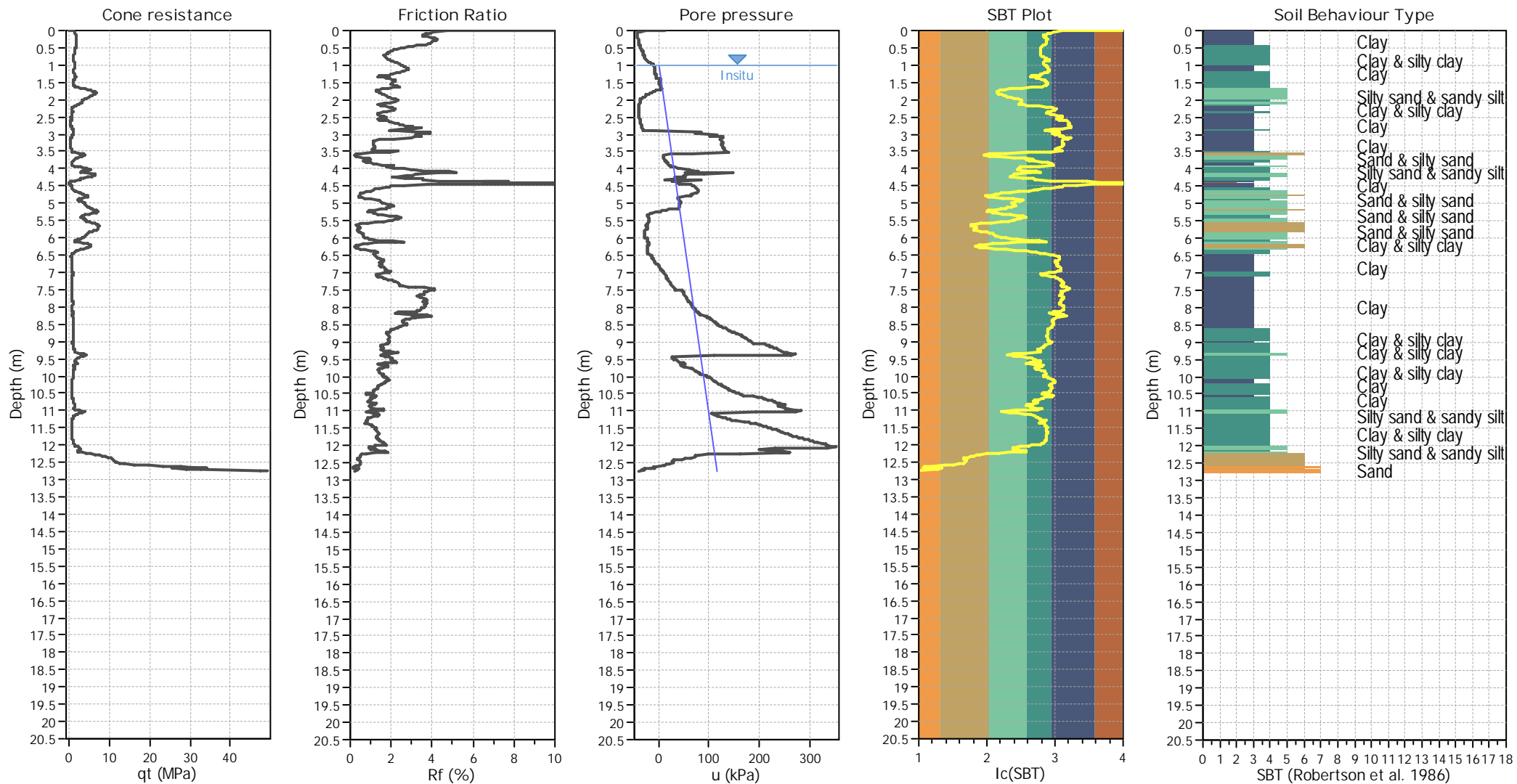
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K <sub>σ</sub> applied:	Yes
Earthquake magnitude M <sub>w</sub> :	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

SBT legend

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

CPT basic interpretation plots



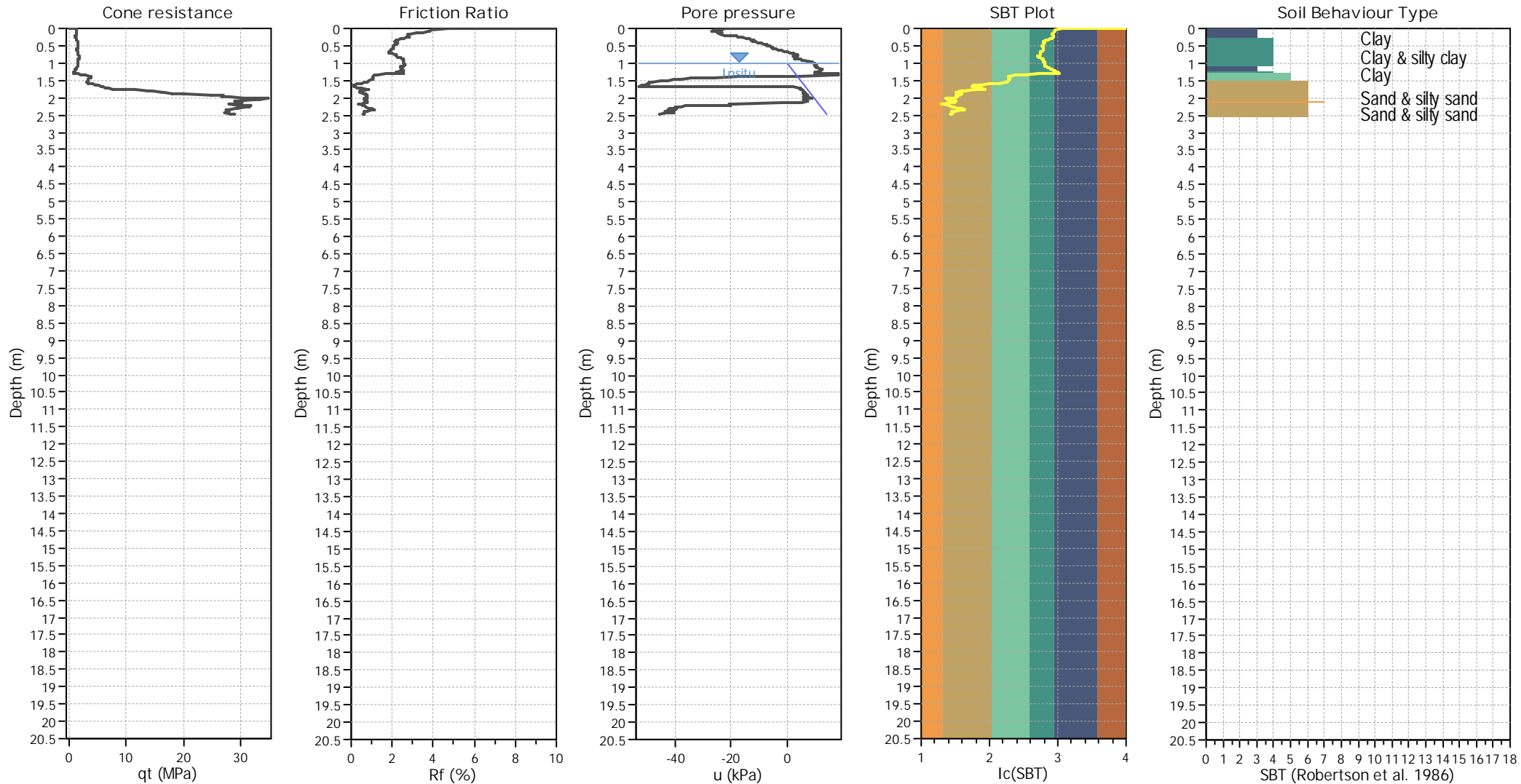
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K <sub>σ</sub> applied:	Yes
Earthquake magnitude M <sub>w</sub> :	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

SBT legend

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

CPT basic interpretation plots



Input parameters and analysis data

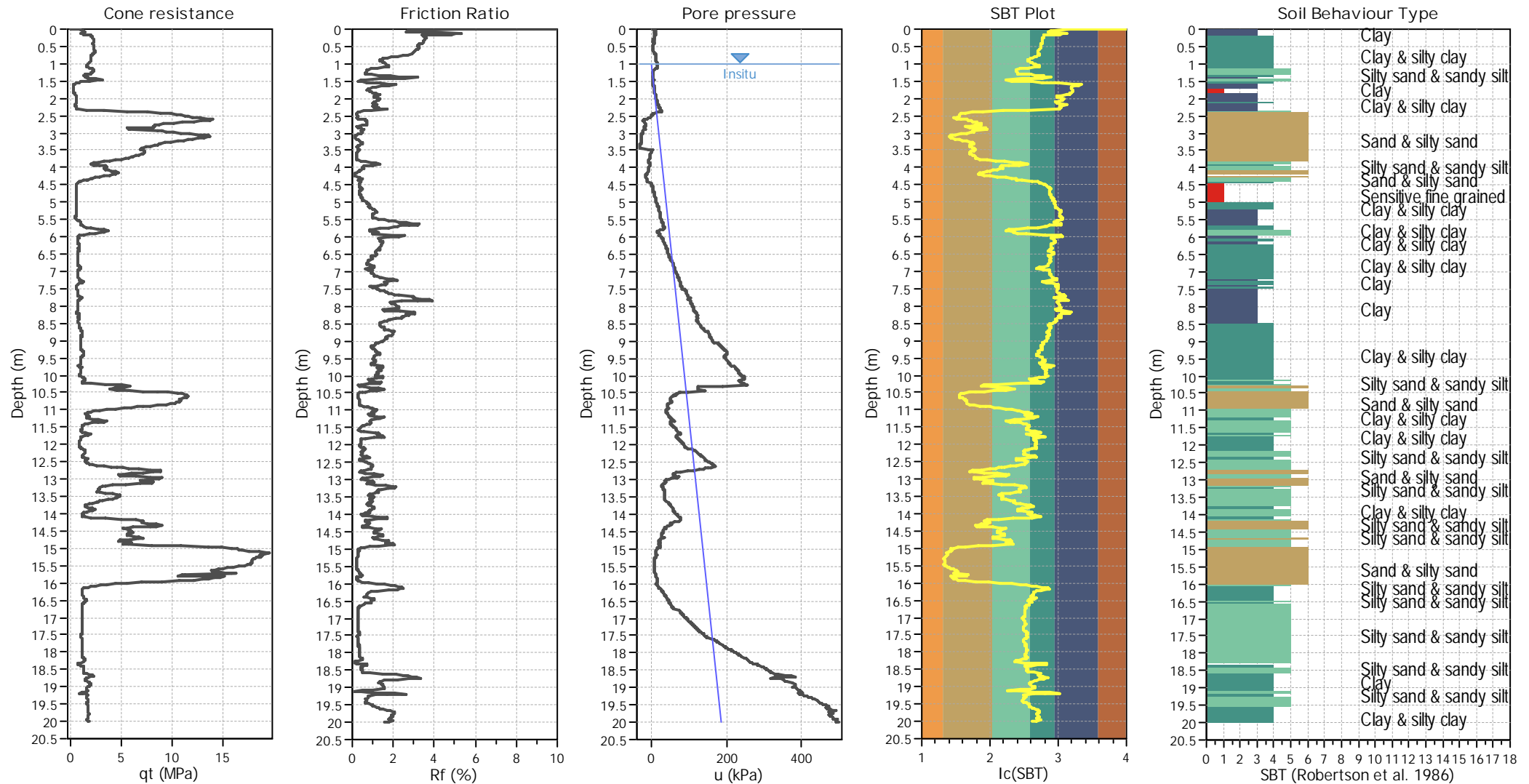
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K <sub>0</sub> applied:	Yes
Earthquake magnitude M <sub>w</sub> :	6.00	Unit 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

SBT legend

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












## CPT basic interpretation plots



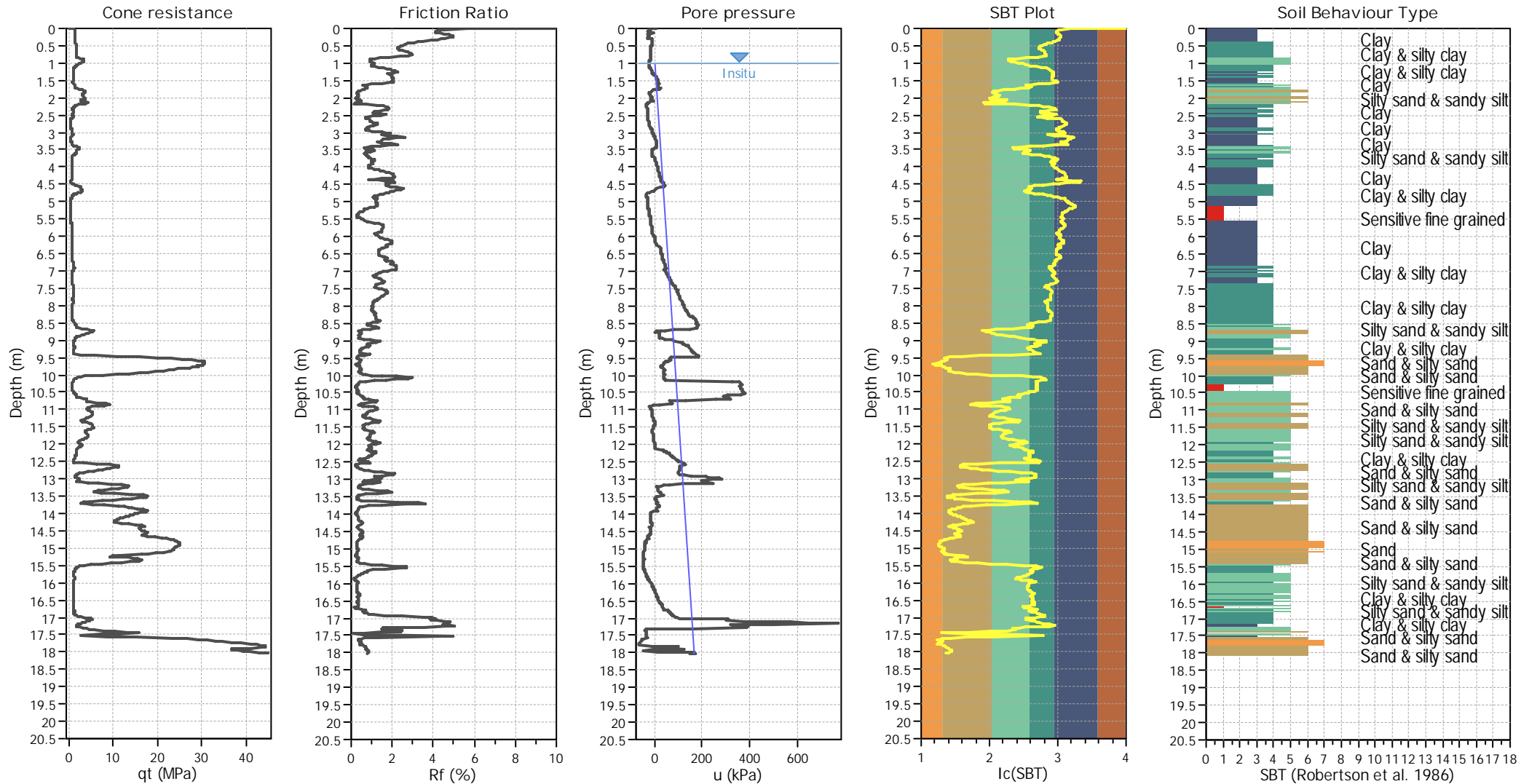
### Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K <sub>g</sub> applied:	Yes
Earthquake magnitude M <sub>w</sub> :	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

### SBT legend

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

CPT basic interpretation plots



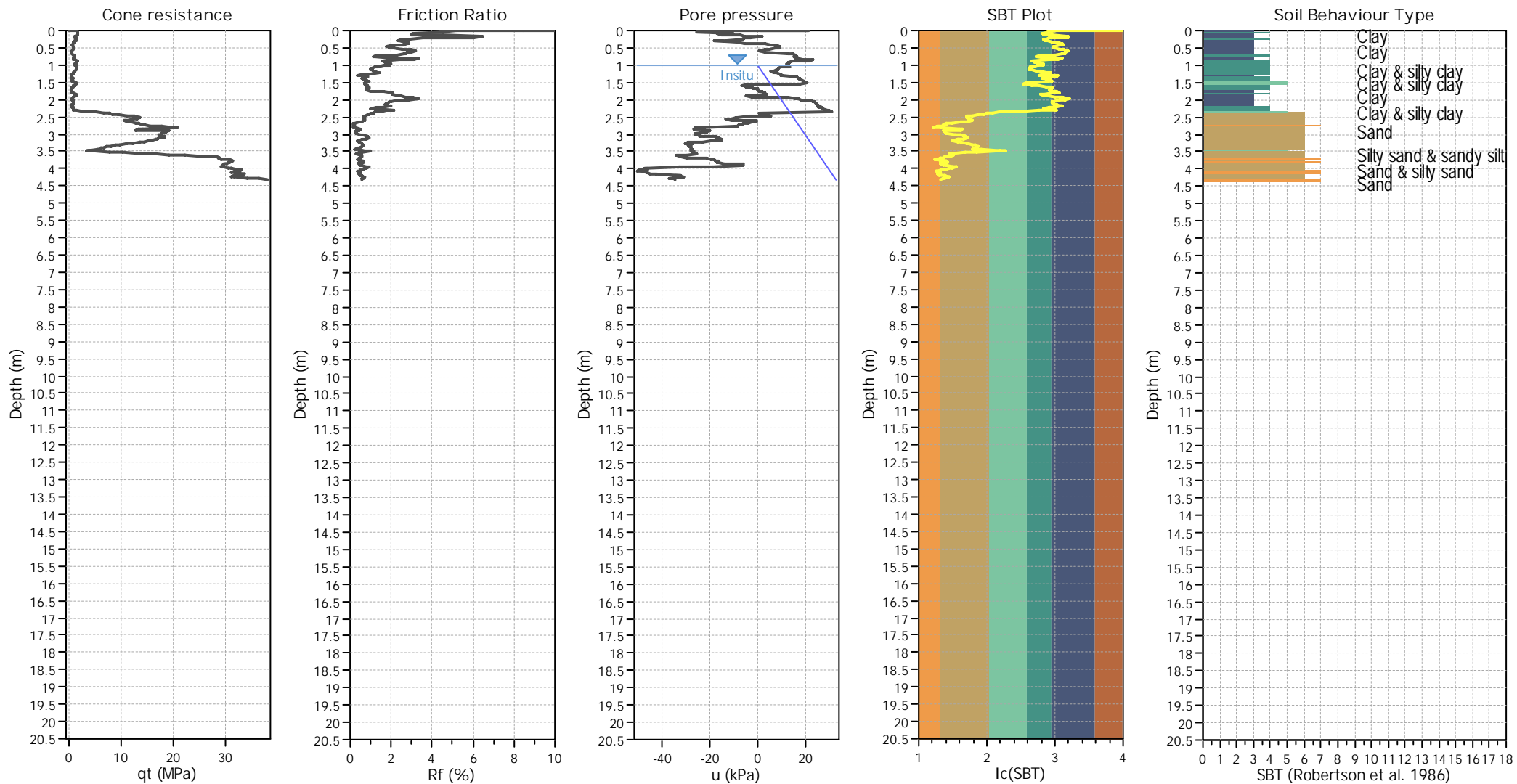
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K <sub>0</sub> applied:	Yes
Earthquake magnitude M <sub>w</sub> :	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

SBT legend

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

CPT basic interpretation plots

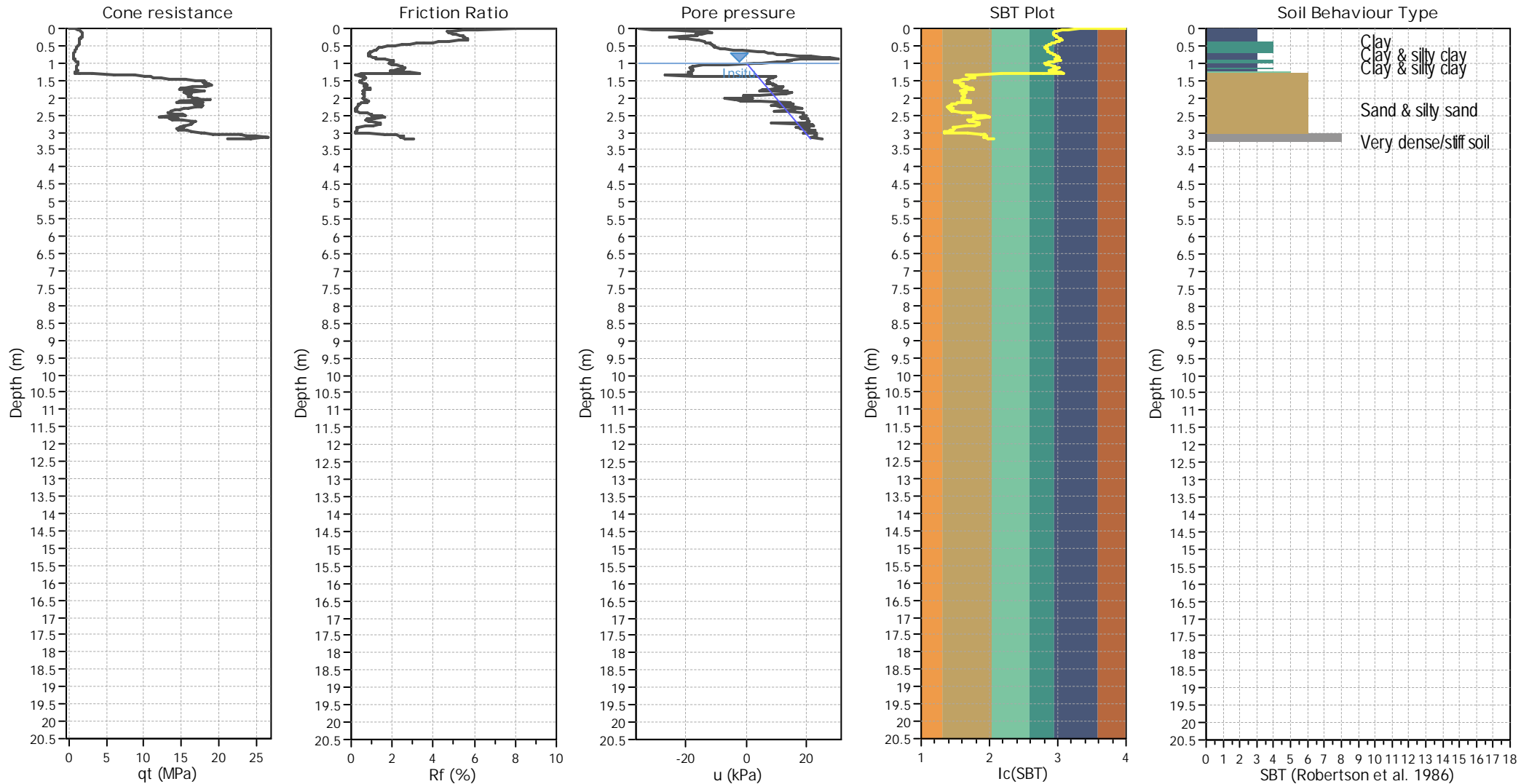


Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K <sub>σ</sub> applied:	Yes
Earthquake magnitude M <sub>w</sub> :	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

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

CPT basic interpretation plots



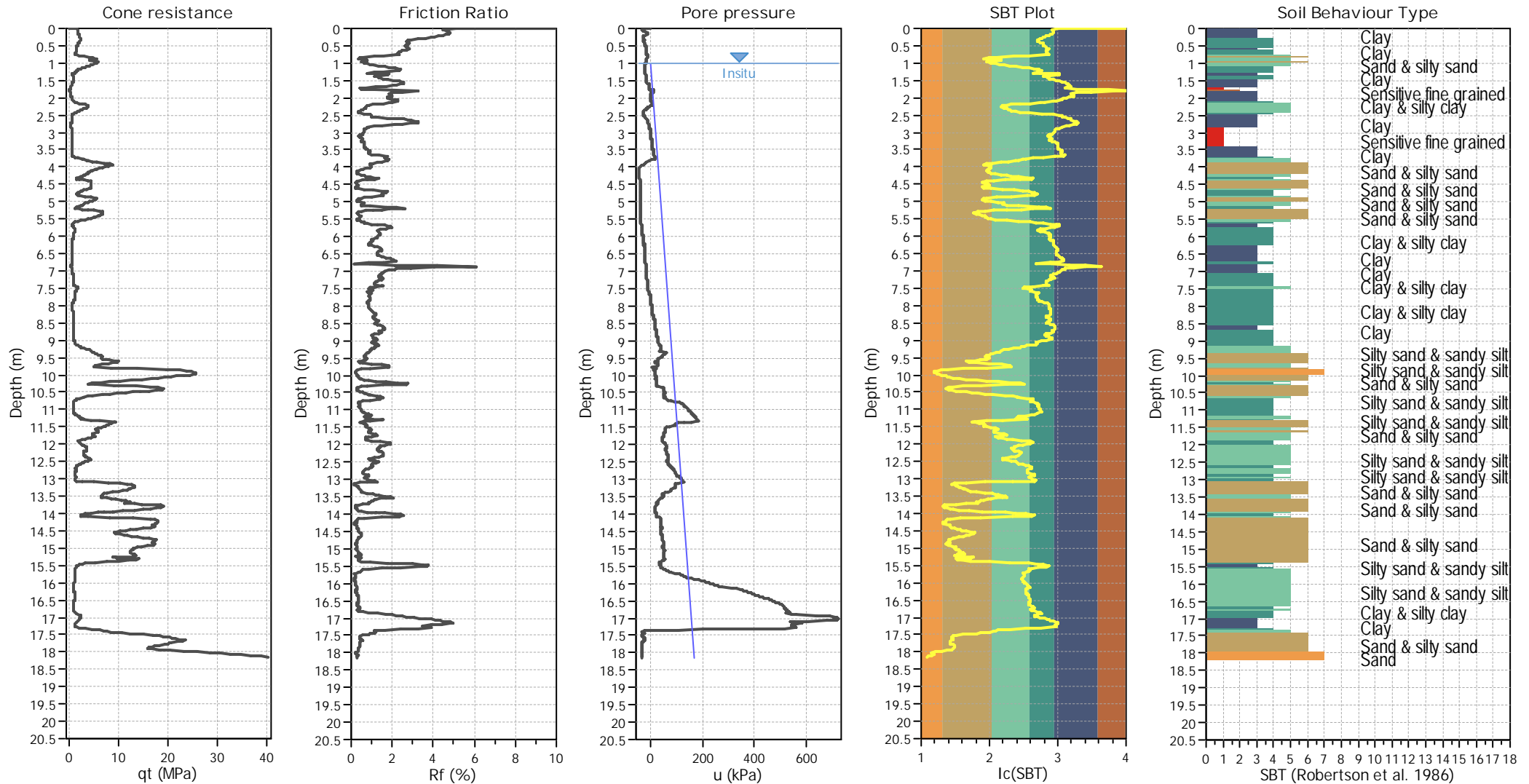
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K <sub>0</sub> applied:	Yes
Earthquake magnitude M <sub>w</sub> :	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

