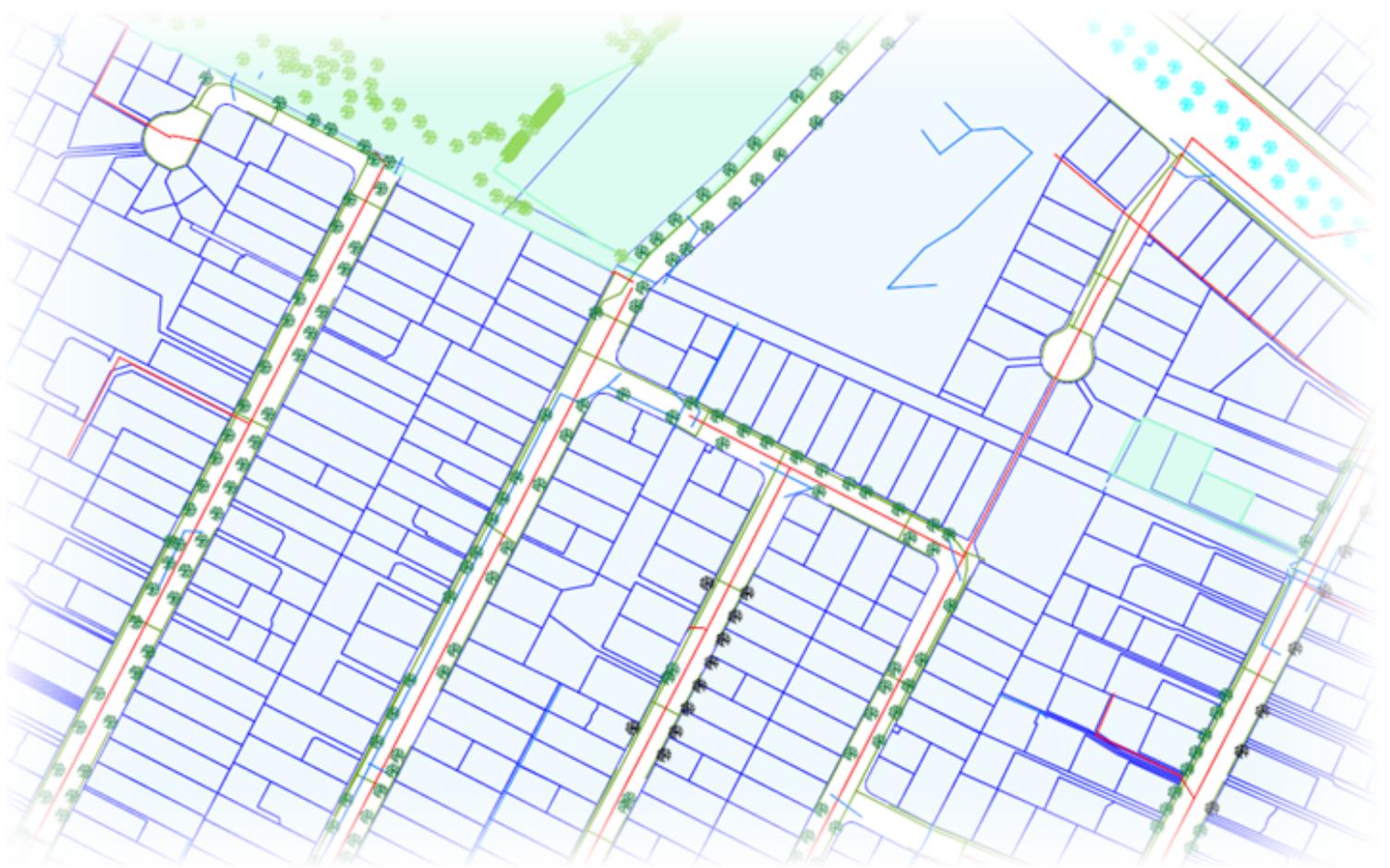


# Land Information Memorandum



Property address:  
250 Styx Mill Road

LIM number: H00892132  
Page 1

Christchurch City Council  
53 Hereford Street, PO Box 73015  
Christchurch 8154, New Zealand  
Tel 64 3 941 8999  
Fax 64 3 941 8984  
[www.ccc.govt.nz](http://www.ccc.govt.nz)

## Application details

Please supply to SAUNDERS & CO - CHRISTCHURCH  
PO BOX 18  
CHRISTCHURCH 8140

Client reference

Phone number (03) 379 7690

Fax number

Date issued 10 March 2022

Date received 7 March 2022

## Property details

Property address 250 Styx Mill Road

Valuation roll number 21916 23500

Valuation information Capital Value: \$1275000  
Land Value: \$1270000  
Improvements Value: \$5000  
*Please note: these values are intended for Rating purposes*

Legal description Lot 5 DP 311370

Existing owner Independent Producers Limited  
C/O Independent Fisheries Limited  
PO Box 19554  
Woolston  
Christchurch 8241

## Council references

Debtor number 3169557

Rate account ID 73147728

LIM number H00892132

Property ID 1142518

Property address:  
250 Styx Mill Road

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## Document information

This Land Information Memorandum (LIM) has been prepared for the purpose of section 44A of the Local Government Official Information and Meetings Act 1987 (LGOIMA). It is a summary of the information that we hold on the property. Each heading or "clause" in this LIM corresponds to a part of section 44A.

Sections 1 to 10 contain all of the information known to the Christchurch City Council that must be included under section 44A(2) LGOIMA. Any other information concerning the land as the Council considers, at its discretion, to be relevant is included at section 11 of this LIM (section 44A(3) LGOIMA). If there are no comments or information provided in these sections this means that the Council does not hold information on the property that corresponds to that part of section 44A.

The information included in this LIM is based on a search of Council records only and there may be other information relating to the land which is unknown to the Council. Please note that other agencies may also hold information relevant to the property, or administer legislation relevant to the use of the land, for example, the Regional Council (Ecan), Heritage New Zealand Pouhere Taonga, and Land Information New Zealand.

Council records may not show illegal or unauthorised building or works on the property. The applicant is solely responsible for ensuring that the land is suitable for a particular purpose.

A LIM is only valid at the date of issue as information is based only upon information the Council held at the time of that LIM request being made.

## Property file service

This Land Information Memorandum does not contain all information held on a property file. Customers may request property files by phoning the Council's Customer Call Centre on (03) 941 8999, or visiting any of the Council Service Centres. For further information please visit [www.ccc.govt.nz](http://www.ccc.govt.nz).

To enable the Council to measure the accuracy of this LIM document based on our current records, we would appreciate your response should you find any information contained therein which may be considered to be incorrect or omitted. Please telephone the Customer Call Centre on (03) 941 8999.

A search of records held by the Council has revealed the following information:

## 1. Special features and characteristics of the land

*Section 44A(2)(a) LGOIMA. This is information known to the Council but not apparent from the district scheme under the Town and Country Planning Act 1977 or a district plan under the Resource Management Act 1991. It identifies each (if any) special feature or characteristic of the land concerned, including but not limited to potential erosion, avulsion, falling debris, subsidence, slippage, alluvion, or inundation, or likely presence of hazardous contaminants.*

( For enquiries, please phone (03) 941 8999 or visit [www.ccc.govt.nz](http://www.ccc.govt.nz).

### 1 Consultant Report Available

Land Information New Zealand (LINZ) engaged Tonkin and Taylor to provide a Geotechnical Report on Ground Movements that occurred as a result of the Canterbury Earthquake Sequence. The report indicates this property may have been effected by a degree of earthquake induced subsidence. The report obtained by LINZ can be accessed on their website at <https://www.linz.govt.nz> and search Information for Canterbury Surveyors.

### 1 Liquefaction Vulnerability

Christchurch City Council holds indicative information on liquefaction hazard for Christchurch. Information on liquefaction, including an interactive web tool, can be found on the Council website at [ccc.govt.nz/liquefaction](http://ccc.govt.nz/liquefaction). Depending on the liquefaction potential of the area that the property is in, the Council may require site-specific investigations before granting future subdivision or building consent for the property.

## Related information

1 There is attached a sub division soil investigation report covering this property.

## 2. Private and public stormwater and sewerage drains

Section 44A(2)(b) LGOIMA. This is information about private and public stormwater and sewerage drains as shown in the Council's records.

( For stormwater and sewerage enquiries, please phone (03) 941 8999 or visit [www.ccc.govt.nz](http://www.ccc.govt.nz).

### Related information

- 1 No up-to-date drainage plan is available for the development of this site. However, the installation of a water connection along with sewer and stormwater drains is checked by the Council prior to the issue of a Code Compliance Certificate.

### 3. Drinking Water Supply

*Section 44A(2)(ba) and (bb) LGOIMA. This is information notified to the Council about whether the land is supplied with drinking water, whether the supplier is the owner of the land or a networked supplier, any conditions that are applicable, and any information the Council has about the supply.*

Please note the council does not guarantee a particular water quality to its customers. If you require information on current water quality at this property please contact the Three Waters & Waste Unit.

( For water supply queries, please phone (03) 941 8999 or visit [www.ccc.govt.nz](http://www.ccc.govt.nz).

#### Water Supply

There is either a water meter not in use or no water connection to this property. Christchurch City Council is the networked supplier of water to this property. An application can be made to the Christchurch City Council for a water connection. The conditions of supply are set out in the Christchurch City Council Water Supply, Wastewater & Stormwater Bylaw (2014), refer to [www.ccc.govt.nz](http://www.ccc.govt.nz).

Christchurch City Council is the networked supplier of water to this property. This property can be connected to the Christchurch City Council Water Supply. The conditions of supply are set out in the Christchurch City Council Water Supply, Wastewater & Stormwater Bylaw (2014), refer to [www.ccc.govt.nz](http://www.ccc.govt.nz).

#### Related information

- 1 No up-to-date drainage plan is available for the development of this site. However, the installation of a water connection is checked by the Council prior to the issue of a Code Compliance Certificate.

## 4. Rates

Section 44A(2)(c) LGOIMA. This is information on any rates owing in relation to the land.

( For rates enquiries, please phone (03) 941 8999 or visit [www.ccc.govt.nz](http://www.ccc.govt.nz).

### (a) Annual rates

Annual rates to 30/06/2022: \$ 5,002.94

	Instalment Amount	Date Due
Instalment 1	\$ 1,250.69	31/08/2021
Instalment 2	\$ 1,250.69	30/11/2021
Instalment 3	\$ 1,250.69	28/02/2022
Instalment 4	\$ 1,250.87	31/05/2022

Rates owing as at 10/03/2022: \$ 0.00

### (b) Excess water charges

\$ 0.00

( For water charge enquiries, please phone (03) 941 8999 or visit [www.ccc.govt.nz](http://www.ccc.govt.nz).

### (c) Final water meter reading required?

No Reading Required

( To arrange a final water meter reading, please phone (03) 941 8999 or visit [www.ccc.govt.nz](http://www.ccc.govt.nz).

## 5. Consents, certificates, notices, orders, or requisitions affecting the land and buildings

*Section 44A(2)(d) LGOIMA. This is information concerning any consent, certificate, notice, order, or requisition, affecting the land or any building on the land, previously issued by the Council.* The information in this section may also cover building consent and/or code compliance information issued by building certifiers under the Building Act 1991 and building consent authorities that are not the Council under the Building Act 2004.

You can check the property file to identify whether any consent or certificate was issued by a building certifier under the Building Act 1991.

*Section 44A(2)(da) LGOIMA. The information required to be provided to a territorial authority under section 362T(2) of the Building Act 2004. There is currently no information required to be provided by a building contractor to a territorial authority under section 362T(2) of the Building Act 2004. The Building (Residential Consumer Rights and Remedies) Regulations 2014 only prescribed the information that must be given to the clients of a building contractor.*

( For building enquiries, please phone (03) 941 8999, email [EPADutyBCO@ccc.govt.nz](mailto:EPADutyBCO@ccc.govt.nz) or visit [www.ccc.govt.nz](http://www.ccc.govt.nz).

## 6. Certificates issued by a building certifier

Section 44A(2)(e) LGOIMA. This is information notified to the Council concerning any certificate issued by a building certifier pursuant to the Building Act 1991 or the Building Act 2004.

( For building enquiries, please phone (03) 941 8999, email [EPADutyBCO@ccc.govt.nz](mailto:EPADutyBCO@ccc.govt.nz) or visit [www.ccc.govt.nz](http://www.ccc.govt.nz).

## 7. Weathertightness

*Section 44A(2)(ea) LGOIMA. This is information notified to the Council under section 124 of the Weathertight Homes Resolution Services Act 2006.*

( For weathertight homes enquiries, please phone (03) 941 8999 or visit [www.ccc.govt.nz](http://www.ccc.govt.nz).

*If there is no information below this means Council is unaware of any formal Weathertight Homes Resolution Services claim lodged against this property.*

## 8. Land use and conditions

Section 44A(2)(f) LGOIMA. This is information relating to the use to which the land may be put and conditions attached to that use. The planning information provided below is not exhaustive and reference to the Christchurch District Plan and any notified proposed changes to that plan is recommended: <https://ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/plans/christchurch-district-plan/>.

There maybe some provisions of the Christchurch City Plan or Banks Peninsula District Plan that affect this property that are still operative.

( For planning queries, please phone (03) 941 8999, email [DutyPlanner@ccc.govt.nz](mailto:DutyPlanner@ccc.govt.nz) or visit [www.ccc.govt.nz](http://www.ccc.govt.nz).

### ┆ **Regional plan or bylaw**

There may be objectives, policies or rules in a regional plan or a regional bylaw that regulate land use and activities on this site. Please direct enquiries to Canterbury Regional Council (Environment Canterbury).

### ┆ **Waterway Provisions for Other Councils**

A resource consent or permit may also be required from the Canterbury Regional Council or other territorial authority, particularly with respect to water bodies managed by those authorities. Please refer to the relevant regional plan and any relevant bylaws, and contact the Christchurch City Council if you are uncertain which authority manages the water body in question.

## **(a) (i) Christchurch City Plan & Banks Peninsula District Plan**

### **(ii) Christchurch District Plan**

#### ┆ **Christchurch International Airport Protection Surfaces**

Property or part of property within the Christchurch International Airport Protection Surfaces overlay which is operative.

#### ┆ **Sites of Ngai Tahu Cultural Significance**

Property or part of property within the Nga Wai Rivers overlay which is operative.

#### ┆ **District Plan Esplanade Reserve/Strip**

Property or part of property subject to a requirement for an esplanade reserve or strip if subdivided.

#### ┆ **Liquefaction Management Area (LMA)**

Property or part of property within the Liquefaction Management Area (LMA) Overlay which is operative.

#### ┆ **Air Noise Boundary and Air Noise Contours**

Property or part of property affected by the 50 dB Ldn Air Noise Contour provisions which is operative.

#### ┆ **Outline Development Plan**

Property or part of property is within an Outline Development Plan area which is affected by specific provisions that are operative.

## Waterway Provisions

This property or part of this property is close to at least one waterway. It may be within the setback for an Upstream Waterway. Within that setback, District Plan rules apply to activities including buildings, earthworks, fences and impervious surfacing. Any part of the property within the setback will be affected by those rules.

## District Plan Zone

Property or part of property within the Open Space Water and Margins Zone which is operative.

## District Plan Zone

Property or part of property within the Residential New Neighbourhood Zone which is operative.

## District Plan Zone

Property or part of property within the Rural Urban Fringe Zone which is operative.

## (b) Resource consents

If there are any land use resource consents issued for this property the Council recommends that you check those resource consents on the property file. There may be conditions attached to those resource consents for the property that are still required to be complied with.

- RMA/2021/3027 - Combined subdivision / land use consent  
232 Styx Mill Road Styx  
Subdivision - Fee simple - 49 lots with land use

Also see Global Consent RMA/2021/3028

Status: Consent issued

Applied 10/09/2021

Granted 13/01/2022

Decision issued 13/01/2022

- RMA/2002/1080 - Land Use Consent  
330 Styx Mill Road Styx  
To erect future dwellings on Lots 1, 2, 5 & 6 and to maintain the existing dwelling on Lot 4 under the rules of Rural H of the Waimairi Transitional Plan. - Historical Reference RMA20010071  
Status: Processing complete  
Applied 13/05/2002  
Decision issued 22/05/2002  
Granted 22/05/2002

- | RMA/2021/3028 - Land Use Consent  
Global Resource Consents, Network Rating Unit  
Global Consent - to excavate within 5 metres of a street tree

Also see SUB application RMA/2021/3027

Status: Processing complete

Applied 10/09/2021

Granted 12/01/2022

Decision issued 13/01/2022

- | RMA/1995/5609 - Subdivision Consent  
Fee Simple SUBDIVISION - Historical Reference RMA9967  
Status: Processing complete  
Applied 22/12/1995

- | RMA/2002/439 - Subdivision Consent  
FEE SIMPLE SUBDIVISION - 5 LOTS - Historical Reference RMA20009413  
Status: Processing complete  
Applied 19/02/2002  
Granted 22/05/2002  
Decision issued 22/05/2002

## Related information

- | Council records shows there is an outstanding development contribution notice issued against this property development. For more information please contact the Development Contribution team on 941 8999 or email: [developmentcontributions@ccc.govt.nz](mailto:developmentcontributions@ccc.govt.nz) – RMA/2021/3027
- | Council records show that there is a current/on hold monitoring job in our system. This monitoring is to ensure that the resource consent conditions have been met. For further information you can contact the Compliance & Investigation team A on 941 8999 or email: [rcmon@ccc.govt.nz](mailto:rcmon@ccc.govt.nz) and reference to resource consent RMA/2021/3027.

Property address:  
250 Styx Mill Road

LIM number: H00892132  
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Christchurch City Council  
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Christchurch 8154, New Zealand  
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Fax 64 3 941 8984  
[www.ccc.govt.nz](http://www.ccc.govt.nz)

## 9. Other land and building classifications

*Section 44A(2)(g) LGOIMA. This is information notified to the Council by any statutory organisation having the power to classify land or buildings for any purpose.*

( For land and building enquiries, please phone (03) 941 8999 or visit [www.ccc.govt.nz](http://www.ccc.govt.nz).

Please refer to Section 1 for details

Property address:  
250 Styx Mill Road

LIM number: H00892132  
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## 10. Network utility information

*Section 44A(2)(h) LGOIMA. This is information notified to the Council by any network utility operator pursuant to the Building Act 1991 or the Building Act 2004.*

( For network enquiries, please phone (03) 941 8999 or visit [www.ccc.govt.nz](http://www.ccc.govt.nz).

! **None recorded for this property**

## 11. Other information

Section 44A(3) LGOIMA. This is information concerning the land that the Council has the discretion to include if it considers it to be relevant.

( For any enquiries, please phone (03) 941 8999 or visit [www.ccc.govt.nz](http://www.ccc.govt.nz).

### (a) Kerbside waste collection

- | Your recycling is collected Fortnightly on the Week 2 collection cycle on a Thursday. Please leave your recycling at the Kerbside by 6:00 a.m. Your nearest recycling depot is the Styx Mill EcoDrop.
- | Your refuse is collected Fortnightly on the Week 1 collection cycle on a Thursday. Please leave your rubbish at the Kerbside by 6:00 a.m. Your nearest rubbish depot is the Styx Mill EcoDrop.
- | Your organics are collected Weekly on Thursday. Please leave your organics at the Kerbside by 6:00 a.m.

### (b) Other

#### | Floor Levels Information

Christchurch City Council holds a variety of information relevant to building/property development across the city. This includes minimum finished floor levels that need to be set to meet the surface water requirements in clause E1.3.2 of the building code (where this applies), and the requirements of the Christchurch District Plan (where a property is in the Flood Management Area). Where this information has been processed for your site, it can be viewed at <https://ccc.govt.nz/floorlevelmap/>, otherwise site specific advice can be obtained by emailing [floorlevels@ccc.govt.nz](mailto:floorlevels@ccc.govt.nz).

#### | Community Board

Property located in Fendalton-Waimairi-Harewood Community Board.

#### | Guest Accommodation

Guest accommodation (including whole unit listings on Airbnb; BookaBach; etc.) generally requires a resource consent in this zone when the owner is not residing on the site. For more information, please refer to: <https://ccc.govt.nz/providing-guest-accommodation/>.

#### | Tsunami Evacuation Zone

This property is not in a tsunami evacuation zone. It is not necessary to evacuate in a long or strong earthquake or during an official Civil Defence tsunami warning. Residents may wish to offer to open their home to family or friends who need to evacuate from a tsunami zone, and should plan with potential guests to do so in advance. More information can be found at <https://ccc.govt.nz/services/civil-defence/hazards/tsunami-evacuation-zones-and-routes/>

#### | Electoral Ward

Property located in Harewood Electoral Ward

#### | Listed Land Use Register

Property address:  
250 Styx Mill Road

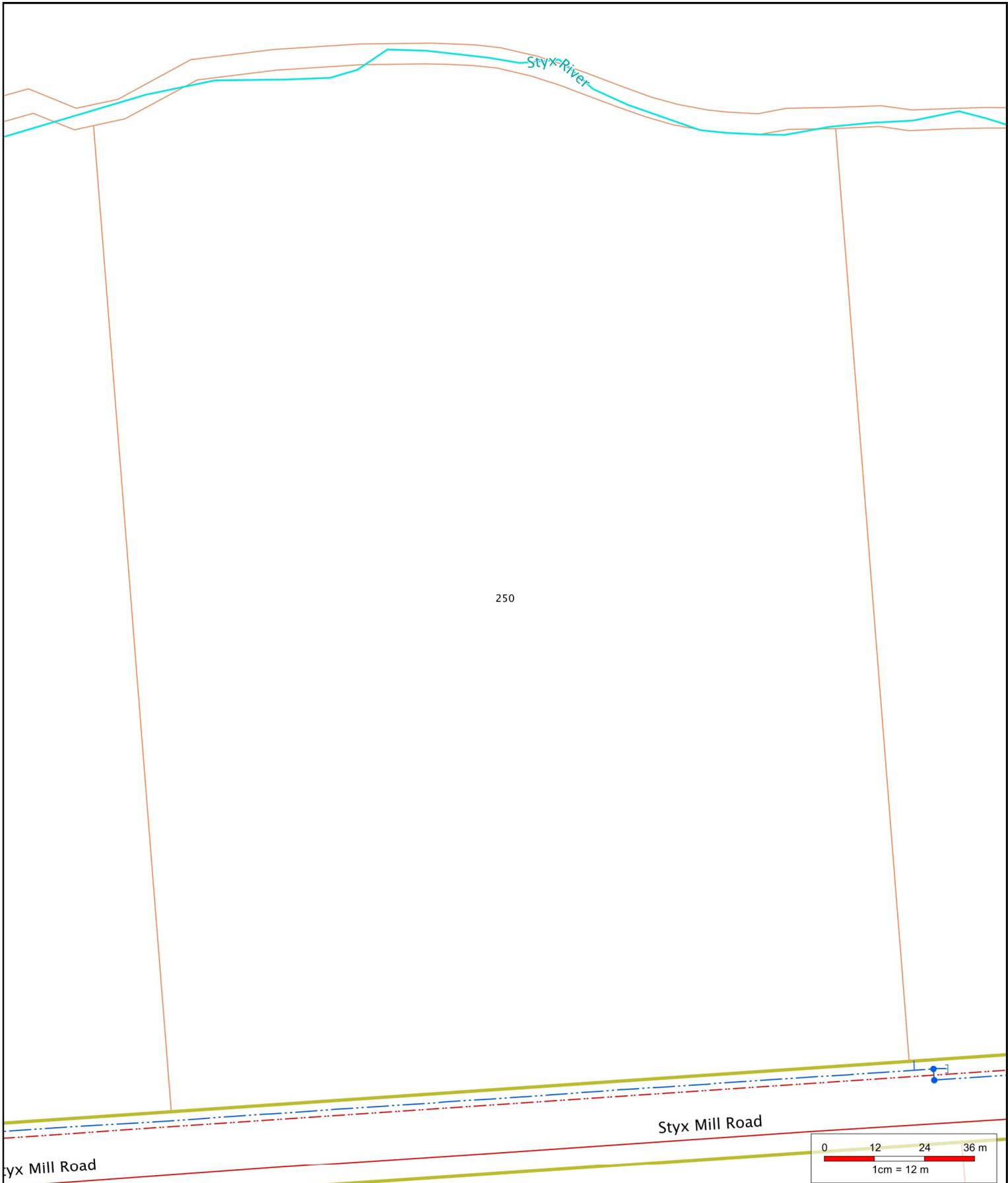
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Hazardous activities and industries involve the use, storage or disposal of hazardous substances. These substances can sometimes contaminate the soil. Environment Canterbury identifies land that is used or has been used for hazardous activities and industries. This information is held on a publically available database called the Listed Land Use Register (LLUR). The Christchurch City Council may not hold information that is held on the LLUR. Therefore, it is recommended that you check Environment Canterbury's online database at [www.llur.ecan.govt.nz](http://www.llur.ecan.govt.nz)

## I **Spatial Query Report**

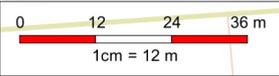
A copy of the spatial query report is attached at the end of this LIM. The spatial query report lists land use resource consents that have been granted within 200 metres of this property.



250

Styx Mill Road

Styx Mill Road



1 : 1,200 on A4  
10/03/2022 4:36:12 PM

ph: 941-8300 fax: 941-8385

Accuracy not guaranteed. Onsite verification required. Display of data scale dependent, full detail available at 1:500.

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**Private Drainage**

- Standard Infrastructure**
- Bio Gas
  - Condensate Trap
  - End Cap
  - Inlet
  - Outlet
  - Valve
  - Main
  - Cable
- Water Intake/Supply**
- Connector
  - Bellows
  - Connector
  - Hydrant

- Water Intake/Supply**
- Inlet
  - Meter
  - Outlet
  - Pump
  - Restrictor
  - Valve
  - Air Release
  - Butterfly
  - Flow restriction
  - Gate
  - Pressure Activated
  - Sluice
  - Valve
  - Reservoir
  - Structure
  - Lateral
  - Main
  - Sub Main

- Wastewater**
- End Cap
  - Valve
  - Air Gap Separator
  - Vent
  - Eye
  - Eye (Vertical)
  - Outfall
  - Pump
  - Junction
  - Access
  - Flush Manhole
  - Inspection Point
  - Standard Manhole
  - Trap
  - Vented Manhole
  - Lateral
  - Main
  - Pressure Main

- Wastewater**
- Lateral Fitting
  - Local Pressure
  - Control Panel
  - Boundary Kit
  - Tank System
  - Site
  - Vacuum Chamber
  - Vacuum Breather
- Stormwater**
- Bend
  - Change
  - Eye
  - Flow Restriction
  - Inlet
  - Dome Sump
  - Double Sump
  - Gross Debris Trap

- Stormwater**
- Inlet
  - Inlet Headwall
  - Pipe End
  - Silt Trap
  - Single Sump
  - Soak Pit
  - Triple Sump
  - Junction
  - Standard Manhole
  - Outlet
  - Pump
  - Structure
  - Basin
  - Lateral
  - Main
  - Lateral Fitting
  - Double Sump

- Stormwater**
- Lateral Fitting
  - Single Sump
  - Soak Pit
  - Inspection point
  - Manhole
- All services**
- Pipe Protection
  - Abandoned
  - Proposed
  - Out of service
- Landbase**
- Easement



**K210318-1**

**2 June 2021**

**Geotechnical Engineering Investigation  
Proposed Subdivision  
232 Styx Mill Road  
Casebrook  
Christchurch**

**Prepared For:**

Davie Lovell-Smith Ltd

PO Box 679

Christchurch

**KGA Geotechnical Group Limited**

***Supporting the Construction Industry since 1990***

7A William Pickering Drive | Albany | Auckland

Unit 3, 201 Opawa Road | Hillsborough | Christchurch

P O Box 302 361 | North Harbour | Auckland 0751

P O Box 7630 | Sydenham | Christchurch 8240

09 478 6655

[www.kga.co.nz](http://www.kga.co.nz)

03 343 5302

## REPORT ISSUE AUTHORISATION

**Geotechnical Engineering Investigation**

**Proposed Subdivision**

**232 Styx Mill Road**

**Casebrook**

**Christchurch**

**Prepared by:**



K210318-1

**Teegan Vink**

BSc (Geology), PMEG  
Engineering Geologist

**Reviewed by:**



K210318-1

**Robert Kamuhangire**

BSc (Civil Hons), MSc, CEng, MICE, CMEngNZ, CPEng  
Principal Geotechnical Engineer

**Authorised by:**



K210318-1

**Abilio Nogueira**

BE (Eng. Geol.), CMEngNZ, CPEng  
Director

## EXECUTIVE SUMMARY

### Geotechnical Engineering Investigation

#### Proposed Subdivision

#### 232 Styx Mill Road

#### Casebrook

#### Christchurch

<b>SUB-SOIL CONDITIONS</b>	<b>Lithology</b>	The sub-surface conditions comprise topsoil up to 0.4m deep overlying sandy and silty soils to between 2.7 to 5.0m deep overlying sandy gravels to 10m+ depth	
	<b>Soil Classification as per NZS 1170.5:2004</b>	Class 'D' (Deep soil sites)	
	<b>Groundwater Depth</b>	Encountered between 1.8m to 3.6m depth (deeper closer to Styx River)	
<b>SEISMIC ASSESSMENT</b>	<b>Vertical Displacement under Earthquake Ground Motions (Index Value)</b>	<b>SLS</b>	<b>ULS</b>
		<5 – 25	10 – 55
	<b>Liquefaction Potential Index (LPI) Value</b>	<b>SLS</b>	<b>ULS</b>
		0 – 1	1 – 10
	<b>Liquefaction Severity Number (LSN) Index Value</b>	<b>SLS</b>	<b>ULS</b>
		<1 – 7	3 – 21
<b>Horizontal Movement within Lots 2 - 54</b>	<b>Lateral Spreading</b>	<b>Lateral Stretch</b>	
	Minor (up to 100mm)	Minor (up to 50mm)	
<b>Seismic Technical Categorisation</b>	<b>MBIE</b>	N/A Rural and Unmapped	
	<b>Site Specific</b>	TC2	
<b>FOUNDATION OPTIONS</b>	<p>According to our assessment, TC2 style foundations (as per the MBIE Guidance document) would be suitable for dwellings within the proposed new Lots ( Lot 2 to Lot 54).</p> <p>This report is a geotechnical assessment in terms of suitability of the land for subdivision and general recommendations regarding proposed development. Details of proposed building development were not known at the time of writing this report and further coordination will be required to conduct site-specific shallow investigations and confirm foundation design for each new lot.</p>		
<b>SUBDIVISION ASSESSMENT</b>	<p>The site has been assessed as suitable for subdivision from a geotechnical point of view, and a Statement of Professional Opinion is included within Appendix F.</p> <p>This report has been prepared for Subdivision Consent purposes and is insufficient for Building Consent.</p>		
<b>REPORT DISTRIBUTION</b>	<p>A full copy of this report must be provided to all relevant parties involved in the project. This should include, but not be limited to, owner, architectural designers, engineers (civil and structural) and the earthworks/building contractor</p>		

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**Attachments:**

Sheet 1	Site Plan
Sheet 2A – 2F	Hand Auger and Scala Penetrometer Logs
Sheet 3A – 3L	CPT / DPSH Logs

<b>Appendix A:</b>	Third Party Documents
<b>Appendix B:</b>	Site Photographs
<b>Appendix C:</b>	Background Information Documents
<b>Appendix D:</b>	Liquefaction Analyses
<b>Appendix E:</b>	Slope Stability and Lateral Spreading Potential Assessment
<b>Appendix F:</b>	Statement of Professional Opinion (SOPO)

## 1. INTRODUCTION

At the instruction of Davie Lovell-Smith Ltd (DLS), we have undertaken a geotechnical engineering investigation on the property at 232 Styx Mill Road in Casebrook, Christchurch. The work was carried out in accordance with our Agreement dated 15 April 2021.

As part of the ground investigation, we have undertaken a detailed site and environs walkover inspection, and referenced available information from the New Zealand Geotechnical Database (NZGD), Environment Canterbury (ECan) and Christchurch City Council (CCC) websites. We have conducted a subsurface investigation comprising hand auger boreholes, with associated Scala penetrometer tests and cone penetrometer testing in order to assess ground conditions and likely behaviour of the ground. This testing has been carried out in order to assess ground conditions and likely behaviour of the ground, for purposes of subdivision consent

The investigation was carried out with reference to the Ministry of Business, Innovation & Employment (MBIE) Guidance - Version 3, dated December 2012 - "Repairing and rebuilding houses affected by the Canterbury earthquakes" and subsequent updates, as well as the relevant New Zealand Geotechnical Society (NZGS) and MBIE modules; "Earthquake Geotechnical Engineering Practice".