SBT legend

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

## CPT basic interpretation plots



## Input parameters and analysis data

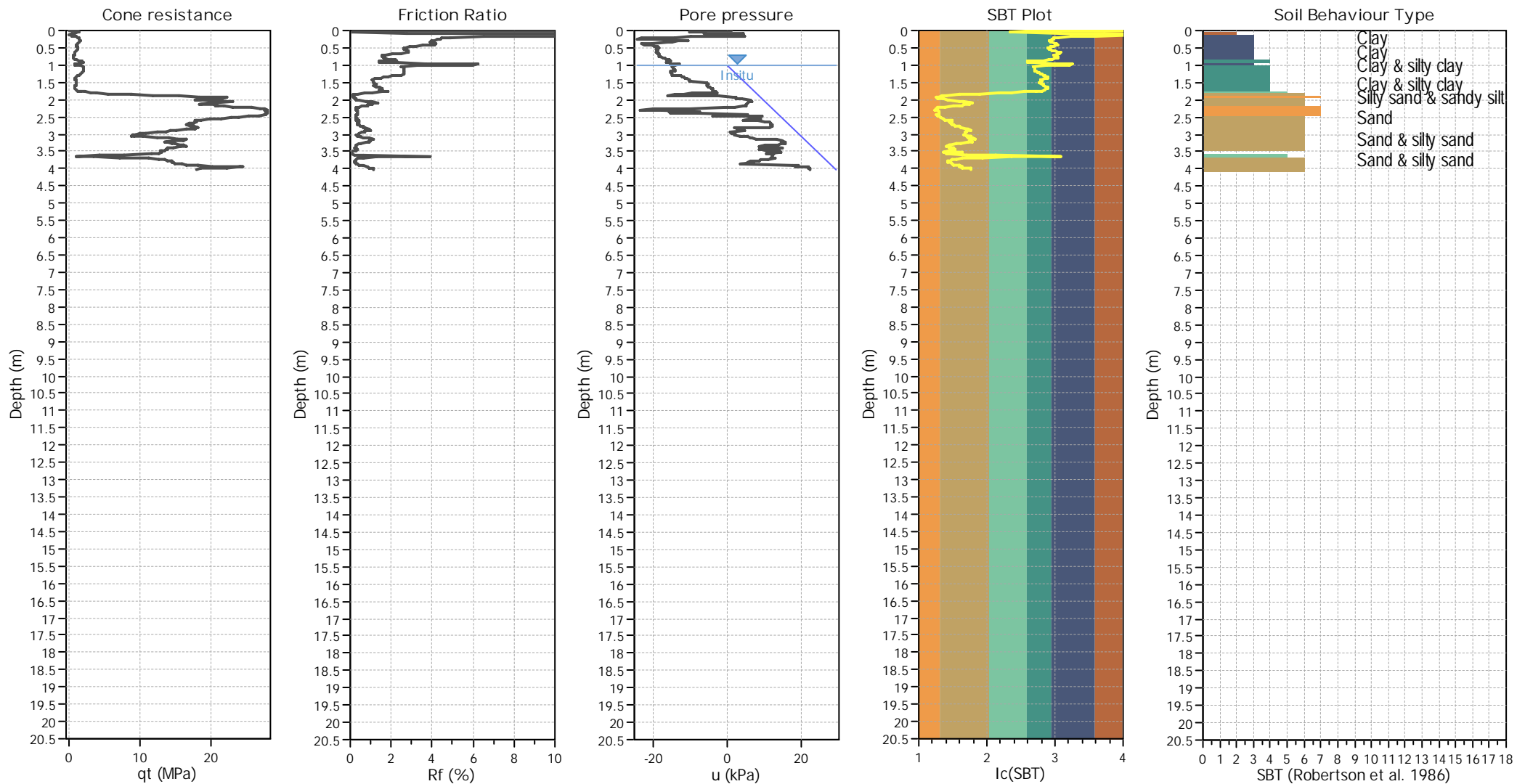
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on $I_c$ value	$I_c$ cut-off value:	2.60	$K_0$ applied:	Yes
Earthquake magnitude $M_w$ :	6.00	Unit weight calculation:	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

## SBT legend

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



CPT basic interpretation plots



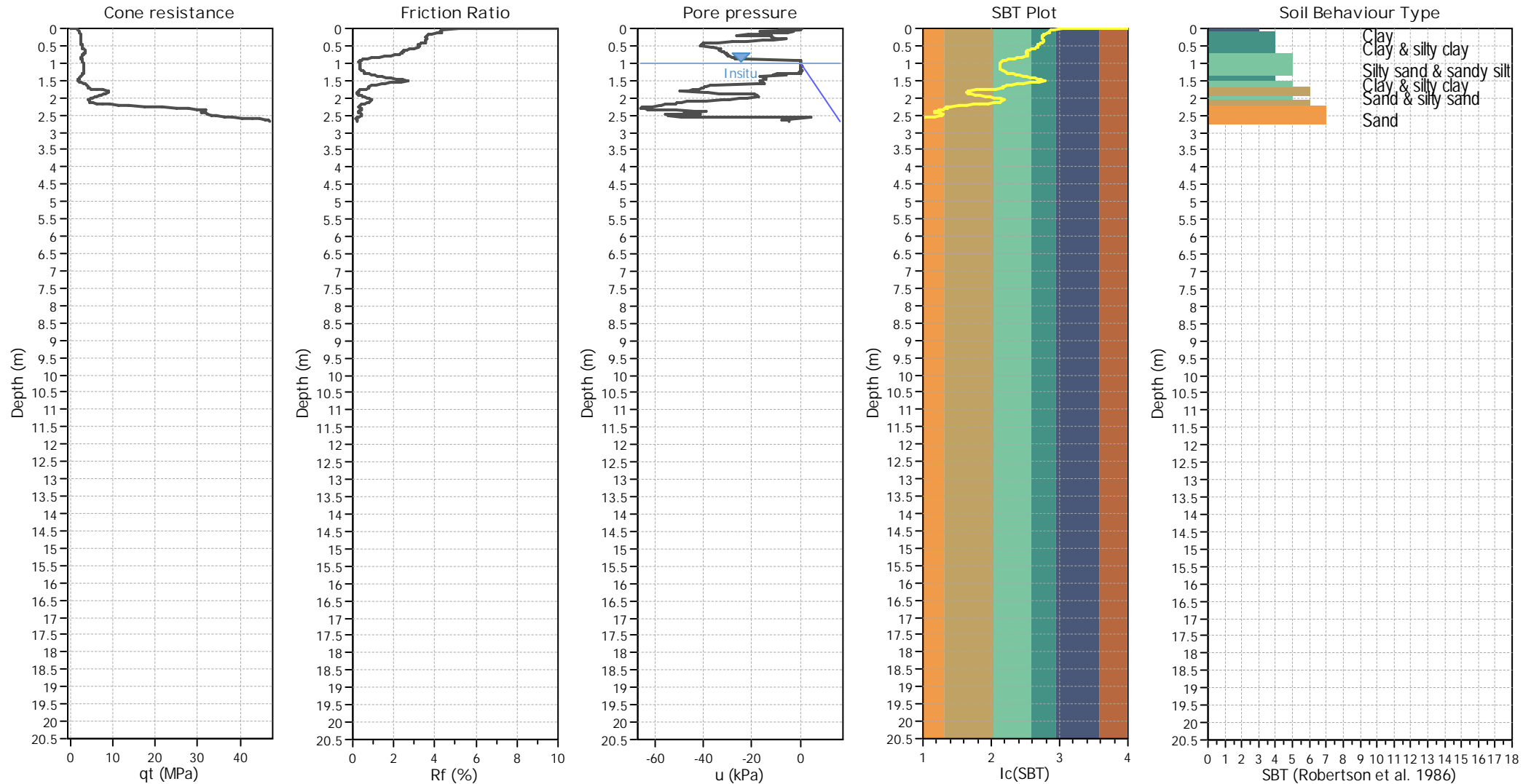
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K <sub>0</sub> applied:	Yes
Earthquake magnitude M <sub>w</sub> :	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

SBT legend

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

## CPT basic interpretation plots



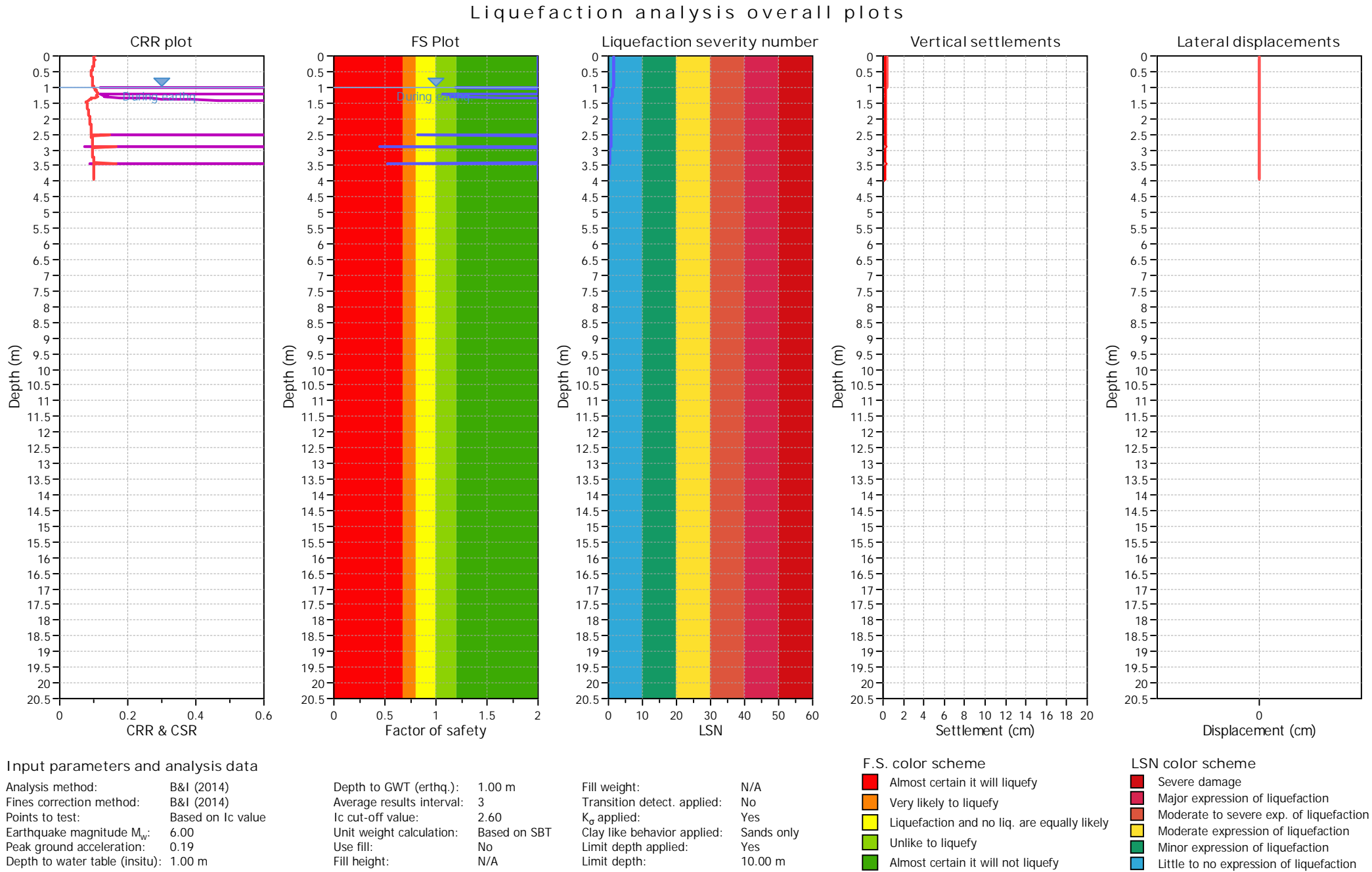
## Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on $I_c$ value	$I_c$ cut-off value:	2.60	$K_0$ 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

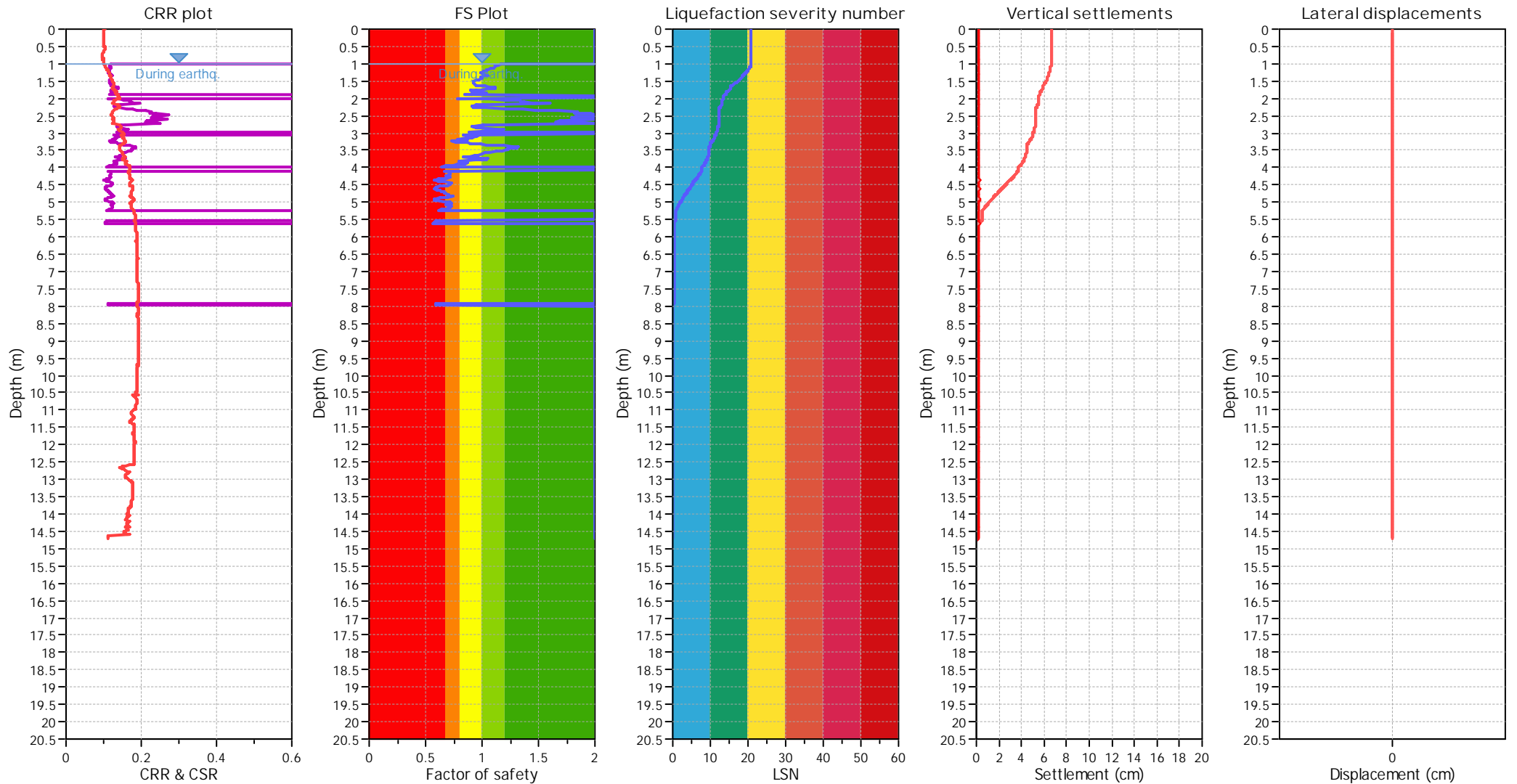
## SBT legend

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

Liquefaction analysis overall plots SLS1, SLS2, ULS



Liquefaction analysis overall plots

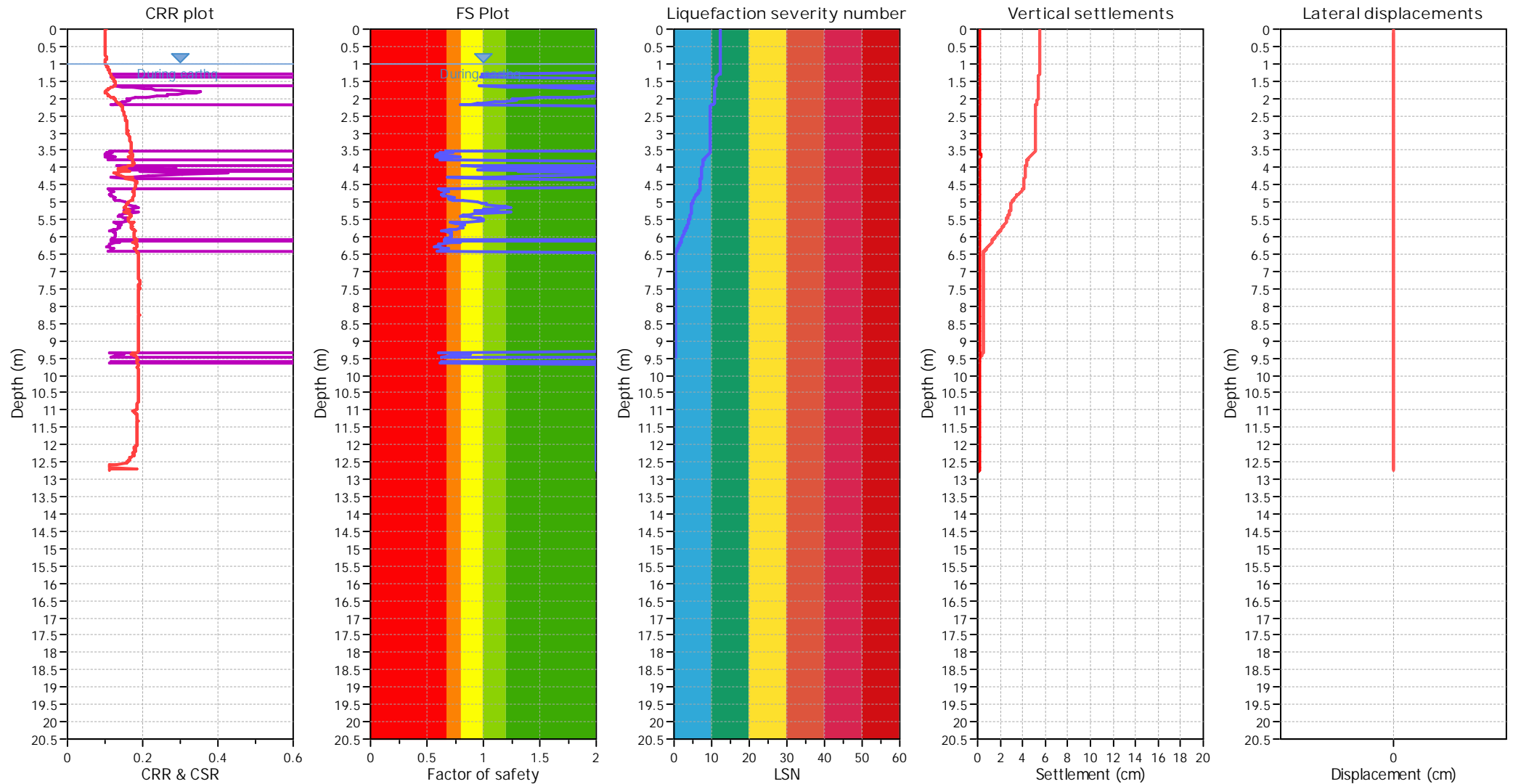


Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A	F.S. color scheme	LSN color scheme
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No	Almost certain it will liquefy	Severe damage
Points to test:	Based on Ic value	Ic cut-off value:	2.60	$K_0$ applied:	Yes	Very likely to liquefy	Major expression of liquefaction
Earthquake magnitude $M_w$ :	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only	Liquefaction and no liq. are equally likely	Moderate to severe exp. of liquefaction
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes	Unlike to liquefy	Moderate expression of liquefaction
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m	Almost certain it will not liquefy	Minor expression of liquefaction
							Little to no expression of liquefaction



## Liquefaction analysis overall plots



## Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	$K_0$ 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

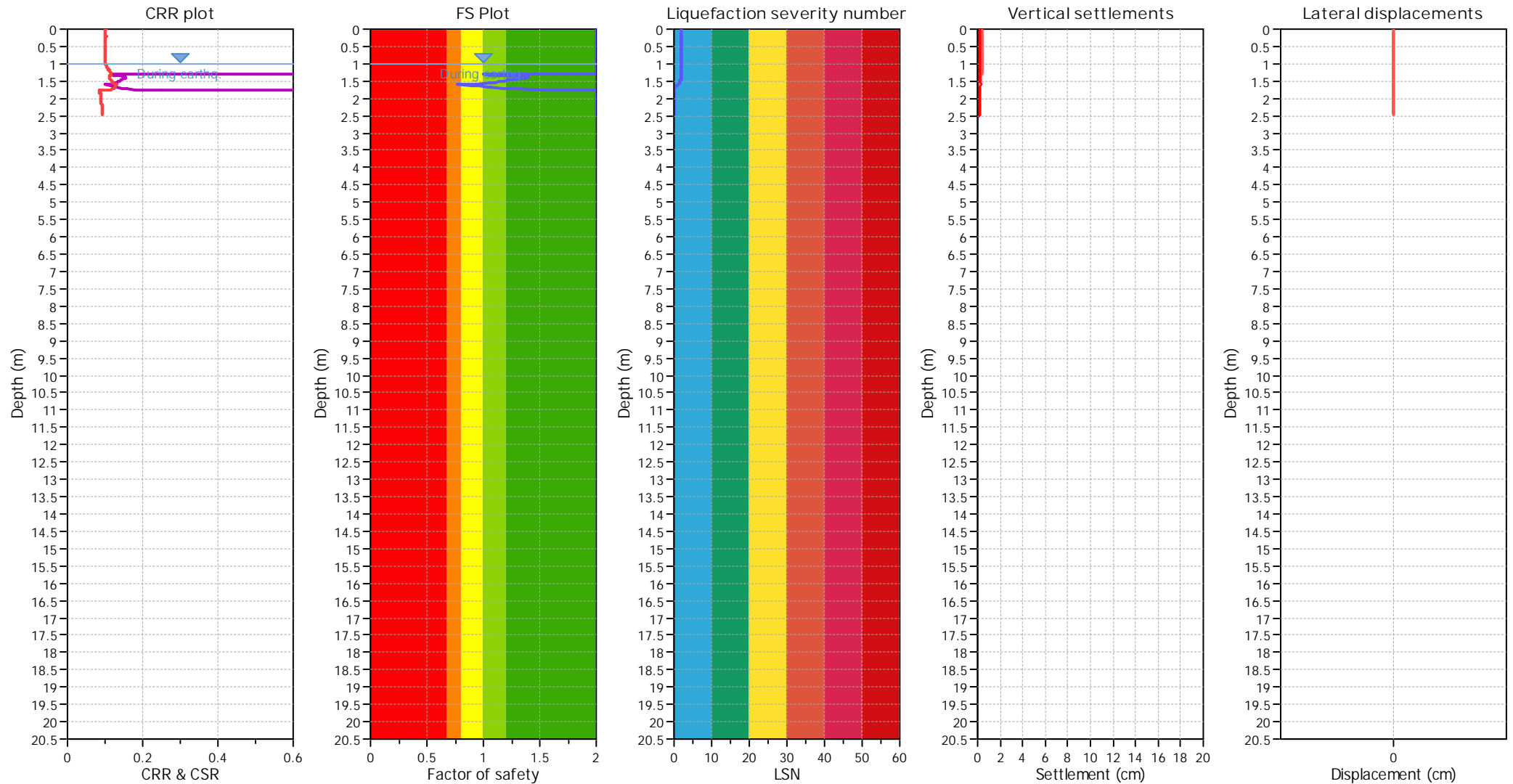
## F.S. color scheme

<span style="color: red;">■</span>	Almost certain it will liquefy
<span style="color: orange;">■</span>	Very likely to liquefy
<span style="color: yellow;">■</span>	Liquefaction and no liq. are equally likely
<span style="color: lightgreen;">■</span>	Unlike to liquefy
<span style="color: green;">■</span>	Almost certain it will not liquefy