This report presents our findings and conclusions. It has been prepared in the context of providing geotechnical information for use in assessing the suitability of the land for subdivision. This report is not sufficient for building foundation design as part of a Building Consent application, though we seek to provide preliminary guidance on foundation options for the future development of the property.

## 2. SITE DESCRIPTION

The proposed development spans part of two properties, the properties are legally described as Lot 5 and Lot 6, DP 311370 and has an area of approximately 4ha each. The properties are irregular in plan shape and are located on the northern side of Styx Mill Road. They are otherwise bounded by residential properties 'lifestyle' properties and rural land, as shown on our Site Plan, attached as Sheet 1. The site is near-level with the Styx River running along the northeastern boundary, approximately 4.0m below the site level. The slope angle down to the river is approximately 1V:1.5H and the water level at the river was approximately 4.0m below the site ground level.

### **3. EXISTING STRUCTURE AND PROPOSED DEVELOPMENT**

The property is currently rural farmland and no structures are present. Several fences form paddocks across the property.

We have been provided with a preliminary subdivision plan by DLS titled 'Styx Mill Road' (Ref: E17713, dated, March 2021) outlining the area of the proposed subdivision and lot locations. The plan shows the subdivision is to contain 53 residential lots (Lot 2 to Lot 54) and a reserve area by the river. The lots range from 401m<sup>2</sup> to 1200m<sup>2</sup> and the reserve area by the river is shown to be 4462m<sup>2</sup>. All residential lots are at least and at least 20m from the crest of the slope down to the river.

Based on historic aerial photographs sourced from ECan, the property has never been developed and has been used as farmland to graze stock since the 1940s.

### **4. BACKGROUND INFORMATION**

#### **4.1 Sources Consulted**

The following third party information sources were consulted and referred to in this report:

- New Zealand Geotechnical Database (NZGD)
- Environment Canterbury (ECan)
- Christchurch City Council (CCC)

A summary of our understanding of the third party information is presented below. We note that the below summary of information is limited to that considered relevant to the geotechnical assessment of the property, and is intended to present facts and opinions as contained in third party sources and does not constitute interpretation or endorsement by KGA.

#### **4.2 New Zealand Geotechnical Database (NZGD) & Environment Canterbury (ECan)**

The NZGD website was searched for geotechnical information in the form of relevant well/borehole logs and CPT data. One Cone Penetrometer Test (CPT) was found in the vicinity of the property. The log is reproduced in Appendix C, and is referenced further in Section 7.1 of this report.

The ECan website indicates that the site is overlaying a “Coastal Confined Gravel Aquifer.” According to GNS Science, the median depth to the water table ranges from 2.0m to 4.0m below ground level (bgl) across the site.

A summary of aerial photography and field observations, as well as the Peak Ground Acceleration (PGA) experienced on the site during the major earthquake events of the Canterbury Earthquake Sequence (CES) is given in Table 1. We have also scaled the PGA to a magnitude 7.5 event to be able to compare the recorded PGA to the ULS and SLS values recommended in the MBIE Guidance ( $PGA_{7.5}(ULS)=0.35g$ ,  $PGA_{7.5}(SLS)=0.13g$ ).

For the magnitude scaling factor assessment, it is important to note that the 13 June and 23 December 2011 aftershocks each comprised two separate earthquakes. In both cases, the second of the two earthquakes was the more damaging, but the first earthquake is inferred to have caused elevated pore water pressure and increase the susceptibility for liquefaction to occur. To take the two earthquakes into consideration for modelling purposes, the Tonkin & Taylor Liquefaction Vulnerability Study considers the second earthquake with an increased magnitude to include the effects of the first one. The design earthquake magnitude for each event is presented in Table 1, and a copy of the Property Summary Report is included in Appendix C.

**Table 1: Summary Desk Study Information**

	<b>September 2010 (M 7.1)</b>	<b>February 2011 (M 6.2)</b>	<b>June 2011 (M 6.0)</b>	<b>December 2011 (M 5.9)</b>
<b>Aerial Photography Liquefaction Interpretation (KGA)</b>	Not mapped	No observed liquefaction	Not mapped	Not mapped
<b>Aerial Photography Liquefaction Interpretation (EQC)</b>	Not mapped	No observed liquefaction	Not mapped	Not mapped
<b>PGA (g)</b>	0.20	0.19	0.11	0.15
<b><sup>1</sup> Scaled PGA<sub>7.5</sub> (g)</b>	0.18	0.13	0.08	0.11

<sup>1</sup> Scaled to M7.5 using Idriss and Boulanger recommendations (2008)

### **4.3 Christchurch City Council (CCC) – Flooding Risk**

According to the flood data provided by the CCC, the property is not within a CCC District Plan Flood Management Area. It is recommended that the new dwellings are elevated well above the surrounding ground level to provide a default level of protection from surface flooding. The CCC should be contacted directly to comment on the floor level requirement, as a full flood risk assessment is outside the scope of this report.

### **4.4 Environment Canterbury (ECan) – Listed Land Use Register**

Environment Canterbury has identified sites where hazardous activities and industries have been located throughout Canterbury, and maintains the Listed Land Use Register (LLUR) database which alerts about potential contamination before site works commence. After consultation of the database regarding these sites, the following information was obtained: “The Listed Land Use Register does not currently have any information about a Hazardous Activities and Industries List site on this land parcel.” The relevant extracts from the LLUR are presented in Appendix C.

In light of the existing information, we consider that no further investigation into ground contamination is needed. However, due to the limited extent of our investigation, we cannot guarantee that contamination is not present. During the excavation for foundations, consideration should be given to the observation of the excavated soils and alert for any evidence of contamination.

## **5. SITE OBSERVATIONS**

During our site walkover on 17 May 2021, the following observations were noted:

- The site is near-level grassed farmland.
- Several fences break up the site into paddocks.
- Gentle undulations were noted across the site.
- A steep embankment, approximately 1V:1.5H and approximately 4.0m high, runs along the northeast boundary down to the Styx River below, we did not observe any evidence of slope instability along this portion of the site or any deflections to the fence along the slope crest that could indicate ground movements.

Relevant site photographs are provided in Appendix B.

## 6. GEOLOGY

The published geology of the Christchurch urban area shows the site is underlain by the Yaldhurst Member of the Springston Formation. The Springston Formation was deposited during the Holocene epoch ( $\leq 10,000$  years old), and has accumulated the inland margin of the Christchurch Formation. The Springston Formation contains postglacial fluvial channel and overbank sediments resulting in the deposition of well-sorted gravels, sands and silts sourced from the Southern Alps. Due to the movement of the Waimakariri River channels, the deposits appear as fan shaped wedges or localised lenses, creating extensive layers with varying thicknesses.

The Yaldhurst Member is the most recent deposit of the Springston Formation and was deposited just above the present Waimakariri River flood level during the last 3000 years. It contains three distinct lithological units; alluvial sand and silt overbank deposits; historic river flood channels containing silts, sands and alluvial gravel; and peat deposits.

## 7. GROUND INVESTIGATION

### 7.1 Existing Ground Information

A search of the ECan and NZGD websites identified one CPT within the vicinity of the site. We considered this test relevant, and the CPT data was used in our liquefaction analyses. The investigation log is reproduced in Appendix C, and the data referenced in more detail in Table 2.

**Table 2: NZGD Data**

NZGD Test Reference	Source	Source Reference	Probe Depth (m)	Approx. Distance From Site (m)
CPT_149331	KGA/Ground Investigations	CPT-04	5.5	50 SW

## 7.2 Current Ground Investigation

In order to supplement the existing ground information, further project specific deep and shallow ground investigation for subsoil identification and bearing capacity purposes was undertaken. The subsurface conditions on site were explored by drilling six hand auger boreholes (HA01 to HA06), performing six Scala penetrometer tests (SP01 to SP06) within the borehole locations, and completing twelve cone penetrometer tests (CPT-01 to CPT-12) as shown in Table 3. The shallow drilling services were provided by KGA on 17 May 2021, with the CPTs undertaken by Ground Investigation Ltd on 17 and 18 May 2021. A description of the testing is given in the following sections.

**Table 3: Schedule of Exploratory Holes**

Test Type	Test Ref.	Depth (m)	Reason for Termination	Date of Test
Hand Auger	HA01 to HA06	3.0	Target depth	17 May 2021
Scala Penetrometer	SP01 to HA06	3.0	Target depth	17 May 2021
CPT	CPT-01	4.3	Effective refusal in dense gravel	18 May 2021
	CPT-02	7.5		
	CPT-03	10.1		
	CPT-04	10.0	Target depth	17 May 2021
	CPT-05	5.4	Effective refusal in dense gravel	
	CPT-06	5.6		
	CPT-07	6.5		
	CPT-08	6.8		
	CPT-09	4.9		
	CPT-10	6.0		18 May 2021
	CPT-11	6.8	17 May 2021	
	CPT-12	5.7	18 May 2021	
DPSH	DPSH-01	4.4	Effective refusal	18 May 2021
	DPSH-05	11.0	Target depth	
	DPSH-06	6.0	Effective refusal	
	DPSH-07	10.0	Target depth	
	DPSH-09	10.0		
	DPSH-10	10.0		
	DPSH-12	6.5	Effective refusal	

The exploratory borehole locations were selected to provide representative indications of the subsurface ground conditions within the area being assessed. The exploratory test locations are indicated on our Site Plan, attached as Sheet 1.

### **7.3 Scala Penetrometer Tests and Hand Auger Boreholes**

The Scala penetrometer probe consists of a hand operated dynamic cone penetrometer and is used to evaluate the penetration resistance of a soil. A 9kg hammer weight is dropped over a distance of 510mm driving a 20mm diameter cone into the ground. The number of hammer blows is recorded for each 50mm of penetration. Testing is in accordance with Test 6.5.2:1988 of NZS 4402.

Hand auger boreholes were drilled in conjunction with the Scala penetrometer testing using a 50mm diameter hand auger and a soil description log in accordance with the NZGS Guidelines "Field description of soil and rock" is presented for each borehole. Scala Penetrometer testing was carried out at nominal 1.0m depth intervals with hand auger boreholes drilled over the Scala test points to the same depth to reduce the friction on the rod for subsequent testing.

The hand auger boreholes and Scala penetrometer tests were scheduled to be taken to 3.0m depth or to a depth where effective refusal was reached, whichever was shallower. The logs of the hand auger boreholes and Scala penetrometer probes are provided as Sheets 2A to 2F.

### **7.4 Cone Penetrometer / DPSH Testing**

The CPT testing was undertaken by Ground Investigation Ltd with a 1.1 tonne Pagani TG63-150, using a cone of 10cm<sup>2</sup> cross-sectional area, and a 150cm<sup>2</sup> friction sleeve area. Continuous measurement of pore water pressure was undertaken during testing (u<sub>2</sub>).

Tests were undertaken in accordance with A.S.T.M. Standard D 5778-12 procedure. The test target depth was to a minimum depth of 10m or refusal, whichever came first.

The DPSH apparatus consists of a mechanically driven dynamic cone penetrometer, and it is used to evaluate the penetration resistance of soils. A 63.5kg hammer weight is dropped over a distance of 750mm, driving a 50mm diameter 90° cone into the ground. The number of hammer blows is recorded for each 100mm of penetration. Testing is in accordance with BS1377: Part 9: Test 3.2 – Determination of the Dynamic Probing Resistance using the 90° Cone.

The CPT and DPSH logs are attached as Sheets 3A to 3L.

## **7.5 Subsurface Conditions**

The results of our investigation indicate that the site generally consists of up to 0.4m of topsoil overlying silty and sandy soils overlying sandy gravels. The depth to the sandy gravels ranges from approximately 3.0m depth in the western portion of the site and grades down to approximately 5.0m depth in the northeast portion of the site near the Styx River. The sandy gravel extends to beyond 10m depth. Based on CPT and DPSH results the sandy gravel appears to be very dense.

For a full detailed description, reference should be made to the borehole logs, attached as Sheets 2A to 2F. In order to prepare a subsurface model of the site, the subsurface conditions encountered have been inferred between our boreholes and interpreted from the CPT tests below the borehole depths. It must be accepted that the conditions are likely to vary between each borehole location, particularly when the distance between boreholes is large.

## **7.6 Groundwater**

Groundwater was encountered between 1.8m to 3.5m depth during our site testing. This is generally consistent with GNS water levels inferred in Section 4.2. Based on our observations it appears that groundwater gradient trends down to deeper closer to the river and shallower further away from the Styx River. Generally the groundwater appears to be approximately 1.0m to 1.5m above the top of the gravel layer.

Groundwater levels can and will vary with changes in weather patterns, particularly following periods of prolonged wet or dry weather.

## 8. LIQUEFACTION ASSESSMENT

### 8.1 General

Liquefaction analyses were completed for both SLS and ULS design criteria, using the CPT data referenced in Table 2 and 3. Calculations were performed over the full investigation depth which was generally less than the MBIE 'Index depth' of 10m due to shallow refusal in dense gravel generally being encountered across the site.

This section presents three parameters commonly used to assess the liquefaction vulnerability; the liquefaction induced settlements, Liquefaction Potential Index (LPI) and the Liquefaction Severity Number (LSN).

The seismic design requirements adopted for use in the analyses are defined in Part C of the MBIE Guidelines "Repairing and rebuilding houses affected by the Canterbury earthquakes" with the recent update regarding Boulanger & Idriss (2014) liquefaction analysis methodology. These are:

- Buildings of normal use (Importance Level 2).
- Deep or soft soil sites (Class D).
- Magnitude M7.5 EQ event and peak Ground Acceleration (PGA) of 0.13g and magnitude M6.0 EQ event and peak Ground Acceleration (PGA) of 0.19g for annual exceedance probabilities of 1/25 (SLS1 and SLS2) – considering the highest calculated total volumetric strain from either scenario adopted.
- Magnitude M7.5 EQ event and 0.35g for annual exceedance probabilities of 1/500 (ULS).
- Boulanger and Idriss (2014) methodology for liquefaction triggering.
- Zhang et al. (2002) volumetric densification calculation.

The in situ groundwater level was considered to exist at 2.0m at the western side of the site and graded down to 3.5m bgl at the northwestern end of the site near the Styx River. For our liquefaction analysis we used a range of ground water levels. For CPT\_149331, CPT-01, CPT-02 and CPT-10 the groundwater level during an earthquake was conservatively assumed at 1.5m bgl. For CPT-03, CPT 04, CPT-08, CPT-09, CPT-11 and CPT-12 the groundwater level during an earthquake was conservatively assumed at 2.0m bgl. For CPT-05, CPT-06 and CPT-07 the ground water level during an earthquake was conservatively assumed at 3.0m bgl.

## 8.2 Calculated Settlement

We have analysed the CPT data using the current software 'CLiq' and a copy of the output from the analyses has been included within Appendix D. The software includes for normalisation of the data for overburden pressure and is considered to provide improved indications of liquefaction potential. The results are presented in Table 4.

**Table 4: Liquefaction Induced Global Settlements Analysis Results**

Test	Calculation Limit Depth (m)	Calculated Vertical Settlement (mm)		
		SLS1	SLS2	ULS
CPT_149331	Full Depth (5.5)	<5	5	15
CPT-01	Full Depth (4.3)	<5	<5	10
CPT-02	Full Depth (7.5)	<5	<5	10
CPT-03	Full Depth (10.1)	<5	<5	15
CPT-04	Full Depth (10.0)	<5	10	35
CPT-05	Full Depth (5.4)	<5	5	20
CPT-06	Full Depth (5.6)	<5	10	30
CPT-07	Full Depth (6.5)	<5	5	20
CPT-08	Full Depth (6.8)	<5	<5	10
CPT-09	Full Depth (4.9)	<5	15	30
CPT-10	Full Depth (6.0)	<5	5	20
CPT-11	Full Depth (6.8)	<5	10	20
CPT-12	Full Depth (5.7)	<5	5	30

Under SLS and ULS seismic demands, the above calculated settlements generally fall within TC2 categorisation as defined by the MBIE Guidance. The analyses suggest that there is at least a 3.0m thick non-liquefiable crust under SLS seismic demands and at least 1.5m thick non-liquefiable crust under ULS seismic demand.

Post-earthquake general observations show that the empirical calculation of the settlement is uncertain with perhaps a  $\pm 50\%$  margin to the numbers given in Table 4. We therefore recommend that engineering judgment is applied when interpreting the computed settlements.

We point out that the settlements presented in Table 4 describe the settlements of the ground not occupied by a building, occurring due to dissipation of excess pore water pressure generated during earthquake shaking. Additional settlements may also occur due to yield of the liquefied soils under foundation loading, soil loss of volume (liquefaction ejecta) and lateral spreading, but these components are very difficult to predict. Subsurface conditions may vary across the site, making accurate prediction of future settlements even more difficult.

### **8.3 Liquefaction Induced Ground Deformation**

Guidance on expected levels of liquefaction-induced ground deformation is provided within Section 5.3 of Module 3 of the Earthquake Geotechnical Engineers Practice documents issued by MBIE and NZGS. This provides a summary of expected performance levels for liquefied soil deposits, based on the liquefaction triggering factor, liquefaction potential index and liquefaction severity number. The LPI and LSN are indices that quantify liquefaction-induced damage by taking into consideration the severity, thickness and depth of the liquefiable layers within the soil profile. The expected level of ground performance is summarised in Table 5.1 of Module 3, defined as six performance levels as a consequence of liquefaction (L0 – ‘Insignificant’ to L5 – ‘Very severe’). We have analysed the CPT data using CLiq and the calculated LPI and LSN values are presented in Table 5 below.

It should be noted that LPI and LSN indices are typically applied to area-wide screening, and are considered to have reasonable predictive capacity when applied this way; however, they may misrepresent performance in approximately 20% - 30% of cases. Therefore the expected performance levels provided in Table 5 below are only intended as general guidance, and the uncertainties and/or non-uniformities of ground deformation should be considered in any subsequent design.

**Table 5: General Performance Levels**

Test	SLS2		Effect from Liquefaction	ULS		Effect from Liquefaction
	LPI	LSN		LPI	LSN	
<b>CPT_149331</b>	<1	2	Insignificant	3	7	Mild/Moderate
<b>CPT-01</b>	0	<1	Insignificant	1	3	Insignificant
<b>CPT-02</b>	<1	<1	Insignificant	2	6	Mild/Moderate
<b>CPT-03</b>	<1	1	Insignificant	2	5	Mild/Moderate
<b>CPT-04</b>	<1	2	Insignificant	5	8	Moderate
<b>CPT-05</b>	<1	1	Insignificant	3	5	Moderate/High
<b>CPT-06</b>	<1	2	Insignificant	4	8	Moderate
<b>CPT-07</b>	<1	1	Insignificant	3	6	Moderate
<b>CPT-08</b>	0	<1	Insignificant	1	4	Mild
<b>CPT-09</b>	<1	4	Insignificant	5	9	Moderate
<b>CPT-10</b>	<1	1	Insignificant	4	8	Mild/Moderate
<b>CPT-11</b>	<1	2	Insignificant	4	7	Mild/Moderate
<b>CPT-12</b>	<1	2	Insignificant	4	10	Moderate

The LPI and LSN values in Table 5 indicate a performance level of L0 ('insignificant' effect from excess pore water pressure and liquefaction) for the SLS case and L0 – L2 ('insignificant' to 'moderate') for the ULS case. The ULS performance levels indicate liquefaction occurs in layers of limited thickness (10% or less of the deposit to liquefy), with ground deformation results relatively small in differential settlements.

Reference should be made to Table 5.1 of Module 3 for a full description of the expected characteristics and consequences of liquefaction.

## 9. SLOPE STABILITY AND LATERAL SPREADING POTENTIAL ASSESSMENT

Based on our review of the onsite CPTs indicating that the liquefiable layer is not at consistent depth (and/or of consistent thickness) across the site and as the site is at least 20m from the edge of Styx River, we consider the lateral spreading potential at the site to be minor (i.e. less than 100mm at ULS levels of shaking). None-the-less, we have undertaken a detailed analysis to assess the lateral spreading potential for the lots closer to the reserve area in the less likely event that the liquefiable layers encountered around CPT-06 and CPT-07 extend to the river edge.

To assess the stability of the slope alongside the Styx River under static and seismic conditions, a representative cross section (A – A') was created from observations during our investigation and the location of the cross section is shown on our Site Plan. Results of the analyses are contained in Appendix E.

Our assessments are based on the procedure within Section 6.3 of the New Zealand Transport Agency's (NZTA) Bridge Manual SP/M/022 (incorporating Amendment 3), dated October 2018. The NZTA Bridge Manual was adopted as it is a more complete New Zealand specific authoritative Guidance document within the field. The stability of the Styx River bank along the northern boundary of the subdivision was undertaken using the computer-based program "SLIDE" by RocScience. The purpose of the stability analysis was to assess if any lots closest to the 'Reserve Area' would be at risk of slope stability or lateral spreading if and rise of slope stability (inclusive of lateral movement would be confined to the planned reserve area along the Styx River. The planned reserve area is an approximately 20m wide strip of land alongside the Styx River.

In carrying out our analyses, we have modelled the current ground surface utilising five separate load case scenarios and we have noted the distance to the edge of the slope where suitable Factor of Safety were recorded as below:

1. A static circular scenario (which modelled the measured groundwater conditions), and assessed with  $FS \leq 1.5$ .
2. A SLS circular seismic scenario (which modelled the measured groundwater conditions with an added seismic horizontal acceleration coefficient of 0.19g, as per MBIE Guidance), and assessed with  $FS \leq 1.0$ .
3. A ULS circular seismic scenario (which modelled the measured groundwater conditions with an added seismic horizontal acceleration coefficient of 0.35g, as per MBIE Guidance), and assessed with  $FS \leq 1.0$ .

4. A post seismic circular scenario (which modelled the measured groundwater conditions with a liquefiable layer), and assessed with  $FS \leq 1.0$  (assuming no flow failure as per NZTA Guide.
5. A post seismic non-circular scenario (which modelled the measured groundwater conditions with a liquefiable layer) and assessed with  $FS \leq 1.0$ .

We note that scenarios 1 to 3 considered non-liquefied ground conditions but maximum PGA while load scenarios 4 and 5 considered liquefied ground conditions but no PGA

The results of our analysis is included in Table 6 below.

**Table 6: Minimum Factor of Safety (Fs) and Distance from top of slope for analysis scenario**

<b>Analysis Scenario</b>	<b>Acceptable FS (Based on NZTA Bridge Manuel)</b>	<b>Distance Achieved from Top of Slope (m)</b>
Static Circular Scenario	1.5	4.5
SLS Circular Seismic Scenario	1.0	5.7
ULS Circular Seismic Scenario	1.0	11.8
Post Seismic Circular Scenario	1.0	13.6
Post Seismic Non-Circular Scenario	1.0	9.6

The results of the stability analysis indicate that the factor of safety against slope instability for the Lots closest to the reserve terrace is at least 1.5 under static conditions and 1.0 under design seismic conditions. We therefore consider that the site and the proposed development will remain safe and will not be adversely affected by slope instability or lateral spreading. We note that slope stability may affect the reserve area however, slope stability issues are unlikely to affect any of the proposed 33 lots (Lot 2 to Lot 34).

## 10. SITE DESIGNATION AND POTENTIAL FOR LATERAL SPREADING

The site is classified as Class “D” – (Deep or soft soil) for structural purposes in the New Zealand design standards (NZS 1170.5:2004).

Based on the near-surface non-plastic silt and sand based alluvium soils, as noted in our boreholes, and our experience of similar soils elsewhere, the shallow soils are susceptible to very minor swelling and shrinking movements under seasonal variations of water content.

Our aerial photograph interpretation indicates that no liquefaction ejecta was observed following the February 2011 Canterbury Earthquake.

The site experienced  $M_w$  7.5 scaled peak ground accelerations (PGAs) of 0.08g to 0.18g, as per Table 1. Therefore, it may not be classified as ‘sufficiently tested’ for an SLS event according to Section 13.5 of the MBIE Guidance document. However we do note that the site experienced PGAs similar to that of a SLS event.

The inferred lateral movement from LiDAR (NZGD) was not available for the site. The site was also not mapped by the EQC for the February and June 2011 earthquakes. However, we note that along the northeastern boundary is the Styx River comprising a small waterway and a deep gully beneath the site. As noted in Section 10, we carried out a stability analysis on the slope mentioned above. Based on our analysis we consider that there is low risk of slope stability being an issue for the residential lots, Lot 2 to Lot 34, outside of the reserve area. We do however note that following large seismic shaking some lateral movement and slope stability issues may occur within the reserve area. Based on these considerations, we believe that the proposed subdivision outside of the reserve area presents potential for minor (up to 100mm) global lateral movement and minor lateral stretch (up to 50mm) of the ground across the site.

The site is situated in a N/A, Rural and Unmapped area as per the MBIE mapping available on the NZGD, and our analyses suggests that a TC2 classification (as per the MBIE Guidance) for Lots 2 to 34 as per DLS’s plan dated March 2021 is appropriate for the site under SLS and ULS level seismic demands.

## 11. GEOTECHNICAL CONSIDERATIONS FOR SITE SUBDIVISION

### 11.1 Geotechnical Considerations

Based on our investigation results and observations, the following recommendations should be considered for the proposed subdivision:

- Topsoil and fill were identified up to 0.4m depth at investigation points.
- The local groundwater level was encountered at depths between 1.8m to 3.5m.
- According to our assessment, Lots 2 to 34 of the current subdivision plan are likely to behave as equivalent to a TC2 site, as defined in the MBIE Guidance document for residential sites.
- We note that lateral movement may occur alongside the Styx River within the reserve area. However, this lateral movement is not expected to affect the subdivision residential lots that area at least 20m from the edge of the slope.

Based on the above, we consider that MBIE TC2 style foundations will be appropriate for new dwellings within the proposed new development. Further site-specific shallow soils testing will be required within the new dwelling footprints for bearing capacity purposes once development details are known.

## 12. SUITABILITY OF THE SITE FOR SUBDIVISION

Section 106 of the Resource Management Act (RMA) states that a consent authority may refuse to grant subdivision consent, or may grant conditional subdivision consent, if it considers that:

- There is significant risk from natural hazards.
- Sufficient provision has not been made for legal and physical access to each allotment to be created by the subdivision.

**Table 8: Assessment of the site against the RMA requirements**

Hazard	Potential Susceptibility	
	Current (Section 106, 1A)	Post Development (Section 106, 1Ac)
Erosion	No evidence of erosion or gullying across site.	Provided stormwater is discharged in a controlled manner and appropriate engineering design is implemented, erosion is unlikely to worsen due to development or have significant adverse effects on the development.
Falling Debris	The site is flat and located away from any hills, with no risk of falling debris.	--
Slippage / lateral movement	The site, outside of the reserve area alongside the Styx River presents a minor potential for global horizontal movement and lateral stretch.	The development will not have any effect that could worsen the existing potential for horizontal movement on site, provided no open channels are proposed and that the proposed reserve area is a no build zone
Subsidence	Potential liquefaction hazard is present on site.	Significant damage is unlikely to occur to the proposed development, provided building foundations are appropriately designed as per recommendations in Section 11 of this geotechnical report.
Inundation	The site is not within a flood management area as per the Christchurch District Plan. The CDC should be contacted to comment on floor level requirements.	Provided stormwater discharge is appropriately managed, any finished floor level requirements are respected, and/or advice is sought from an experienced civil engineer, we consider that the risk of inundation will not be exacerbated by developing the land and may be appropriately managed.

Based on these considerations, we believe on reasonable grounds that the site is suitable for the proposed subdivision in terms of geotechnical constraints. A Statement of Professional Opinion on the suitability of land for subdivision is presented in Appendix F. It should be noted that other natural hazards (such as tsunamis) not specifically included in Table 8 are outside of the scope of works for our geotechnical investigation.

### **13. FURTHER WORKS**

This report is a geotechnical assessment of the site in terms of suitability of the land for subdivision and geotechnical advice on the development of the site. Further site specific geotechnical investigations should be undertaken to confirm the foundation design for each individual Lot.

### **14. LIMITATIONS**

Our report was prepared in line with the current MBIE Guidance. To satisfy the requirements of the Building Code and the New Zealand Standard “NZS 1170 - Structural Design Actions”, foundations must be designed so that the building must remain functional under SLS level loads; minor damage is acceptable provided the damage is readily repairable, and the building does not collapse under ULS level loads, but could suffer moderate to significant structural damage.

Desk study data was obtained from several investigation and modelling study sources made available to the public and engineering industry post the Canterbury earthquake sequence. Acknowledgment is given regarding the free use of the New Zealand Geotechnical Database, Christchurch City Council and Environment Canterbury websites. The data is used in good faith and no responsibility can be taken for the accuracy or completeness of the data.

This report was prepared in the context defined in Section 1 above and must not be relied upon by any other party other than our Client, for whom it was prepared, and the relevant Territorial Authority. It has been compiled with respect to the brief given to us, and must not be relied upon in any other context, recreated for any other purpose, or used by any person who is not our Client without first obtaining our written permission.

We point out that our conclusions are based on desk study material, a visual surface inspection of the site, third party investigation data from nearby sites and discrete exploratory hole positions. Ground conditions may vary between investigation points. The recommendations given in this report are provided as an overall strategy to minimise risks from geotechnical hazards. It should be noted that they are unlikely to remain effective if they are adopted in a piecemeal manner.

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## **ATTACHMENTS**



**LEGEND**

- CPT-01 KGA SOURCED CONE PENETROMETER TEST
- CPT-05(HA/SP03) KGA SOURCED CONE PENETROMETER, HAND AUGER AND SCALA PENETROMETER TEST
- CPT\_149331 NZGD SOURCED CONE PENETROMETER TEST
- APPROXIMATE SITE BOUNDARY
- PROPOSED DEVELOPMENT BOUNDARY
- CROSS SECTIONAL LINE USED FOR SLOPE STABILITY ANALYSIS

- NOTES**
- LOCATIONS OF FEATURES AND GROUND INVESTIGATION POINTS ARE APPROXIMATE ONLY.
  - AERIAL IMAGE SOURCED FROM CANTERBURY MAPS WEBSITE.

A	03/06/2021	Report Issue	KF	RK	AN
REV	DATE	REVISION DESCRIPTION	BY	CHK	APP

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CLIENT  
**DAVIE LOVELL-SMITH**

PROJECT TITLE  
**GEOTECHNICAL INVESTIGATION  
232 STYX MILL ROAD  
CASEBROOK**

DRAWING TITLE  
**SITE PLAN**

DESIGNED	KF	DATE	03/06/2021	CHECKED	RK	DATE	06/2021
DRAWN	KF	DATE	03/06/2021	APPROVED	AN	DATE	06/2021

STATUS  
**FOR SUBDIVISION CONSENT**

SCALE	NOT TO SCALE	SIZE	A3
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COORDINATE SYSTEM	NZTM	HEIGHT DATUM	--
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PROJECT NUMBER	K210318	DRAWING NUMBER	KGA 1	REVISION	A
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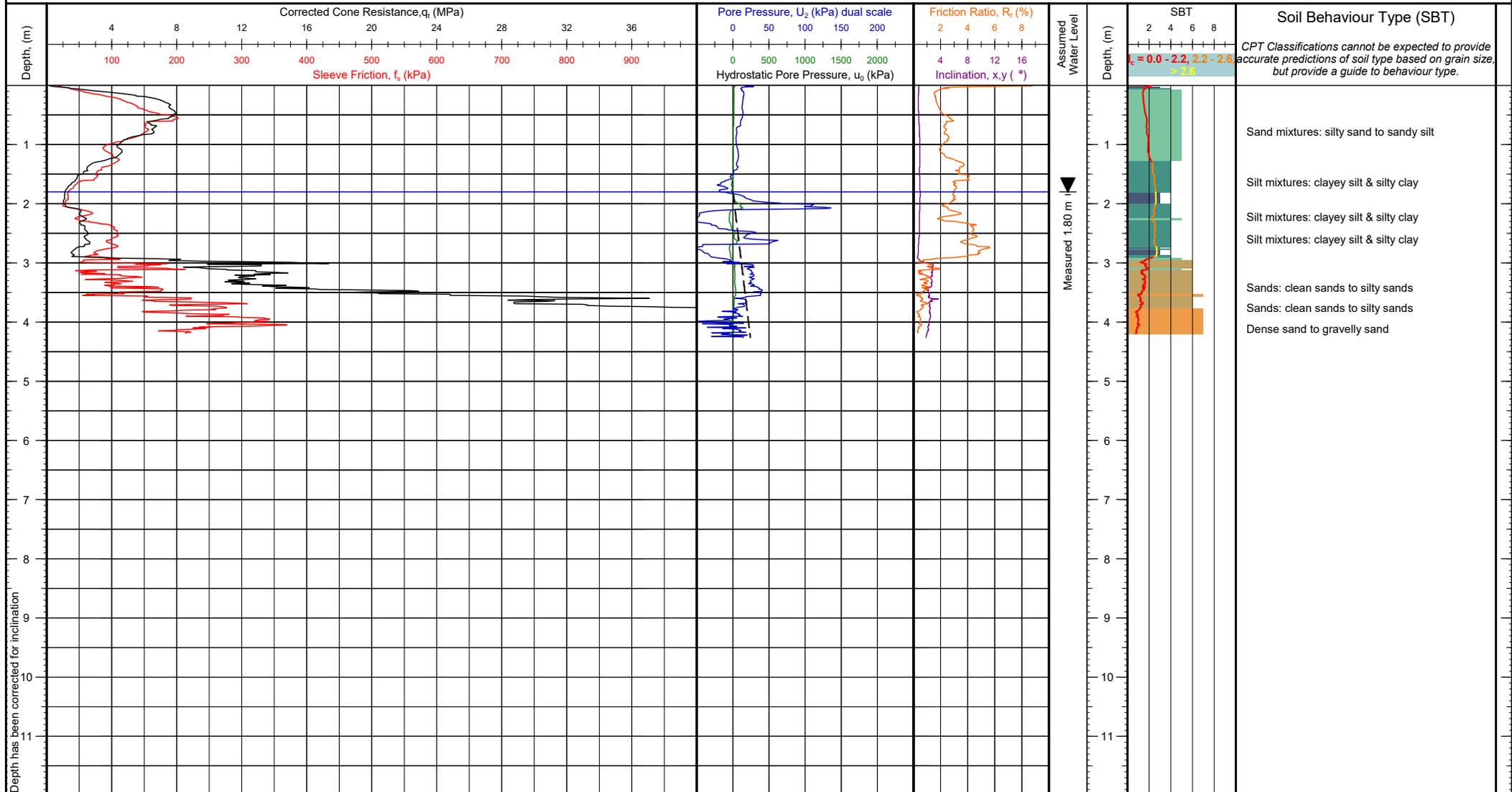








# CONE PENETRATION TEST (CPT) LOG

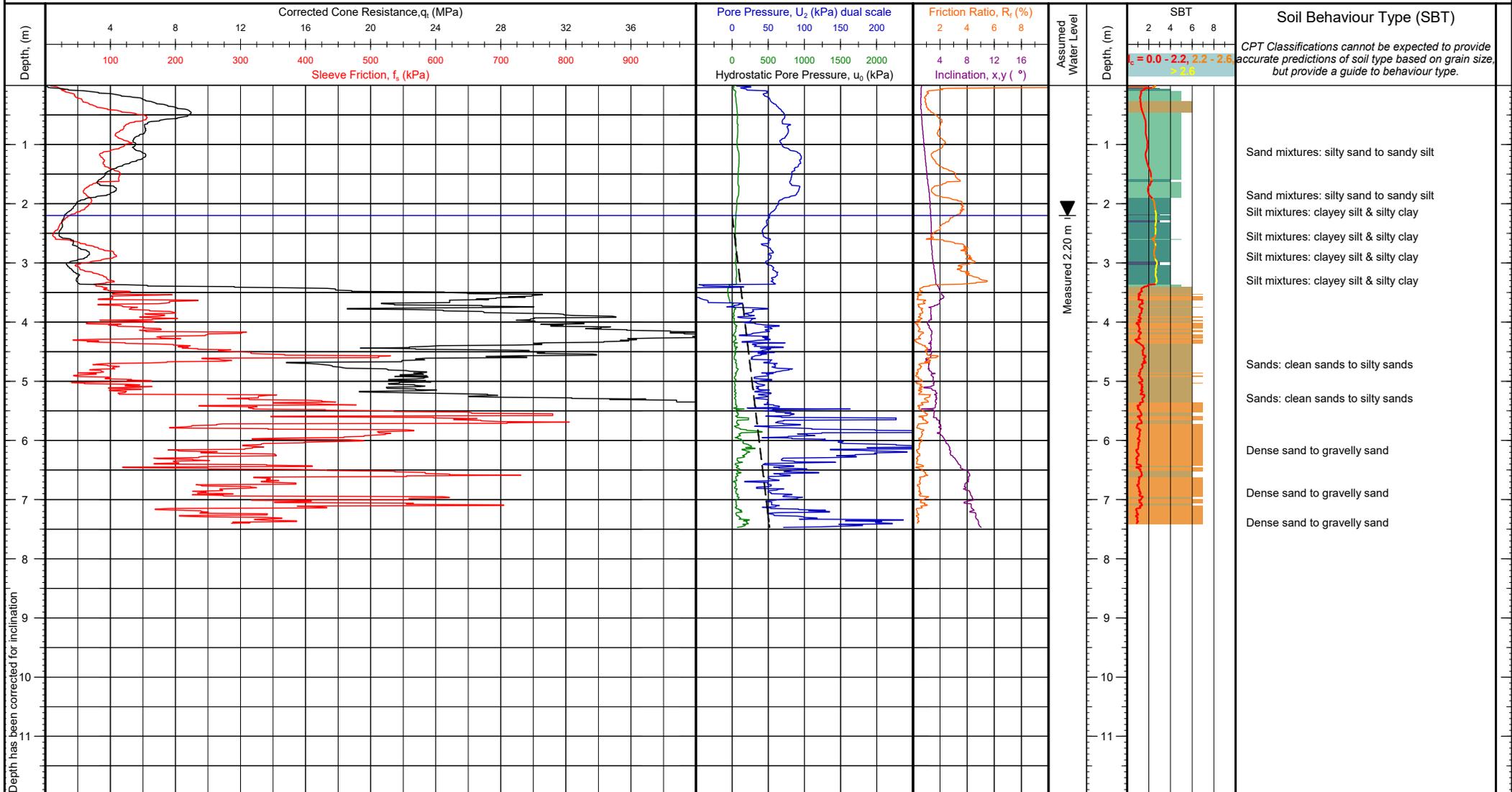


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<b>Project:</b> 232 Styx Mill Road	<b>Cone Ref:</b> MKJ539	<b>WGS84 (deg):</b> -43.467037, 172.595690	<b>Date of Test:</b> 18/05/2021	<b>Test Number:</b> <b>CPT-01</b>
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<b>Engineer:</b> Abilio Nogueira	<b>Area Ratio:</b> 0.79	<b>Surveyor:</b>	<b>Pre Drill (m):</b> N/A	<b>G.I. Job Ref:</b> 210503
<b>Contractor:</b> Ground Investigation Ltd	<b>Filter Type:</b> $u_2$	<b>Termination Reason:</b> High cone end resistance		

**Comments:** Continued with DPSH-01

Where possible GWL is measured after testing, or estimated in the office. This may not represent the true GWL

# CONE PENETRATION TEST (CPT) LOG

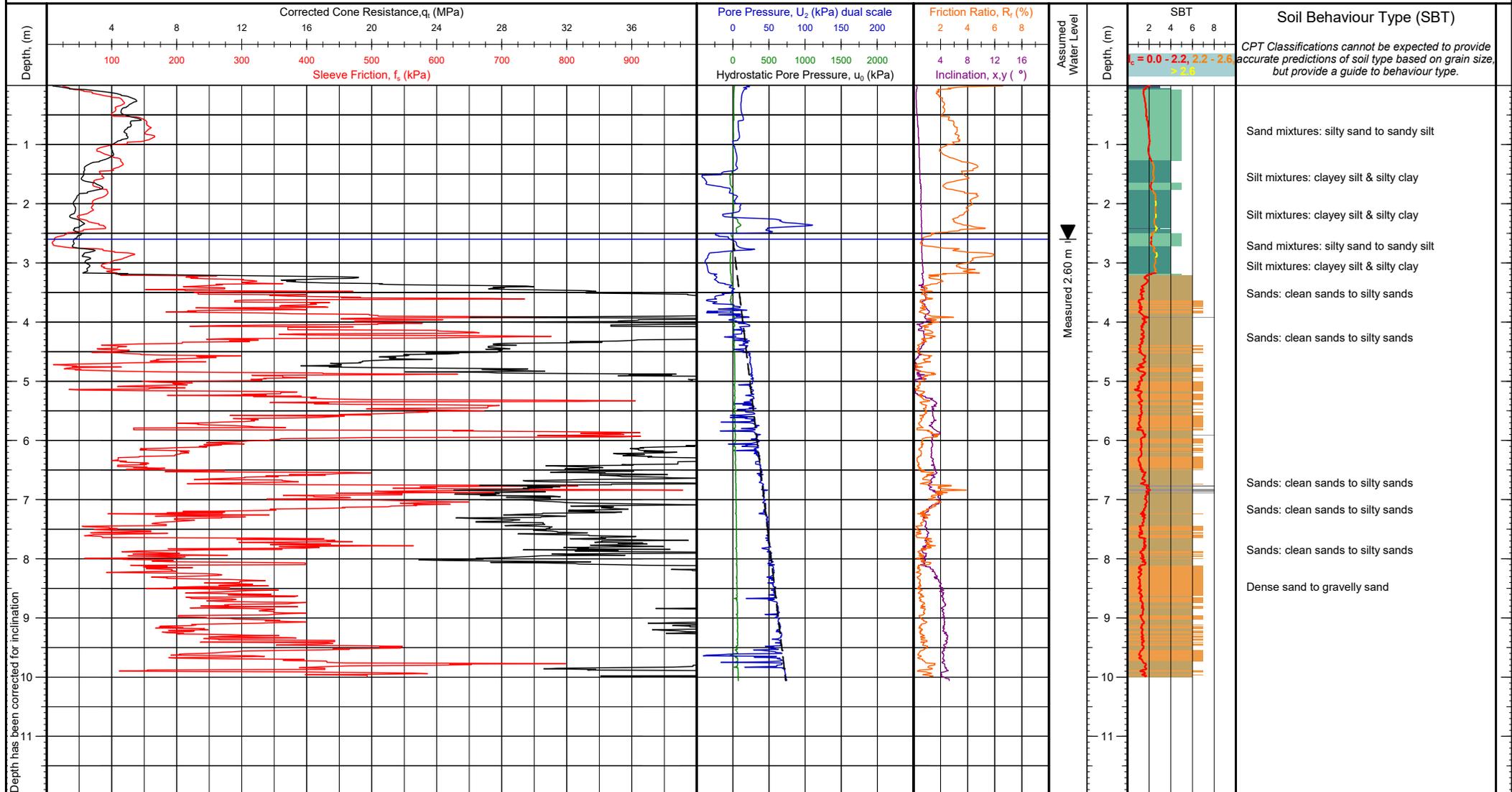


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<b>Project:</b> 232 Styx Mill Road	<b>Cone Ref:</b> MKJ335	<b>WGS84 (deg):</b> -43.466710, 172.596153	<b>Date of Test:</b> 18/05/2021	
<b>Location:</b> Casebrook, Christchurch	<b>Cone Type:</b> 10cm <sup>2</sup> Compression	<b>Location Method:</b> Handheld GPS	<b>Depth (m):</b> 7.47	<b>Test Number:</b> <b>CPT-02</b>
<b>Engineer:</b> Abilio Nogueira	<b>Area Ratio:</b> 0.78	<b>Surveyor:</b>	<b>Pre Drill (m):</b> N/A	
<b>Contractor:</b> Ground Investigation Ltd	<b>Filter Type:</b> $u_2$	<b>Termination Reason:</b> High cone end resistance		<b>G.I. Job Ref:</b> 210503

**Comments:**

Where possible GWL is measured after testing, or estimated in the office. This may not represent the true GWL

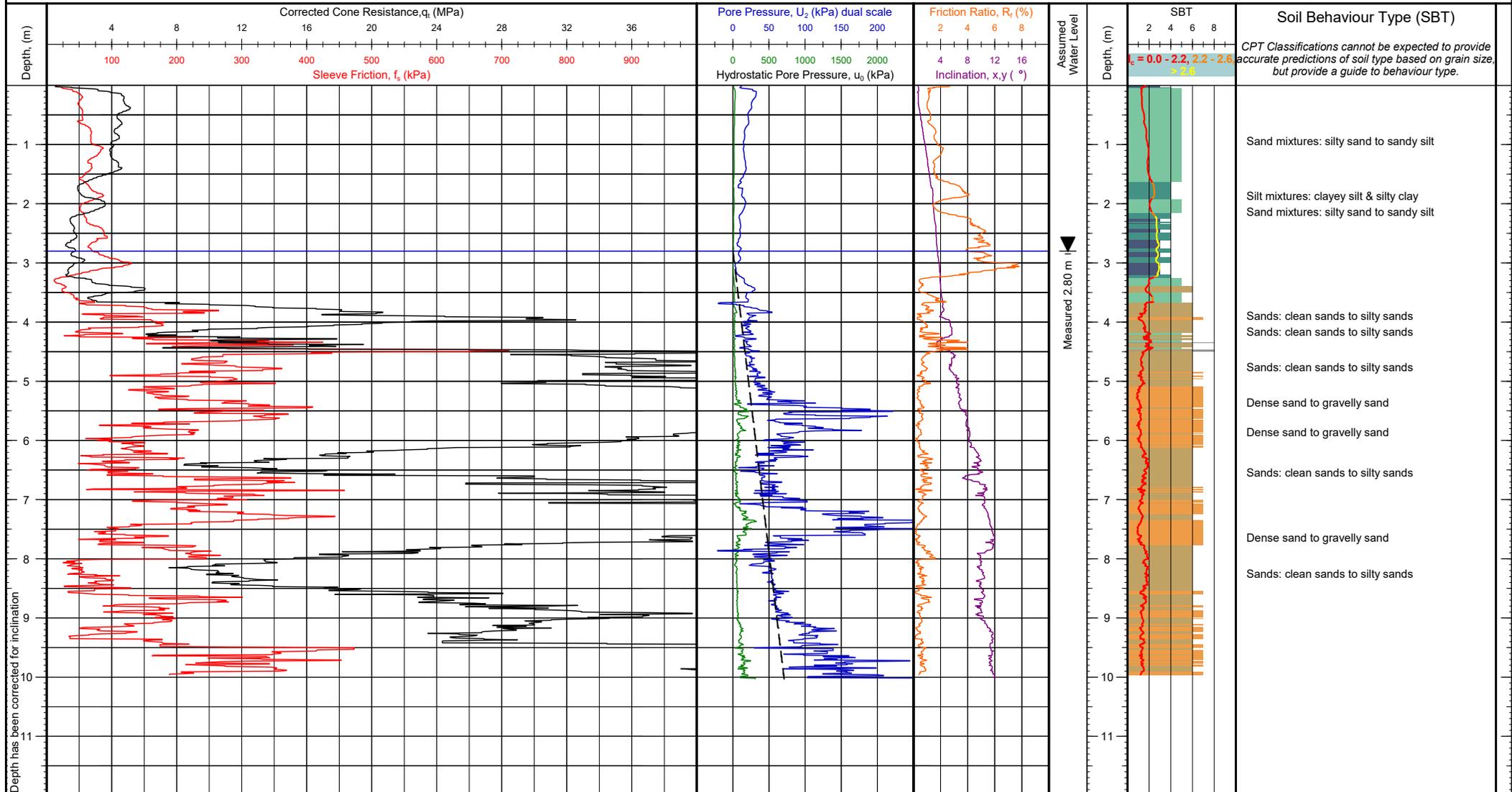
# CONE PENETRATION TEST (CPT) LOG



<b>Client:</b> KGA Geotechnical <b>Project:</b> 232 Styx Mill Road <b>Location:</b> Casebrook, Christchurch <b>Engineer:</b> Abilio Nogueira <b>Contractor:</b> Ground Investigation Ltd	<b>Operator:</b> John Cresswell <b>Cone Ref:</b> MKJ539 <b>Cone Type:</b> 10cm <sup>2</sup> Compression <b>Area Ratio:</b> 0.79 <b>Filter Type:</b> u <sub>2</sub>	<b>NZTM 2000 N, E (m):</b> 5187320.90, 1567368.69	<b>Elevation (m):</b> Unknown	<b>Client Reference:</b>
		<b>WGS84 (deg):</b> -43.466312, 172.596593	<b>Date of Test:</b> 18/05/2021	
<b>Comments:</b>		<b>Location Method:</b> Handheld GPS	<b>Depth (m):</b> 10.06	<b>Test Number:</b> <b>CPT-03</b>
		<b>Surveyor:</b>	<b>Pre Drill (m):</b> N/A	
		<b>Termination Reason:</b> Target depth		

Where possible GWL is measured after testing, or estimated in the office. This may not represent the true GWL

# CONE PENETRATION TEST (CPT) LOG

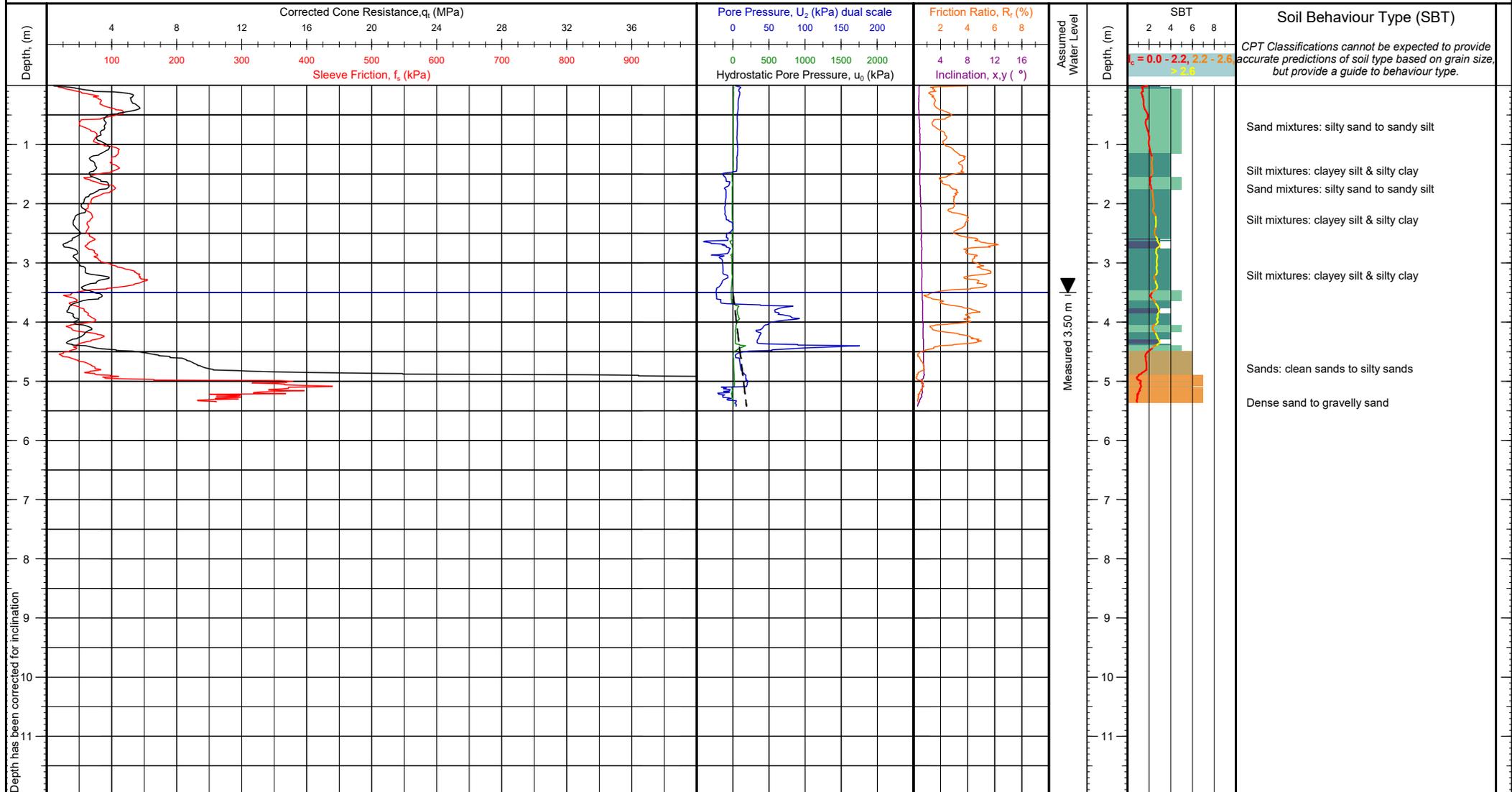


<b>Client:</b> KGA Geotechnical	<b>Operator:</b> John Cresswell	<b>NZTM 2000 N, E (m):</b> 5187340.74, 1567405.08	<b>Elevation (m):</b> Unknown	<b>Client Reference:</b>
<b>Project:</b> 232 Styx Mill Road	<b>Cone Ref:</b> MKJ335	<b>WGS84 (deg):</b> -43.466135, 172.597044	<b>Date of Test:</b> 17/05/2021	
<b>Location:</b> Casebrook, Christchurch	<b>Cone Type:</b> 10cm <sup>2</sup> Compression	<b>Location Method:</b> Handheld GPS	<b>Depth (m):</b> 10.03	<b>Test Number:</b> <b>CPT-04</b>
<b>Engineer:</b> Abilio Nogueira	<b>Area Ratio:</b> 0.78	<b>Surveyor:</b>	<b>Pre Drill (m):</b> N/A	
<b>Contractor:</b> Ground Investigation Ltd	<b>Filter Type:</b> u <sub>2</sub>	<b>Termination Reason:</b> Target depth		<b>G.I. Job Ref:</b> 210503

**Comments:**

Where possible GWL is measured after testing, or estimated in the office. This may not represent the true GWL

# CONE PENETRATION TEST (CPT) LOG

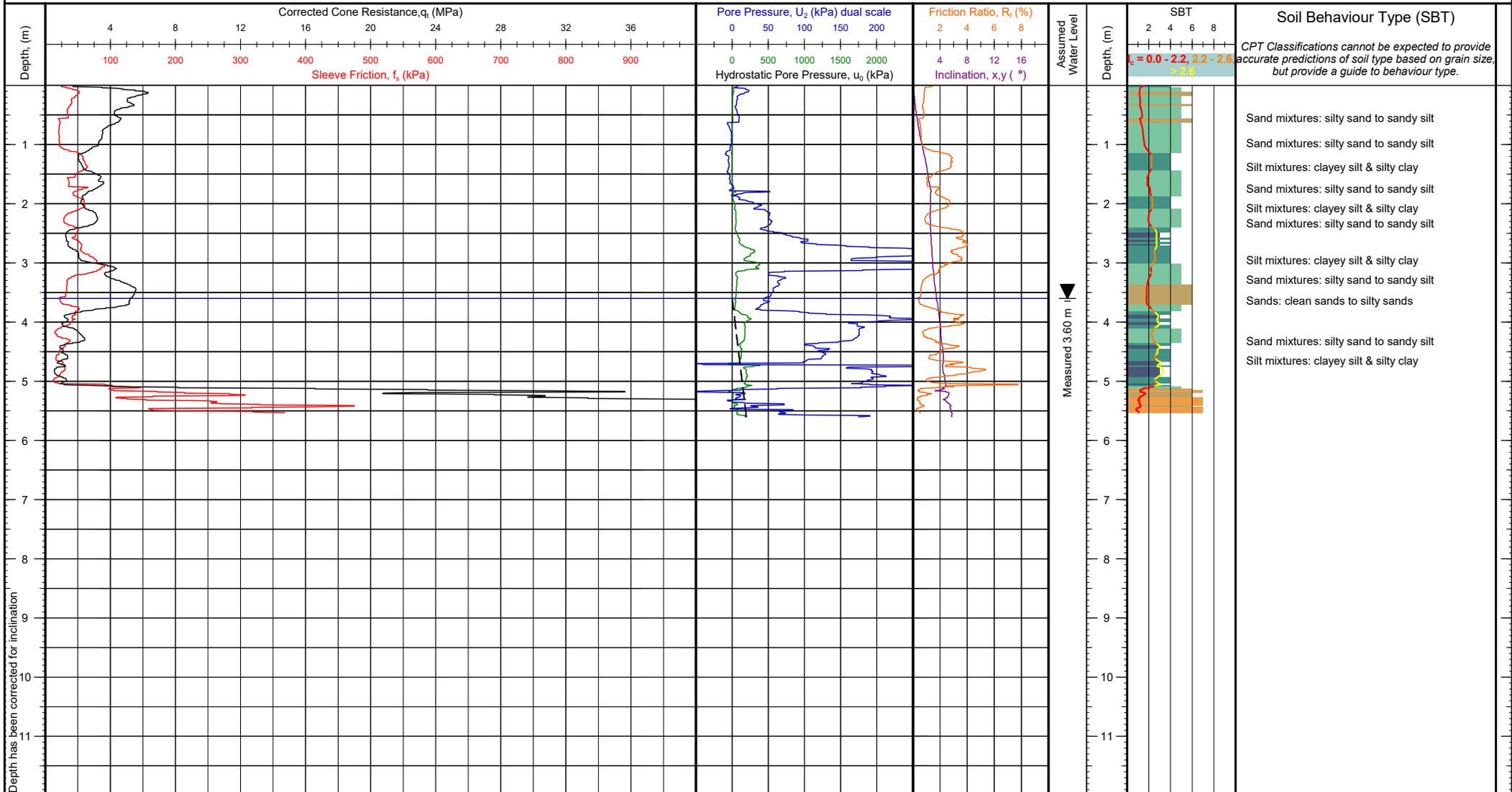


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<b>Engineer:</b> Abilio Nogueira	<b>Area Ratio:</b> 0.79	<b>Surveyor:</b>	<b>Pre Drill (m):</b> N/A	<b>G.I. Job Ref:</b> 210503
<b>Contractor:</b> Ground Investigation Ltd	<b>Filter Type:</b> $u_2$	<b>Termination Reason:</b> High cone end resistance		

**Comments:** Continued with DPSH-05

Where possible GWL is measured after testing, or estimated in the office. This may not represent the true GWL

# CONE PENETRATION TEST (CPT) LOG

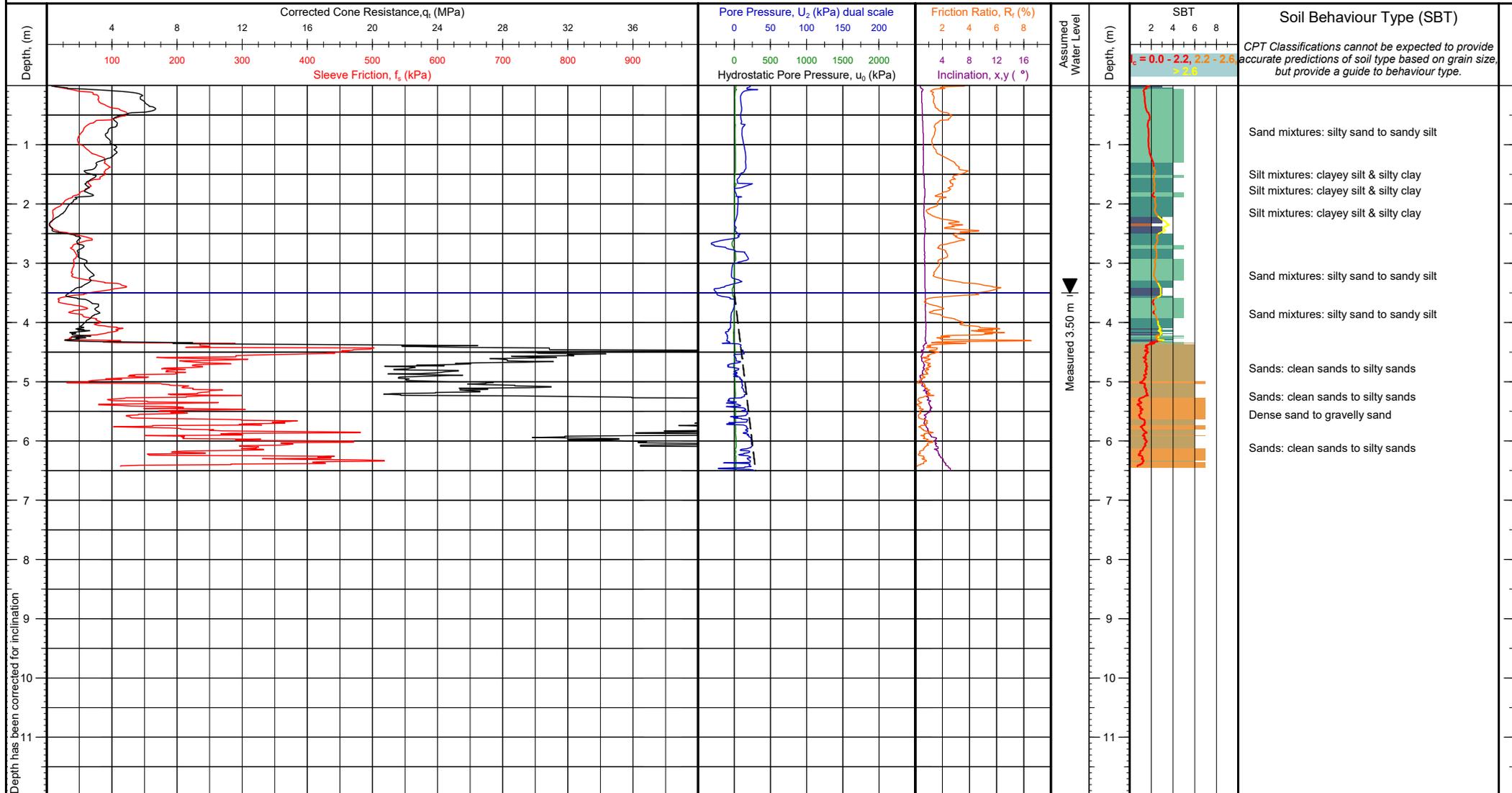


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<b>Project:</b> 232 Styx Mill Road	<b>Cone Ref:</b> MKJ335	<b>WGS84 (deg):</b> -43.466167, 172.597867	<b>Date of Test:</b> 17/05/2021	
<b>Location:</b> Casebrook, Christchurch	<b>Cone Type:</b> 10cm <sup>2</sup> Compression	<b>Location Method:</b> Handheld GPS	<b>Depth (m):</b> 5.60	<b>Test Number:</b> <b>CPT-06</b>
<b>Engineer:</b> Abilio Nogueira	<b>Area Ratio:</b> 0.78	<b>Surveyor:</b>	<b>Pre Drill (m):</b> N/A	
<b>Contractor:</b> Ground Investigation Ltd	<b>Filter Type:</b> $u_2$	<b>Termination Reason:</b> High cone end resistance		<b>G.I. Job Ref:</b> 210503

**Comments:** Continued with DPSH-06

Where possible GWL is measured after testing, or estimated in the office. This may not represent the true GWL