## LSN color scheme

<span style="color: red;">■</span>	Severe damage
<span style="color: magenta;">■</span>	Major expression of liquefaction
<span style="color: brown;">■</span>	Moderate to severe exp. of liquefaction
<span style="color: orange;">■</span>	Moderate expression of liquefaction
<span style="color: green;">■</span>	Minor expression of liquefaction
<span style="color: blue;">■</span>	Little to no expression of liquefaction

## Liquefaction analysis overall plots



## Input parameters and analysis data

Analysis method: B&I (2014)  
 Fines correction method: B&I (2014)  
 Points to test: Based on  $I_c$  value  
 Earthquake magnitude  $M_w$ : 6.00  
 Peak ground acceleration: 0.19  
 Depth to water table (insitu): 1.00 m

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

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

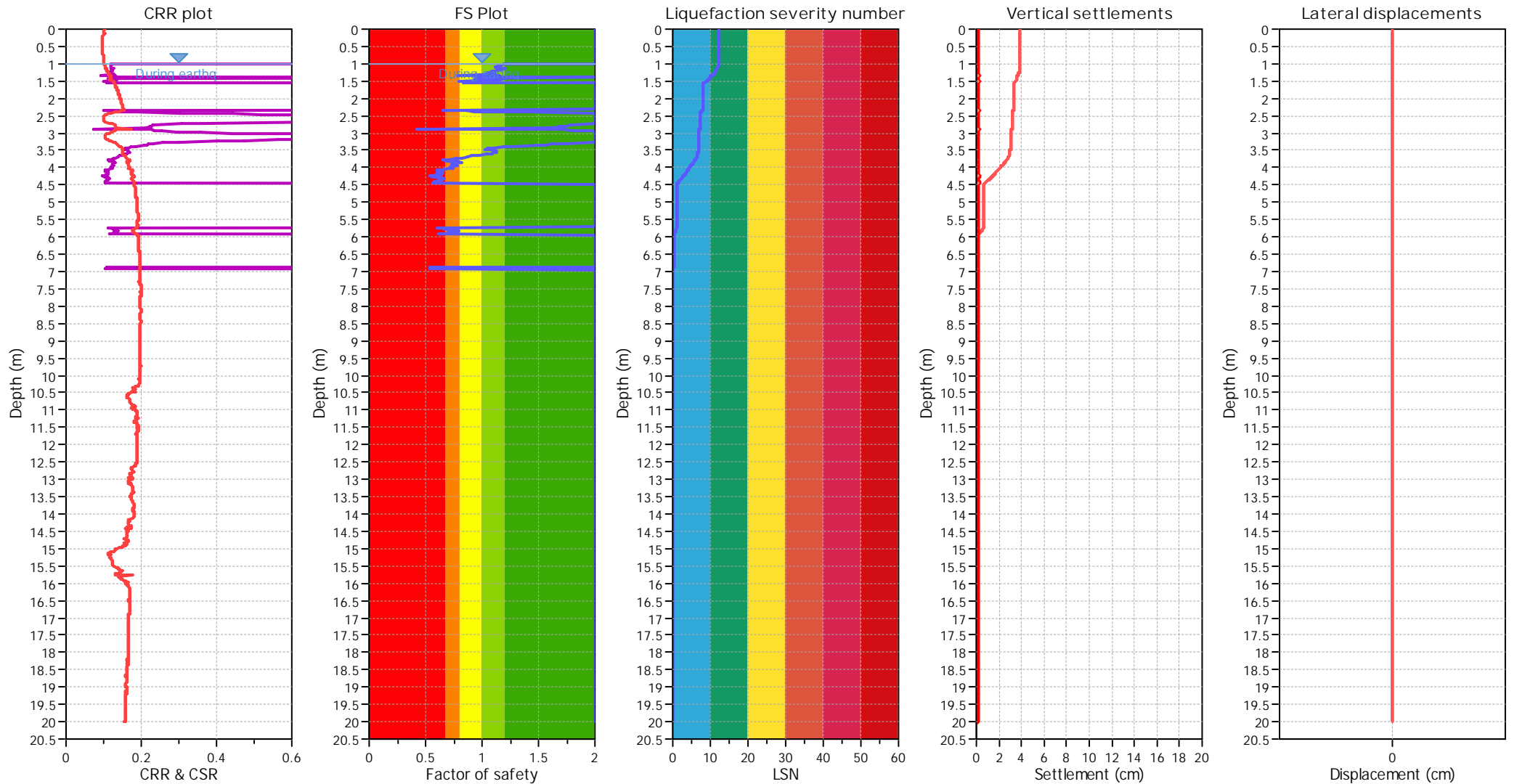
## F.S. color scheme

■ 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

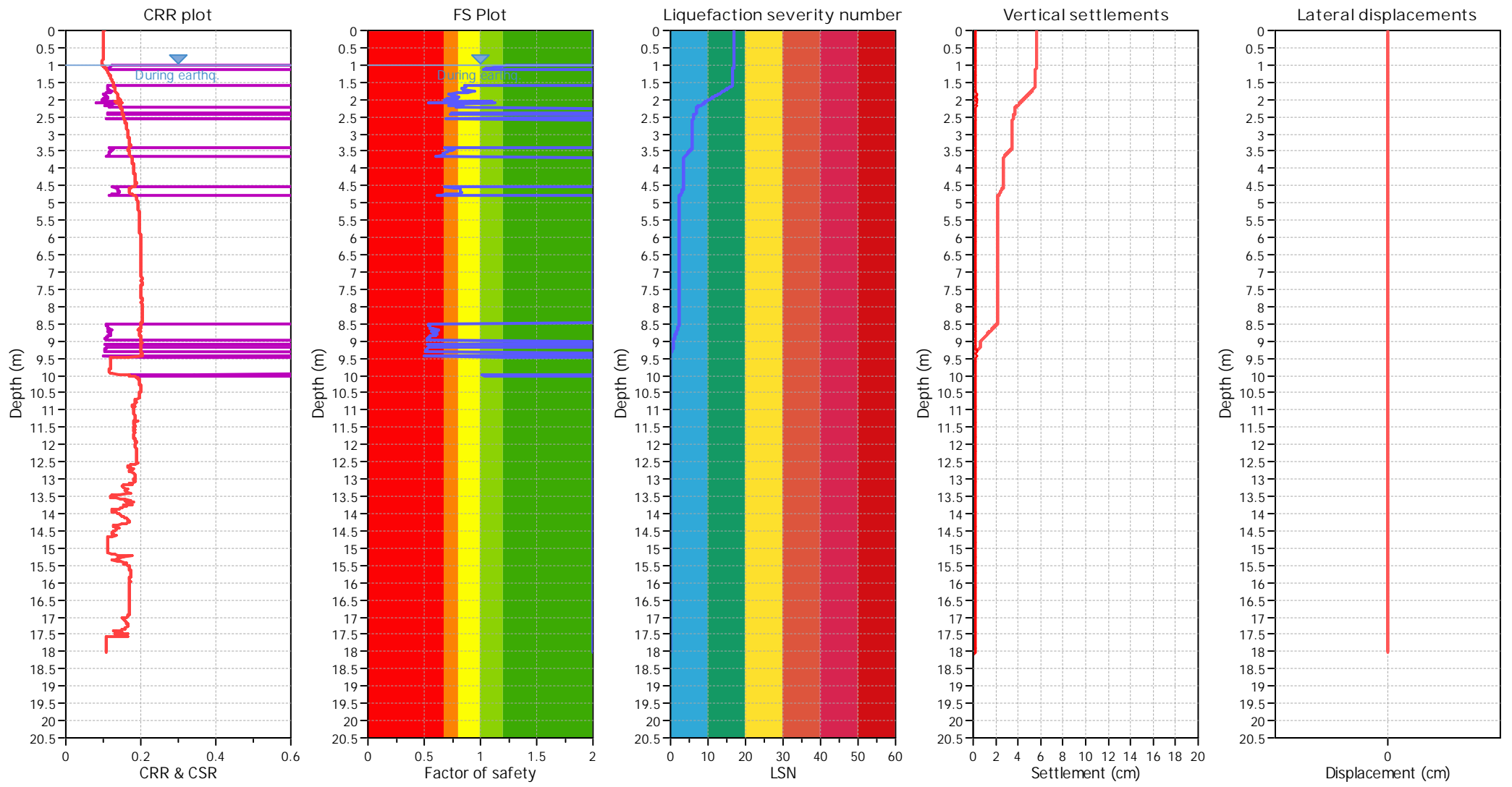
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A	F.S. color scheme	LSN color scheme
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No	Almost certain it will liquefy	Severe damage
Points to test:	Based on Ic value	Ic cut-off value:	2.60	$K_0$ applied:	Yes	Very likely to liquefy	Major expression of liquefaction
Earthquake magnitude $M_w$ :	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only	Liquefaction and no liq. are equally likely	Moderate to severe exp. of liquefaction
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes	Unlike to liquefy	Moderate expression of liquefaction
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m	Almost certain it will not liquefy	Minor expression of liquefaction
							Little to no expression of liquefaction

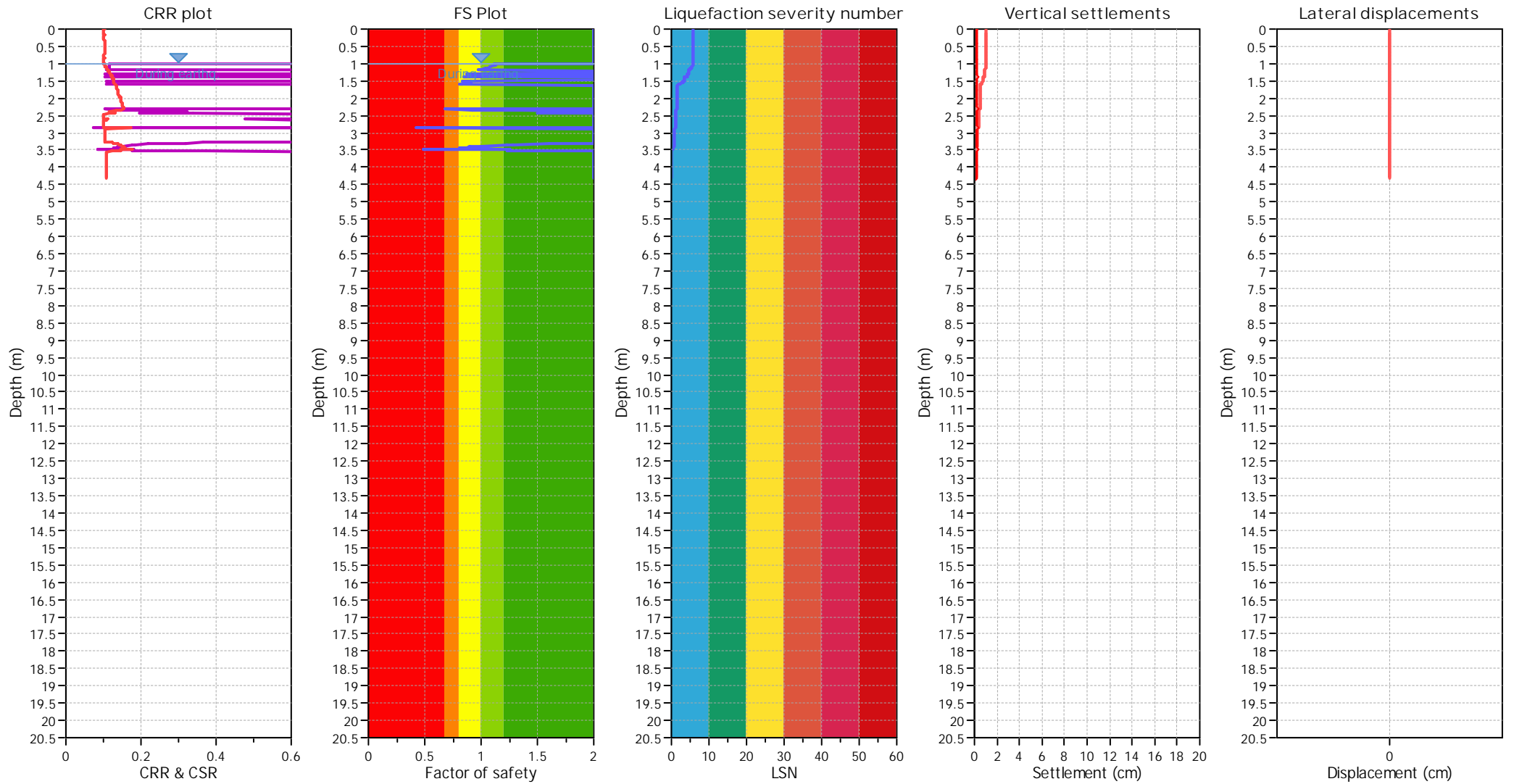
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A	F.S. color scheme	LSN color scheme
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No	<div></div> Almost certain it will liquefy	<div></div> Severe damage
Points to test:	Based on Ic value	Ic cut-off value:	2.60	$K_0$ applied:	Yes	<div></div> Very likely to liquefy	<div></div> Major expression of liquefaction
Earthquake magnitude $M_w$ :	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only	<div></div> Liquefaction and no liq. are equally likely	<div></div> Moderate to severe exp. of liquefaction
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes	<div></div> Unlike to liquefy	<div></div> Moderate expression of liquefaction
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m	<div></div> Almost certain it will not liquefy	<div></div> Minor expression of liquefaction
							<div></div> Little to no expression of liquefaction

Liquefaction analysis overall plots

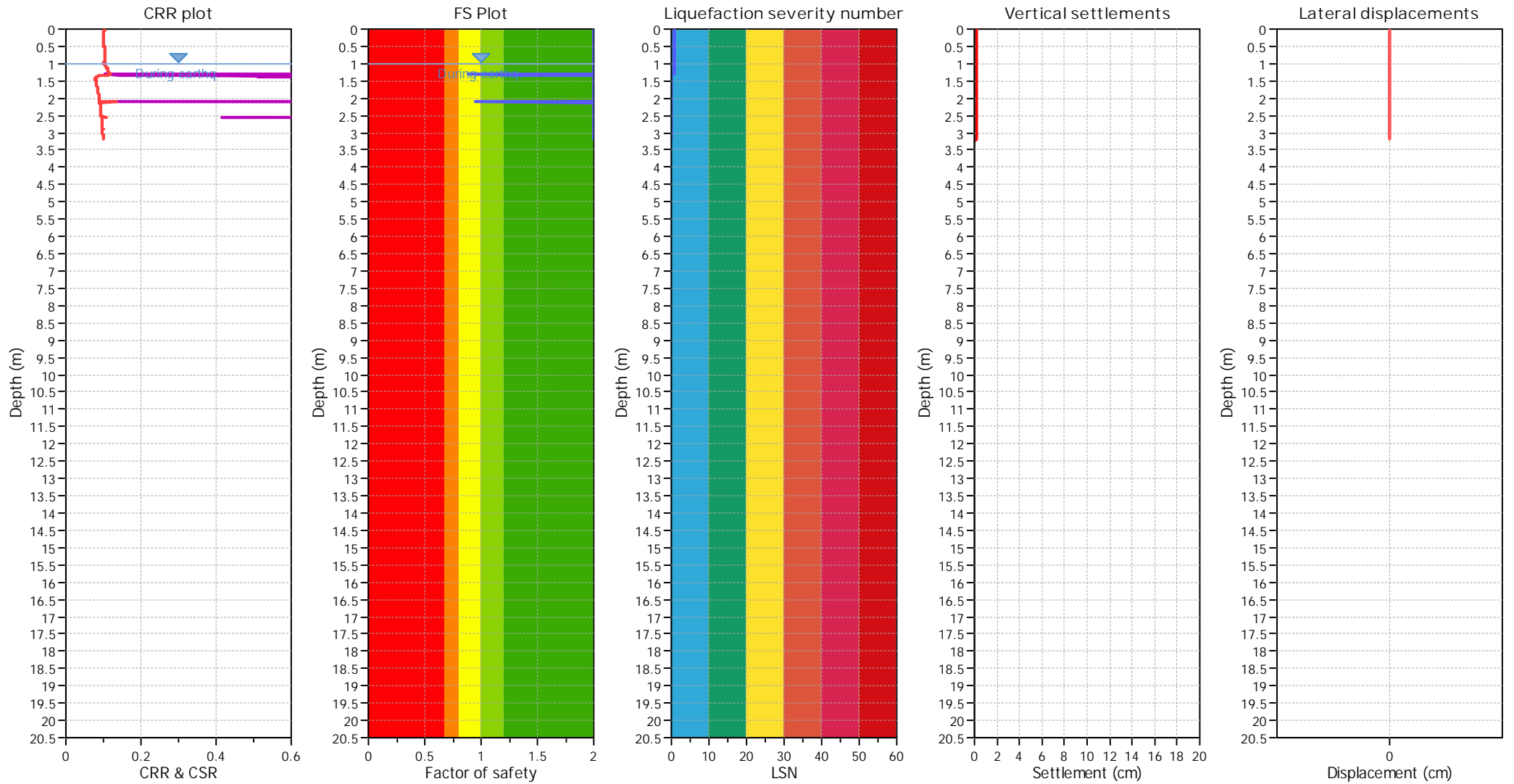


Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A	F.S. color scheme	LSN color scheme
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No	Almost certain it will liquefy	Severe damage
Points to test:	Based on Ic value	Ic cut-off value:	2.60	$K_0$ applied:	Yes	Very likely to liquefy	Major expression of liquefaction
Earthquake magnitude $M_w$ :	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only	Liquefaction and no liq. are equally likely	Moderate to severe exp. of liquefaction
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes	Unlike to liquefy	Moderate expression of liquefaction
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m	Almost certain it will not liquefy	Minor expression of liquefaction
							Little to no expression of liquefaction



Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)  
Fines correction method: B&I (2014)  
Points to test: Based on Ic value  
Earthquake magnitude  $M_w$ : 6.00  
Peak ground acceleration: 0.19  
Depth to water table (insitu): 1.00 m

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

Fill weight: N/A  
Transition detect. applied: No  
 $K_0$  applied: Yes  
Clay like behavior applied: Sands only  
Limit depth applied: Yes  
Limit depth: 10.00 m

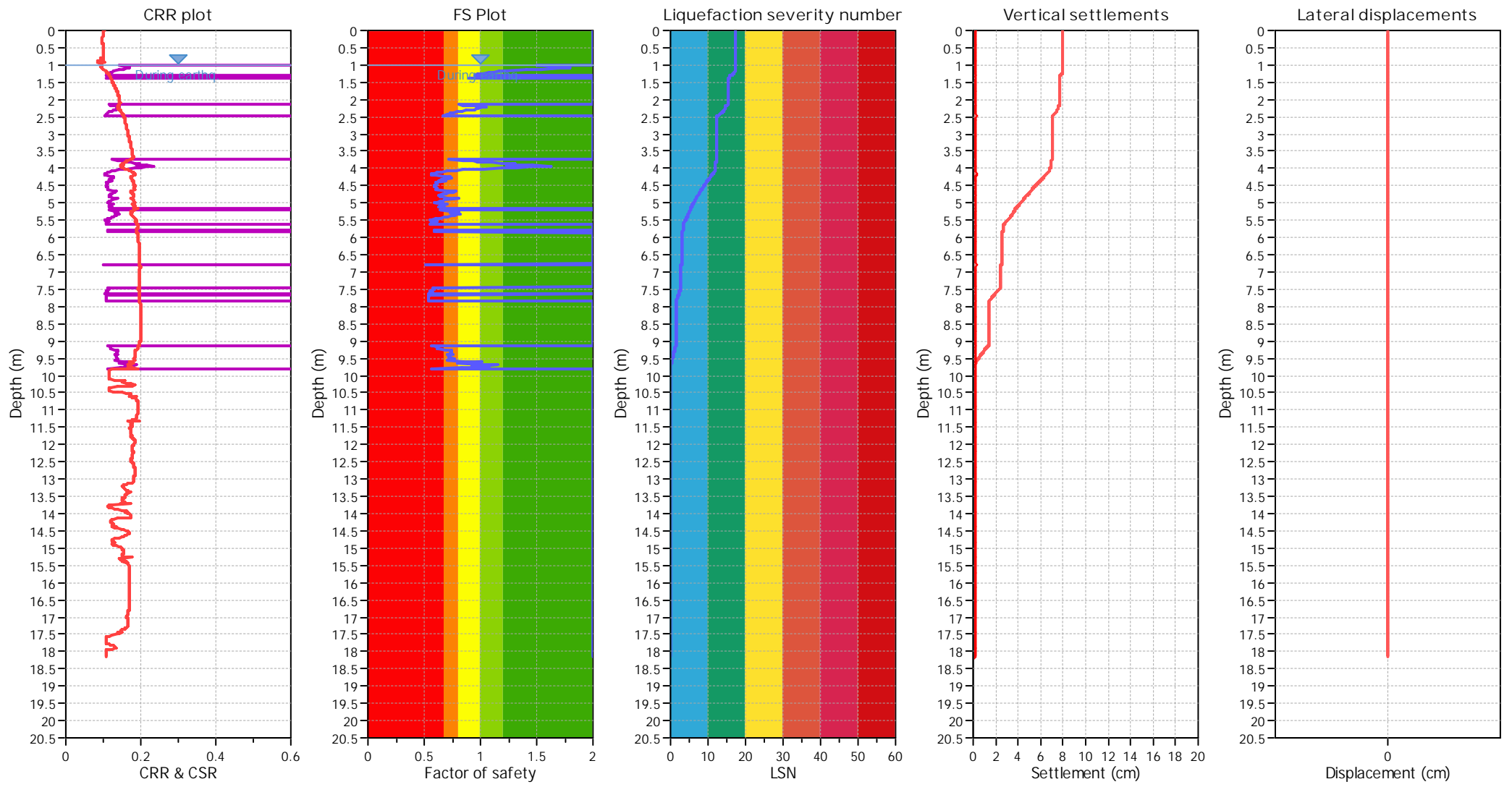
F.S. color scheme

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

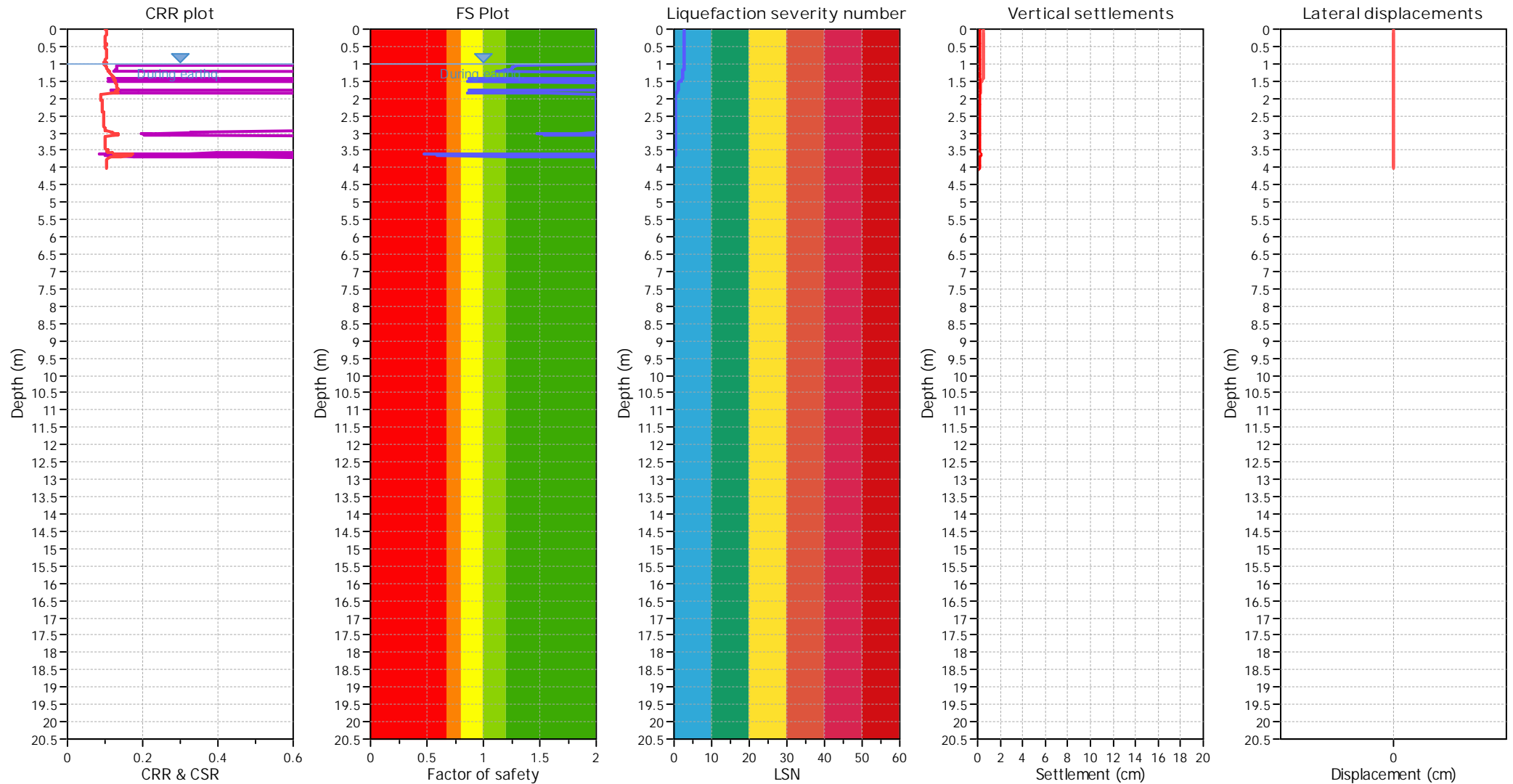
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A	F.S. color scheme	LSN color scheme
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No	Almost certain it will liquefy	Severe damage
Points to test:	Based on Ic value	Ic cut-off value:	2.60	$K_0$ applied:	Yes	Very likely to liquefy	Major expression of liquefaction
Earthquake magnitude $M_w$ :	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only	Liquefaction and no liq. are equally likely	Moderate to severe exp. of liquefaction
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes	Unlike to liquefy	Moderate expression of liquefaction
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m	Almost certain it will not liquefy	Minor expression of liquefaction
							Little to no expression of liquefaction