# CONE PENETRATION TEST (CPT) LOG

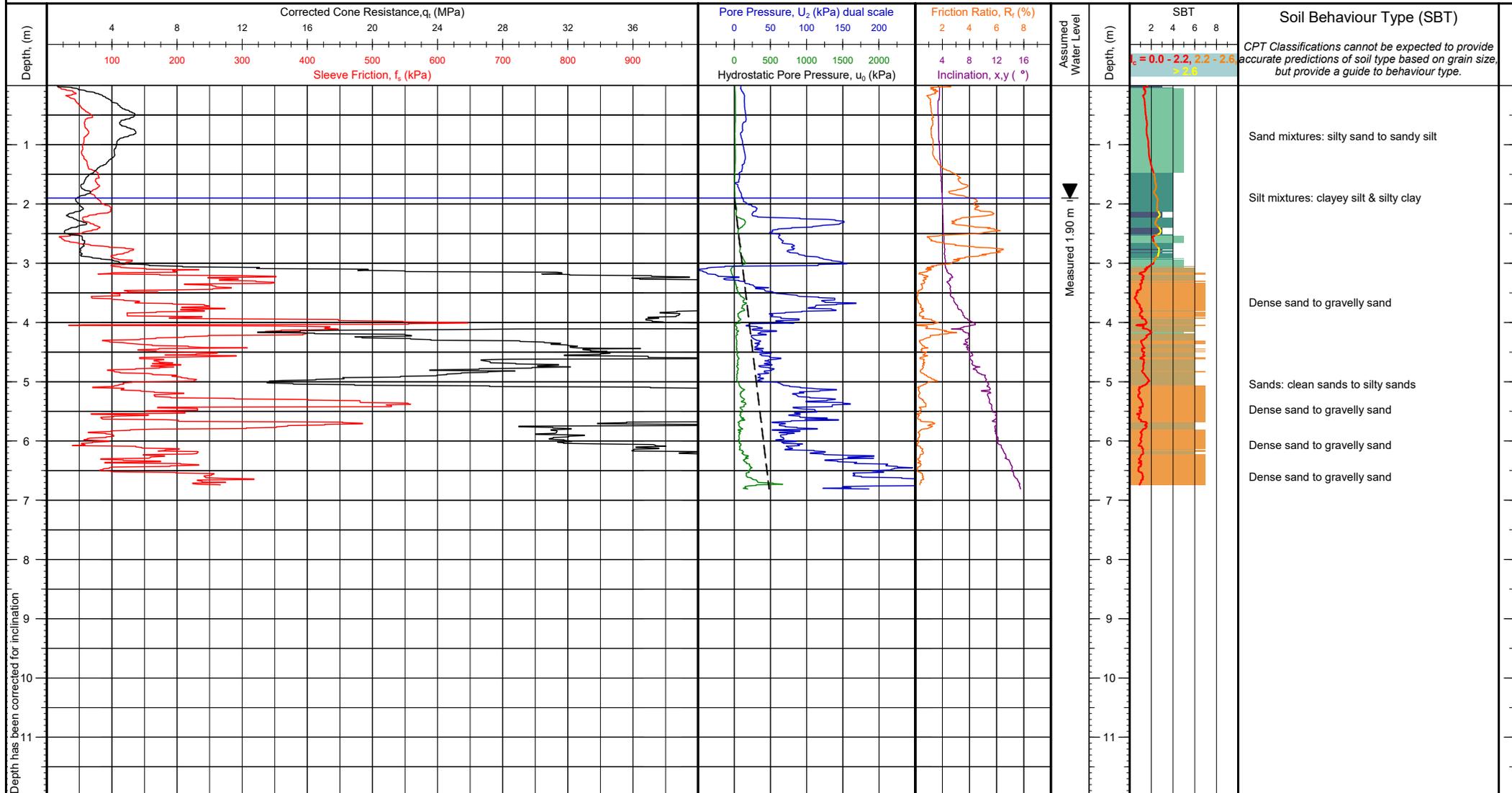


<b>Client:</b> KGA Geotechnical	<b>Operator:</b> John Cresswell	<b>NZTM 2000 N, E (m):</b> 5187312.21, 1567499.45	<b>Elevation (m):</b> Unknown	<b>Client Reference:</b>
<b>Project:</b> 232 Styx Mill Road	<b>Cone Ref:</b> MKJ539	<b>WGS84 (deg):</b> -43.466396, 172.598209	<b>Date of Test:</b> 17/05/2021	<b>Test Number:</b> <b>CPT-07</b>
<b>Location:</b> Casebrook, Christchurch	<b>Cone Type:</b> 10cm <sup>2</sup> Compression	<b>Location Method:</b> Handheld GPS	<b>Depth (m):</b> 6.50	
<b>Engineer:</b> Abilio Nogueira	<b>Area Ratio:</b> 0.79	<b>Surveyor:</b>	<b>Pre Drill (m):</b> N/A	<b>G.I. Job Ref:</b> 210503
<b>Contractor:</b> Ground Investigation Ltd	<b>Filter Type:</b> $u_2$	<b>Termination Reason:</b> High cone end resistance		

**Comments:** Continued with DPSH-07

Where possible GWL is measured after testing, or estimated in the office. This may not represent the true GWL

# CONE PENETRATION TEST (CPT) LOG

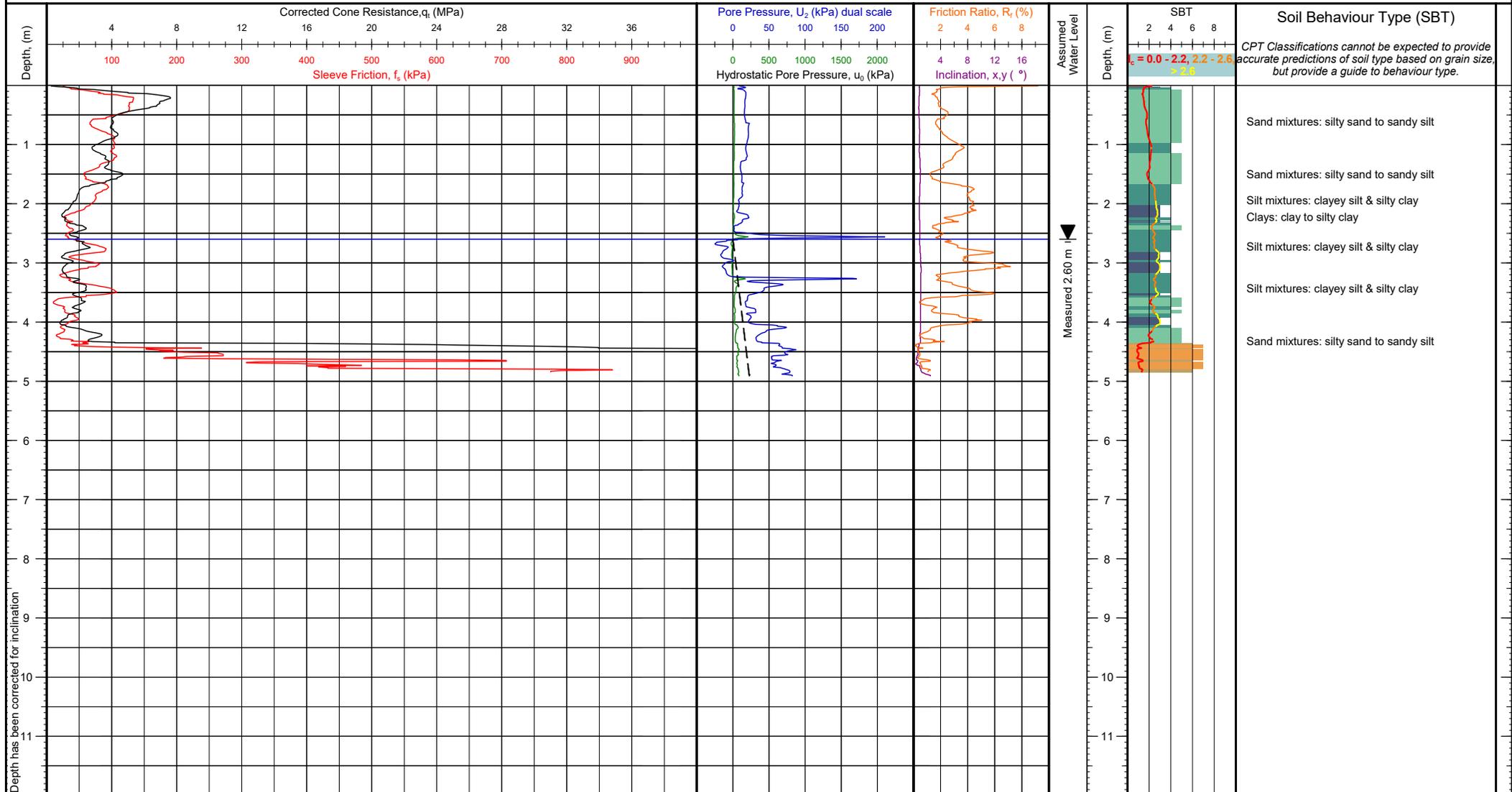


<b>Client:</b> KGA Geotechnical	<b>Operator:</b> John Cresswell	<b>NZTM 2000 N, E (m):</b> 5187253.46, 1567499.09	<b>Elevation (m):</b> Unknown	<b>Client Reference:</b>
<b>Project:</b> 232 Styx Mill Road	<b>Cone Ref:</b> MKJ335	<b>WGS84 (deg):</b> -43.466925, 172.598201	<b>Date of Test:</b> 17/05/2021	<b>Test Number:</b> <b>CPT-08</b>
<b>Location:</b> Casebrook, Christchurch	<b>Cone Type:</b> 10cm <sup>2</sup> Compression	<b>Location Method:</b> Handheld GPS	<b>Depth (m):</b> 6.81	
<b>Engineer:</b> Abilio Nogueira	<b>Area Ratio:</b> 0.78	<b>Surveyor:</b>	<b>Pre Drill (m):</b> N/A	<b>G.I. Job Ref:</b> 210503
<b>Contractor:</b> Ground Investigation Ltd	<b>Filter Type:</b> $u_2$	<b>Termination Reason:</b> High cone end resistance		

**Comments:**

Where possible GWL is measured after testing, or estimated in the office. This may not represent the true GWL

# CONE PENETRATION TEST (CPT) LOG

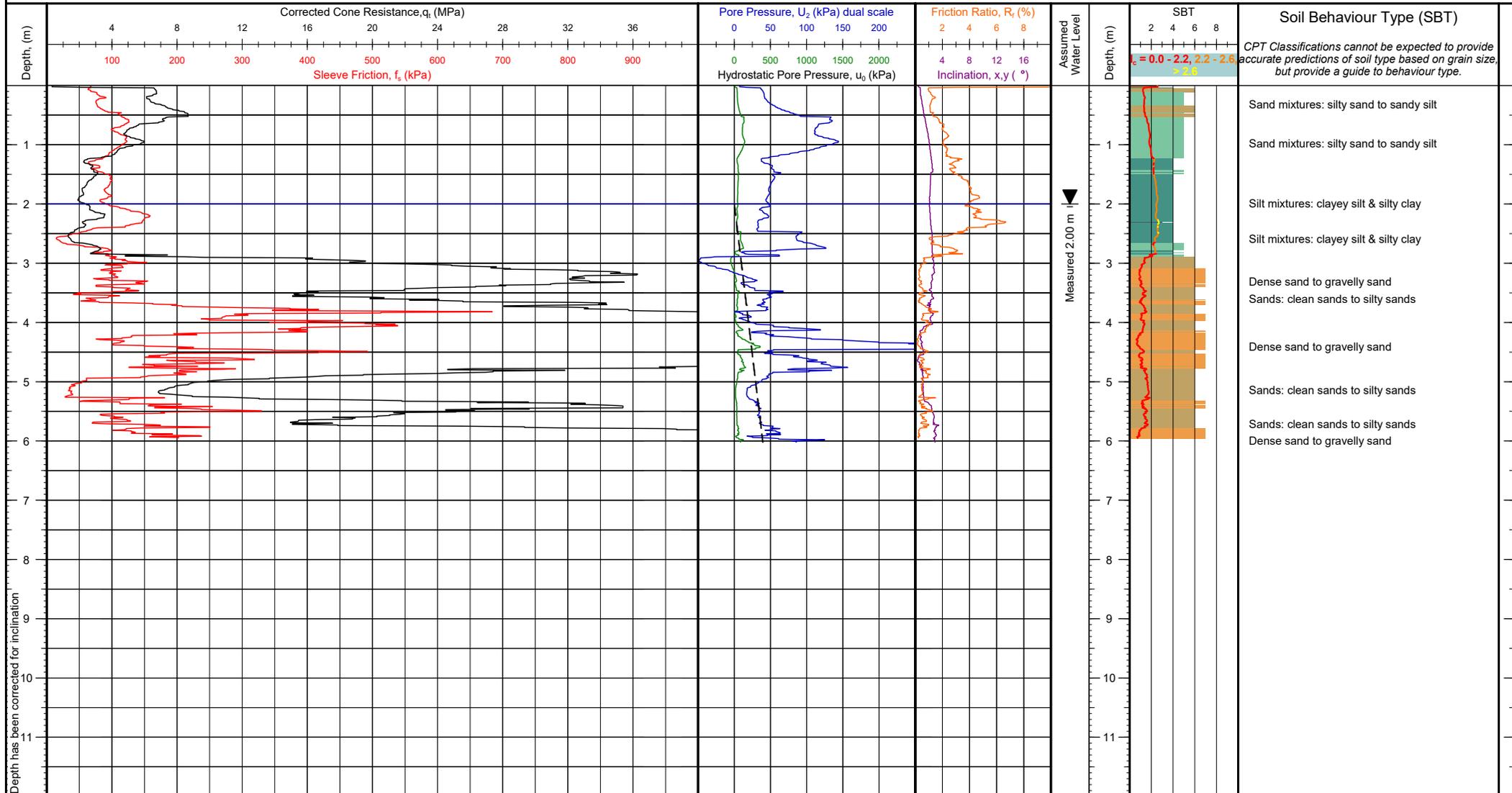


<b>Client:</b> KGA Geotechnical	<b>Operator:</b> John Cresswell	<b>NZTM 2000 N, E (m):</b> 5187247.72, 1567439.34	<b>Elevation (m):</b> Unknown	<b>Client Reference:</b>
<b>Project:</b> 232 Styx Mill Road	<b>Cone Ref:</b> MKJ539	<b>WGS84 (deg):</b> -43.466974, 172.597462	<b>Date of Test:</b> 18/05/2021	<b>Test Number:</b> <b>CPT-09</b>
<b>Location:</b> Casebrook, Christchurch	<b>Cone Type:</b> 10cm <sup>2</sup> Compression	<b>Location Method:</b> Handheld GPS	<b>Depth (m):</b> 4.91	
<b>Engineer:</b> Abilio Nogueira	<b>Area Ratio:</b> 0.79	<b>Surveyor:</b>	<b>Pre Drill (m):</b> N/A	<b>G.I. Job Ref:</b> 210503
<b>Contractor:</b> Ground Investigation Ltd	<b>Filter Type:</b> $u_2$	<b>Termination Reason:</b> High cone end resistance		

**Comments:** Continued with DPSH-09

Where possible GWL is measured after testing, or estimated in the office. This may not represent the true GWL

# CONE PENETRATION TEST (CPT) LOG

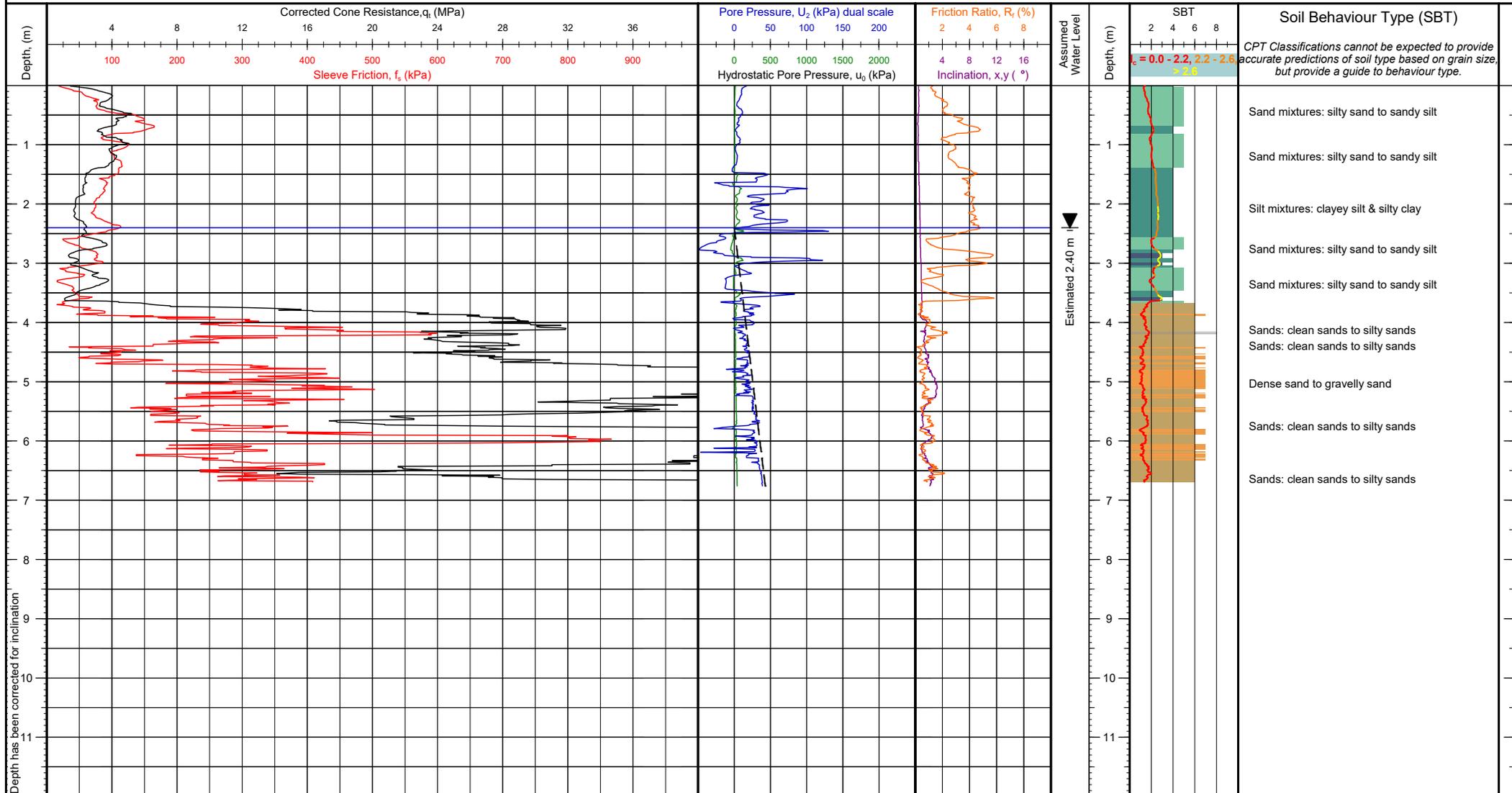


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<b>Project:</b> 232 Styx Mill Road	<b>Cone Ref:</b> MKJ335	<b>WGS84 (deg):</b> -43.467088, 172.596571	<b>Date of Test:</b> 17/05/2021	<b>Test Number:</b> <b>CPT-10</b>
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<b>Engineer:</b> Abilio Nogueira	<b>Area Ratio:</b> 0.78	<b>Surveyor:</b>	<b>Pre Drill (m):</b> N/A	<b>G.I. Job Ref:</b> 210503
<b>Contractor:</b> Ground Investigation Ltd	<b>Filter Type:</b> $u_2$	<b>Termination Reason:</b> High cone end resistance		

**Comments:** Continued with DPSH-10

Where possible GWL is measured after testing, or estimated in the office. This may not represent the true GWL

# CONE PENETRATION TEST (CPT) LOG

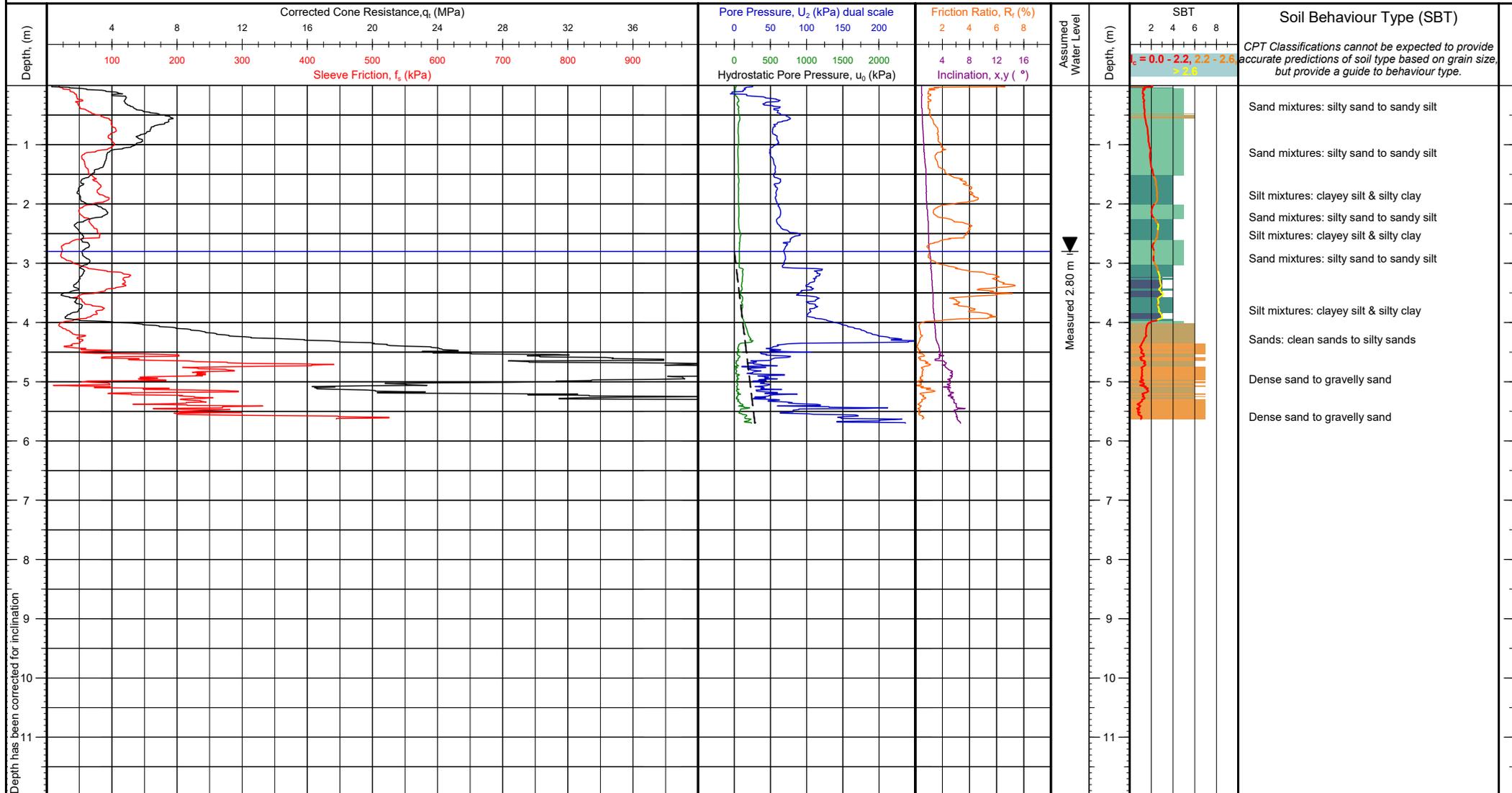


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<b>Project:</b> 232 Styx Mill Road	<b>Cone Ref:</b> MKJ539	<b>WGS84 (deg):</b> -43.466603, 172.596908	<b>Date of Test:</b> 17/05/2021	
<b>Location:</b> Casebrook, Christchurch	<b>Cone Type:</b> 10cm <sup>2</sup> Compression	<b>Location Method:</b> Handheld GPS	<b>Depth (m):</b> 6.76	<b>Test Number:</b> <b>CPT-11</b>
<b>Engineer:</b> Abilio Nogueira	<b>Area Ratio:</b> 0.79	<b>Surveyor:</b>	<b>Pre Drill (m):</b> N/A	
<b>Contractor:</b> Ground Investigation Ltd	<b>Filter Type:</b> $u_2$	<b>Termination Reason:</b> High cone end resistance		<b>G.I. Job Ref:</b> 210503

**Comments:**

Where possible GWL is measured after testing, or estimated in the office. This may not represent the true GWL

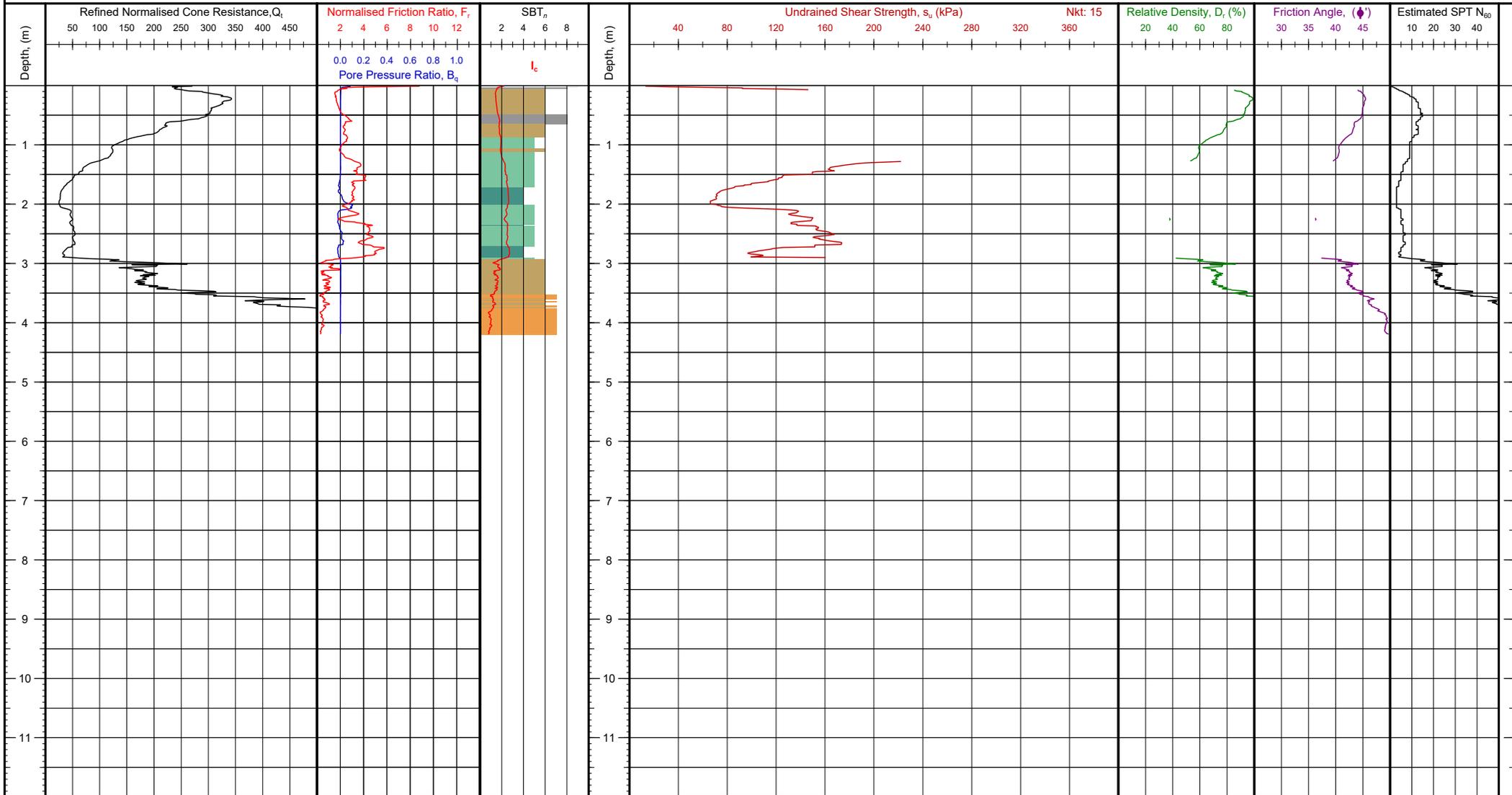
# CONE PENETRATION TEST (CPT) LOG



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<b>Location:</b> Casebrook, Christchurch	<b>Cone Type:</b> 10cm <sup>2</sup> Compression	<b>Location Method:</b> Handheld GPS	<b>Depth (m):</b> 5.70	
<b>Engineer:</b> Abilio Nogueira	<b>Area Ratio:</b> 0.78	<b>Surveyor:</b>	<b>Pre Drill (m):</b> N/A	<b>G.I. Job Ref:</b> 210503
<b>Contractor:</b> Ground Investigation Ltd	<b>Filter Type:</b> $u_2$	<b>Termination Reason:</b> High cone end resistance		

**Comments:** Continued with DPSH-12

Where possible GWL is measured after testing, or estimated in the office. This may not represent the true GWL



**Client:** KGA Geotechnical  
**Project:** 232 Styx Mill Road  
**Location:** Casebrook, Christchurch  
**Engineer:** Abilio Nogueira  
**Contractor:** Ground Investigation Ltd

**Soil Behaviour Type SBT<sub>n</sub> - Robertson et al. 1990**

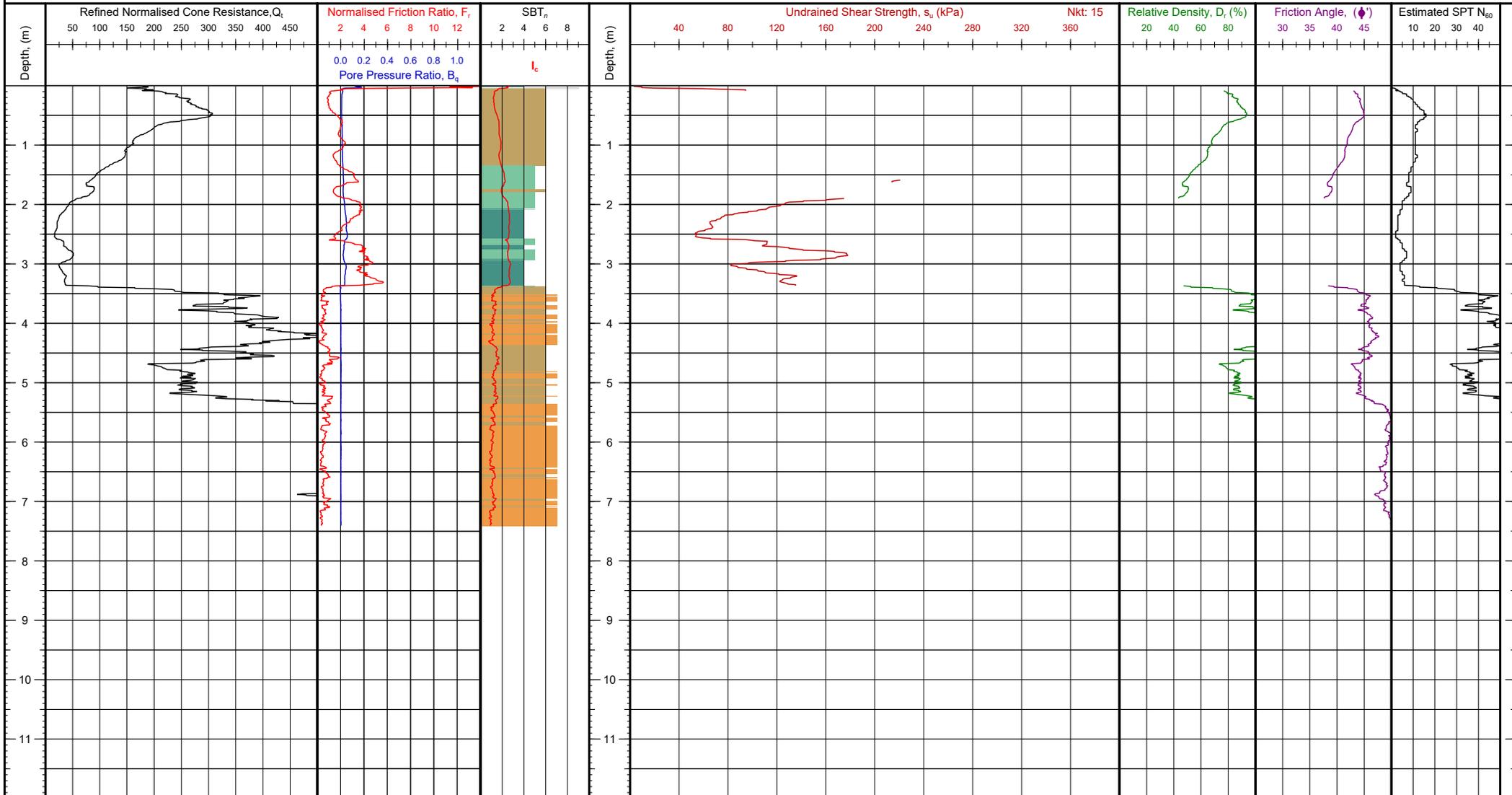
0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine grained	6	Sands: clean sands to silty sands
2	Organic: Organic clay/silt, peat	7	Dense sand to gravelly sand
3	Clay: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff silt/clay

**Notes and Limitations:**  
 Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

**Client Reference:**

**Test Number:** CPT-01

**G.I. Job Ref:** 210503



**Client:** KGA Geotechnical  
**Project:** 232 Styx Mill Road  
**Location:** Casebrook, Christchurch  
**Engineer:** Abilio Nogueira  
**Contractor:** Ground Investigation Ltd

**Soil Behaviour Type SBT<sub>n</sub> - Robertson et al. 1990**

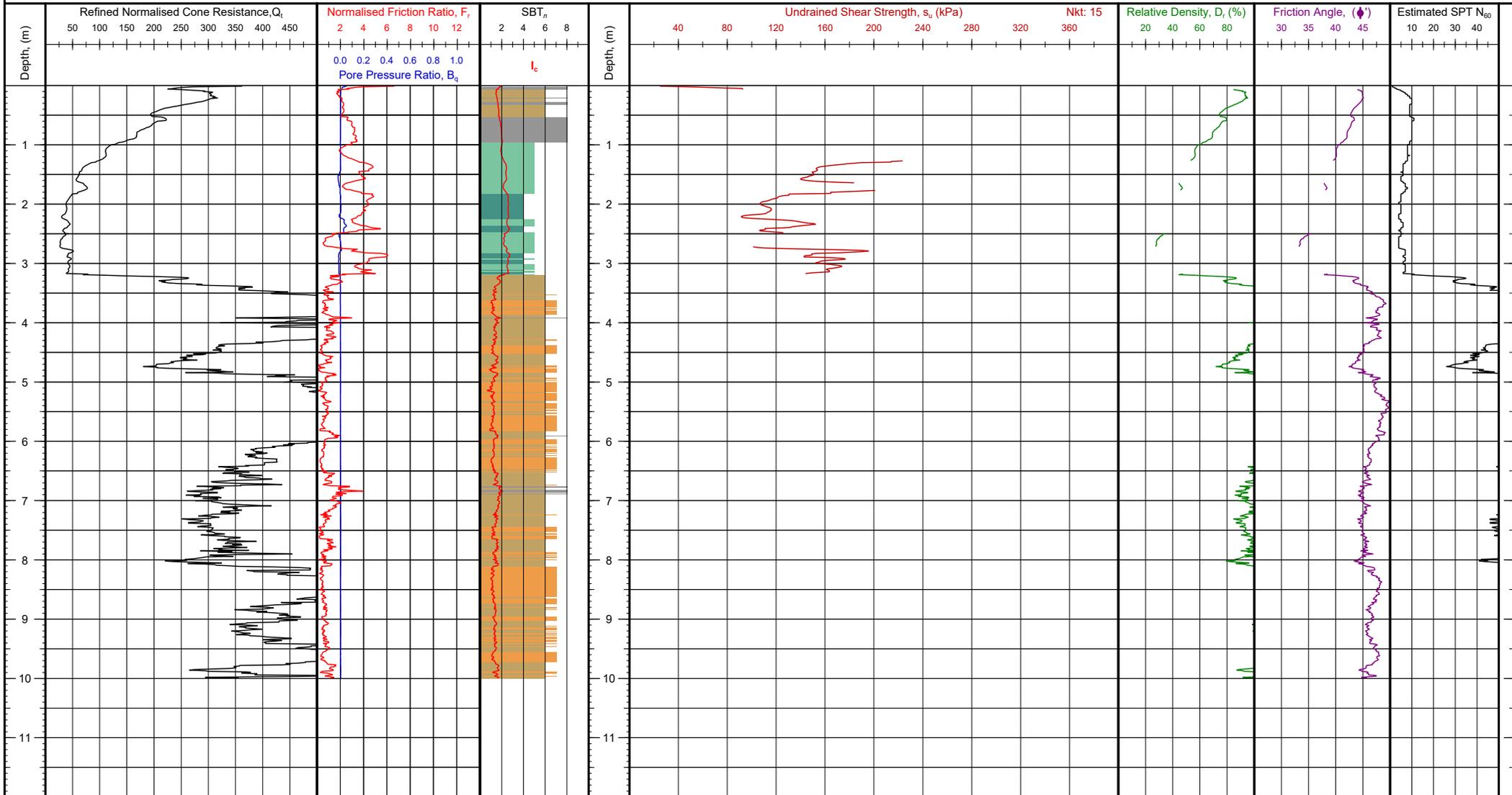
0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine grained	6	Sands: clean sands to silty sands
2	Organic: Organic clay/silt, peat	7	Dense sand to gravelly sand
3	Clay: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff silt/clay

**Notes and Limitations:**  
 Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

**Client Reference:**

**Test Number:** CPT-02

**G.I. Job Ref:** 210503



**Client:** KGA Geotechnical  
**Project:** 232 Styx Mill Road  
**Location:** Casebrook, Christchurch  
**Engineer:** Abilio Nogueira  
**Contractor:** Ground Investigation Ltd

**Soil Behaviour Type  $SBT_n$  - Robertson et al. 1990**

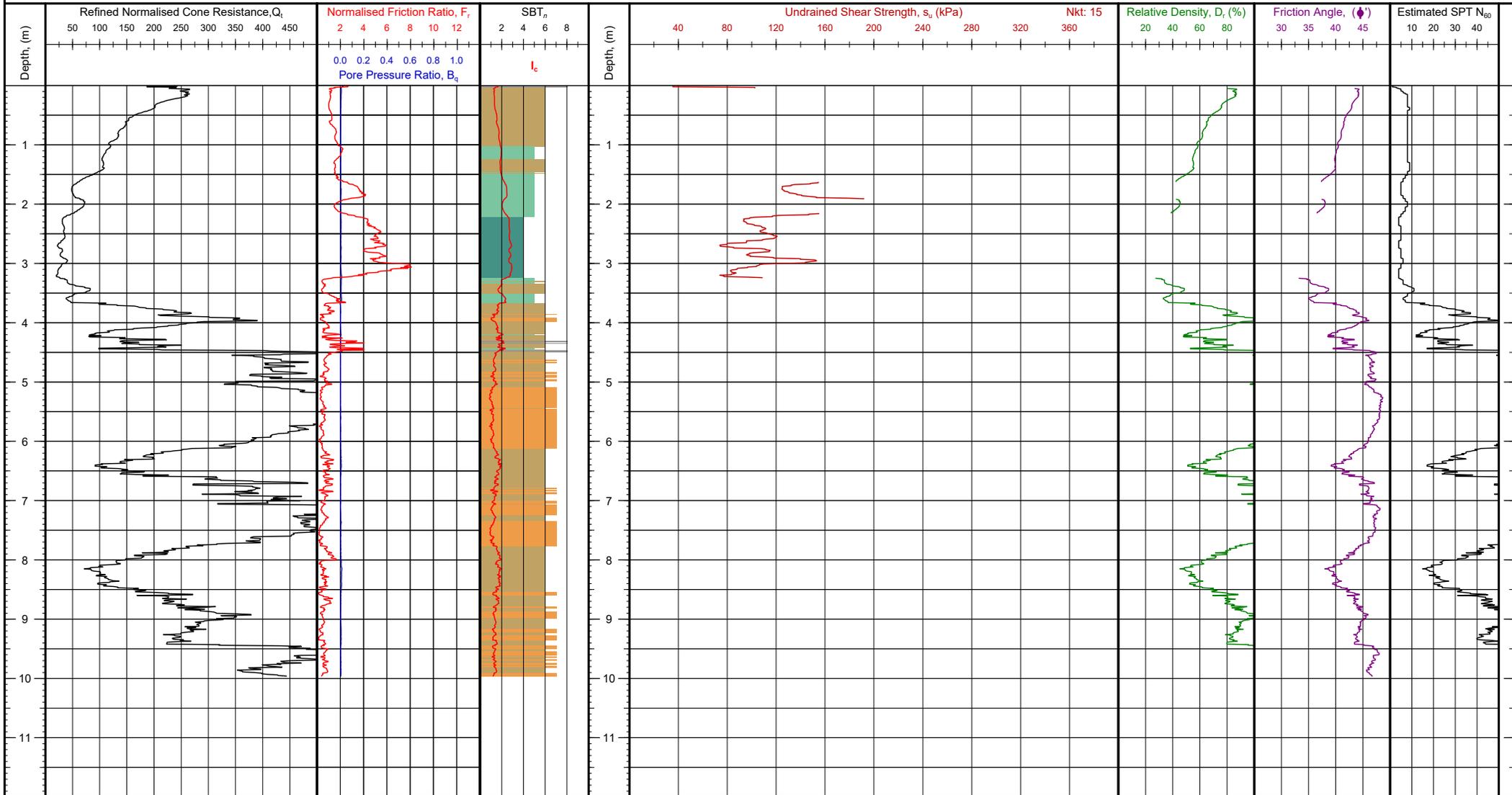
0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine grained	6	Sands: clean sands to silty sands
2	Organic: Organic clay/silt, peat	7	Dense sand to gravelly sand
3	Clay: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff silt/clay

**Notes and Limitations:**  
 Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

**Client Reference:**

**Test Number:** CPT-03

**G.I. Job Ref:** 210503



**Client:** KGA Geotechnical  
**Project:** 232 Styx Mill Road  
**Location:** Casebrook, Christchurch  
**Engineer:** Abilio Nogueira  
**Contractor:** Ground Investigation Ltd

**Soil Behaviour Type  $SBT_n$  - Robertson et al. 1990**

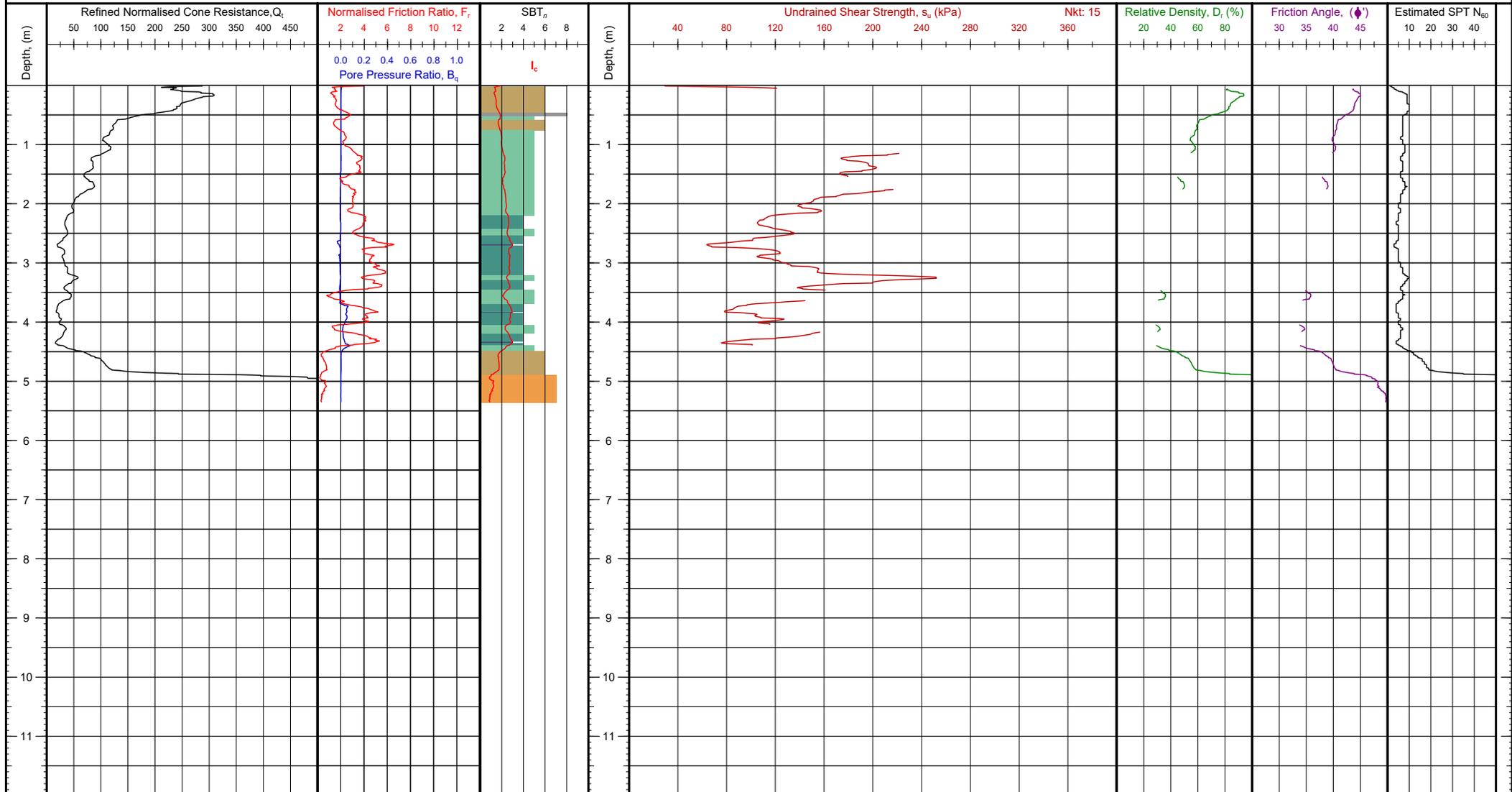
0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine grained	6	Sands: clean sands to silty sands
2	Organic: Organic clay/silt, peat	7	Dense sand to gravelly sand
3	Clay: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff silt/clay

**Notes and Limitations:**  
 Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

**Client Reference:**

**Test Number:** CPT-04

**G.I. Job Ref:** 210503



**Soil Behaviour Type SBT<sub>n</sub> - Robertson et al. 1990**

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine grained	6	Sands: clean sands to silty sands
2	Organic: Organic clay/silt, peat	7	Dense sand to gravelly sand
3	Clay: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff silt/clay

**Notes and Limitations:**

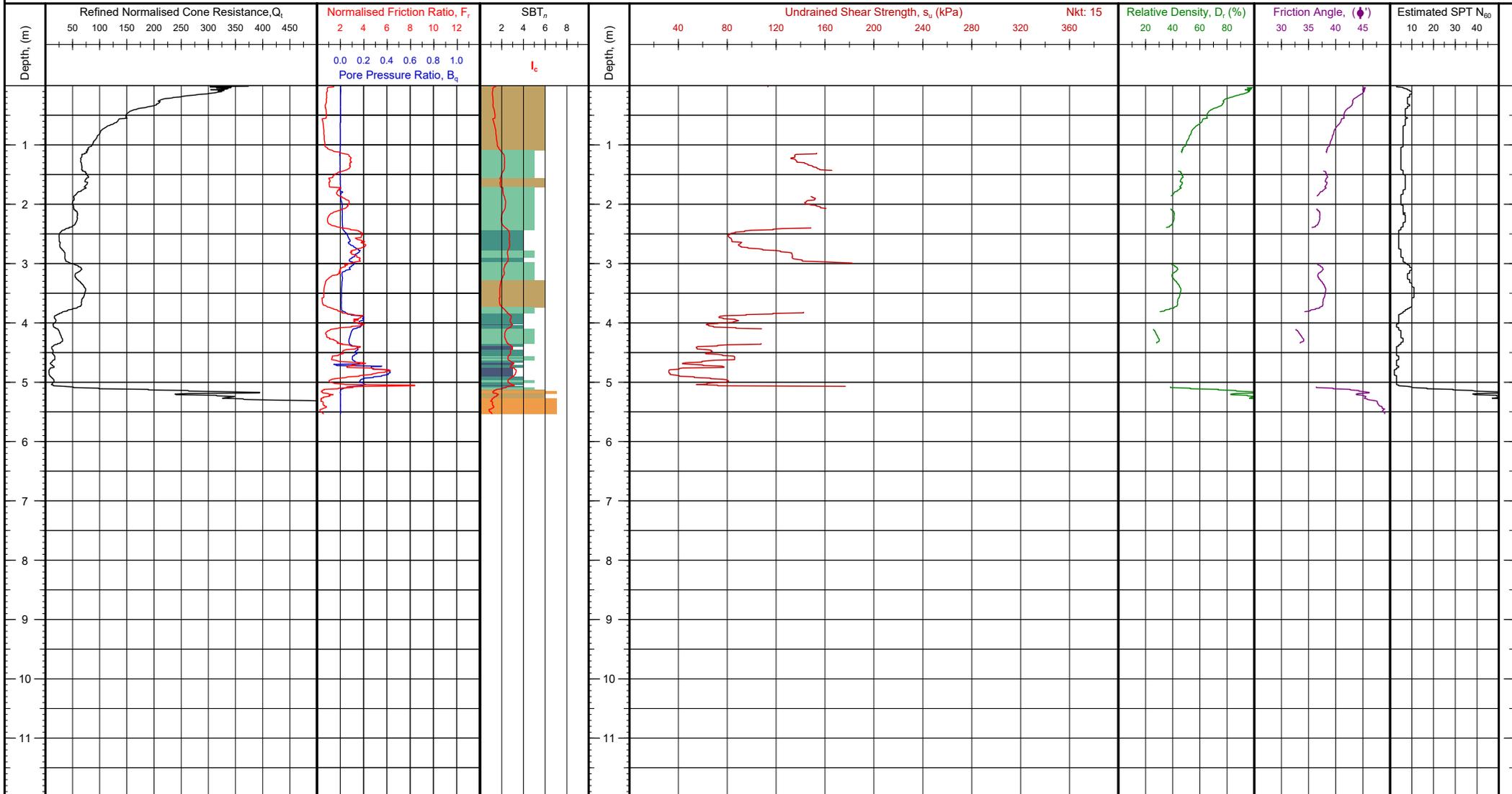
Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

**Client Reference:**

**Test Number: CPT-05**

**G.I. Job Ref: 210503**

**Client:** KGA Geotechnical  
**Project:** 232 Styx Mill Road  
**Location:** Casebrook, Christchurch  
**Engineer:** Abilio Nogueira  
**Contractor:** Ground Investigation Ltd



**Client:** KGA Geotechnical  
**Project:** 232 Styx Mill Road  
**Location:** Casebrook, Christchurch  
**Engineer:** Abilio Nogueira  
**Contractor:** Ground Investigation Ltd

**Soil Behaviour Type  $SBT_n$  - Robertson et al. 1990**

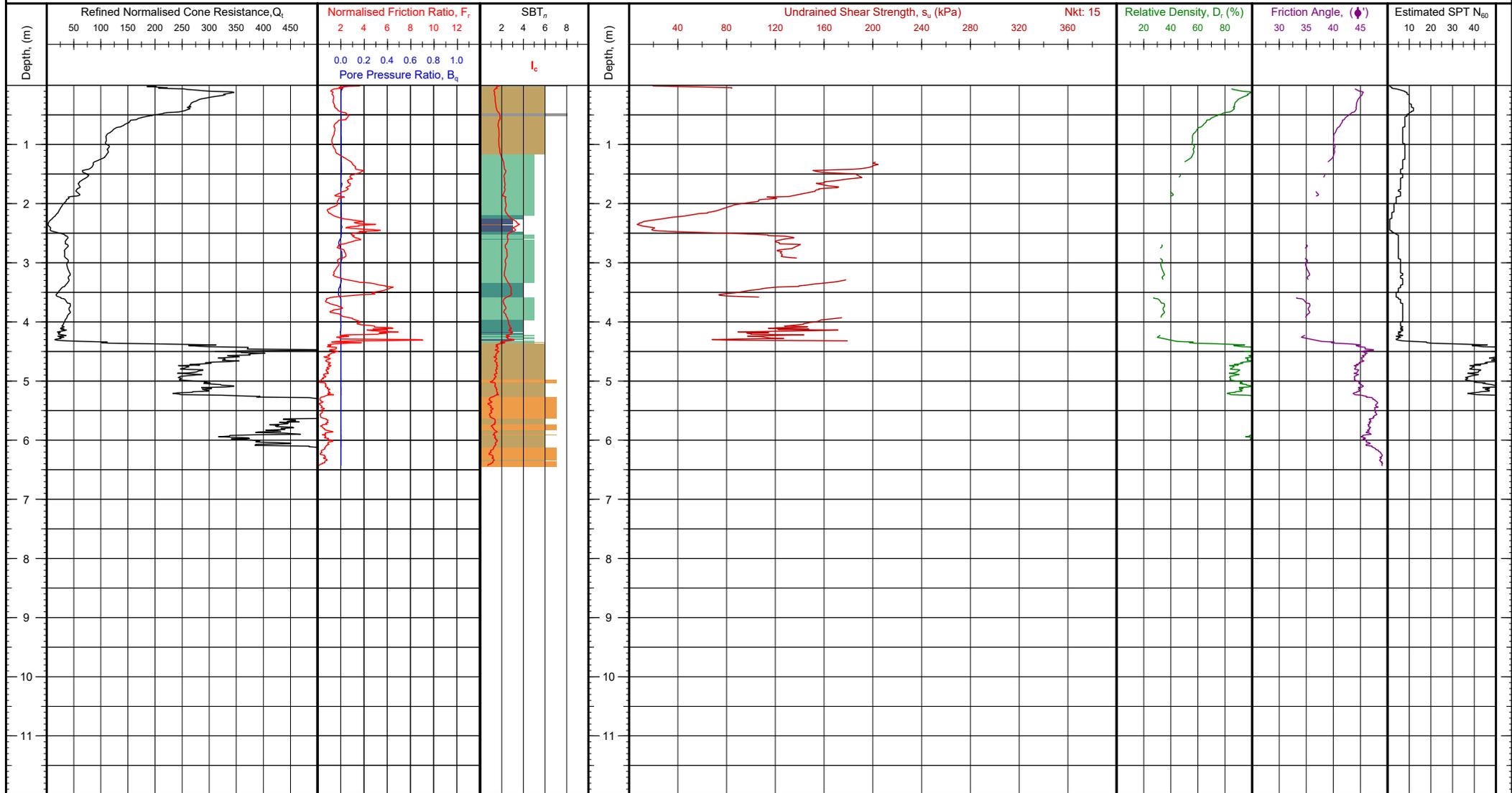
0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine grained	6	Sands: clean sands to silty sands
2	Organic: Organic clay/silt, peat	7	Dense sand to gravelly sand
3	Clay: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff silt/clay

**Notes and Limitations:**  
 Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

**Client Reference:**

**Test Number:** CPT-06

**G.I. Job Ref:** 210503



**Soil Behaviour Type SBT<sub>n</sub> - Robertson et al. 1990**

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine grained	6	Sands: clean sands to silty sands
2	Organic: Organic clay/silt, peat	7	Dense sand to gravelly sand
3	Clay: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff silt/clay

**Notes and Limitations:**

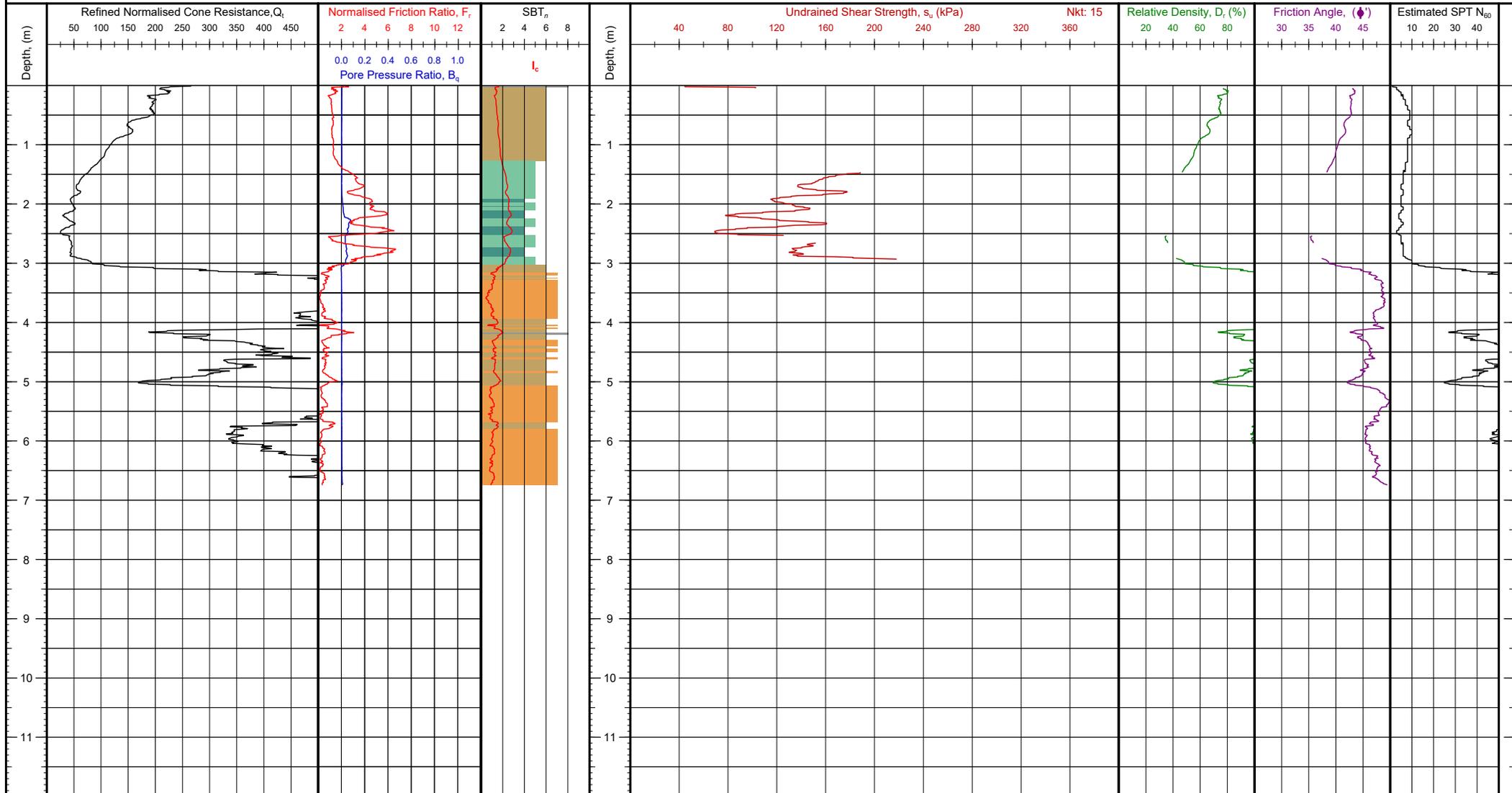
Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

**Client Reference:**

**Test Number: CPT-07**

**G.I. Job Ref: 210503**

**Client:** KGA Geotechnical  
**Project:** 232 Styx Mill Road  
**Location:** Casebrook, Christchurch  
**Engineer:** Abilio Nogueira  
**Contractor:** Ground Investigation Ltd



**Soil Behaviour Type  $S_{BT_n}$  - Robertson et al. 1990**

- |   |   |
|---|---|
| <span style="background-color: black; color: white; padding: 2px;">0</span> Undefined                                 | <span style="background-color: #90EE90; padding: 2px;">5</span> Sand mixtures: silty sand to sandy silt |
| <span style="background-color: #FF0000; color: white; padding: 2px;">1</span> Sensitive fine grained                  | <span style="background-color: #FFA500; padding: 2px;">6</span> Sands: clean sands to silty sands       |
| <span style="background-color: #8B4513; color: white; padding: 2px;">2</span> Organic: Organic clay/silt, peat        | <span style="background-color: #FF8C00; padding: 2px;">7</span> Dense sand to gravelly sand             |
| <span style="background-color: #4682B4; color: white; padding: 2px;">3</span> Clay: clay to silty clay                | <span style="background-color: #A9A9A9; padding: 2px;">8</span> Stiff sand to clayey sand               |
| <span style="background-color: #3CB371; color: white; padding: 2px;">4</span> Silt mixtures: clayey silt & silty clay | <span style="background-color: #D3D3D3; padding: 2px;">9</span> Stiff silt/clay                         |

**Notes and Limitations:**

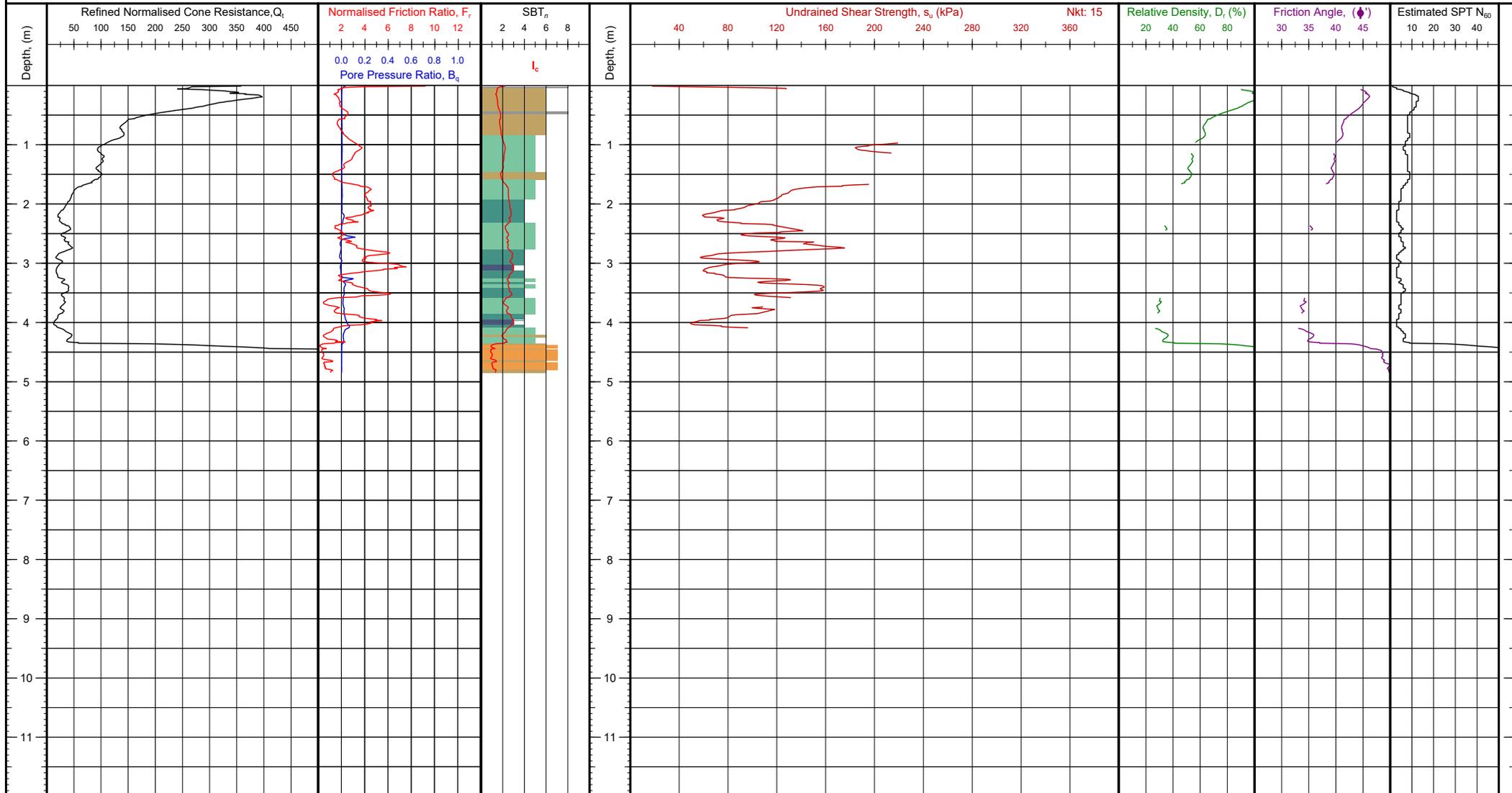
Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

**Client Reference:**

**Test Number: CPT-08**

**G.I. Job Ref: 210503**

**Client:** KGA Geotechnical  
**Project:** 232 Styx Mill Road  
**Location:** Casebrook, Christchurch  
**Engineer:** Abilio Nogueira  
**Contractor:** Ground Investigation Ltd



**Soil Behaviour Type SBT<sub>n</sub> - Robertson et al. 1990**

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine grained	6	Sands: clean sands to silty sands
2	Organic: Organic clay/silt, peat	7	Dense sand to gravelly sand
3	Clay: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff silt/clay