## Liquefaction analysis overall plots



## Input parameters and analysis data

Analysis method: B&I (2014)  
 Fines correction method: B&I (2014)  
 Points to test: Based on  $I_c$  value  
 Earthquake magnitude  $M_w$ : 6.00  
 Peak ground acceleration: 0.19  
 Depth to water table (insitu): 1.00 m

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

Fill weight: N/A  
 Transition detect. applied: No  
 $K_0$  applied: Yes  
 Clay like behavior applied: Sands only  
 Limit depth applied: Yes  
 Limit depth: 10.00 m

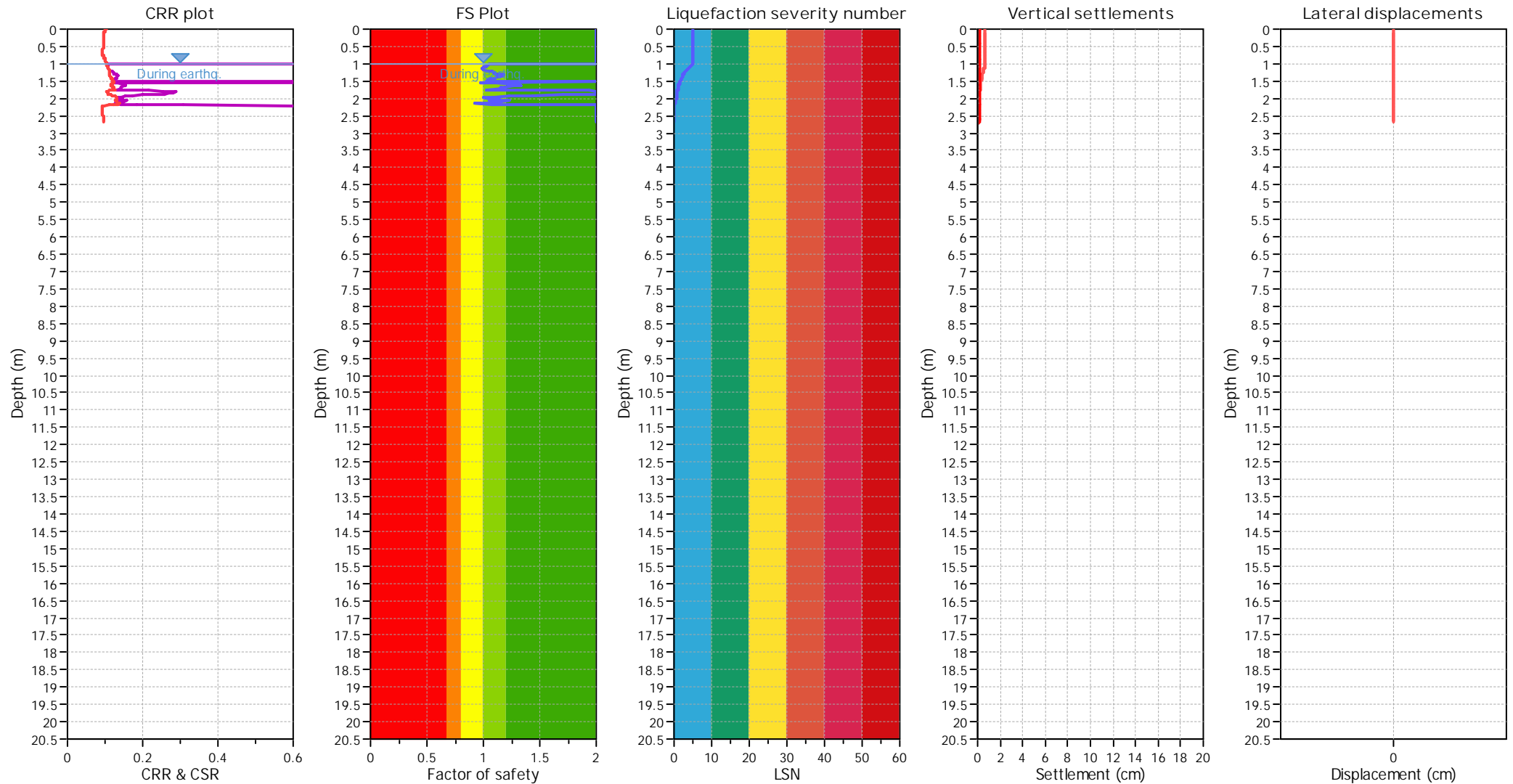
## F.S. color scheme

■ 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



## Input parameters and analysis data

Analysis method: B&I (2014)  
 Fines correction method: B&I (2014)  
 Points to test: Based on  $I_c$  value  
 Earthquake magnitude  $M_w$ : 6.00  
 Peak ground acceleration: 0.19  
 Depth to water table (insitu): 1.00 m

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

Fill weight: N/A  
 Transition detect. applied: No  
 $K_0$  applied: Yes  
 Clay like behavior applied: Sands only  
 Limit depth applied: Yes  
 Limit depth: 10.00 m

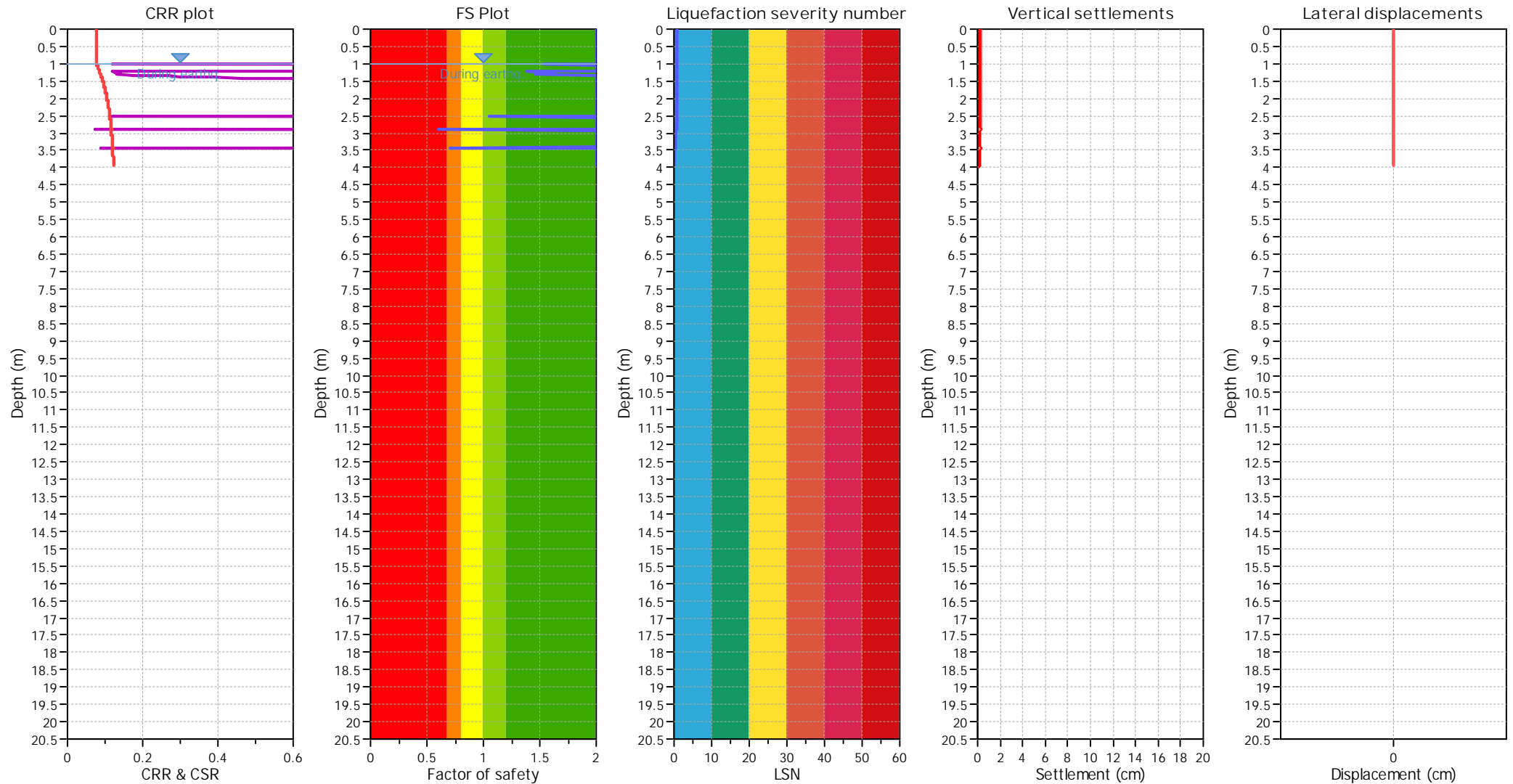
## F.S. color scheme

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



## Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	$K_0$ 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

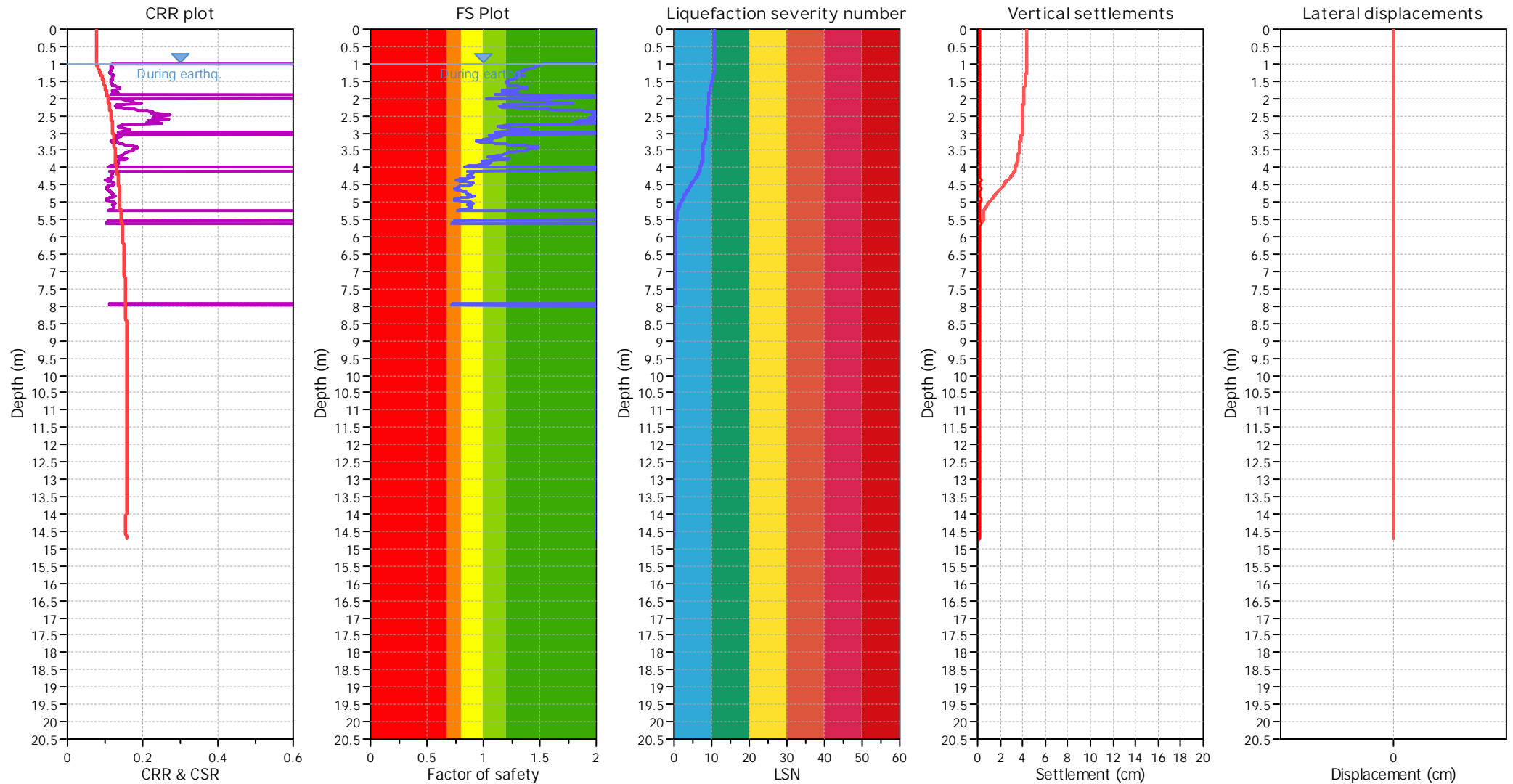
Red	Almost certain it will liquefy
Orange	Very likely to liquefy
Yellow	Liquefaction and no liq. are equally likely
Light Green	Unlike to liquefy
Dark Green	Almost certain it will not liquefy

## LSN color scheme

Red	Severe damage
Orange	Major expression of liquefaction
Yellow	Moderate to severe exp. of liquefaction
Light Green	Moderate expression of liquefaction
Dark Green	Minor expression of liquefaction
Blue	Little to no expression of liquefaction



## Liquefaction analysis overall plots



## Input parameters and analysis data

Analysis method: B&I (2014)  
 Fines correction method: B&I (2014)  
 Points to test: Based on  $I_c$  value  
 Earthquake magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.13  
 Depth to water table (insitu): 1.00 m

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

Fill weight: N/A  
 Transition detect. applied: No  
 $K_0$  applied: Yes  
 Clay like behavior applied: Sands only  
 Limit depth applied: Yes  
 Limit depth: 10.00 m

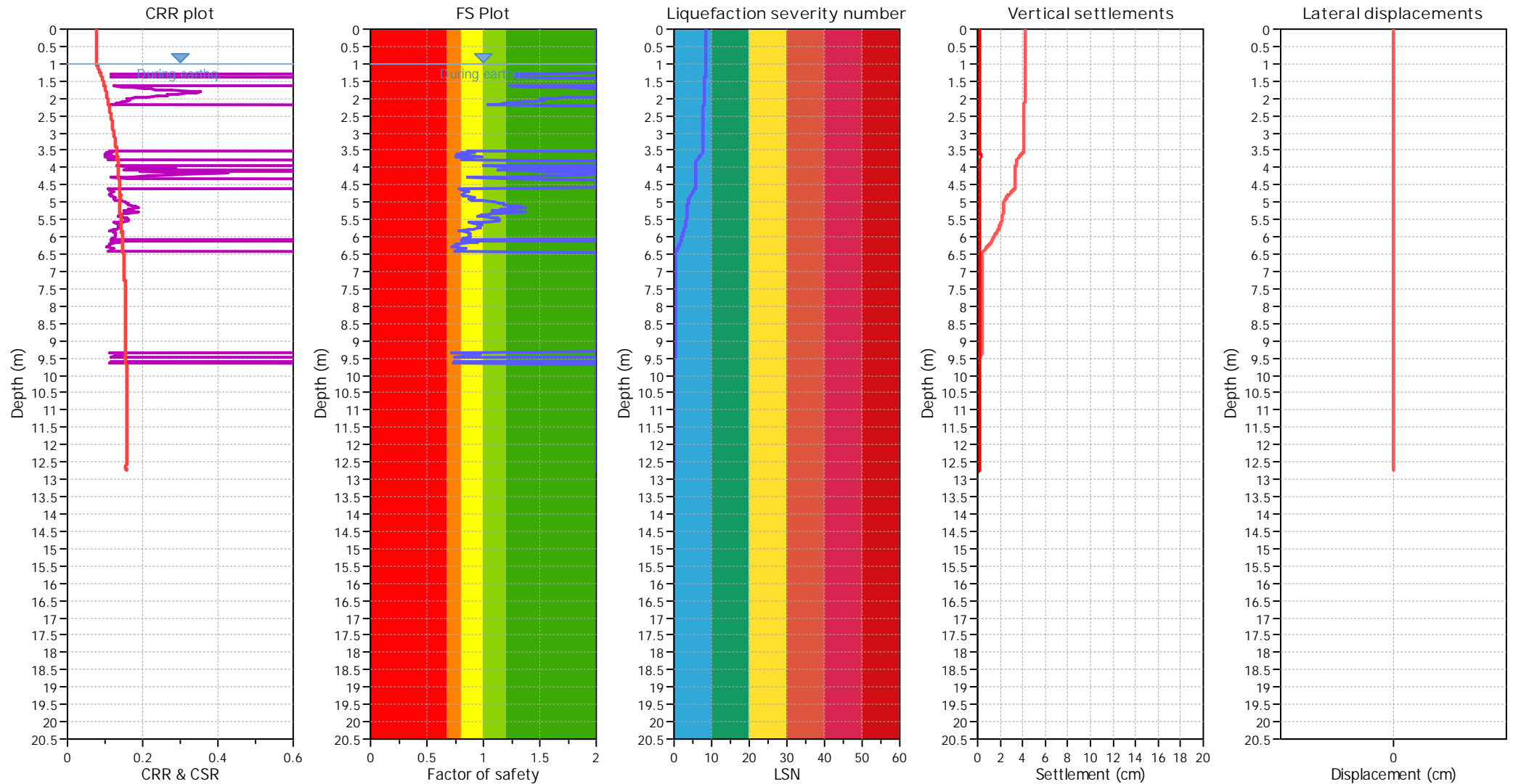
## F.S. color scheme

■ 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



## Input parameters and analysis data

Analysis method: B&I (2014)  
 Fines correction method: B&I (2014)  
 Points to test: Based on  $I_c$  value  
 Earthquake magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.13  
 Depth to water table (insitu): 1.00 m

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

Fill weight: N/A  
 Transition detect. applied: No  
 $K_0$  applied: Yes  
 Clay like behavior applied: Sands only  
 Limit depth applied: Yes  
 Limit depth: 10.00 m

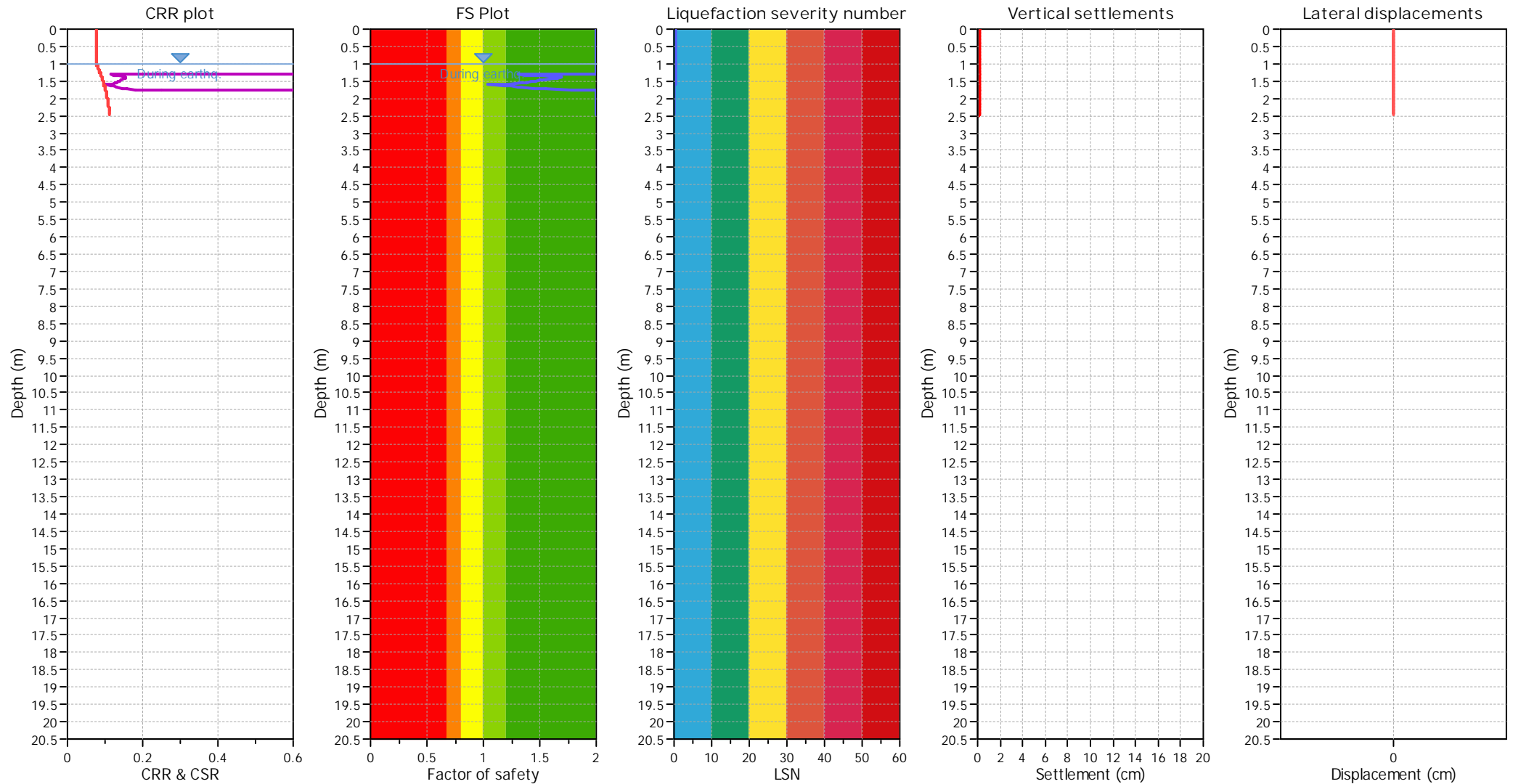
## F.S. color scheme

■ 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



## Input parameters and analysis data

Analysis method: B&I (2014)  
 Fines correction method: B&I (2014)  
 Points to test: Based on  $I_c$  value  
 Earthquake magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.13  
 Depth to water table (insitu): 1.00 m