**Notes and Limitations:**

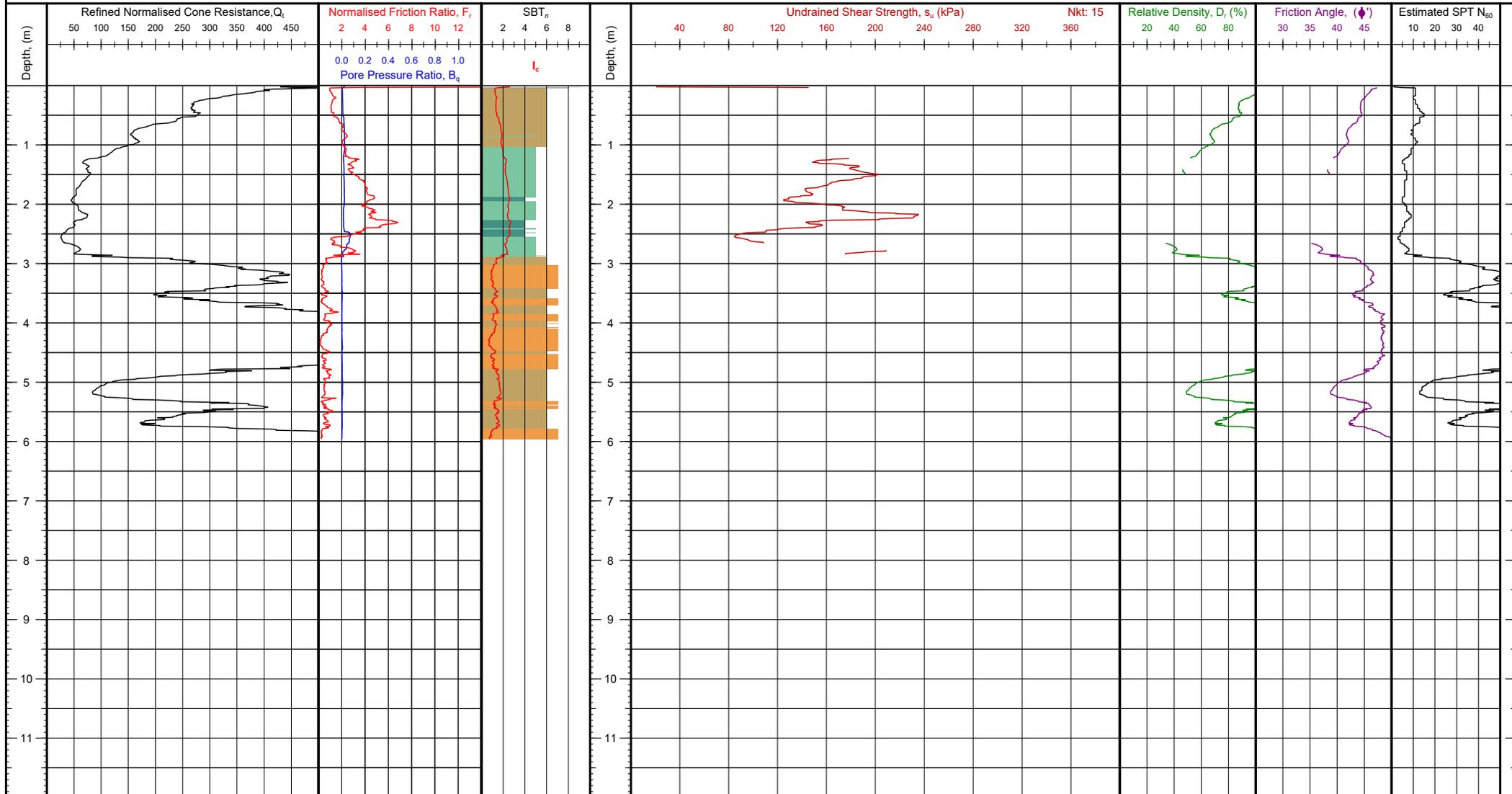
Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

**Client Reference:**

**Test Number: CPT-09**

**G.I. Job Ref: 210503**

**Client:** KGA Geotechnical  
**Project:** 232 Styx Mill Road  
**Location:** Casebrook, Christchurch  
**Engineer:** Abilio Nogueira  
**Contractor:** Ground Investigation Ltd



**Client:** KGA Geotechnical  
**Project:** 232 Styx Mill Road  
**Location:** Casebrook, Christchurch  
**Engineer:** Abilio Nogueira  
**Contractor:** Ground Investigation Ltd

**Soil Behaviour Type  $SBT_n$  - Robertson et al. 1990**

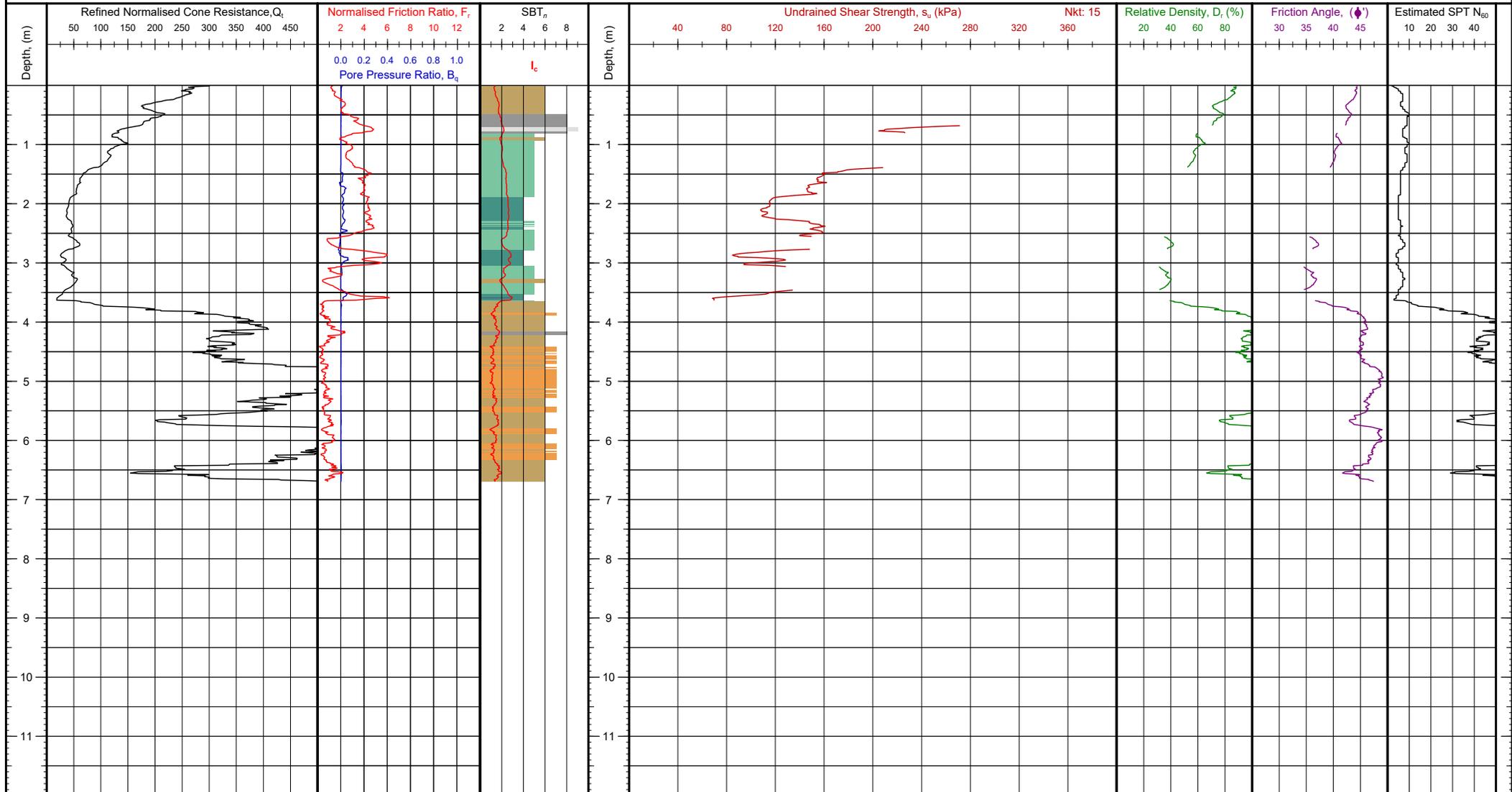
0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine grained	6	Sands: clean sands to silty sands
2	Organic: Organic clay/silt, peat	7	Dense sand to gravelly sand
3	Clay: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff silt/clay

**Notes and Limitations:**  
 Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

**Client Reference:**

**Test Number:** CPT-10

**G.I. Job Ref:** 210503



**Soil Behaviour Type SBT<sub>n</sub> - Robertson et al. 1990**

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine grained	6	Sands: clean sands to silty sands
2	Organic: Organic clay/silt, peat	7	Dense sand to gravelly sand
3	Clay: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff silt/clay

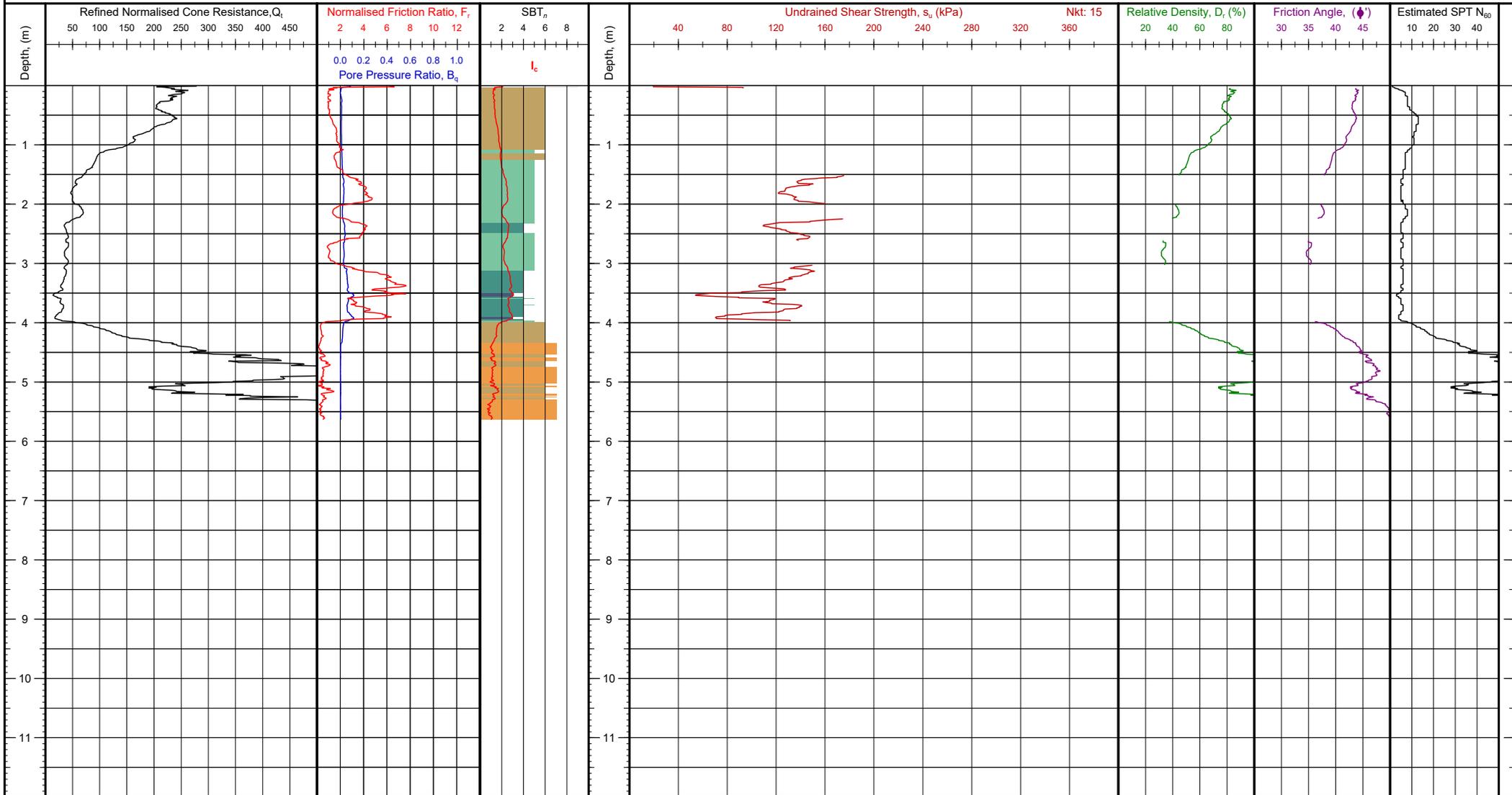
**Notes and Limitations:**

Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

**Client Reference:**

**Test Number:** CPT-11  
**G.I. Job Ref:** 210503

**Client:** KGA Geotechnical  
**Project:** 232 Styx Mill Road  
**Location:** Casebrook, Christchurch  
**Engineer:** Abilio Nogueira  
**Contractor:** Ground Investigation Ltd



**Client:** KGA Geotechnical  
**Project:** 232 Styx Mill Road  
**Location:** Casebrook, Christchurch  
**Engineer:** Abilio Nogueira  
**Contractor:** Ground Investigation Ltd

**Soil Behaviour Type  $SBT_n$  - Robertson et al. 1990**

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine grained	6	Sands: clean sands to silty sands
2	Organic: Organic clay/silt, peat	7	Dense sand to gravelly sand
3	Clay: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff silt/clay

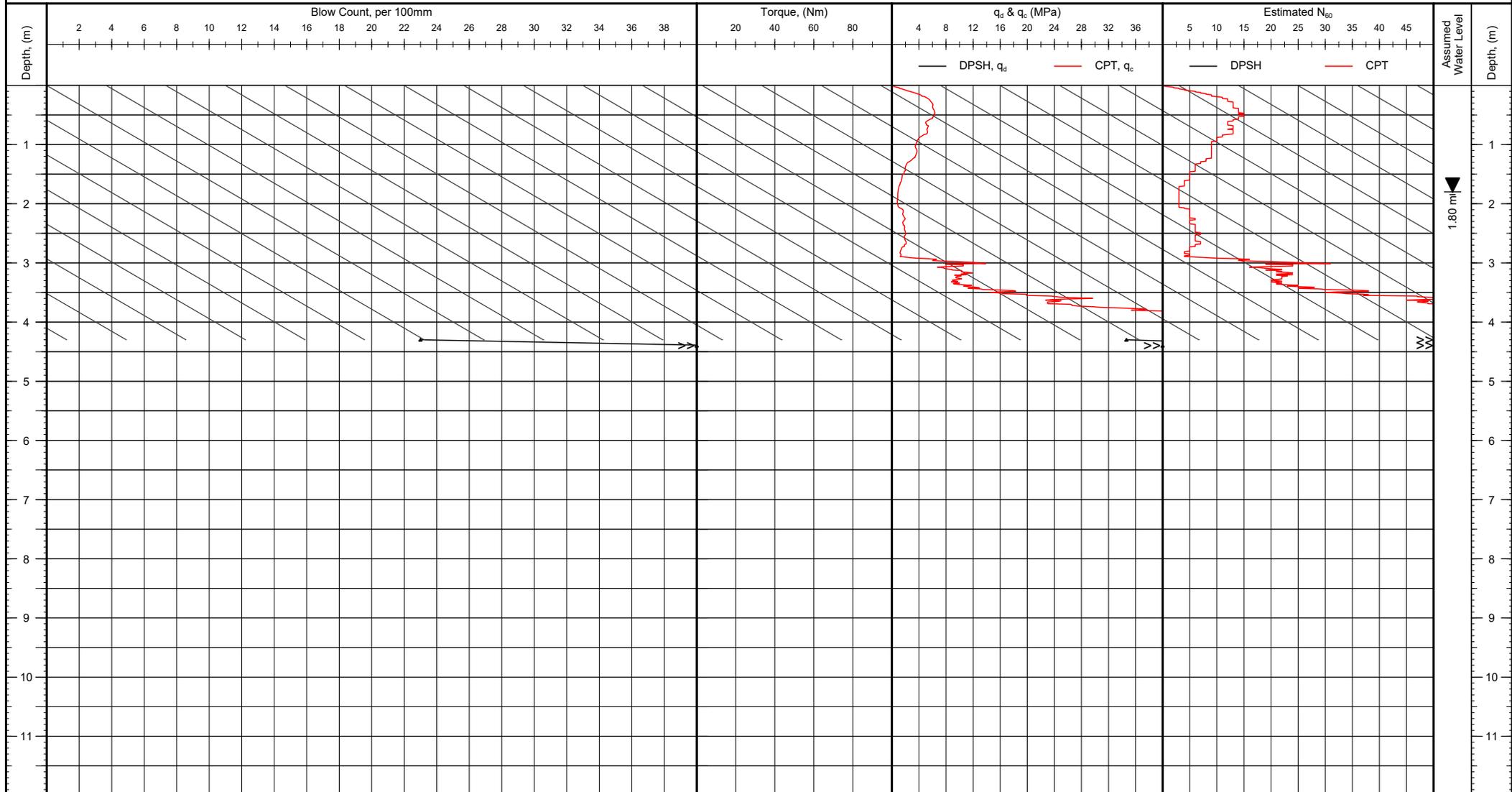
**Notes and Limitations:**  
 Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

**Client Reference:**

**Test Number:** CPT-12

**G.I. Job Ref:** 210503

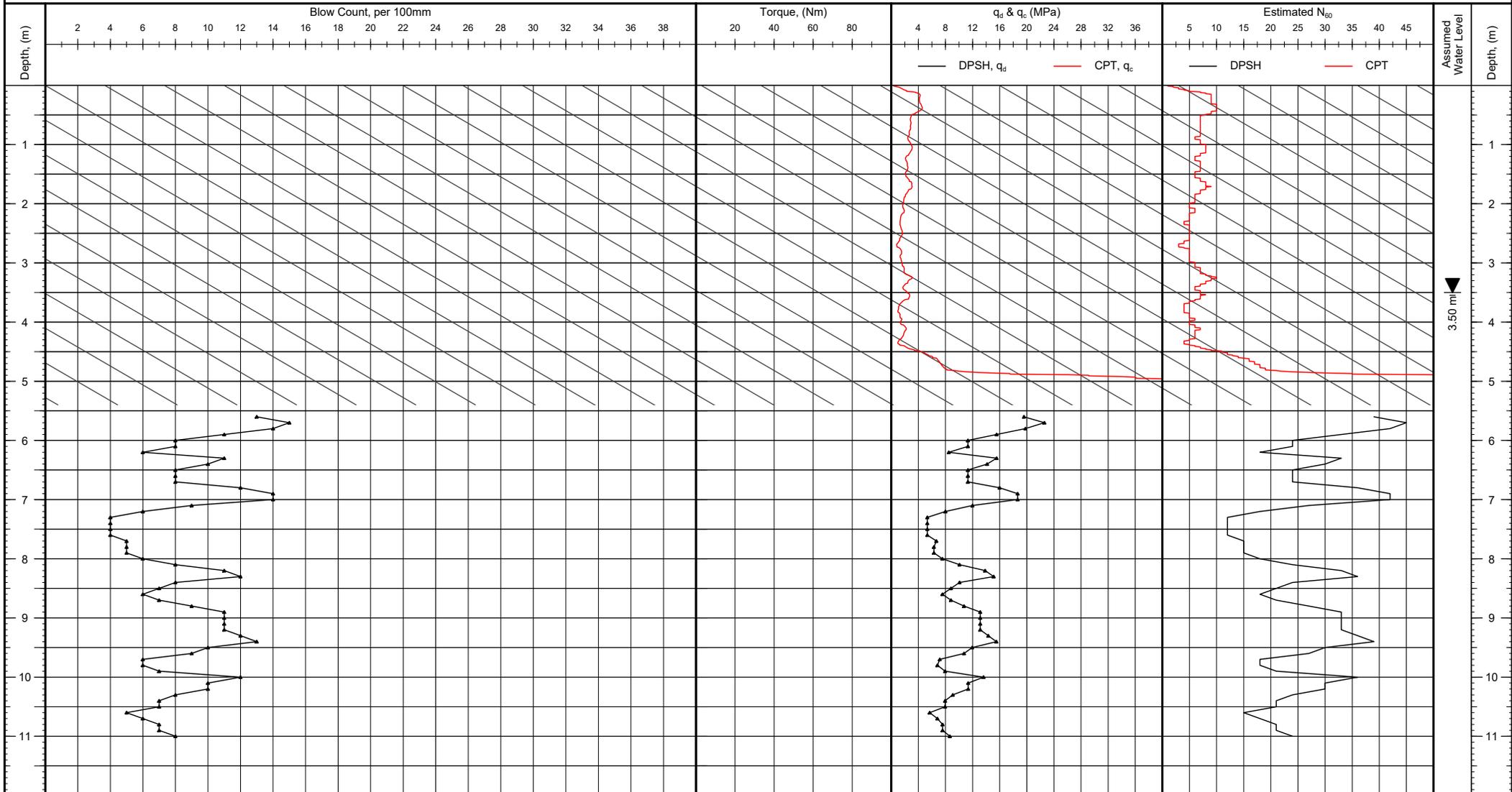
# DYNAMIC PROBE SUPER HEAVY (DPSH) LOG



<b>Client:</b> KGA Geotechnical	<b>Hammer Mass:</b> 63.5 kg	<b>NZTM 2000 N, E (m):</b> 5187237.48, 1567296.37	<b>Elevation (m):</b> Unknown	<b>Client Reference:</b>
<b>Project:</b> 232 Styx Mill Road	<b>Rod Mass:</b> 6.2 kg/m	<b>WGS84 (deg):</b> -43.467060, 172.595694	<b>Date of Test:</b> 18/05/2021	<b>Test Number: DPSH-01</b>
<b>Location:</b> Casebrook, Christchurch	<b>Energy Efficiency:</b> 96%	<b>Location Method:</b> Handheld GPS	<b>Depth (m):</b> 4.40	
<b>Engineer:</b> Abilio Nogueira	<b>Measured Energy:</b> 448.51	<b>Surveyor:</b>	<b>Pre Drill (m):</b> 4.30 m	<b>G.I. Job Ref:</b> 210503
<b>Contractor:</b> Ground Investigation Ltd	<b>Cone Area:</b> 0.002	<b>Termination Reason:</b> Very high blow count		

**Comments:** Continued from CPT-01

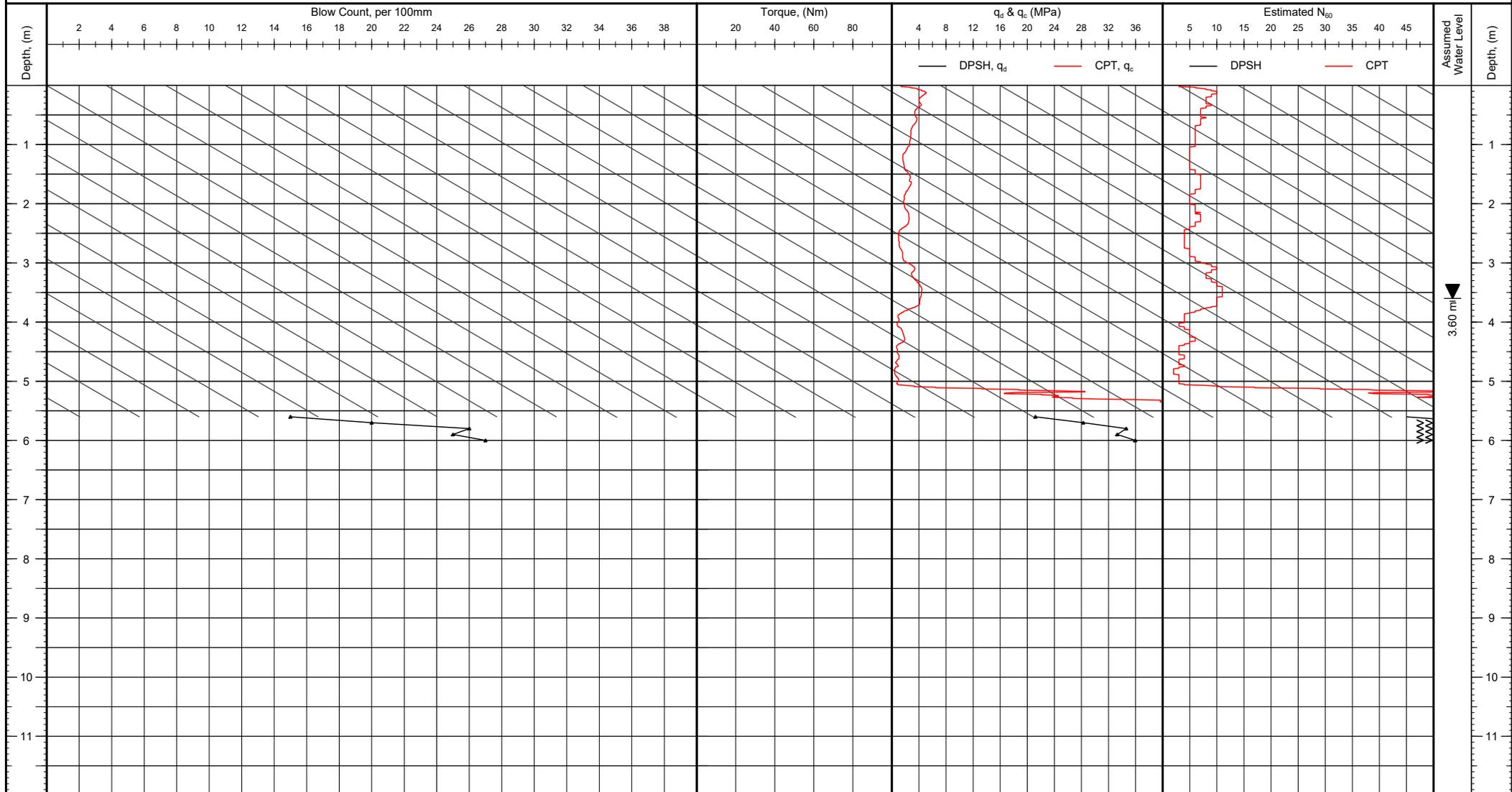
# DYNAMIC PROBE SUPER HEAVY (DPSH) LOG



<b>Client:</b> KGA Geotechnical	<b>Hammer Mass:</b> 63.5 kg	<b>NZTM 2000 N, E (m):</b> 5187381.84, 1567451.88	<b>Elevation (m):</b> Unknown	<b>Client Reference:</b>
<b>Project:</b> 232 Styx Mill Road	<b>Rod Mass:</b> 6.2 kg/m	<b>WGS84 (deg):</b> -43.465767, 172.597625	<b>Date of Test:</b> 18/05/2021	<b>Test Number: DPSH-05</b>
<b>Location:</b> Casebrook, Christchurch	<b>Energy Efficiency:</b> 96%	<b>Location Method:</b> Handheld GPS	<b>Depth (m):</b> 11.00	
<b>Engineer:</b> Abilio Nogueira	<b>Measured Energy:</b> 448.51	<b>Surveyor:</b>	<b>Pre Drill (m):</b> 5.40 m	<b>G.I. Job Ref:</b> 210503
<b>Contractor:</b> Ground Investigation Ltd	<b>Cone Area:</b> 0.002	<b>Termination Reason:</b> Target depth		

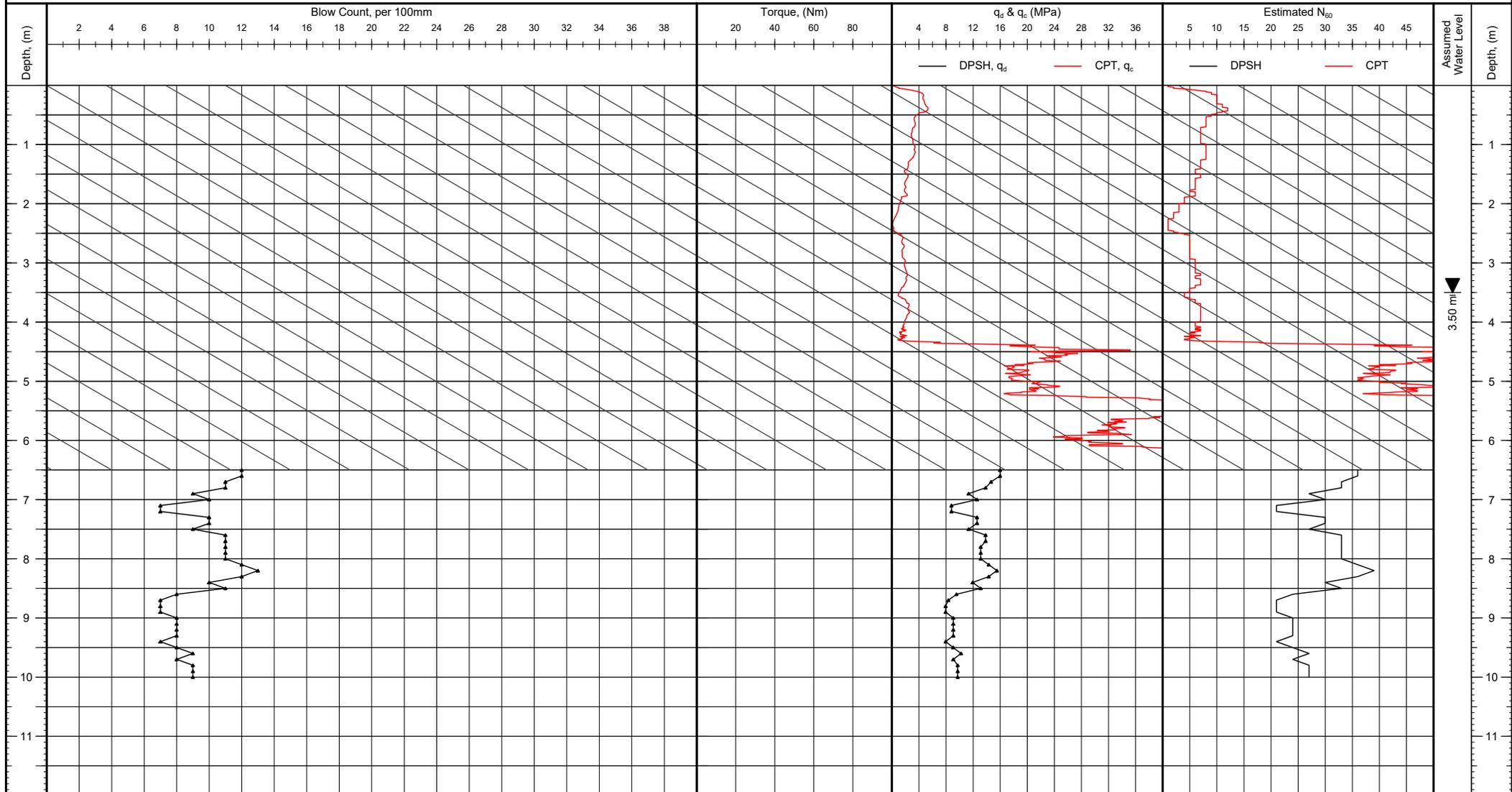
**Comments:** Continued from CPT-05

# DYNAMIC PROBE SUPER HEAVY (DPSH) LOG



<b>Client:</b> KGA Geotechnical	<b>Hammer Mass:</b> 63.5 kg	<b>NZTM 2000 N, E (m):</b> 5187336.06, 1567472.08	<b>Elevation (m):</b> Unknown	<b>Client Reference:</b>
<b>Project:</b> 232 Styx Mill Road	<b>Rod Mass:</b> 6.2 kg/m	<b>WGS84 (deg):</b> -43.466180, 172.597872	<b>Date of Test:</b> 18/05/2021	<b>Test Number: DPSH-06</b>
<b>Location:</b> Casebrook, Christchurch	<b>Energy Efficiency:</b> 96%	<b>Location Method:</b> Handheld GPS	<b>Depth (m):</b> 6.00	
<b>Engineer:</b> Abilio Nogueira	<b>Measured Energy:</b> 448.51	<b>Surveyor:</b>	<b>Pre Drill (m):</b> 5.60 m	<b>G.I. Job Ref:</b> 210503
<b>Contractor:</b> Ground Investigation Ltd	<b>Cone Area:</b> 0.002	<b>Termination Reason:</b> Consistant high blow count		
<b>Comments:</b> Continued from CPT-06				

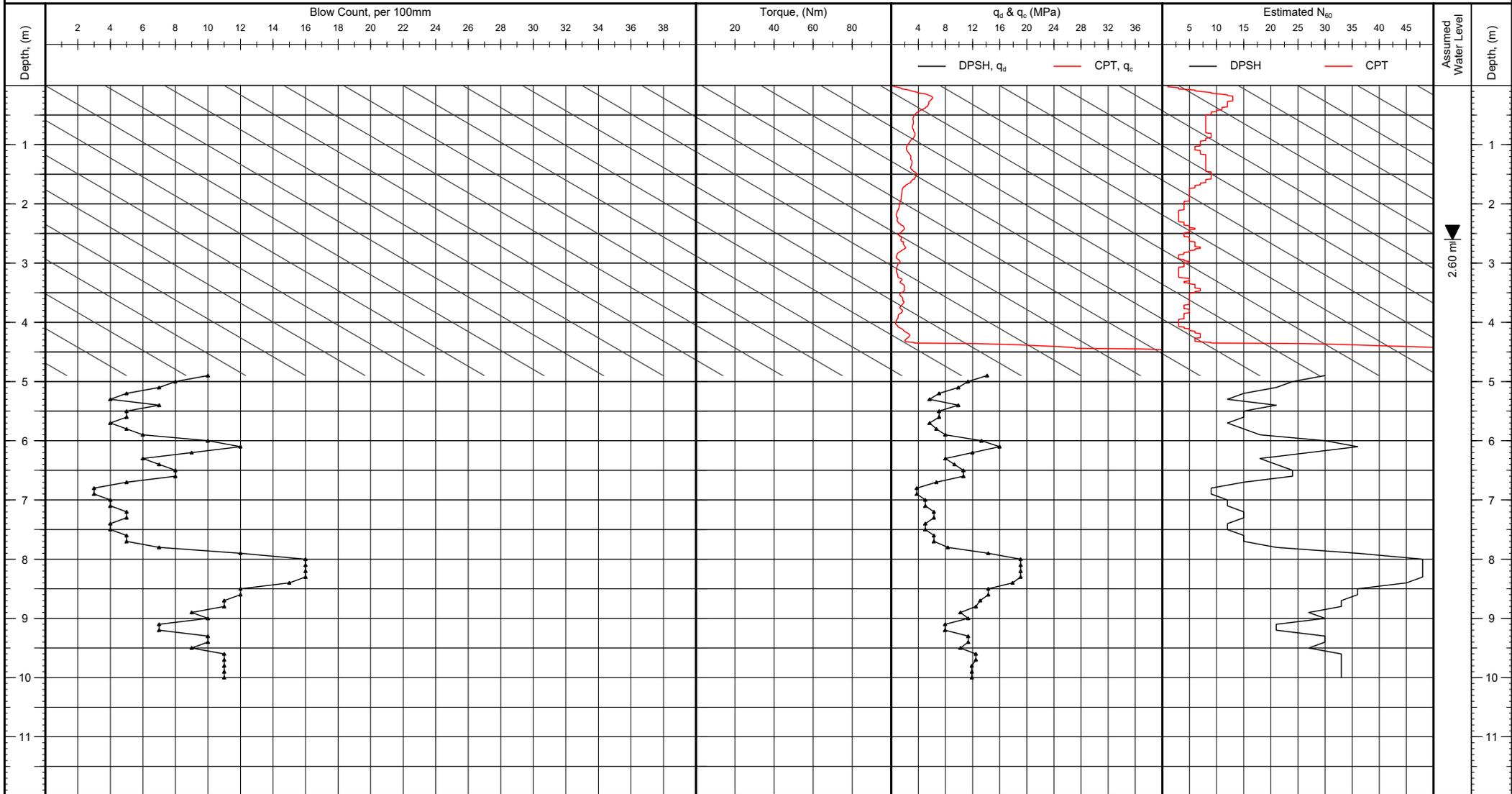
# DYNAMIC PROBE SUPER HEAVY (DPSH) LOG



<b>Client:</b> KGA Geotechnical	<b>Hammer Mass:</b> 63.5 kg	<b>NZTM 2000 N, E (m):</b> 5187315.45, 1567503.40	<b>Elevation (m):</b> Unknown	<b>Client Reference:</b>
<b>Project:</b> 232 Styx Mill Road	<b>Rod Mass:</b> 6.2 kg/m	<b>WGS84 (deg):</b> -43.466367, 172.598258	<b>Date of Test:</b> 18/05/2021	<b>Test Number: DPSH-07</b>
<b>Location:</b> Casebrook, Christchurch	<b>Energy Efficiency:</b> 96%	<b>Location Method:</b> Handheld GPS	<b>Depth (m):</b> 10.00	
<b>Engineer:</b> Abilio Nogueira	<b>Measured Energy:</b> 448.51	<b>Surveyor:</b>	<b>Pre Drill (m):</b> 6.50 m	<b>G.I. Job Ref:</b> 210503
<b>Contractor:</b> Ground Investigation Ltd	<b>Cone Area:</b> 0.002	<b>Termination Reason:</b> Target depth		

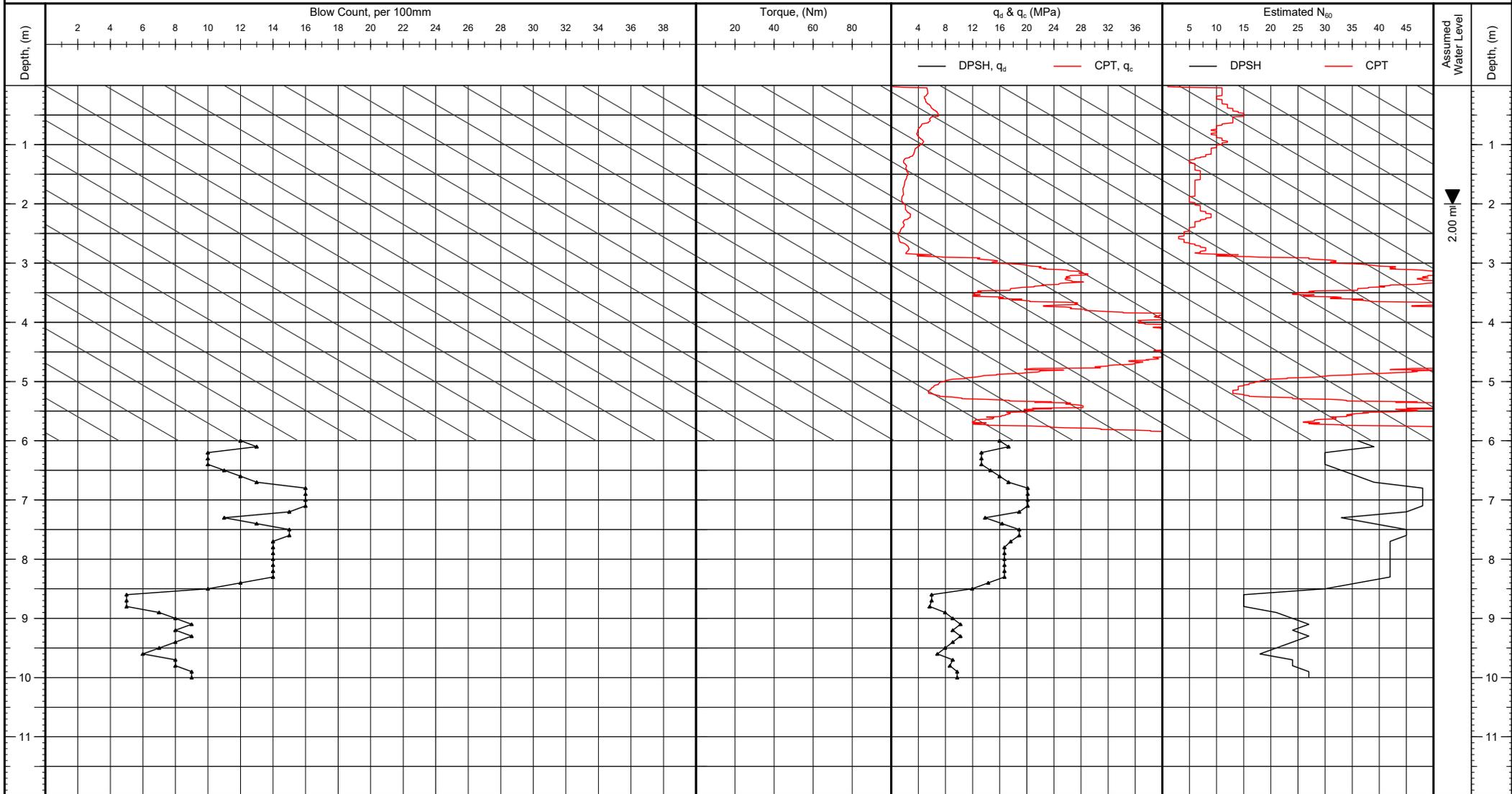
**Comments:** Continued from CPT-07

# DYNAMIC PROBE SUPER HEAVY (DPSH) LOG



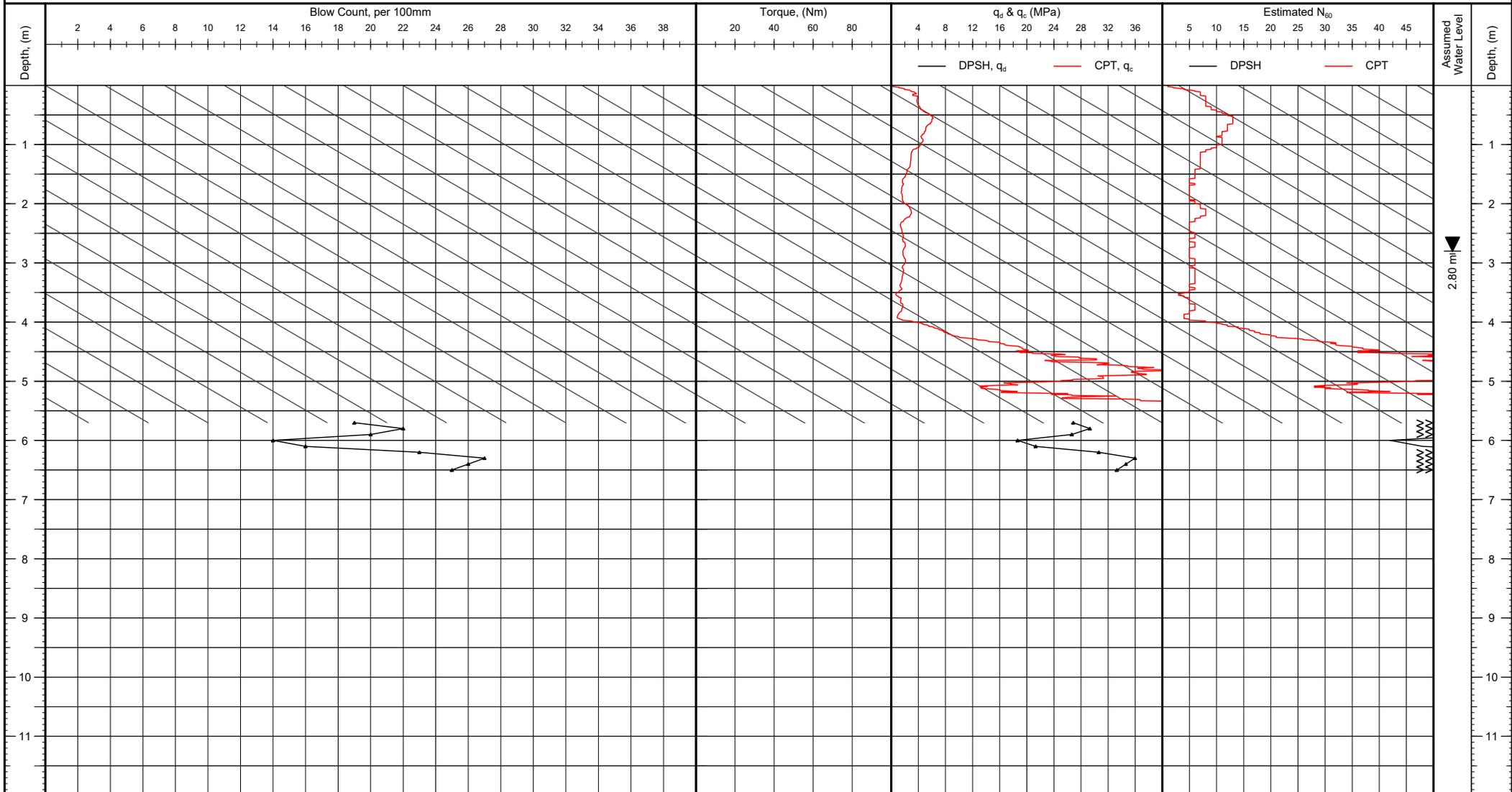
<b>Client:</b> KGA Geotechnical	<b>Hammer Mass:</b> 63.5 kg	<b>NZTM 2000 N, E (m):</b> 5187248.52, 1567442.81	<b>Elevation (m):</b> Unknown	<b>Client Reference:</b>
<b>Project:</b> 232 Styx Mill Road	<b>Rod Mass:</b> 6.2 kg/m	<b>WGS84 (deg):</b> -43.466967, 172.597505	<b>Date of Test:</b> 18/05/2021	<b>Test Number: DPSH-09</b>
<b>Location:</b> Casebrook, Christchurch	<b>Energy Efficiency:</b> 96%	<b>Location Method:</b> Handheld GPS	<b>Depth (m):</b> 10.00	
<b>Engineer:</b> Abilio Nogueira	<b>Measured Energy:</b> 448.51	<b>Surveyor:</b>	<b>Pre Drill (m):</b> 4.90 m	<b>G.I. Job Ref:</b> 210503
<b>Contractor:</b> Ground Investigation Ltd	<b>Cone Area:</b> 0.002	<b>Termination Reason:</b> Target depth		
<b>Comments:</b> Continued from CPT-09				

# DYNAMIC PROBE SUPER HEAVY (DPSH) LOG



<b>Client:</b> KGA Geotechnical	<b>Hammer Mass:</b> 63.5 kg	<b>NZTM 2000 N, E (m):</b> 5187237.82, 1567366.75	<b>Elevation (m):</b> Unknown	<b>Client Reference:</b>
<b>Project:</b> 232 Styx Mill Road	<b>Rod Mass:</b> 6.2 kg/m	<b>WGS84 (deg):</b> -43.467060, 172.596564	<b>Date of Test:</b> 18/05/2021	<b>Test Number: DPSH-10</b>
<b>Location:</b> Casebrook, Christchurch	<b>Energy Efficiency:</b> 96%	<b>Location Method:</b> Handheld GPS	<b>Depth (m):</b> 10.00	
<b>Engineer:</b> Abilio Nogueira	<b>Measured Energy:</b> 448.51	<b>Surveyor:</b>	<b>Pre Drill (m):</b> 6.00 m	<b>G.I. Job Ref:</b> 210503
<b>Contractor:</b> Ground Investigation Ltd	<b>Cone Area:</b> 0.002	<b>Termination Reason:</b> Target depth		
<b>Comments:</b> Continued from CPT-10				

# DYNAMIC PROBE SUPER HEAVY (DPSH) LOG



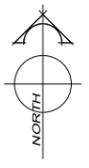
<b>Client:</b> KGA Geotechnical	<b>Hammer Mass:</b> 63.5 kg	<b>NZTM 2000 N, E (m):</b> 5187306.52, 1567447.71	<b>Elevation (m):</b> Unknown	<b>Client Reference:</b>
<b>Project:</b> 232 Styx Mill Road	<b>Rod Mass:</b> 6.2 kg/m	<b>WGS84 (deg):</b> -43.466445, 172.597569	<b>Date of Test:</b> 18/05/2021	<b>Test Number: DPSH-12</b>
<b>Location:</b> Casebrook, Christchurch	<b>Energy Efficiency:</b> 96%	<b>Location Method:</b> Handheld GPS	<b>Depth (m):</b> 6.50	
<b>Engineer:</b> Abilio Nogueira	<b>Measured Energy:</b> 448.51	<b>Surveyor:</b>	<b>Pre Drill (m):</b> 5.70 m	<b>G.I. Job Ref:</b> 210503
<b>Contractor:</b> Ground Investigation Ltd	<b>Cone Area:</b> 0.002	<b>Termination Reason:</b> Consistant high blow count		

**Comments:** Continued from CPT-12



## **APPENDIX A**

### Third Party Documents



HI LUKT LUJ ZA		
HI LUKT LUJ	KHEL	KLZJYWRU

- UN[LZ A
1. Areas and dimensions are approximate only and are subject to final survey and deposit of plans.
  2. Service easements to be created as required.
  3. This plan has been prepared for subdivision concept & discussion purposes only. No liability is accepted if the plan is used for any other purposes.
  4. Contours shown are from Christchurch City Council Lidar Data at 0.25m Contour Intervals and terms of LINZ Vertical Datum 2016.

Total Area :  
Comprised in:



BB-^ ync6 Yvk W1 vC= Jop[ o] y o78 75 U- al hduk  
[1 s vvd A7: :->@>@ ^ 11 z# A- -->25 v5/ L4: hpm] G ka5 v5/

QV [RSLA  
**Styx Mill Road**

ZOLL [RSLA  
**Site Plan of  
Lot 5 & 6 DP 311370**

KYHP: RINZ[H\Z  
**For Discussion Purposes**

ZJHSLA 1:750@A1 KHELA March 2021  
1:1500@A3

JHK MRLA J:\17713\Subcon\Concept Plan_R3.dwg	YJ] RWRU A
KYHP: RINUV A ZOLL] UVA	
<b>E17713</b>	1 OF 1
	<b>R4</b>

Aerial Photography and LIDAR contours Sourced from the LINZ Data Service and licensed by The Canterbury Aerial Imagery (CAI) consortium for re-use under the Creative Commons Attribution 4.0 International



## **APPENDIX B**

### Site Photographs

Aerial Photograph, February 2011



Notes:

1. Aerial photograph sourced from NZ Geotechnical Database

Site Photographs:



*Photo looking south along eastern boundary*



*Photo looking southwest from northeast boundary*



*Photo looking east from southwest corner of site*



*Photo looking northeast from southwest corner of site*



*Photo showing slope down to river*



*Photo along crest of Styx River bank looking southeast*



## **APPENDIX C**

### Background Information Documents

## Nearby Data

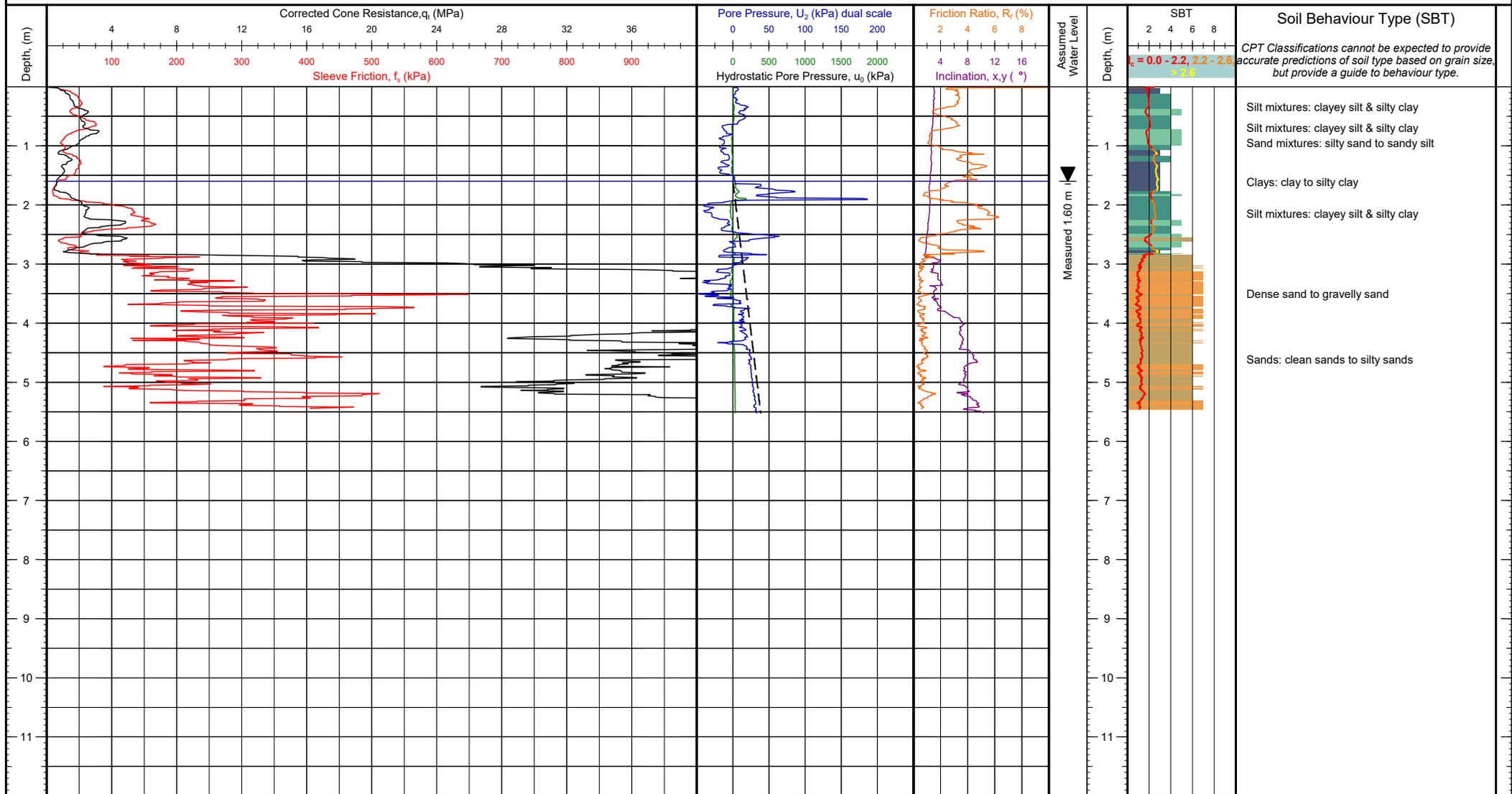


### Notes:

1. Aerial photograph sourced from NZ Geotechnical Database



# CONE PENETRATION TEST (CPT) LOG



<b>Client:</b> KGA Geotechnical	<b>Operator:</b> John Cresswell	<b>NZTM 2000 N, E (m):</b> 5187171.40, 1567228.34	<b>Elevation (m):</b> Unknown	<b>Client Reference:</b>
<b>Project:</b> Cnr Styx Mill Road and Highsted Road	<b>Cone Ref:</b> MKJ311	<b>WGS84 (deg):</b> -43.467652, 172.594849	<b>Date of Test:</b> 17/09/2020	<b>Test Number:</b> <b>CPT-04</b>
<b>Location:</b> Casebrook, Christchurch	<b>Cone Type:</b> 10cm <sup>2</sup> Compression	<b>Location Method:</b> Handheld GPS	<b>Depth (m):</b> 5.52	
<b>Engineer:</b> Abilio Nogueira	<b>Area Ratio:</b> 0.8	<b>Surveyor:</b>	<b>Pre Drill (m):</b> N/A	<b>G.I. Job Ref:</b> 200864
<b>Contractor:</b> Ground Investigation Ltd.	<b>Filter Type:</b> $u_2$	<b>Termination Reason:</b> High cone end resistance		
<b>Comments:</b> Continued with DPSH-04				

## LLUR Extracts:

### Listed Land Use Register (LLUR)

#### Search

(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	✕
<b>232 STYX MILL ROAD</b>				
1	Lot 6 DP 311370	44888	2191623600	✕

### Listed Land Use Register (LLUR)

#### Search

(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

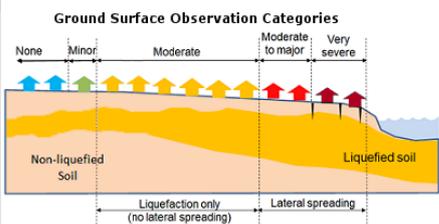
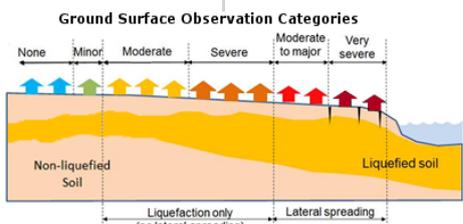
	Legal Description	Titles	Valuation No	✕
<b>250 STYX MILL ROAD</b>				
1	Lot 5 DP 311370	44887	2191623500	✕

# New Zealand Geotechnical Database: Property Summary Report

## General Property Information

<b>Property Address</b>	232 Styx Mill Rd		
<b>QPID #</b>	2440999	<b>Suburb</b>	Casebrook
<b>Valuation Reference No</b>	21916/23600	<b>DPID #</b>	
<b>Legal Description</b>	LOT 6 DP 311370		
<b>Easting (NZTM)</b>	1567426	<b>Northing (NZTM)</b>	5187266
<b>CERA Zone</b>	Green	<b>MBIE Technical Category</b>	N/A - Urban Nonresidential

## Liquefaction Observations

Earthquake	4 Sept 2010	22 Feb 2011	13 June 2011
Liquefaction Observed [from aerial photos]	Not Mapped	None	Not Mapped
Ground Surface Observation Category	Not Inspected	Not Inspected	Refer to Road Map
			

Discrepancies are possible between observations from aerial photography and ground based observations. Refer to notes 1 & 2.

## Property Surface Elevation from LiDAR Surveys (m LVD37)

Survey Dates	Pre Quake	5 Sep 2010	8 Mar-30 May 2011	18 Jul - 3 Sep 2011	17 - 18 Feb 2012
Maximum Elevation					
95 percentile					
Mean Elevation					
5 percentile					
Minimum Elevation					

Refer to note 3.

## Cumulative Property Elevation Changes from LiDAR Surveys (m LVD37)

Period: Pre Quake -	to 5 Sep 2010	to 30 May 2011	to 3 Sep 2011	to 18 Feb 2012
Surface Change				
Other Change				
Tectonic Change	- 0.02	- 0.04	- 0.04	- 0.04

Refer to note 3.

## Interpolated Ground Water Surface Elevation at the time of each Earthquake (m LVD37)

Earthquake	Sep 2010	Feb 2011	Jun 2011	Dec 2011
Surface Elevation	12.16	12.28	12.24	12.18

For back analysis purpose only. Refer to note 4.

## Design Ground Water Surface Elevations (m LVD37)

	Median surface	Median with surrogates	85 percentile offset	15 percentile offset
Surface Elevation	12.26	12.21	0.24	- 0.25

Refer to note 5.

## Terms of Use for this Report

### Terms of Use

The data in this report is governed by the Terms of use of the New Zealand Geotechnical Database. This binds all users of the data. The Terms of Use are found at <https://nzgd.org.nz>

### Important notice

The information in this report was extracted from the New Zealand Geotechnical Database (<https://nzgd.org.nz>), which were prepared and/or compiled for the Earthquake Commission (EQC) to assist in assessing insurance claims made under the Earthquake Commission Act 1993 and/or for the Canterbury Earthquake Recovery Authority (CERA). The source maps and data were not intended for any other purpose. EQC, CERA, their data suppliers and their engineers, Tonkin & Taylor, have no liability for any use of the maps and data or for the consequences of any person relying on them in any way. This "Important notice" must be reproduced wherever this data or any derivatives are reproduced.

### Notes

#### 1. Liquefaction Observations

The Observed Liquefaction is based on the quantity of ejected liquefaction material deposited on the streets as visually identified using aerial photographs. For more details, see the notes accompanying "Liquefaction Interpreted from Aerial Photography", Map Layer CGD0200.

#### 2. The Ground Surface Observation

The Ground Surface Observation Category is based on the quantities of material ejected due to liquefaction and observations of lateral spreading collated from either on-foot rapid inspection of individual properties or road inspections following each significant earthquake. For more details, see the notes accompanying "Liquefaction and Lateral Spreading Observations", Map Layer CGD0300.

#### 3. Vertical Elevations and Movements

Vertical Elevations and Movements are based on Airborne LiDAR acquired following each of the significant earthquakes, and on digital elevation models developed from that LiDAR. Residual change is calculated using the mean elevation change for the whole property. The tectonic elevation changes are uniform (for practical purposes) over the whole property. For more details, see the notes accompanying "LiDAR and Digital Elevation Models", Map Layer CGD0500 and "Vertical Ground Movements", Map Layer CGD0600.

#### 4. The Ground Water Elevations

The Ground Water Elevations are based on Water level dip measurements from wells that were converted to free surface elevations, based on surveyed well-head levels. The free surface elevations only provide mean values at the time of each earthquake and are only suitable for back analysis purpose. For more details, see the notes accompanying "Groundwater Level Contours", Map Layer CGD0800.

#### 5. Design Ground Water Elevations

The two design ground water surface elevations are interpolated median water level dip measurements for wells with long-term (> 12 month) records and wells with short-term records augmented by surrogate median estimates. Designers need to decide which surface is more appropriate based on specific engineering requirements and their own local site observations. Add the 85th percentile offset to the appropriate median and subtract the 15th percentile offset (as indicated by the - sign) from the same median. For more details, see the report and notes accompanying "GNS Science Median Water Table Elevations (Version 2)", Map Layer CGD5160.

### General notes

All information presented in this property report should be interpreted holistically, accounting for both the interdependence of the recorded information and the information for the surrounding properties and subsurface ground. Movements are the approximate averaged ground surface movement for the nominated property. The data tabulated above should be considered within the context of the patterns of the wider region, and limitations of the data. Engineering judgment should be applied when assessing this data.