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

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

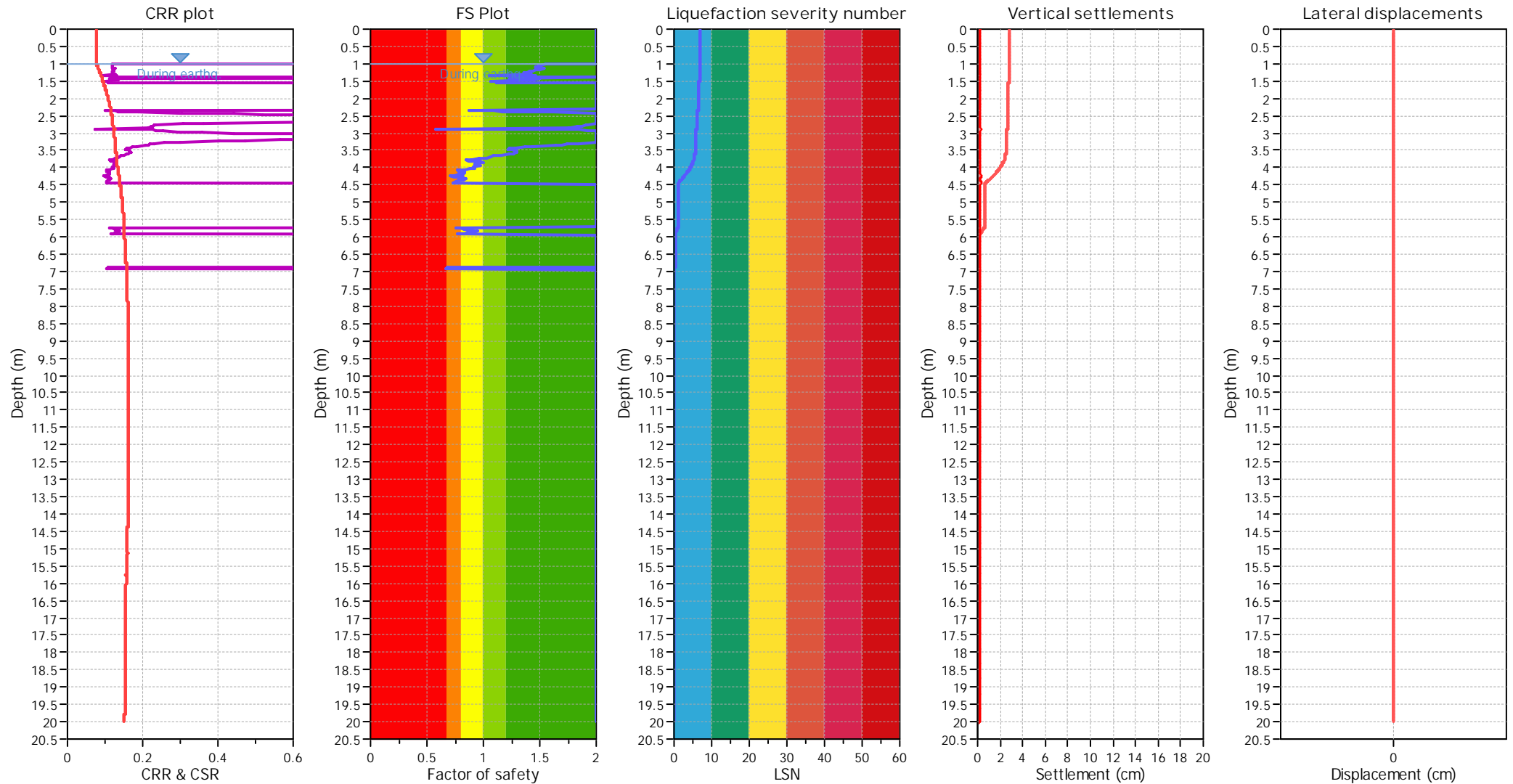
## F.S. color scheme

■ 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



## 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: 0.13  
 Depth to water table (insitu): 1.00 m

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

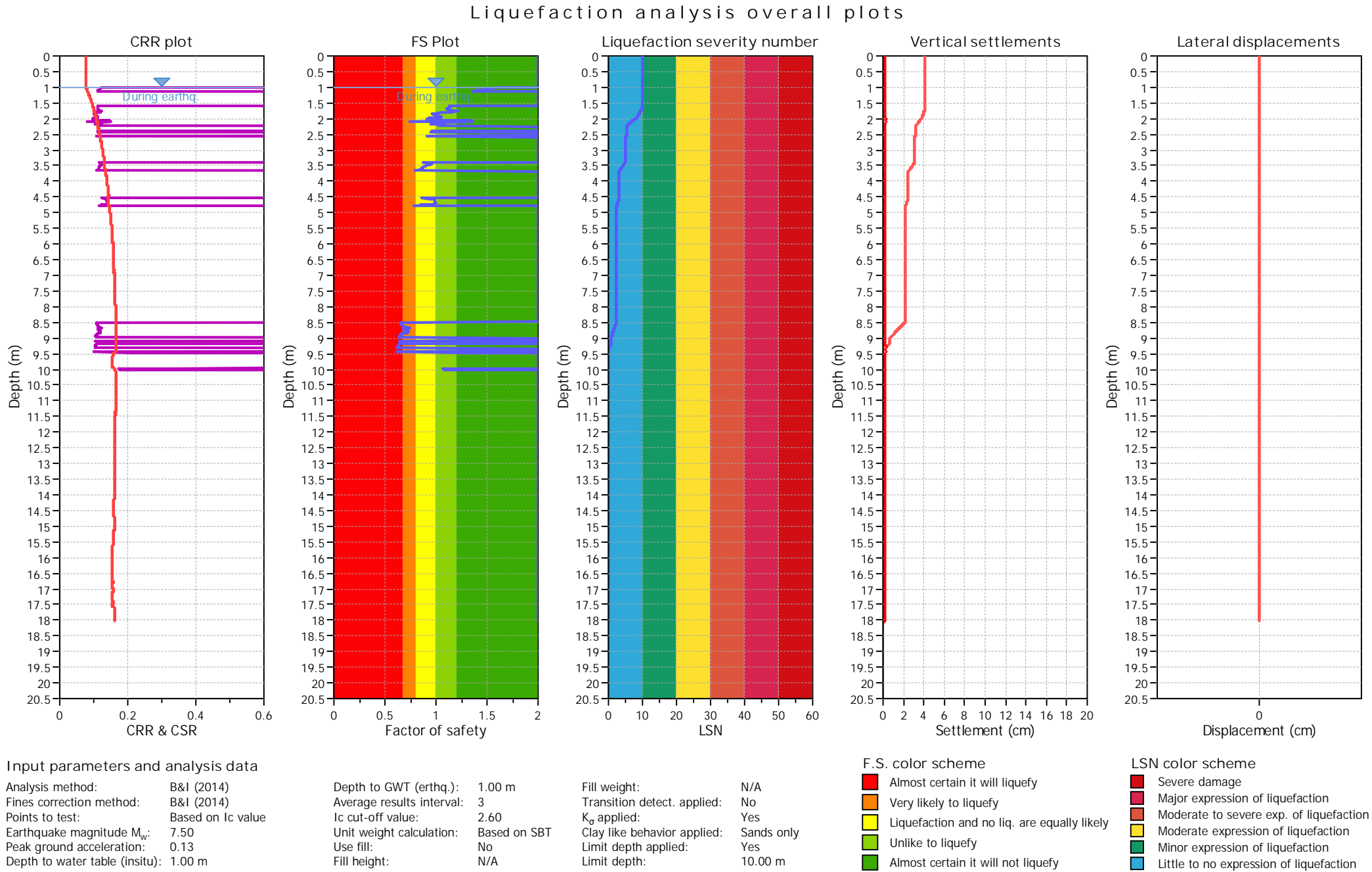
Fill weight: N/A  
 Transition detect. applied: No  
 $K_0$  applied: Yes  
 Clay like behavior applied: Sands only  
 Limit depth applied: Yes  
 Limit depth: 10.00 m

## 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

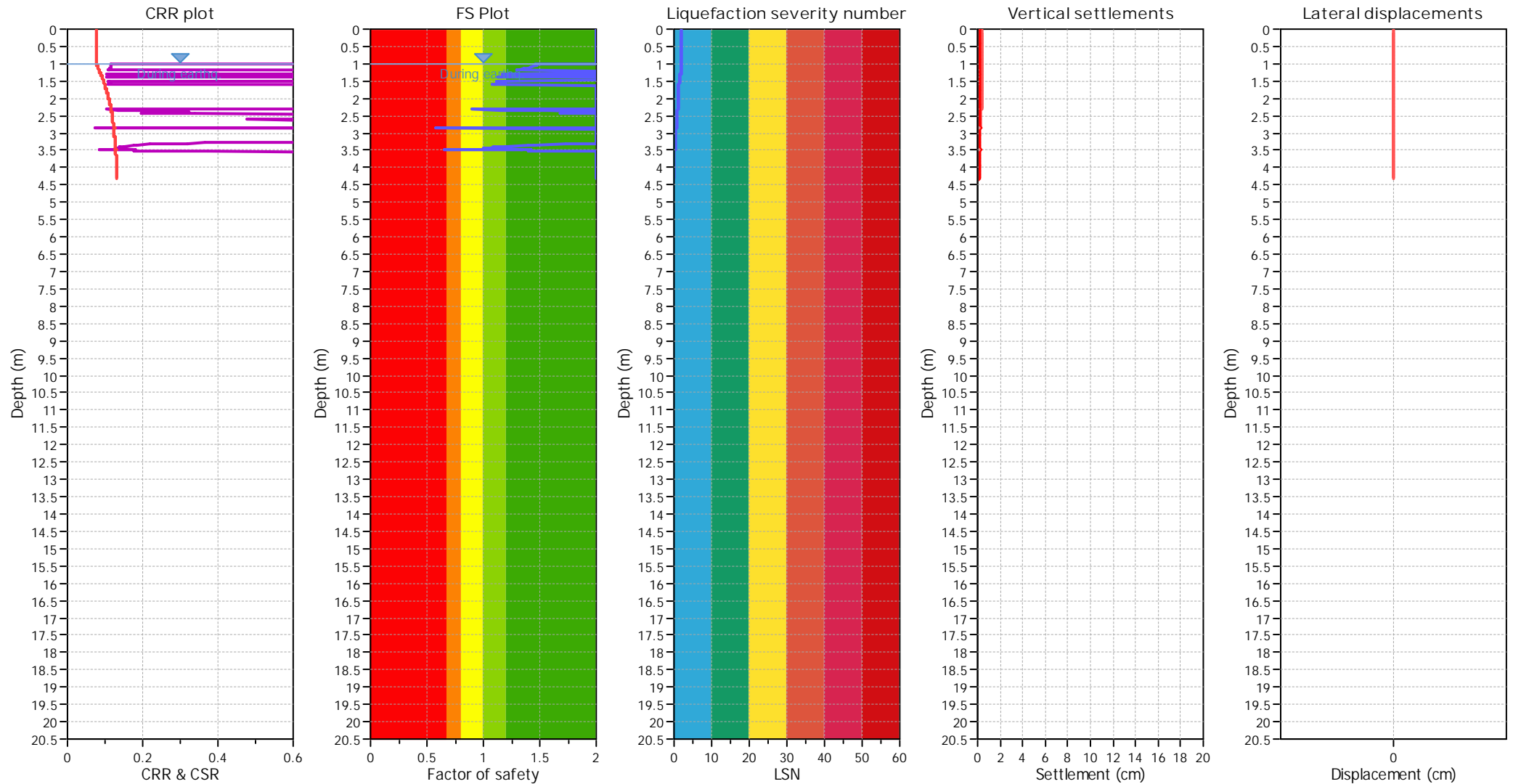
## LSN color scheme

■ 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



## Input parameters and analysis data

Analysis method: B&I (2014)  
 Fines correction method: B&I (2014)  
 Points to test: Based on  $I_c$  value  
 Earthquake magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.13  
 Depth to water table (insitu): 1.00 m

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

Fill weight: N/A  
 Transition detect. applied: No  
 $K_0$  applied: Yes  
 Clay like behavior applied: Sands only  
 Limit depth applied: Yes  
 Limit depth: 10.00 m

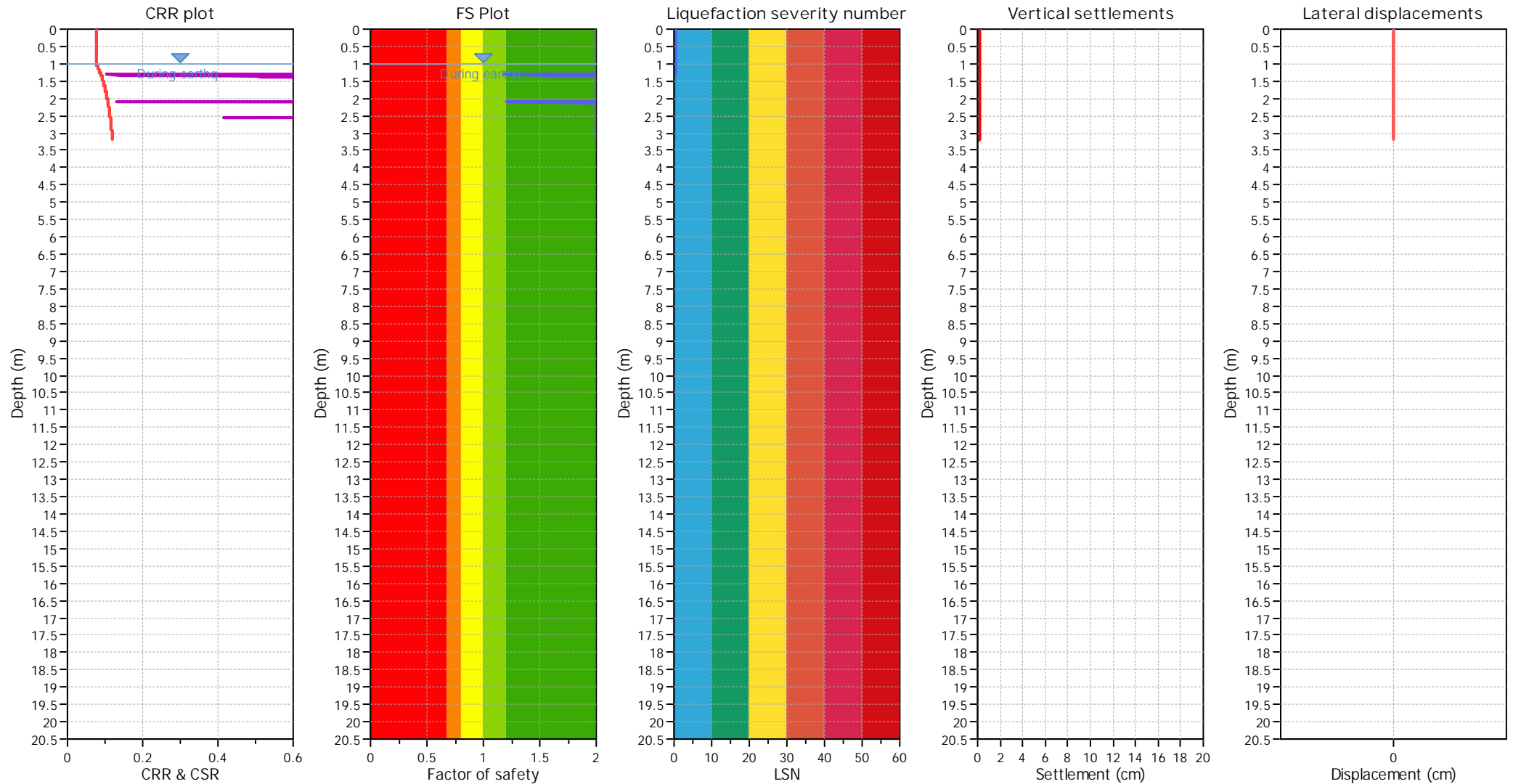
## F.S. color scheme

■ 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



## 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: 0.13  
 Depth to water table (insitu): 1.00 m

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

Fill weight: N/A  
 Transition detect. applied: No  
 $K_0$  applied: Yes  
 Clay like behavior applied: Sands only  
 Limit depth applied: Yes  
 Limit depth: 10.00 m

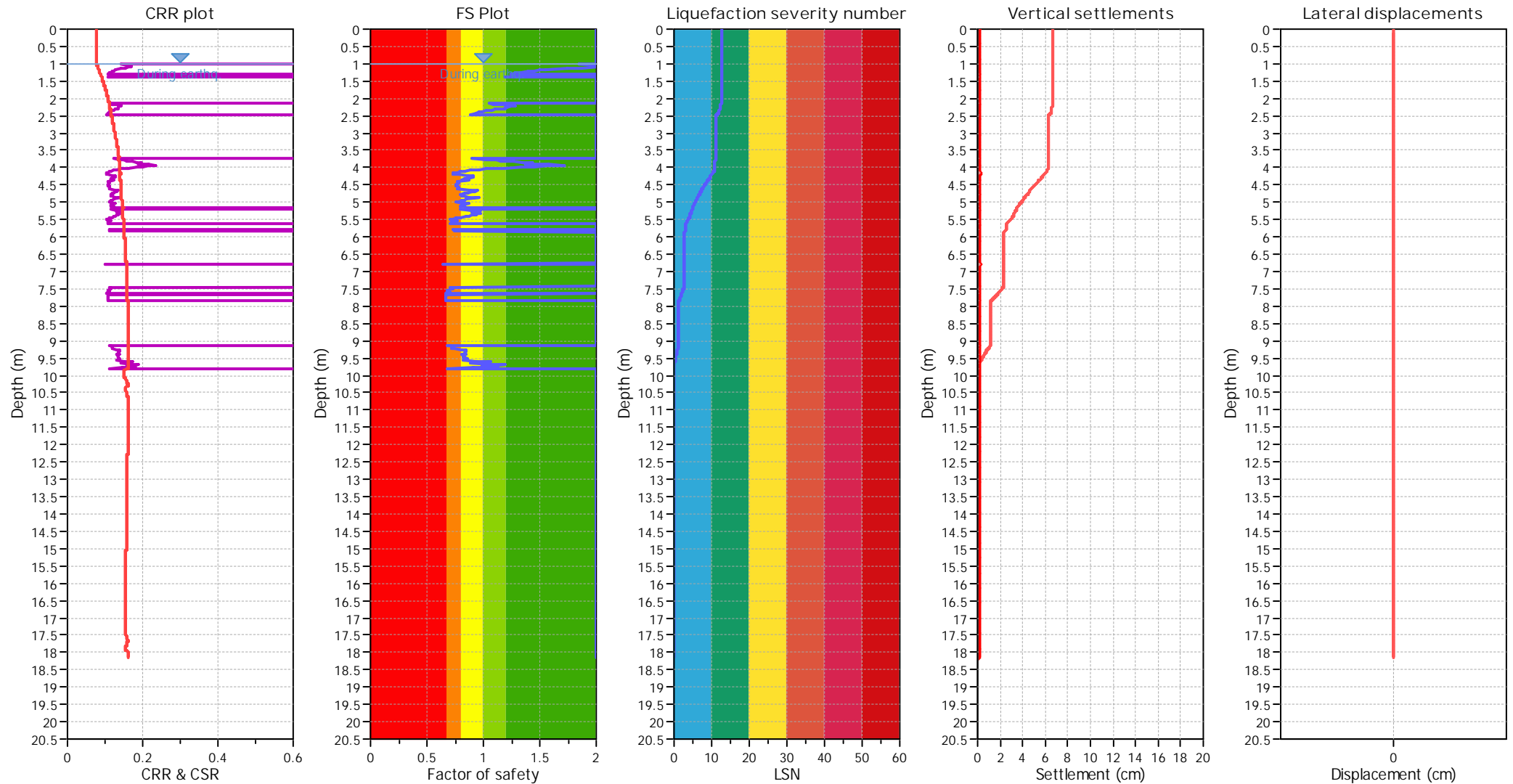
## F.S. color scheme

■ 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



## Input parameters and analysis data

Analysis method: B&I (2014)  
 Fines correction method: B&I (2014)  
 Points to test: Based on  $I_c$  value  
 Earthquake magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.13  
 Depth to water table (insitu): 1.00 m

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

Fill weight: N/A  
 Transition detect. applied: No  
 $K_0$  applied: Yes  
 Clay like behavior applied: Sands only  
 Limit depth applied: Yes  
 Limit depth: 10.00 m

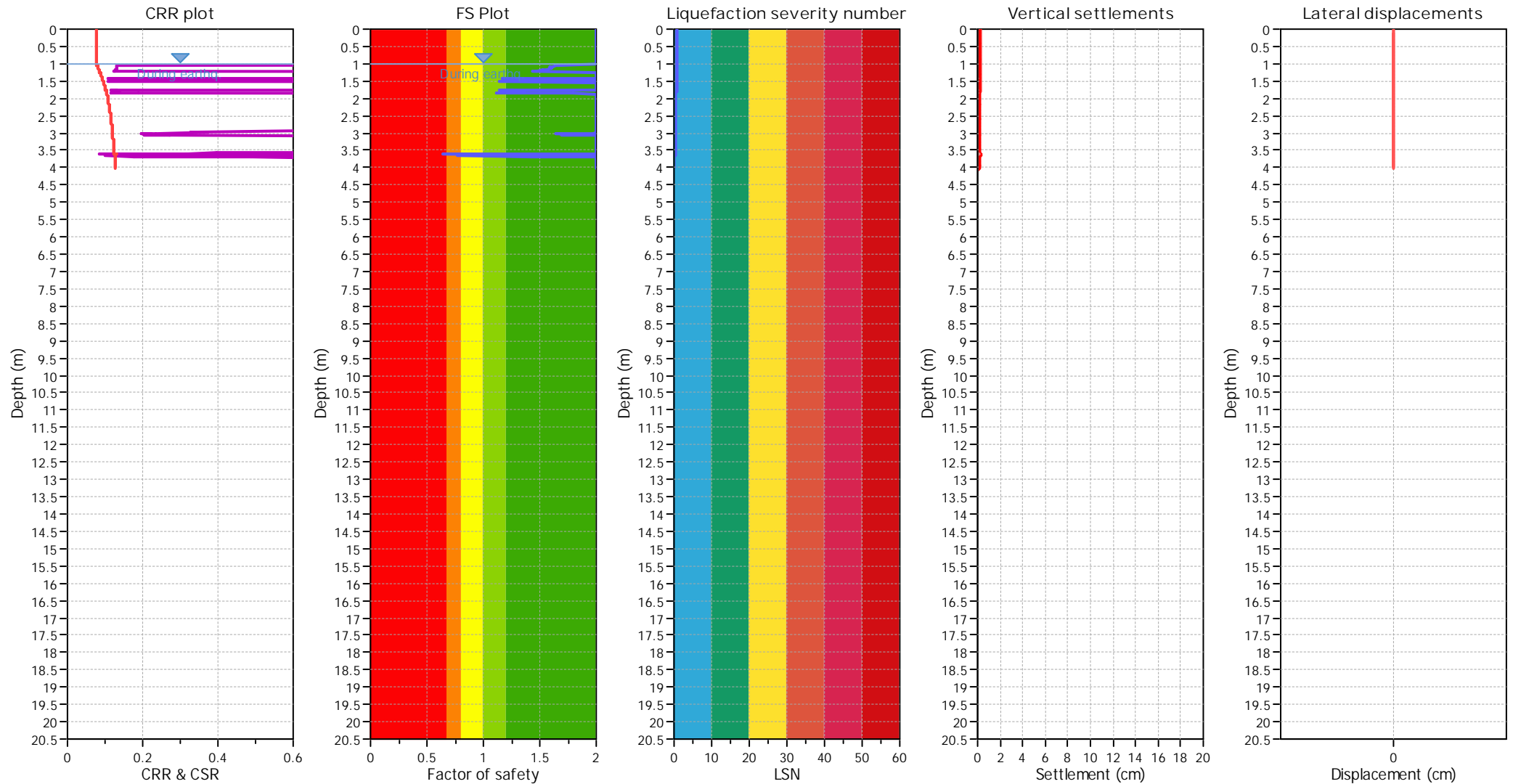
## F.S. color scheme

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



## Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	$K_0$ 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

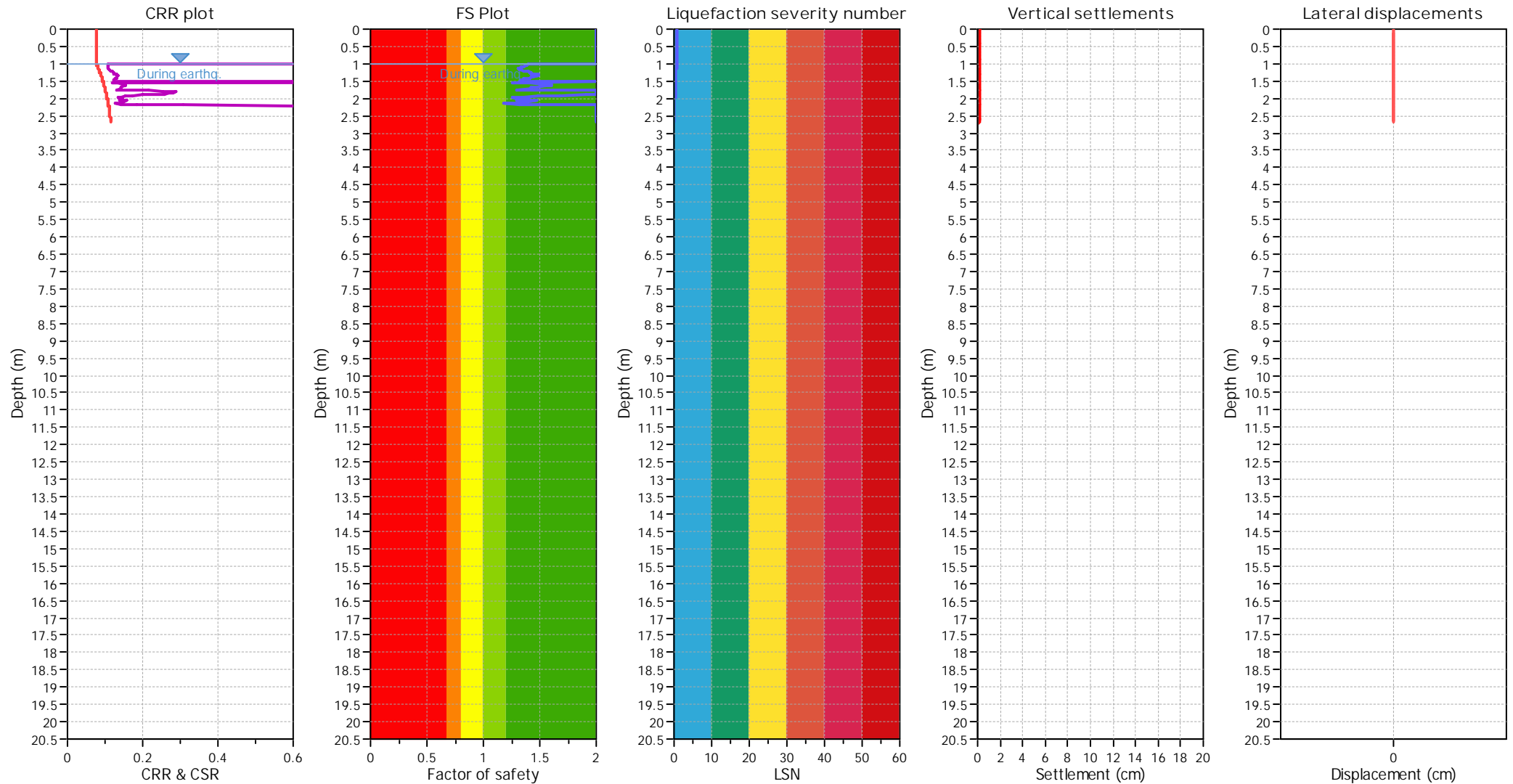
## F.S. color scheme

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

## LSN color scheme

Red	Severe damage
Orange	Major expression of liquefaction
Yellow	Moderate to severe exp. of liquefaction
Light Green	Moderate expression of liquefaction
Dark Green	Minor expression of liquefaction
Blue	Little to no expression of liquefaction

## Liquefaction analysis overall plots



## Input parameters and analysis data

Analysis method: B&I (2014)  
 Fines correction method: B&I (2014)  
 Points to test: Based on  $I_c$  value  
 Earthquake magnitude  $M_w$ : 7.50  
 Peak ground acceleration: 0.13  
 Depth to water table (insitu): 1.00 m

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

Fill weight: N/A  
 Transition detect. applied: No  
 $K_0$  applied: Yes  
 Clay like behavior applied: Sands only  
 Limit depth applied: Yes  
 Limit depth: 10.00 m

## F.S. color scheme

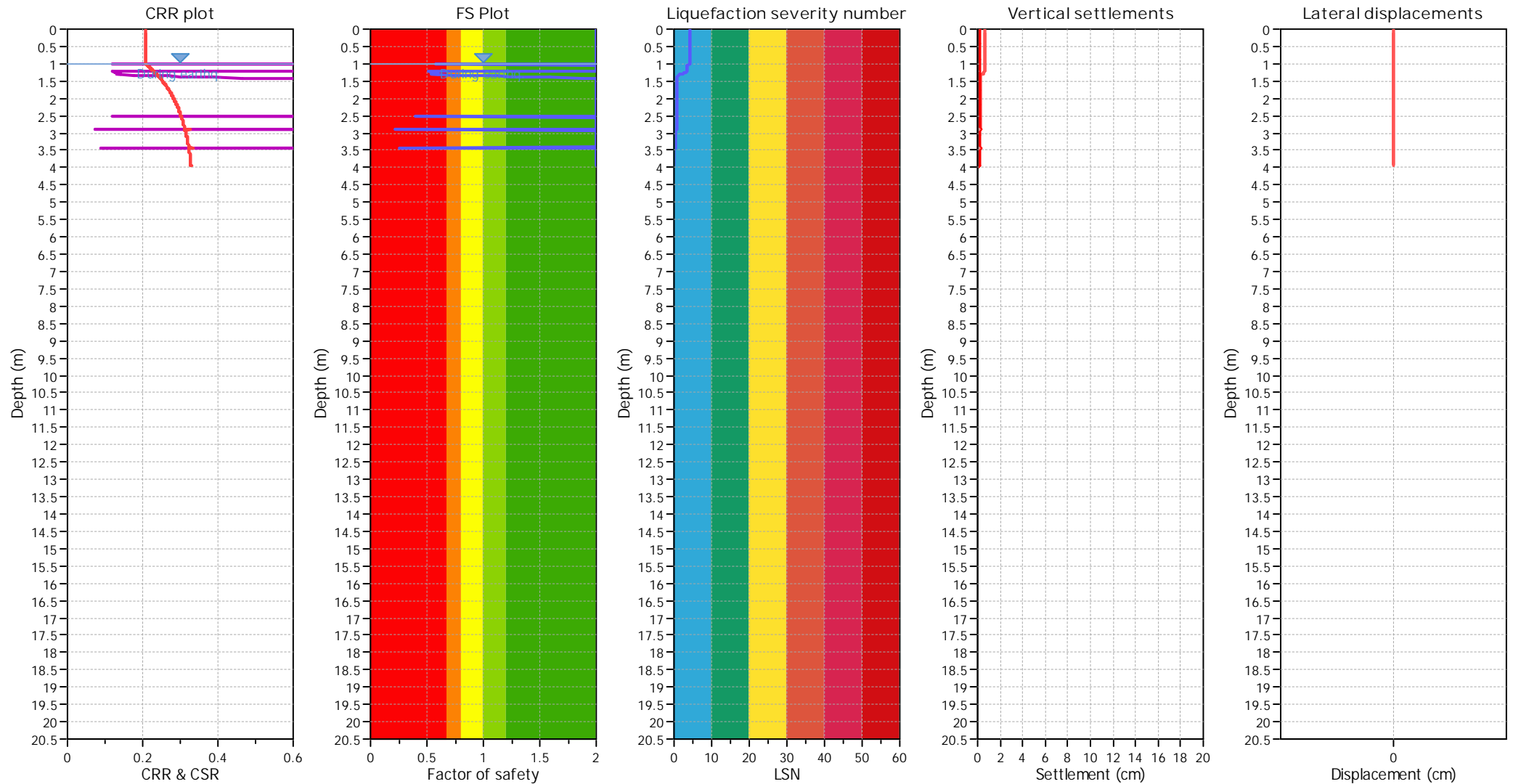
■ Almost certain it will liquefy  
■ Very likely to liquefy  
■ Liquefaction and no liq. are equally likely  
■ Unlike to liquefy  
■ Almost certain it will not liquefy

## 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



## Input parameters and analysis data

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

Depth to GWT (erthq.): 1.00 m  
 Average results interval: 3  
 $I_c$  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  
 $K_0$  applied: Yes  
 Clay like behavior applied: Sands only  
 Limit depth applied: Yes  
 Limit depth: 10.00 m

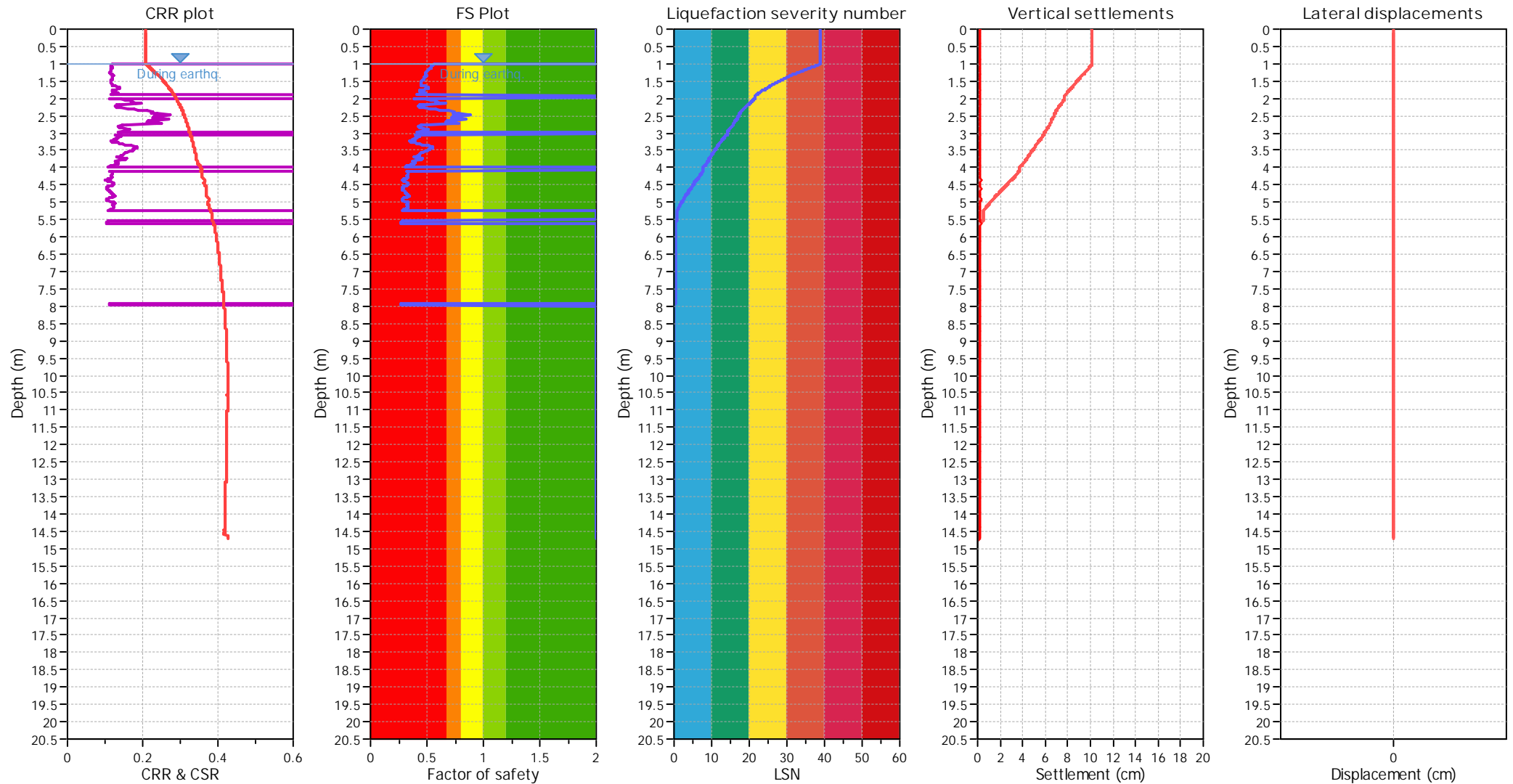
## F.S. color scheme

■ 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



## Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	$K_g$ 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

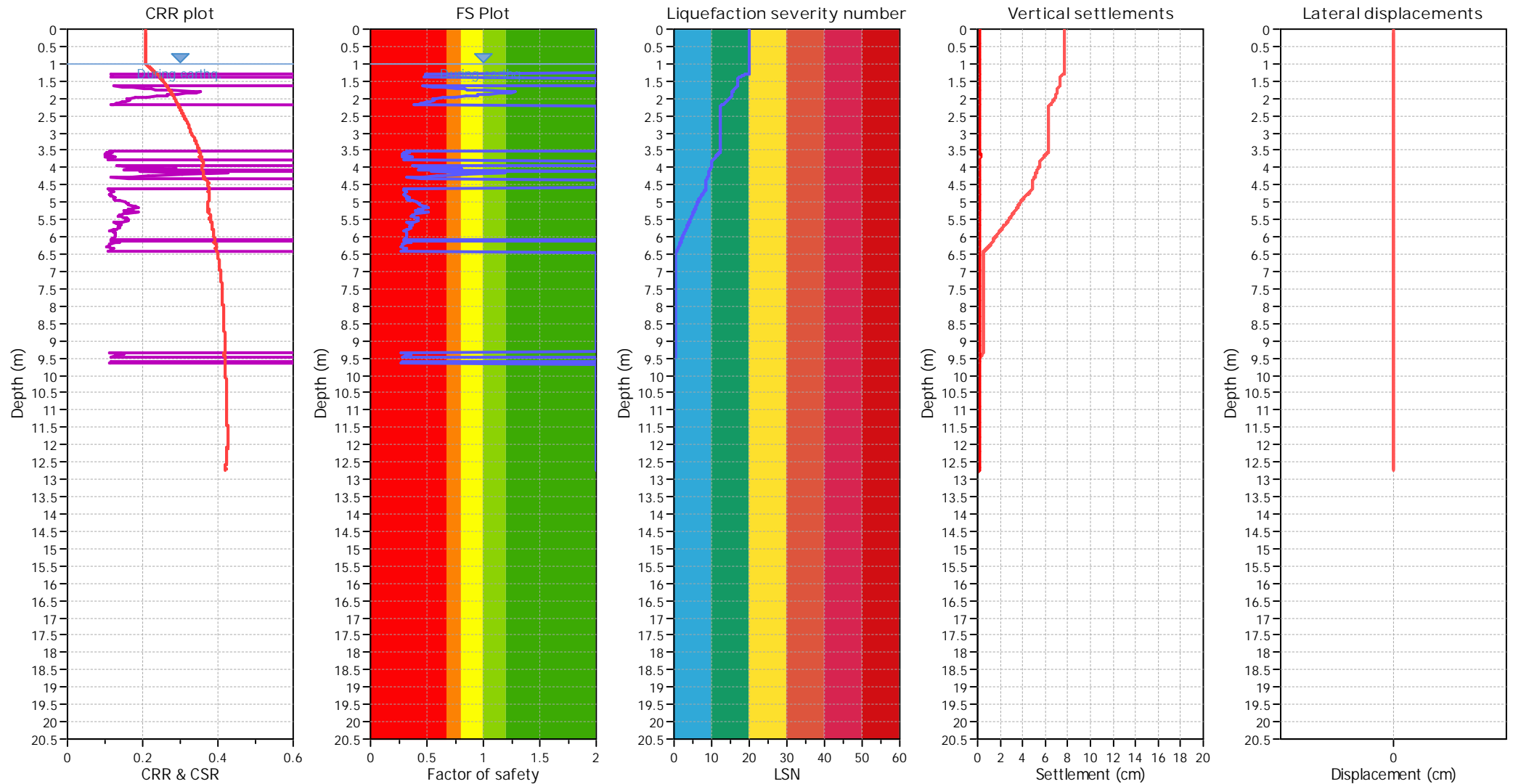
## F.S. color scheme

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

## LSN color scheme

Red	Severe damage
Orange	Major expression of liquefaction
Yellow	Moderate to severe exp. of liquefaction
Light Green	Moderate expression of liquefaction
Dark Green	Minor expression of liquefaction
Blue	Little to no expression of liquefaction

## Liquefaction analysis overall plots



## Input parameters and analysis data

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

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

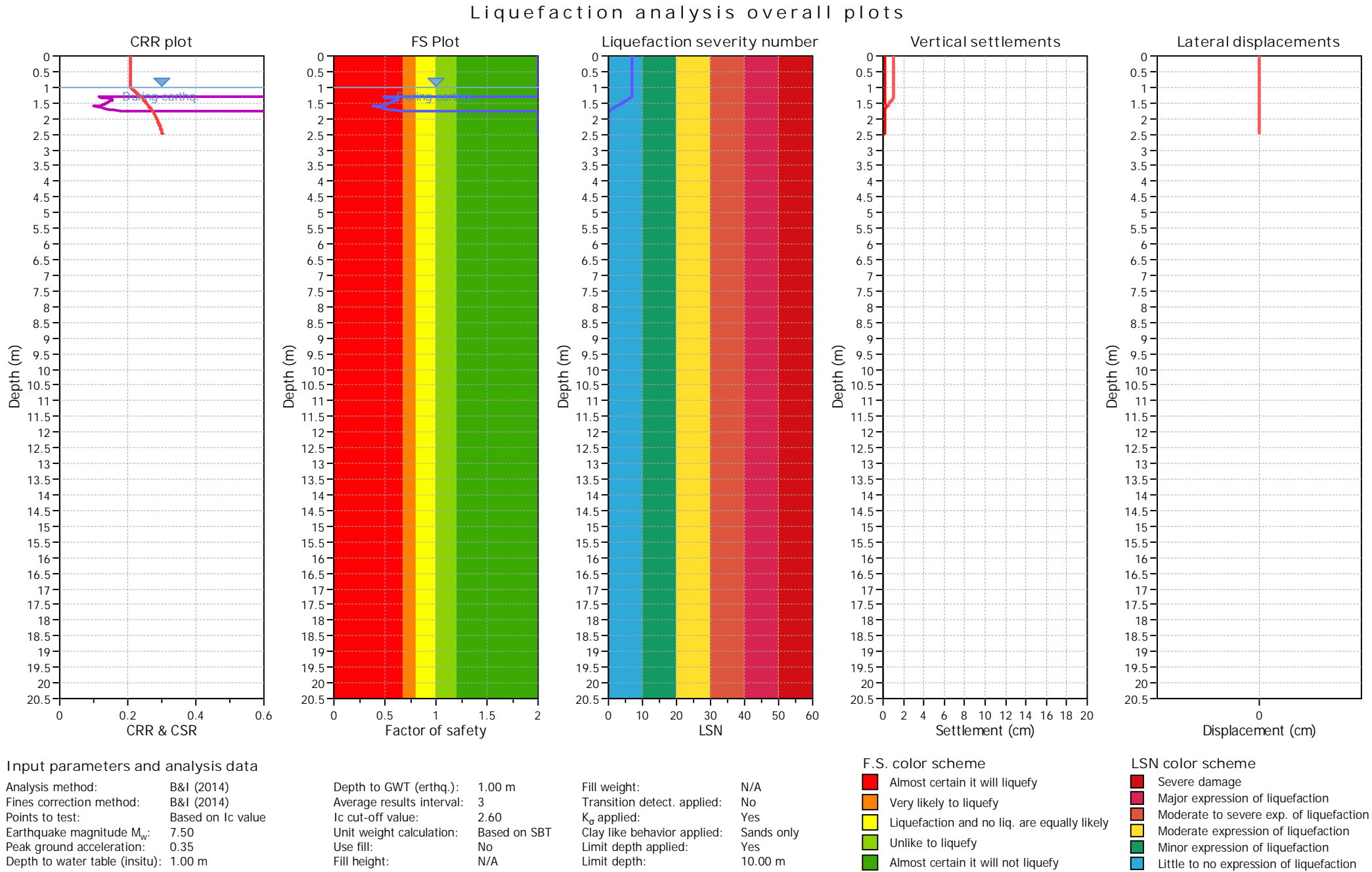
Fill weight: N/A  
 Transition detect. applied: No  
 $K_0$  applied: Yes  
 Clay like behavior applied: Sands only  
 Limit depth applied: Yes  
 Limit depth: 10.00 m

## F.S. color scheme

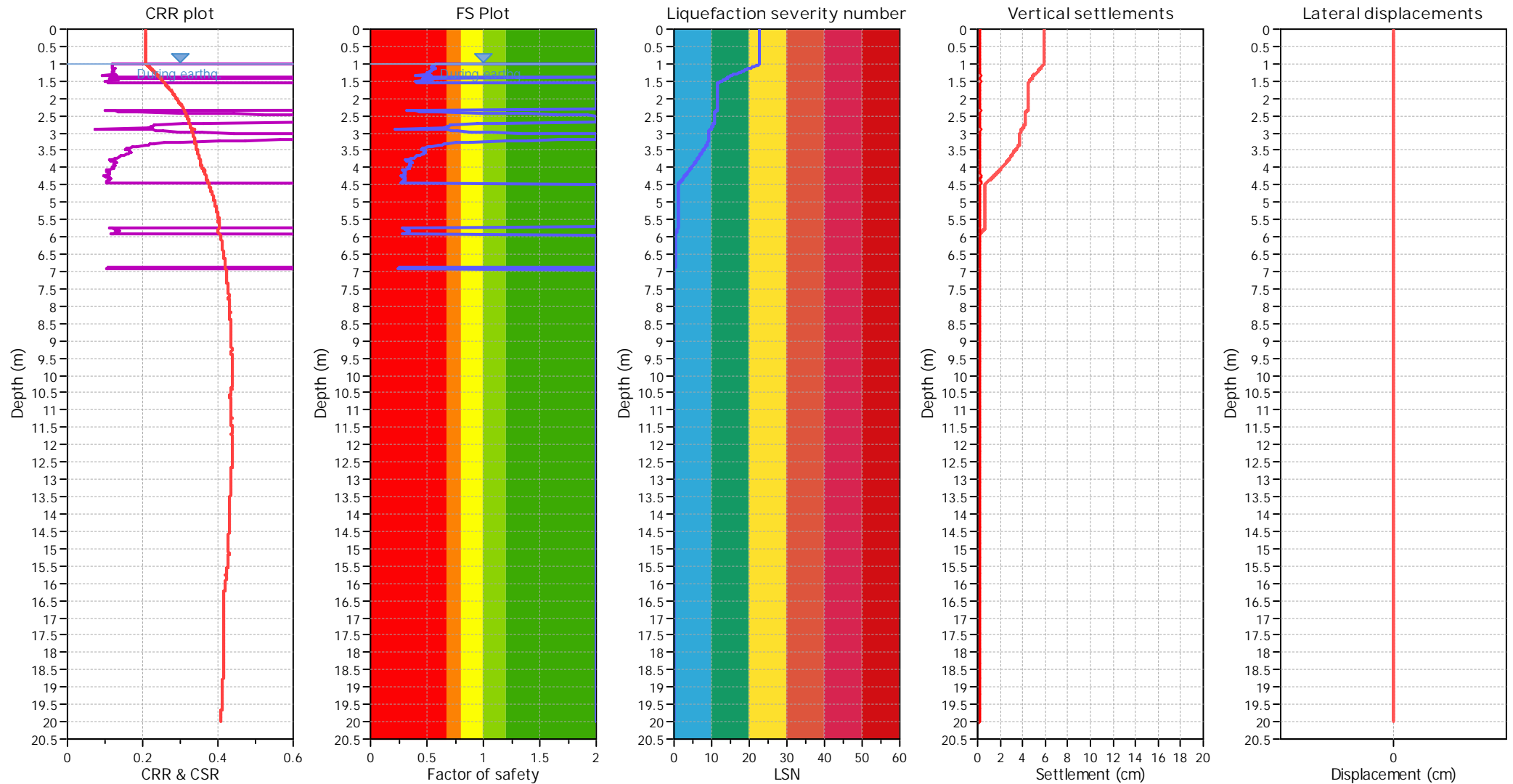
Almost certain it will liquefy  
 Very likely to liquefy  
 Liquefaction and no liq. are equally likely  
 Unlike to liquefy  
 Almost certain it will not liquefy

## 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



## Input parameters and analysis data

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

Depth to GWT (erthq.): 1.00 m  
 Average results interval: 3  
 $I_c$  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  
 $K_0$  applied: Yes  
 Clay like behavior applied: Sands only  
 Limit depth applied: Yes  
 Limit depth: 10.00 m

## F.S. color scheme

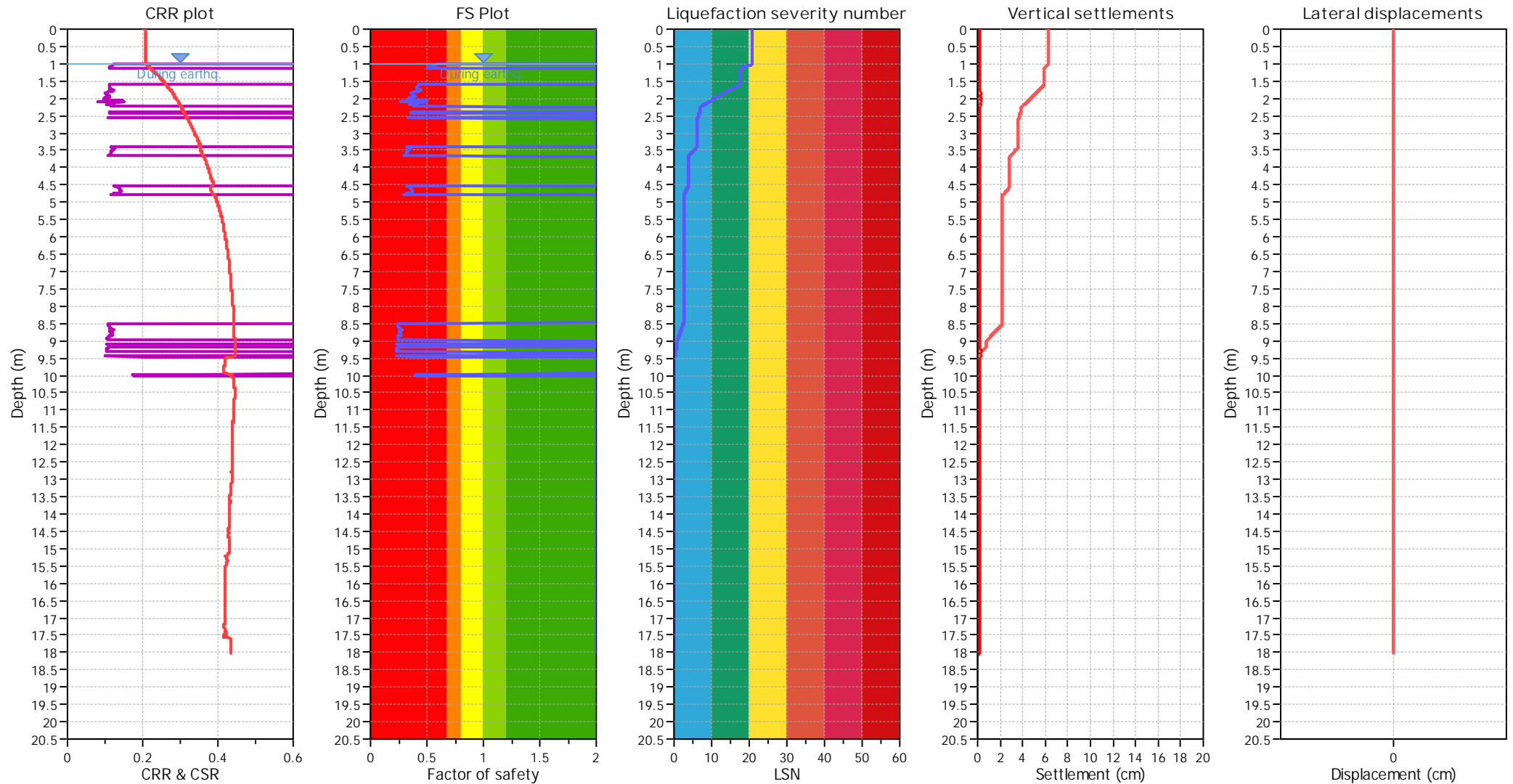
■ Almost certain it will liquefy  
■ Very likely to liquefy  
■ Liquefaction and no liq. are equally likely  
■ Unlike to liquefy  
■ Almost certain it will not liquefy

## 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



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

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

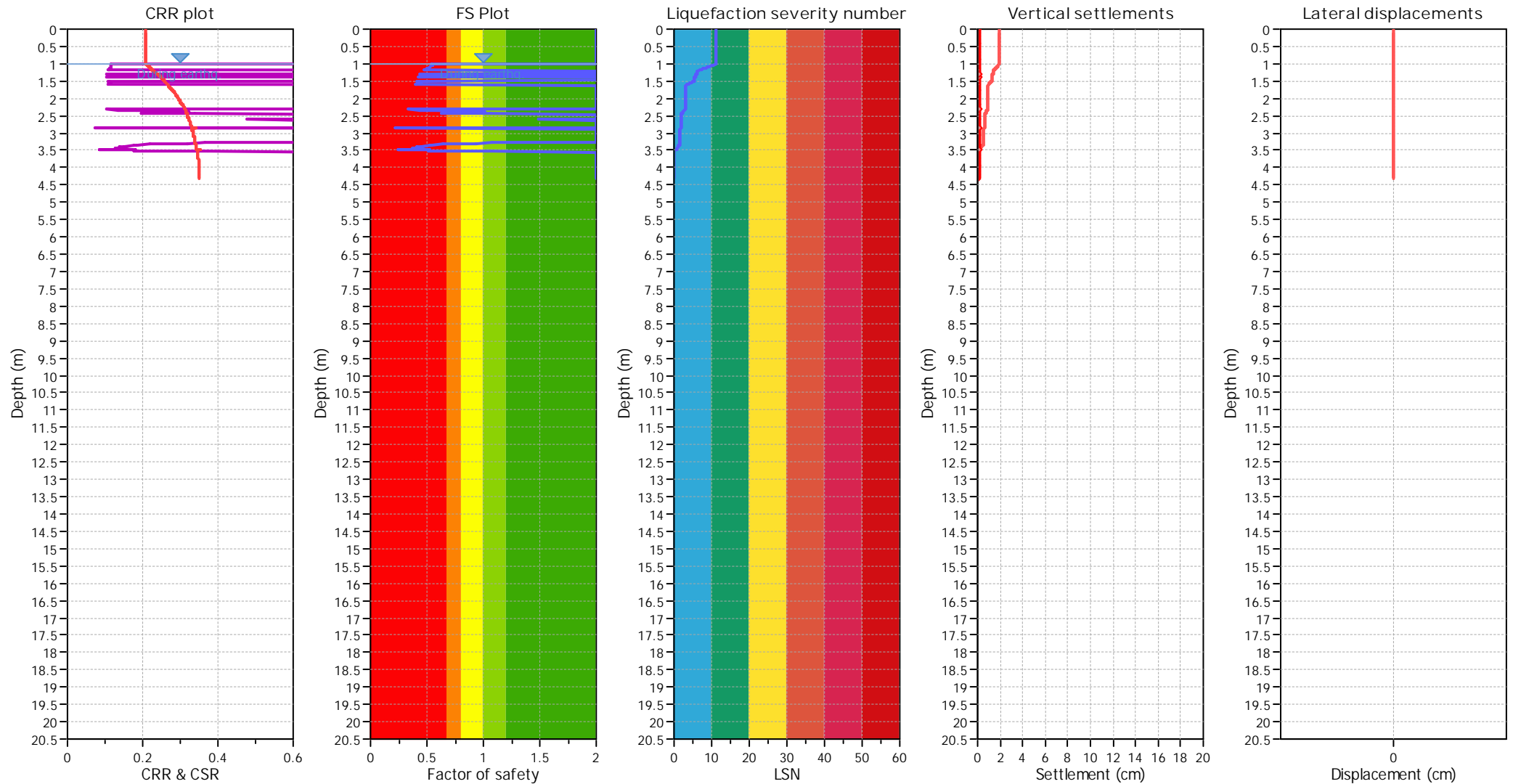
## F.S. color scheme

■ 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



## Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	$K_g$ 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

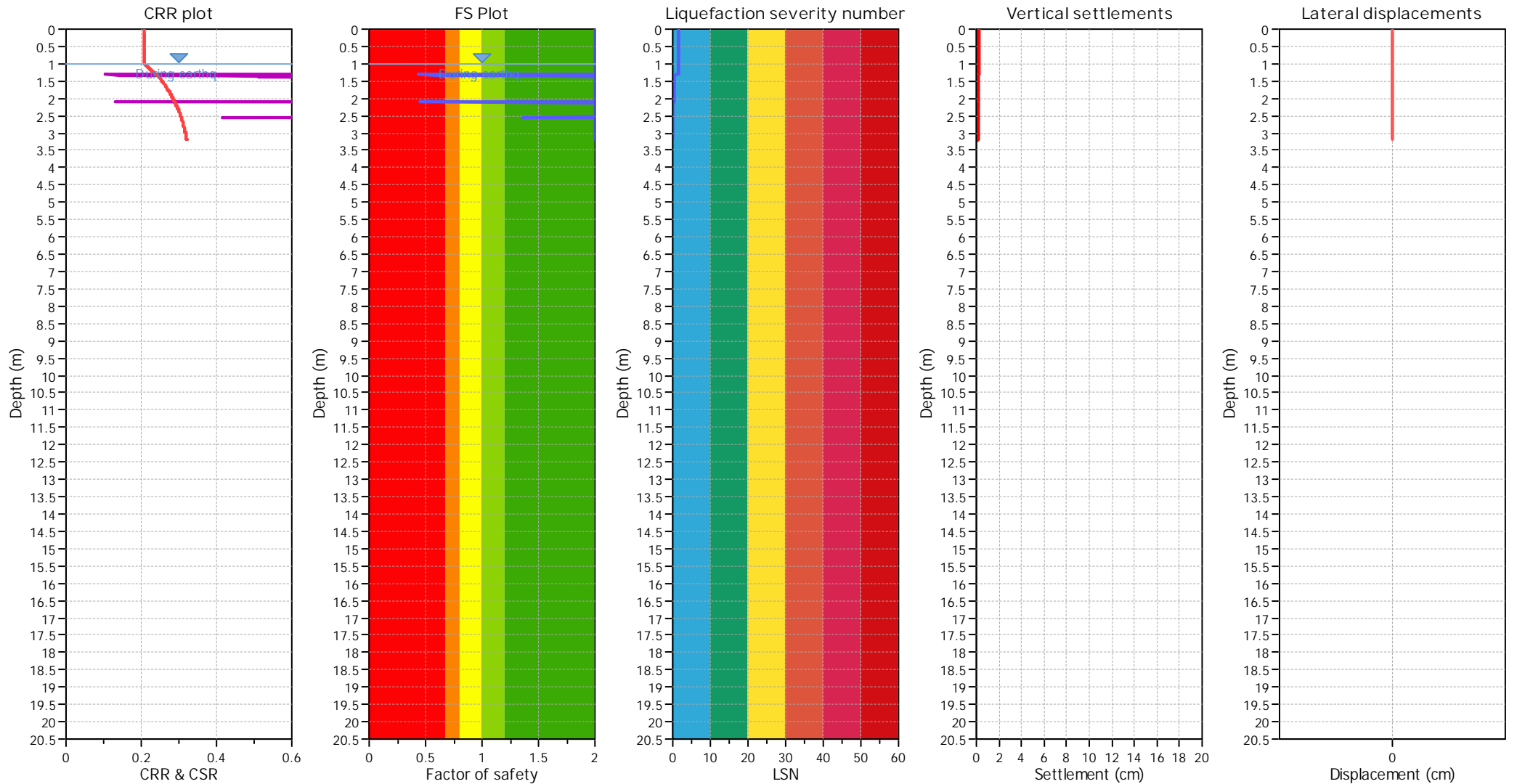
## F.S. color scheme

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

## LSN color scheme

Red	Severe damage
Dark Red	Major expression of liquefaction
Orange	Moderate to severe exp. of liquefaction
Yellow	Moderate expression of liquefaction
Light Green	Minor expression of liquefaction
Blue	Little to no expression of liquefaction

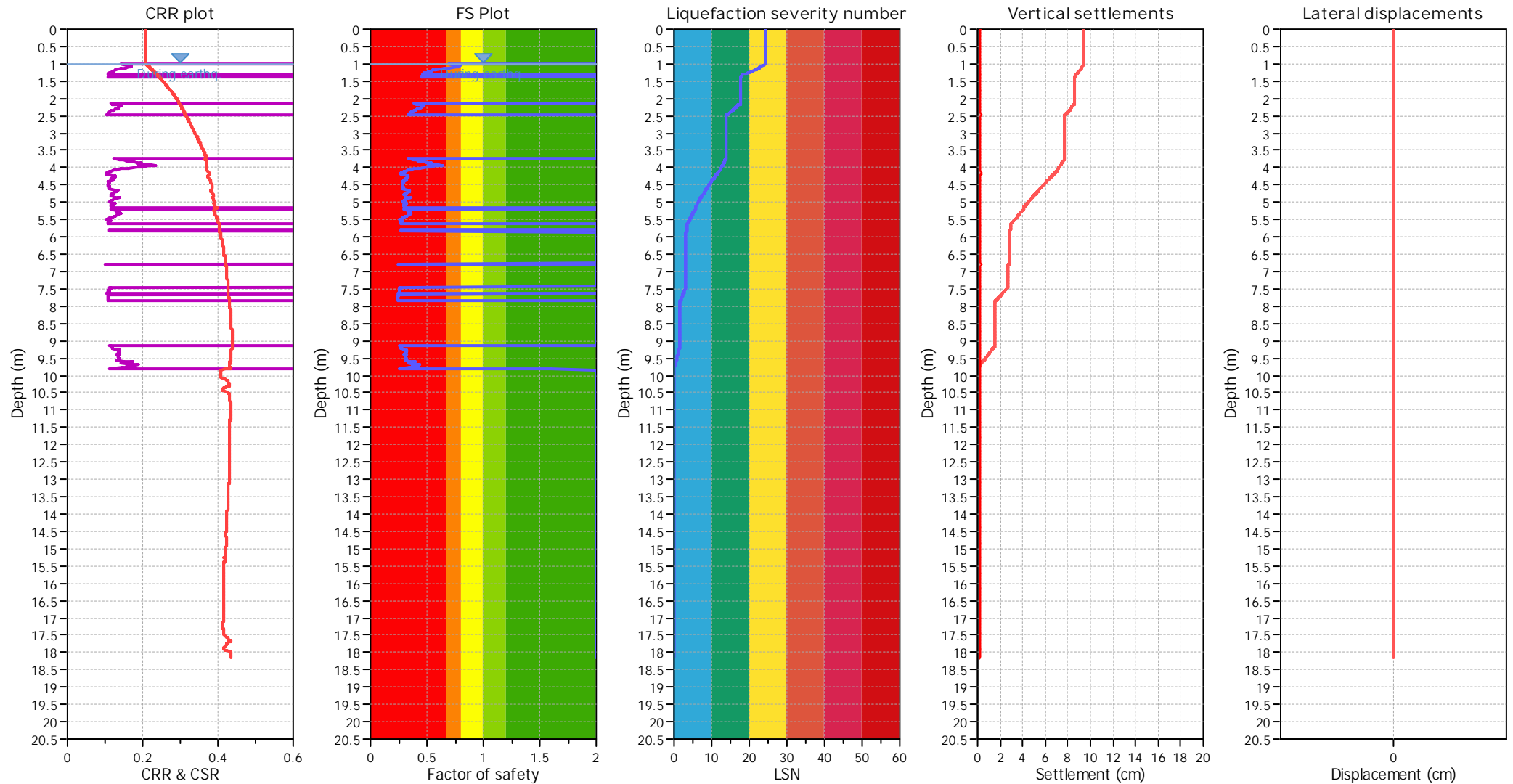
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A	F.S. color scheme	LSN color scheme
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No	Almost certain it will liquefy	Severe damage
Points to test:	Based on Ic value	Ic cut-off value:	2.60	$K_0$ applied:	Yes	Very likely to liquefy	Major expression of liquefaction
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only	Liquefaction and no liq. are equally likely	Moderate to severe exp. of liquefaction
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes	Unlike to liquefy	Moderate expression of liquefaction
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m	Almost certain it will not liquefy	Minor expression of liquefaction
							Little to no expression of liquefaction

## Liquefaction analysis overall plots



## Input parameters and analysis data

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

Depth to GWT (erthq.): 1.00 m  
 Average results interval: 3  
 $I_c$  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  
 $K_0$  applied: Yes  
 Clay like behavior applied: Sands only  
 Limit depth applied: Yes  
 Limit depth: 10.00 m

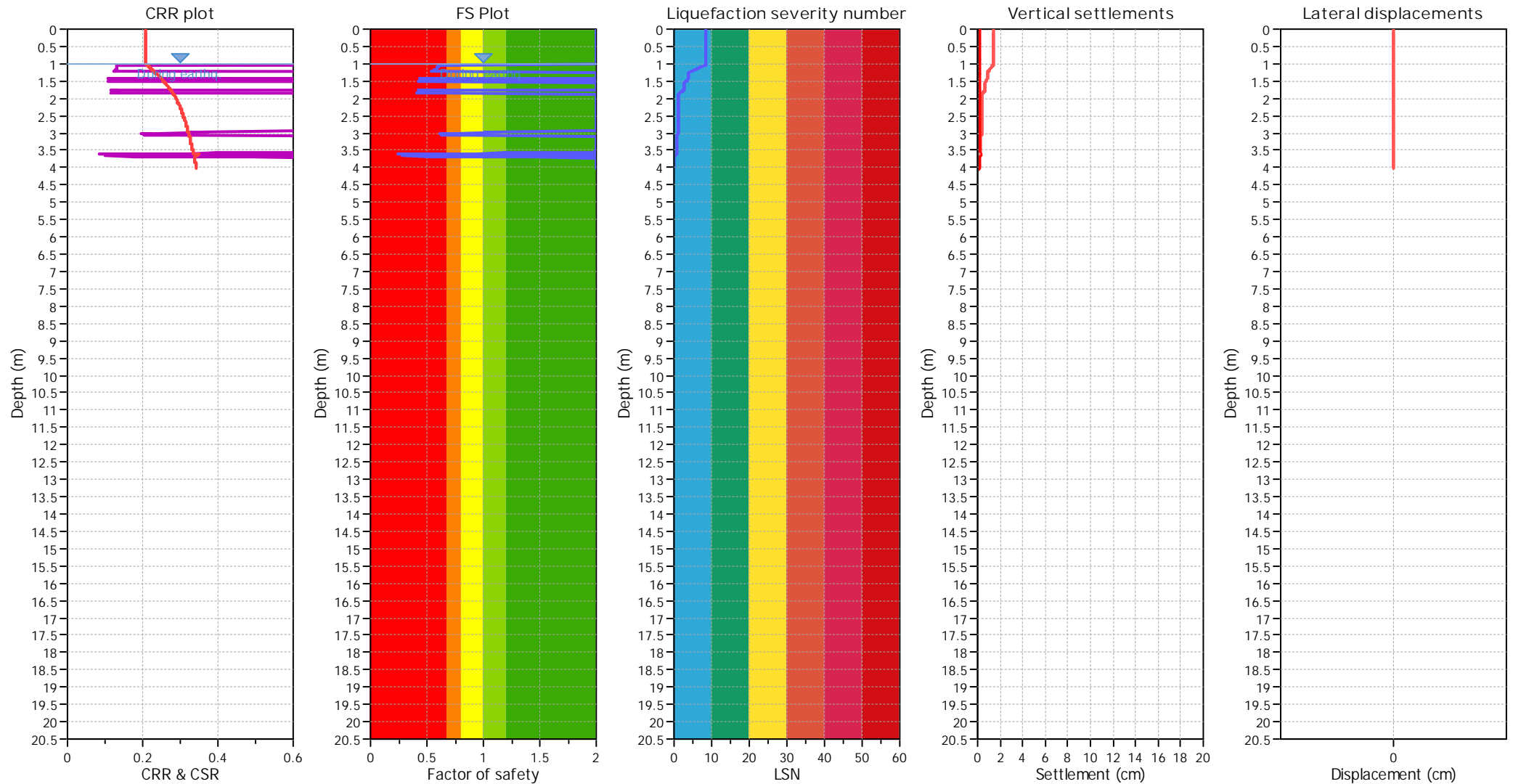
## F.S. color scheme

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



## Input parameters and analysis data

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

Depth to GWT (erthq.): 1.00 m  
 Average results interval: 3  
 $I_c$  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  
 $K_\sigma$  applied: Yes  
 Clay like behavior applied: Sands only  
 Limit depth applied: Yes  
 Limit depth: 10.00 m

## F.S. color scheme

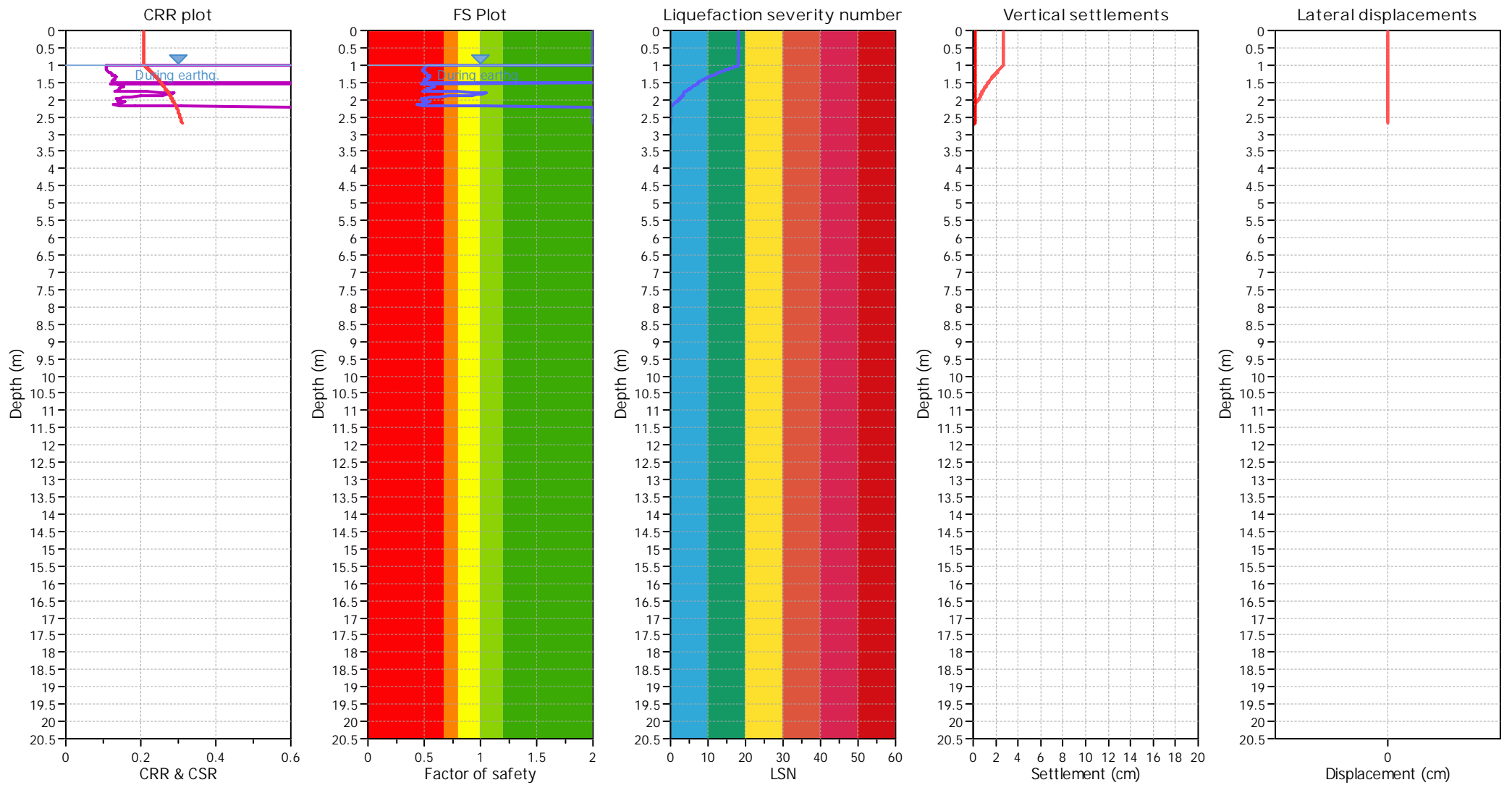
■ Almost certain it will liquefy  
■ Very likely to liquefy  
■ Liquefaction and no liq. are equally likely  
■ Unlike to liquefy  
■ Almost certain it will not liquefy

## 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



Input parameters and analysis data

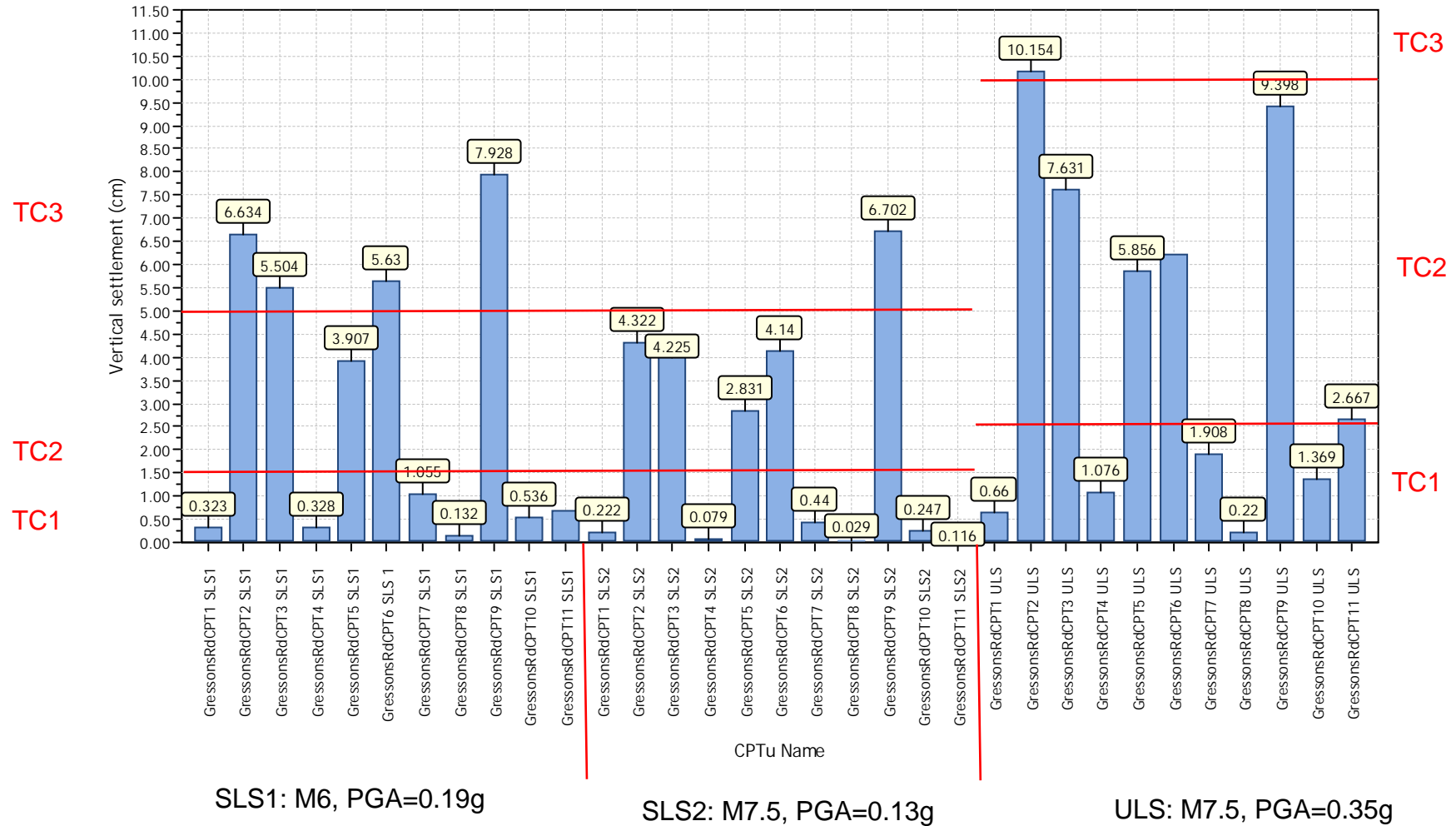
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A	F.S. color scheme	LSN color scheme
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No	<div></div> Almost certain it will liquefy	<div></div> Severe damage
Points to test:	Based on Ic value	Ic cut-off value:	2.60	$K_0$ applied:	Yes	<div></div> Very likely to liquefy	<div></div> Major expression of liquefaction
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only	<div></div> Liquefaction and no liq. are equally likely	<div></div> Moderate to severe exp. of liquefaction
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes	<div></div> Unlike to liquefy	<div></div> Moderate expression of liquefaction
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m	<div></div> Almost certain it will not liquefy	<div></div> Minor expression of liquefaction
							<div></div> Little to no expression of liquefaction

## Overall Vertical Settlements

Project title : Northside Country

Location : 81 Gressons Road

### Overall vertical settlements report

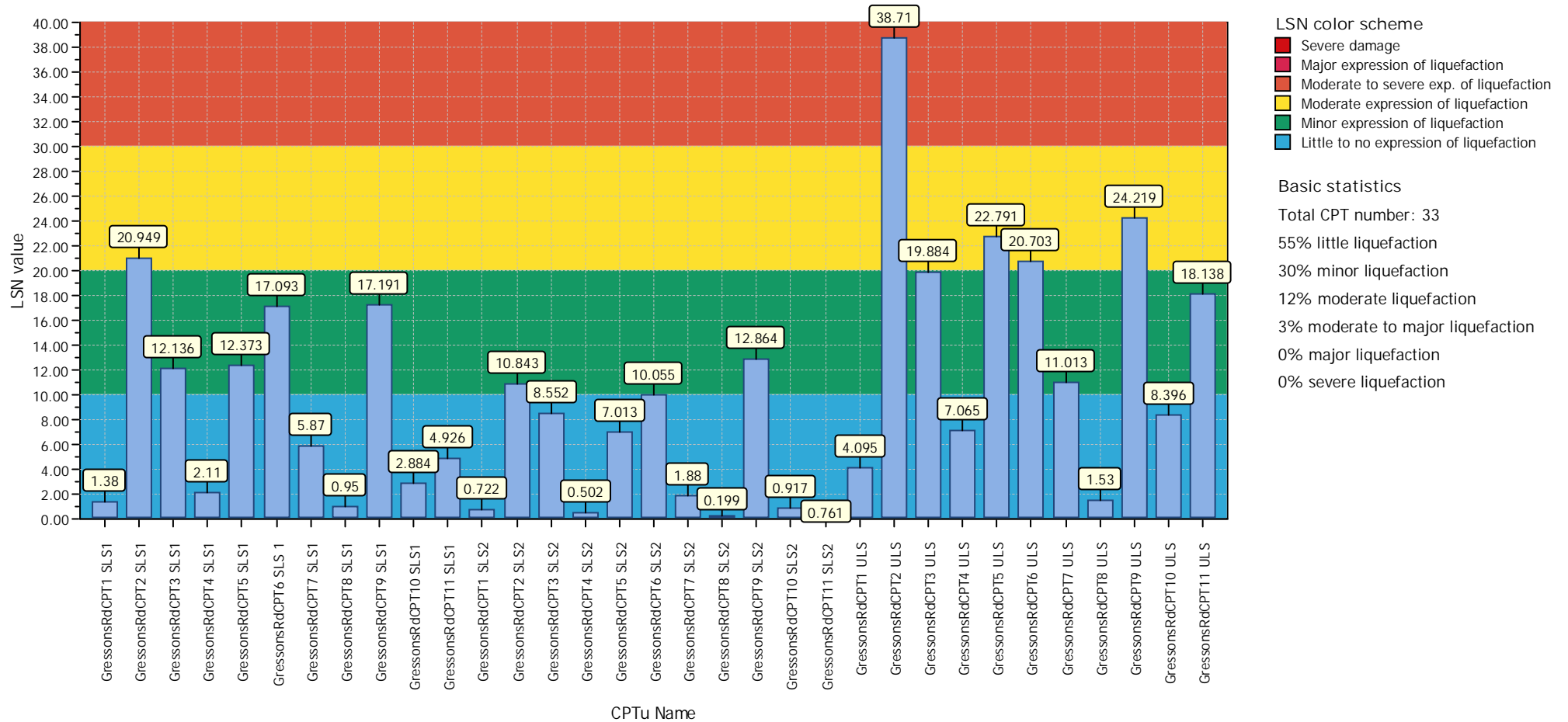


Overall Liquefaction Severity Number (LSN)

Project title : Northside Country

Location : 81 Gressons Road

### Overall Liquefaction Severity Number report





4. The land is generally flat with a gentle fall to the east. It is in agricultural use with shelter belts generally separating field parcels. There is an existing agricultural building on the southern boundary of Lot 2 DP 428676.
5. The land is bordered by Gressons Road (a collector road) to the north and Main North Road (State Highway 1) to the east. To the south lies an unformed section of Preeces Road. Archaeological site A007 is located at its intersection with State Highway 1.
6. The middle portion of the application is separated by a 10m wide private road (pt RS 3101) which extends to State Highway 1.
7. The land is currently zoned Rural in the District Plan (**Appendix A**). Land to the north comprises the existing settlement of Waikuku and is zoned Residential 4B. Several rural-residential/farm dwellings are located to the west on land zone Rural. Surrounding land to the east and south is also rurally zoned and in agricultural use.

### 3 PROPOSAL

8. It is proposed to rezone the subject land to provide for Rural Residential development for approximately 58 future allotments. Two concept plans are provided in **Appendix B** showing development blocks based on approximately 5,000m<sup>2</sup> allotments separated by a different roading pattern both accessed from a new intersection with Gressons Road.
9. The development will be serviced by reticulated sewer and water supply.

### 4 RELEVANT CONSIDERATIONS

#### 4.1 Planning

10. The Council's Rural Residential Development Plan<sup>1</sup> (RRDP) identifies the land as suitable for rural residential development as part of future growth in the east of the District (**Appendix C**).
11. Appendix 2 to the Draft Land Use Recovery Plan (LURP) introduces a new Chapter 6 to the RPS. Rural residential development is defined in as residential units outside the identified priority areas at an average density of between 1 and 2 households per hectare.
12. The new Chapter 6 to the RPS also requires rural residential development to, amongst others, take place in accordance with an adopted rural residential development strategy prepared by territorial authorities (Policy 6.3.9) – such as the Council's RRDP - and be accompanied by an outline development plan which sets out an integrated design for subdivision and land use, and provides for the long-term maintenance of rural residential character (Policy 6.3.9(6)).

#### 4.2 Access

13. Access will be provided from Gressons Road and over part of the unformed Preeces Road.
14. Main North Road (SH1) is a Limited Access Road. No access is proposed directly onto Main North Road. Consultation with NZTA will nevertheless take in connection

---

<sup>1</sup> Waimakariri District Council Rural Residential Development Plan dated June 2010.

with the anticipated additional traffic utilising the Main North Road and Gressons Road intersection.

#### 4.3 Mains Water & Wastewater

15. Proposed Chapter 6 to the RPS (introduced by the Draft LURP) requires Rural Residential development to be located so it can be economically provided with a reticulated sewer and water supply integrated with a publically owned system. In this instance there is no publically owned sewer and water system in the existing settlement. Existing households are served by on-site septic tanks or in one case a small private community scheme serving 5 lots. Domestic water is sourced from private wells.
16. The RRDP identifies the potential for Council to extend reticulation provided by the proposal to the existing Residential 4B Zone/Waikuku settlement. It suggests a new reticulated wastewater system be connected to the Eastern Districts Sewer Scheme (EDSS) at Waikuku Beach or Woodend. A pump station could be located at the intersection of Gressons and Main North Road, with supporting rising main and odour control. In relation to drinking water, the RRDP suggests suitable connection could take place to the Woodend supply or Pegasus supply subject to further capacity investigations.
17. It is noted that reticulated systems also exist at Waikuku Beach and the opportunity exists to connect to these at the Kings Avenue/Waikuku Beach Road intersection.

#### 4.4 Electricity & Telecommunications

18. Chorus and Mainpower will be contacted in relation to extending the networks in the existing settlement of Waikuku.

#### 4.5 Stormwater Management

19. Open drains are located close to the west and along the south boundaries. These are piped in places.
20. The TSG report<sup>2</sup> suggests that stormwater runoff would most likely be to roadside swales and drains, with ultimate discharge to the local streams. Treatment for first flush will be required for stormwater runoff from roads. The requirement for stormwater retention is to be confirmed.

#### 4.6 Natural Hazards

21. There are no natural hazards identified on the planning maps.

##### Geotechnical

22. CERA land classification identifies the land as *N/a Rural – unmapped*. A site specific geotechnical assessment was undertaken by Eliot Sinclair & Partners in October 2012<sup>3</sup> which conservatively assessed the land as achieving the Technical Category TC2 classification. The TC2 classification indicates that minor to moderate land damage from liquefaction is possible in future significant earthquakes. Overall, the assessment finds that the land is not likely to be subject to the land instability matters set out under s.106(1a)(b) of the RMA.

---

<sup>2</sup> Waimakariri District Council. Rural Residential Development Plan Supporting Documents. Technical Services Group Report dated August 2009 updated in March 2010

<sup>3</sup> Eliot Sinclair & Partners. Report dated 29 October 2012.

#### Flood risk

23. The nearest watercourse, Waikuku Stream, is located around 150m north of the site. There are no topographical features that concentrate stormwater onto the site. The *Waimakariri District Flood Planning Hazard Management Strategy Ashley River Floodplain*<sup>4</sup> indicates the land is not at risk from the Ashley River Floodplain up to a 0.5% AEP event.
24. The western and southern portion of the subject land is located over a Coastal Confined Gravel Aquifer System, while the eastern portion is located over a Semi-Confined or Unconfined Aquifer. Groundwater is inferred to be at around 3 – 4m below ground level.
25. Minimum floor levels and associated filling of land are not expected at the present time (subject to the future anticipated Council initiated Plan Change on Natural Hazards).

#### 4.7 Soil Health

26. The current and previous use of the land is for agriculture. ECan does not hold any records of soil contamination within 50m of the land in its Listed Land Use Register (LLUR). Elevated levels of naturally occurring arsenic have been recorded in the wider area derived from buried swamp deposits at depth. As a reticulated groundwater supply is proposed it is not anticipated that any buried arsenic would be disturbed by the proposal.
27. A Preliminary Site Investigation (PSI) in accordance with the NES<sub>soil</sub> will be undertaken in support of the Plan Change Request.

#### 4.8 Ecology

28. There are no known ecological interests.

#### 4.9 Local Amenity

29. The existing settlement of Waikuku lies to the north. A private road (pt RS 1235) connects Gressons Road to MacDonalds Lane at the north of the settlement and represents an opportunity to increase community integration.

#### 4.10 Cultural Values

30. There are no known cultural values on or in close proximity to the subject land.
31. It is noted that District Plan planning map 125 identifies archaeological site A007 to the south of the subject land at the intersection of unformed Preeces Road and Main North Road. The New Zealand Archaeological Association Site Record Scheme Archsite reference for this site is M35/11.

---

<sup>4</sup> Source: Environment Canterbury. Report No. R08/23 dated June 2008.

## **5 THE PLANNING ADVISORY GROUP**

32. The views of the PAG are requested on the following;

- Comments on the assessment of relevant matters, in particular wastewater and drinking water service availability, and any Council records in connection with ground contamination.
- Comments on the concept plan and Council's preferred timing for development.
- Comments on potential changes to the Residential 4A and 4B Zone provisions in the District Plan, these being the potentially applicable Rural Residential Zone provisions to be adopted by the future Plan Change Request.

## **6 CONCLUSION**

33. Thank you for the opportunity to present this proposal with the Project Advisory Group. We look forward to working with the Council to identify the most appropriate methods to enable rural residential development of the subject site.

## **APPENDIX A: DISTRICT PLANNING MAPS**



NOTE:  
Disclaimer - refer to map legend sheet



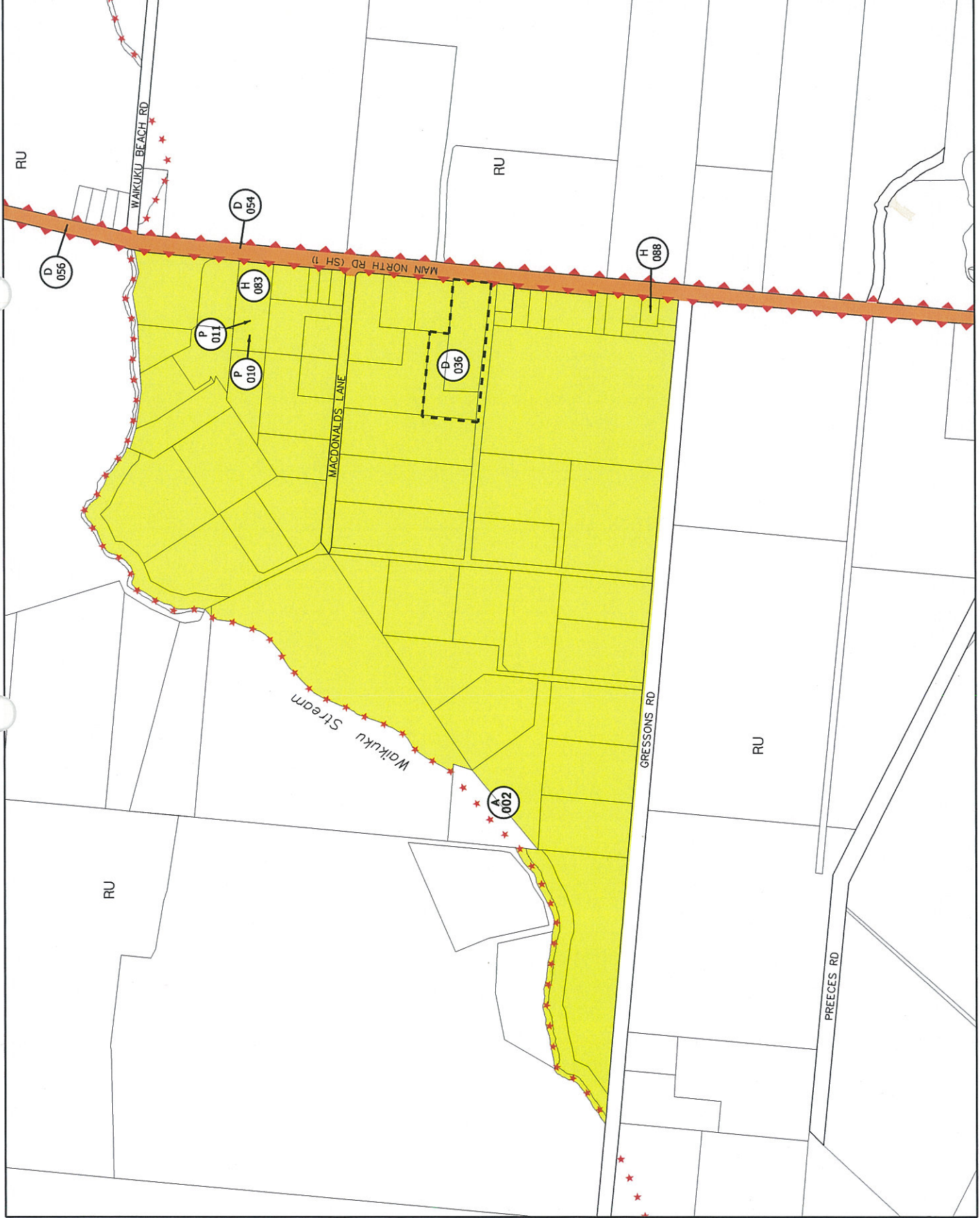
Metres  
0 60 120 180

Scale 1:7,500 (A4)

	36	120
35	<b>122</b>	123
	125	126

Waikuku Village

122





NOTE:  
Disclaimer - refer to map legend sheet



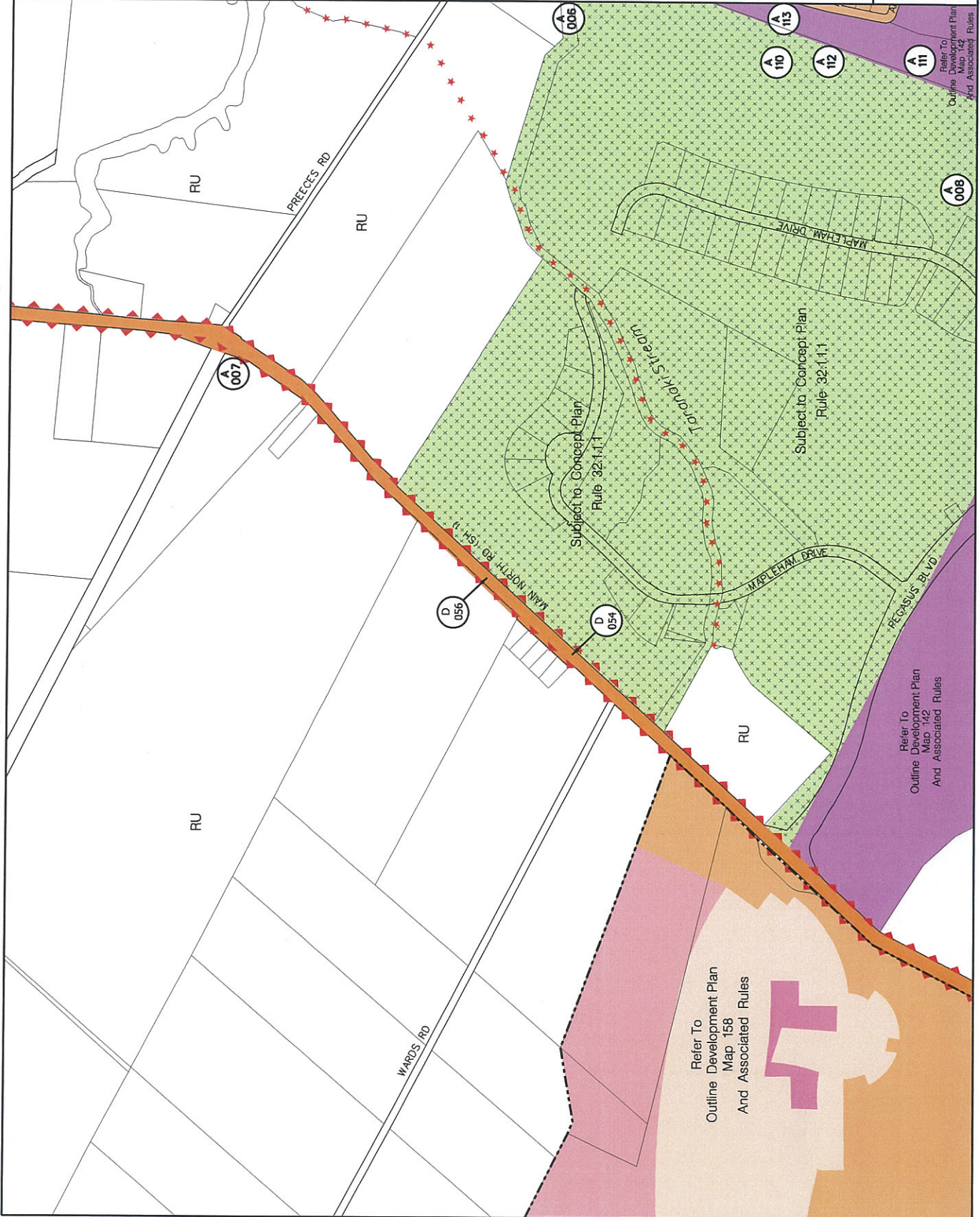
Metres  
0 60 120 180  
Scale 1:7,500 (A4)

35	122	123
125A	125	126
128A	128	129

Mapleham

125

22/04/2013



## **APPENDIX B: CONCEPT PLAN**





PROPOSED SUBDIVISION - OPTION 3B  
OF LOTS 2 & 3 DP 62186, LOT 2 DP 303387 AND LOT 2 DP 428676  
MAIN NORTH ROAD AND GRESSONS ROAD, WAIKUKU  
FOR NORTHSIDE COUNTRY

**Eliot Sinclair**  
surveyors | engineers | planners





Projection NZGD 2000  
Circuit Mount Pleasant 2000

Scale: 1:2000 (A1) 1:4000 (A3)

Date: 4/9/2013

origin of levels

surveyed	designed	initial	date
R Claessens	B Sinclair		
surv. date	R Greening		
July 2012	checked		

datum Lytelton 1937

Sheet  
1 of 1

Drawing Set  
350494 C3A

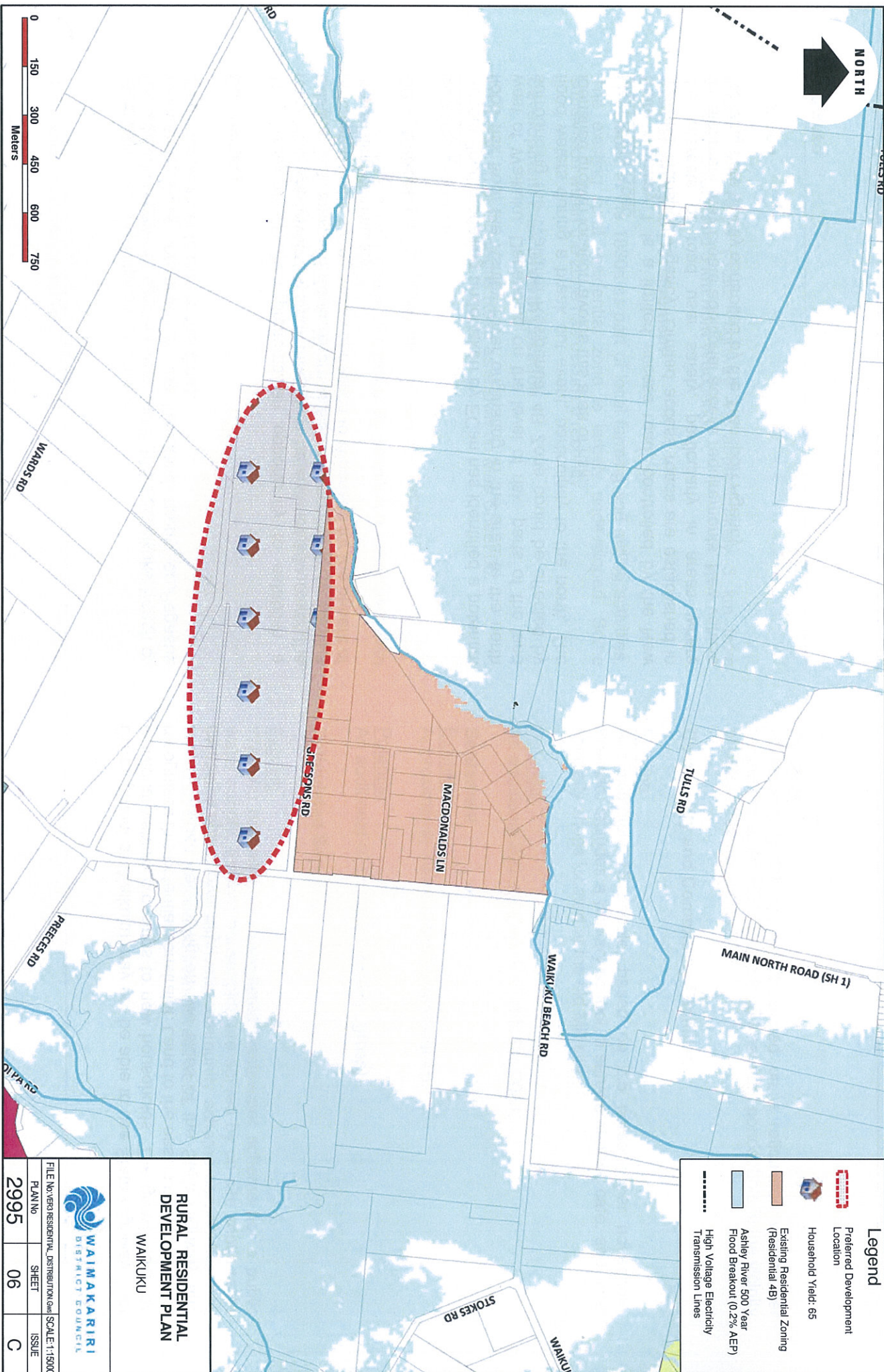
Plot C3A 130904

PROPOSED SUBDIVISION - OPTION 3A  
OF LOTS 2 & 3 DP 62186, LOT 2 DP 30387 AND LOT 2 DP 428676  
MAIN NORTH ROAD AND GRESSONS ROAD, WAIKUKU  
FOR NORTHSIDE COUNTRY






**Eliot Sinclair**  
surveyors | engineers | planners



## **APPENDIX C: RURAL RESIDENTIAL DEVELOPMENT PLAN - WAIKUKU**



# Legend

-  Preferred Development Location
-  Household Yield: 65
-  Existing Residential Zoning (Residential 4B)
-  Ashley River 500 Year Flood Breakout (0.2% AEP)
-  High Voltage Electricity Transmission Lines

## RURAL RESIDENTIAL DEVELOPMENT PLAN WAIUKU



FILE NO: V33 RESIDENTIAL DISTRIBUTION (06)	SCALE: 1:5000
PLAN NO	SHEET
2995	06
	ISSUE
	C

**APPENDIX D: DISTRICT PLAN ZONE REQUIREMENTS**

Zone	Minimum Allotment Area	Minimum Dimensions of Allotment (m)	
		Internal Square	Frontage
Business 2	700m <sup>2</sup>		
Residential 1	300m <sup>2</sup>	15 x 15	15
Residential 2	600m <sup>2</sup>  Exceptions:  At Fairview Briars: min lot area 1300m <sup>2</sup> , ave. lot area not less than 1900m <sup>2</sup> (road frontage dimensions apply).  In the East Rangiora ODP Area, Comprehensive Residential Development areas have a min lot size of 300m <sup>2</sup> (road frontage dimensions apply).	18 x 18	15
Residential 3	600m <sup>2</sup>  Exceptions: Ligget Park. Allin Drive min allotment area 4000m <sup>2</sup>	15 x 15	15
Residential 6	400m <sup>2</sup>	13 x 18	13
Residential 6A	137.5m <sup>2</sup>  Max. lot area on subdivision is 412.5m <sup>2</sup> , other than where a balance area is created on subdivision which exceeds 4ha	Except for corner sites, the length of a road boundary of the lot shall be less than the depth of the lot, measured at right angles to that road boundary	
Residential 4A/4B	4A – min lot area 2,500m <sup>2</sup> , min ave. 5,000m <sup>2</sup>  4B – min lot area 5,000m <sup>2</sup> , min ave. 10,000m <sup>2</sup>		
Residential 5		Shall generally comply with the Concept Plan shown in District Plan Map 140	
Rural	4ha  Exceptions: Former Oxford Part-time Farming Zone: min. lot area 1.0ha. ave. lot area 1.5ha (% of min size and average size specifiec).	120 x 120m	Allotments adjoining State Highways: minimum of 200m or no greater than 10m frontage to a formed road, provided that no more than two frontages of 10m shall be provided without a separation of 200m
Mapleham Rural 4B Zone	Shall generally comply with the Concept Plan shown on District Plan Map 147		