## **APPENDIX D**

### Liquefaction Analyses

**LIQUEFACTION ANALYSIS REPORT**

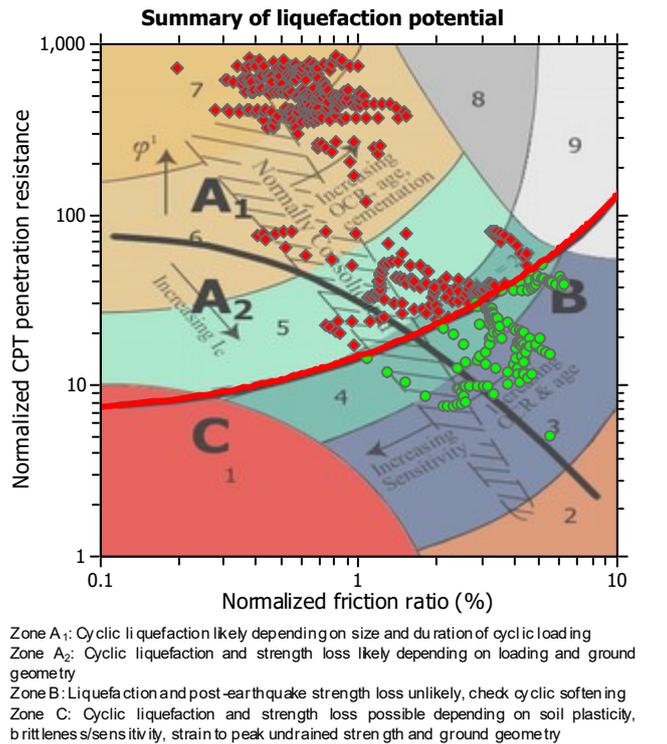
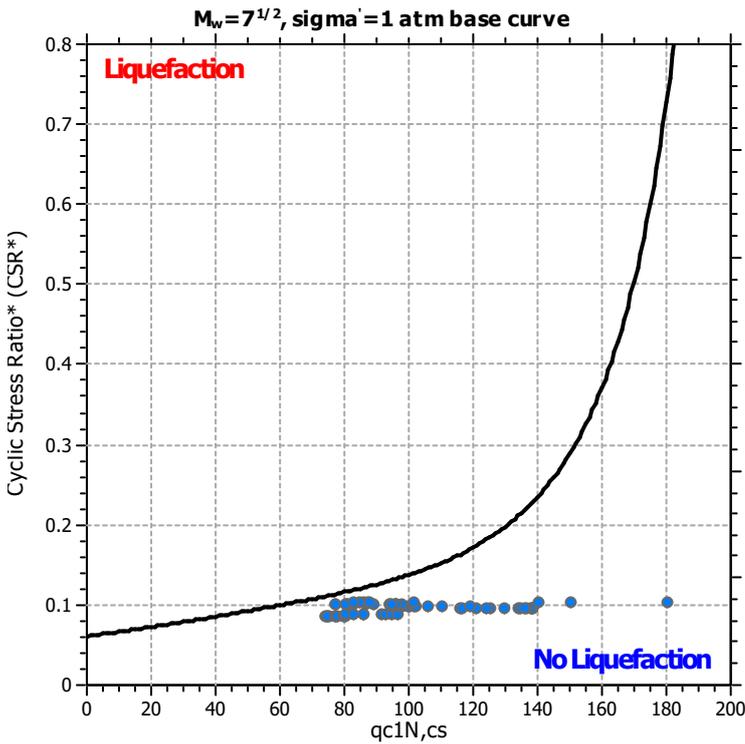
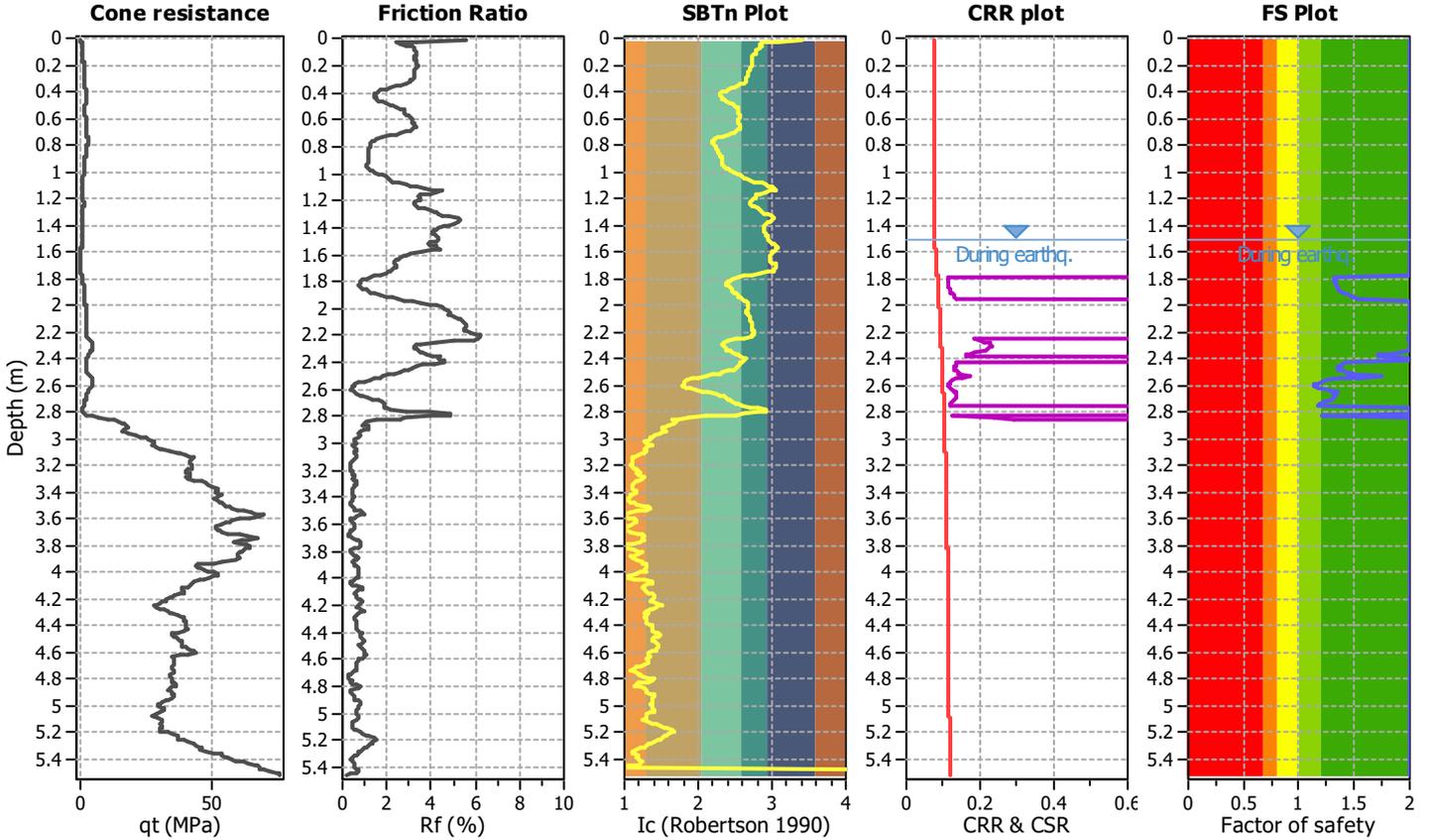
**Project title : K210318**

**Location : 232 Styx Mill Road, Casebrook, Christchurch**

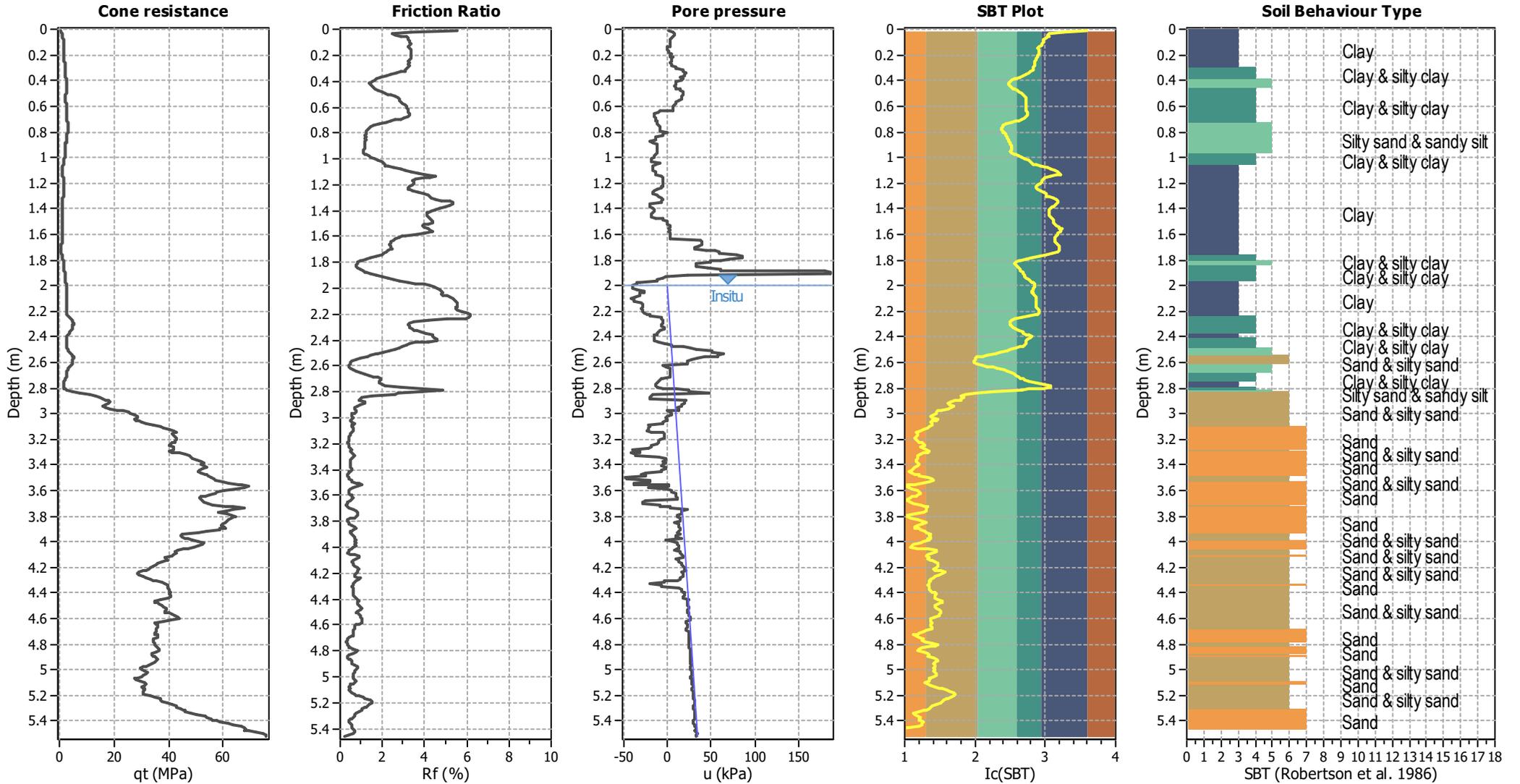
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**Input parameters and analysis data**

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Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.50 m	Fill height:	N/A	applied:	Sands only
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.13	Unit weight calculation:	Based on SBT	$K_g$ applied:	Yes	MSF method:	Method based



### CPT basic interpretation plots



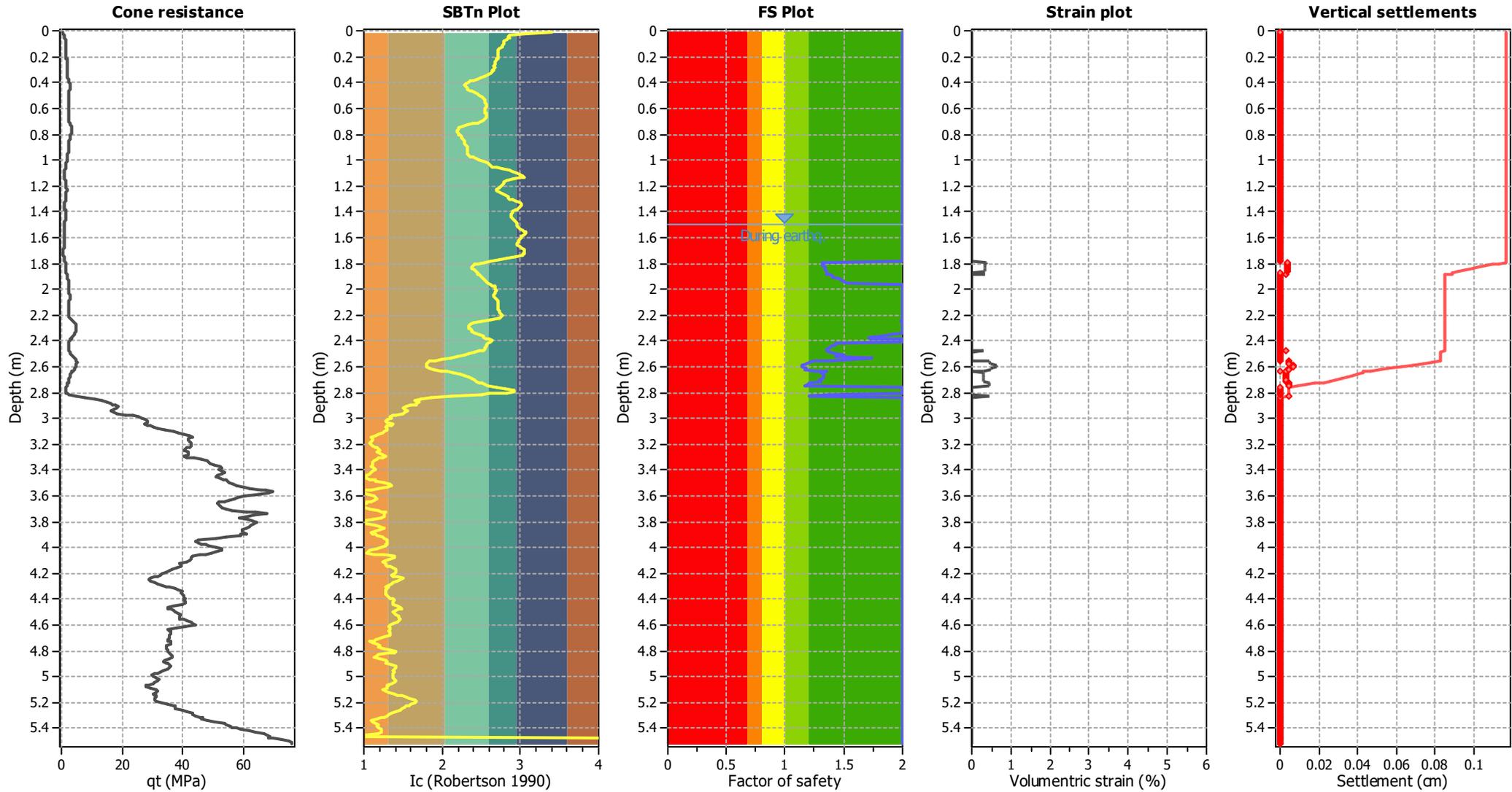
#### Input parameters and analysis data

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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	$K_v$ 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:	No
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

- qt: Total cone resistance (cone resistance  $q_c$  corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

**LIQUEFACTION ANALYSIS REPORT**

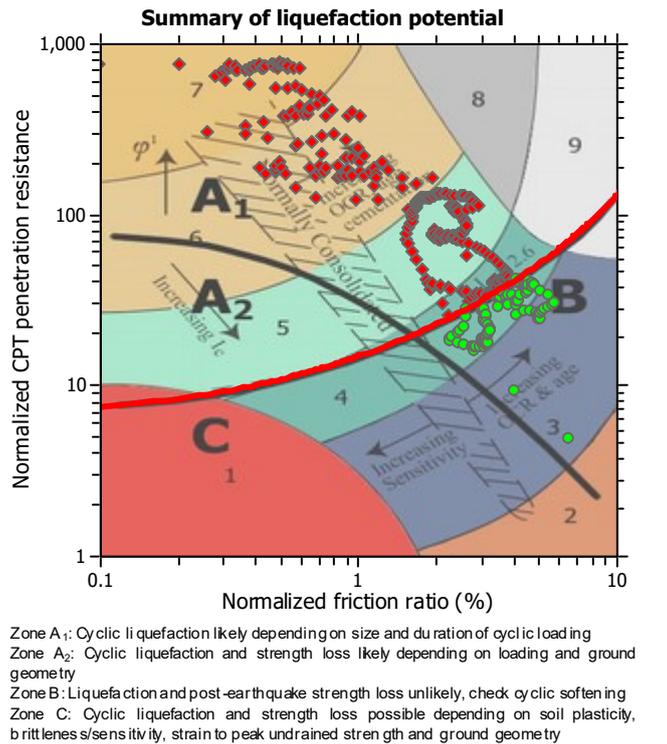
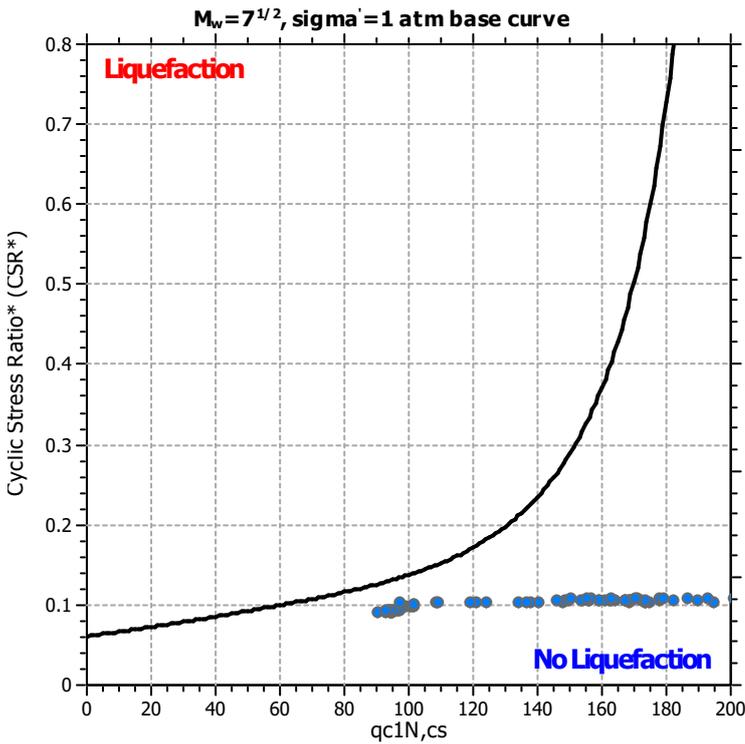
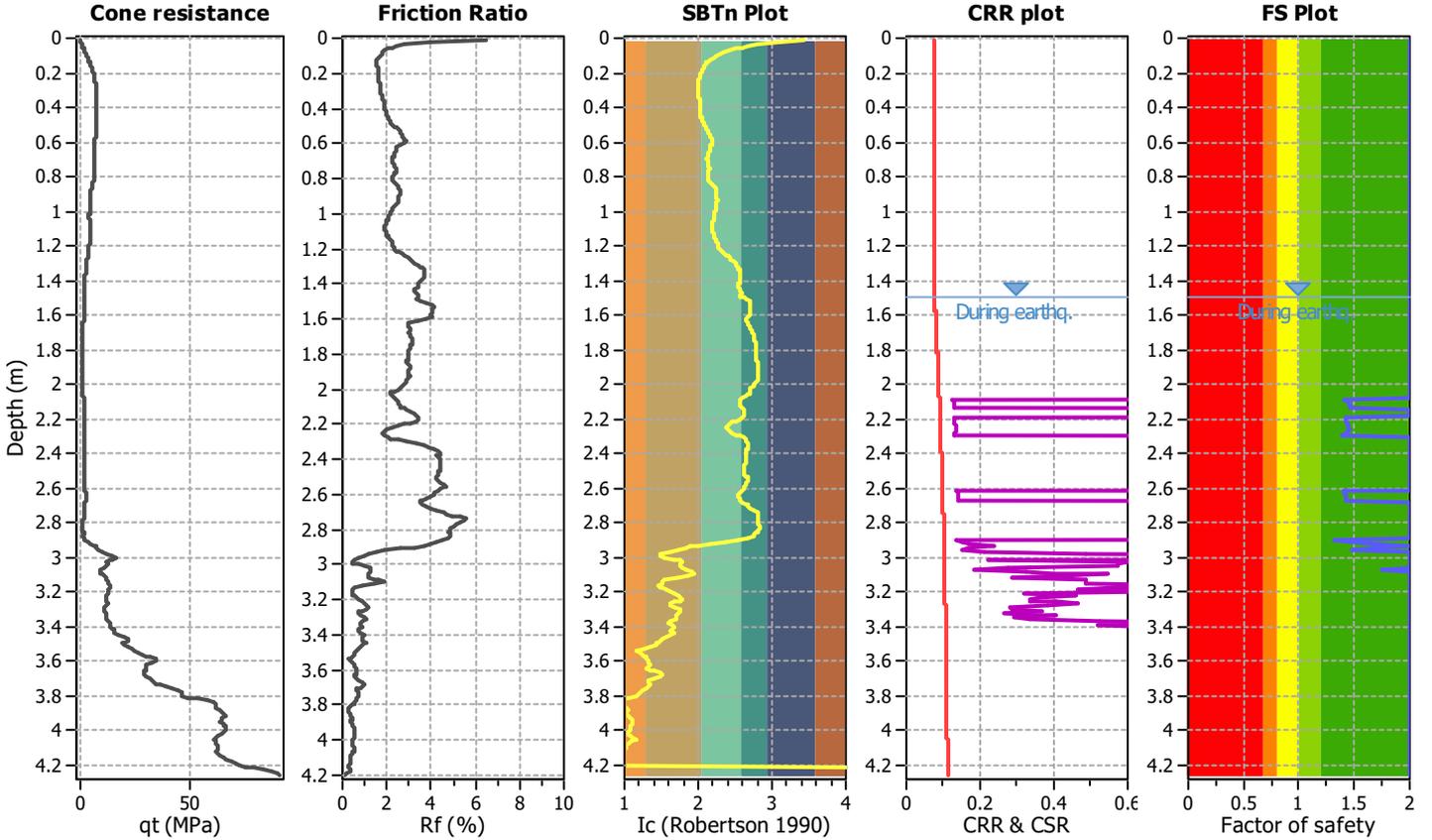
**Project title : K210318**

**Location : 232 Styx Mill Road, Casebrook, Christchurch**

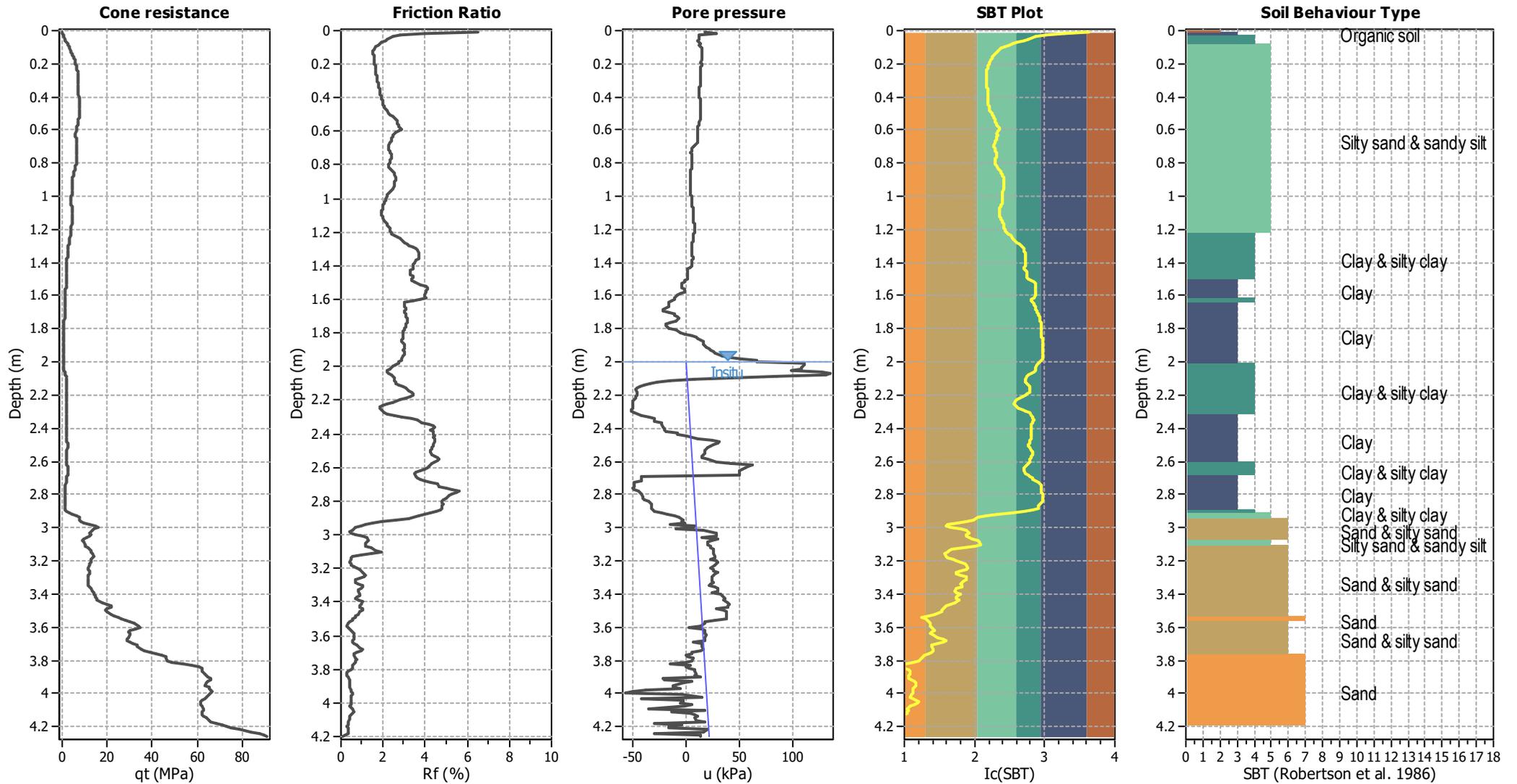
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Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
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### CPT basic interpretation plots



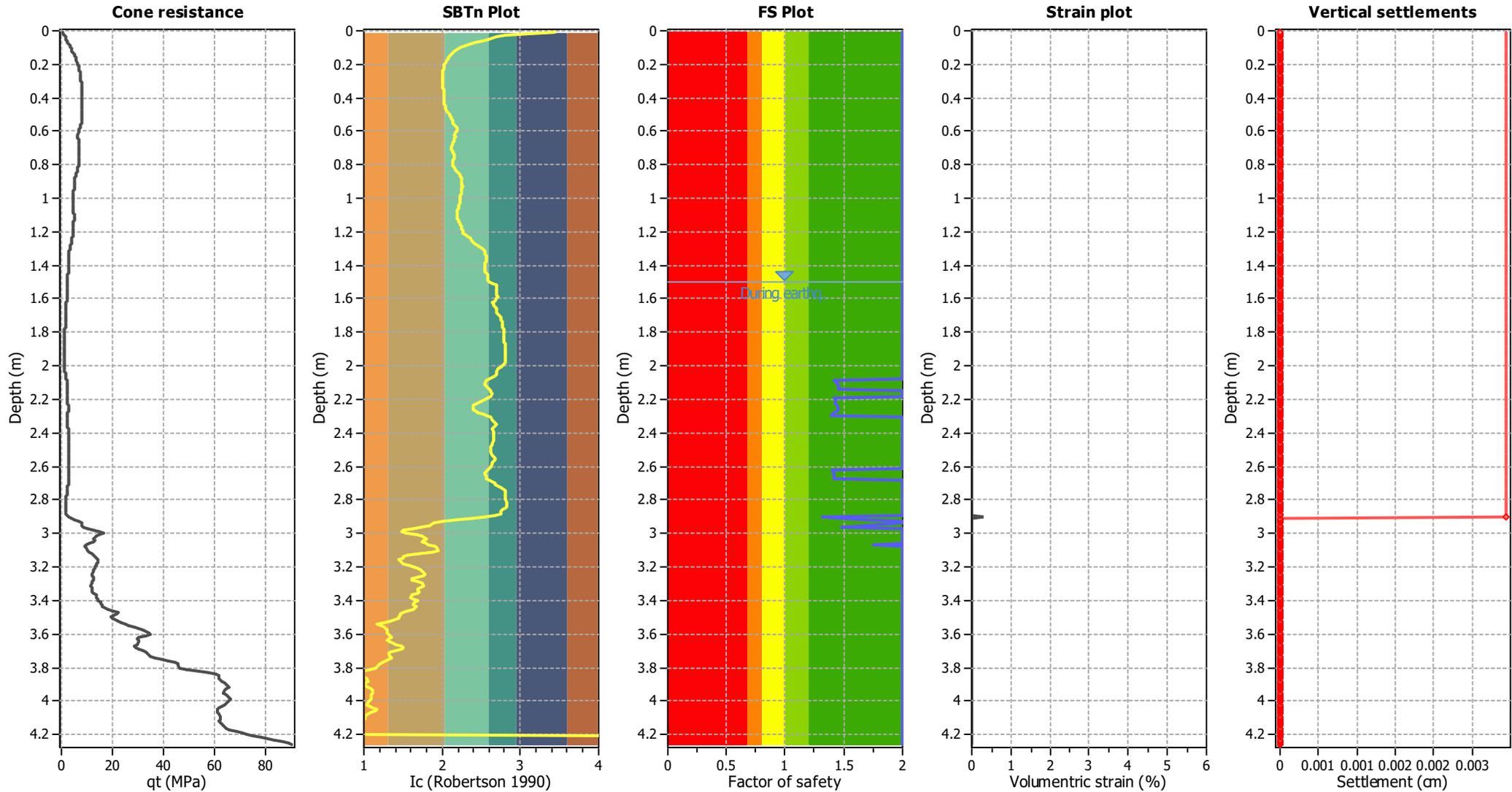
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Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	$K_v$ applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

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

**LIQUEFACTION ANALYSIS REPORT**

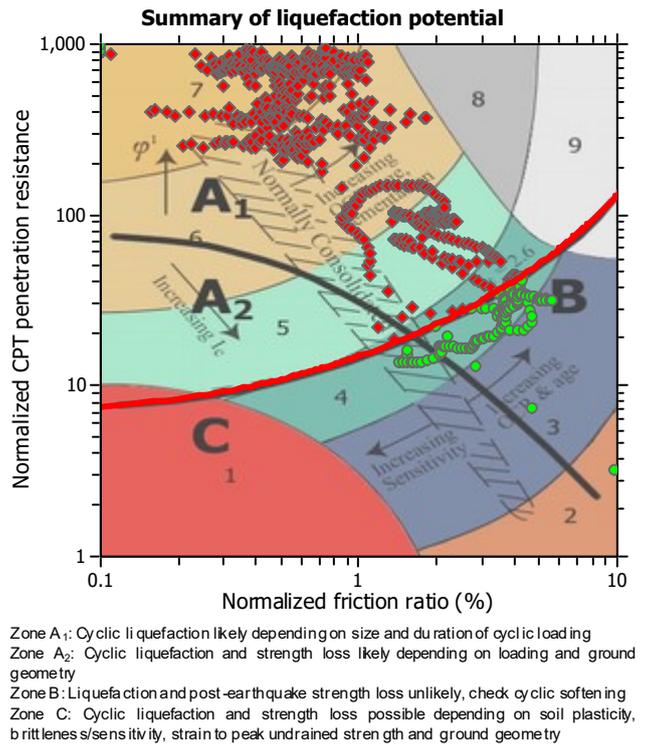
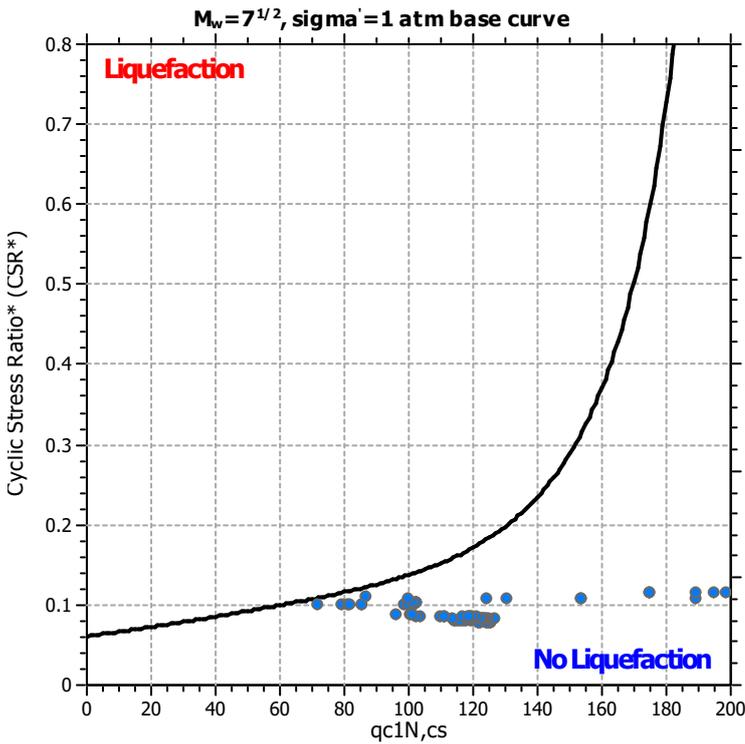
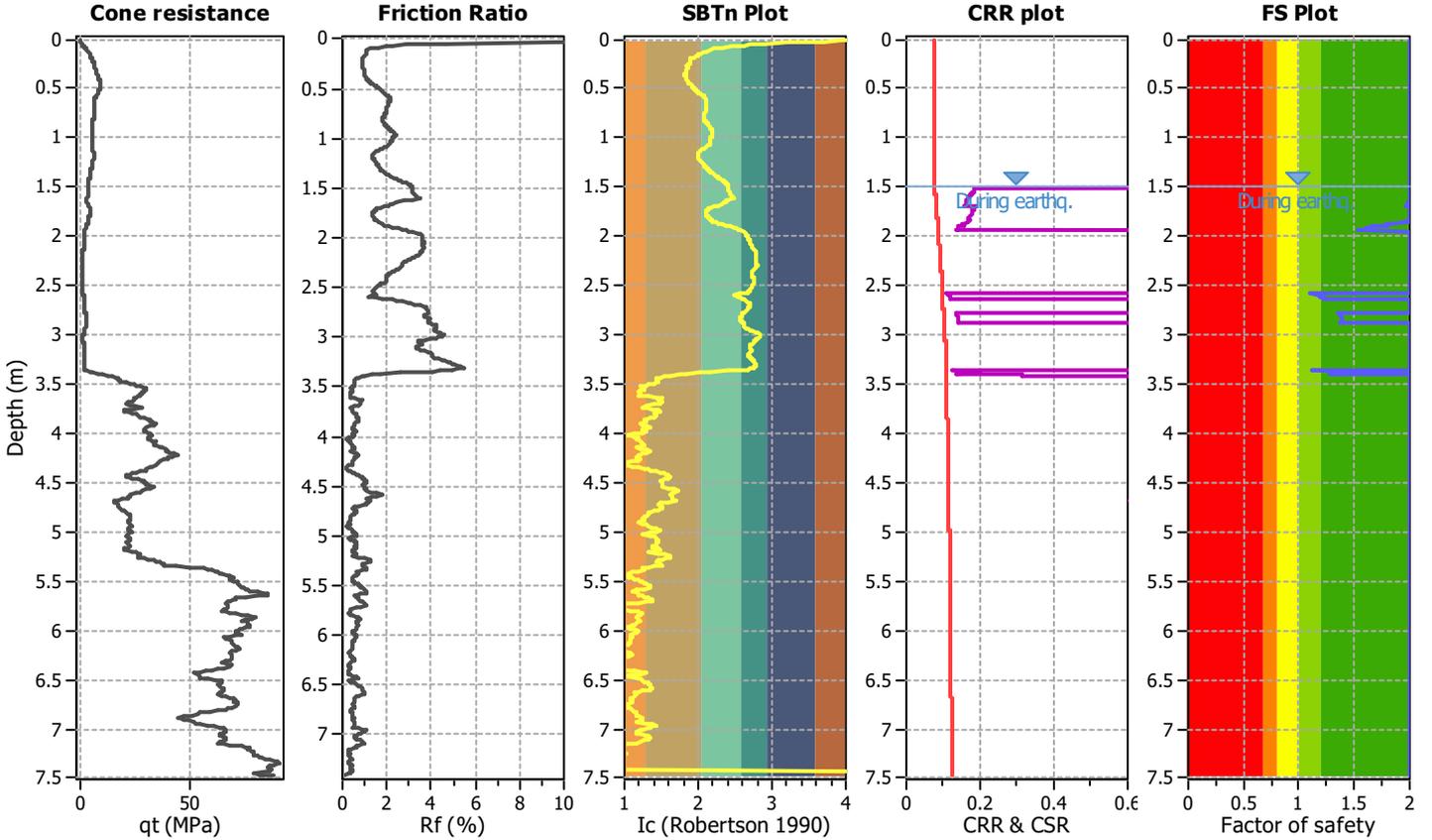
**Project title : K210318**

**Location : 232 Styx Mill Road, Casebrook, Christchurch**

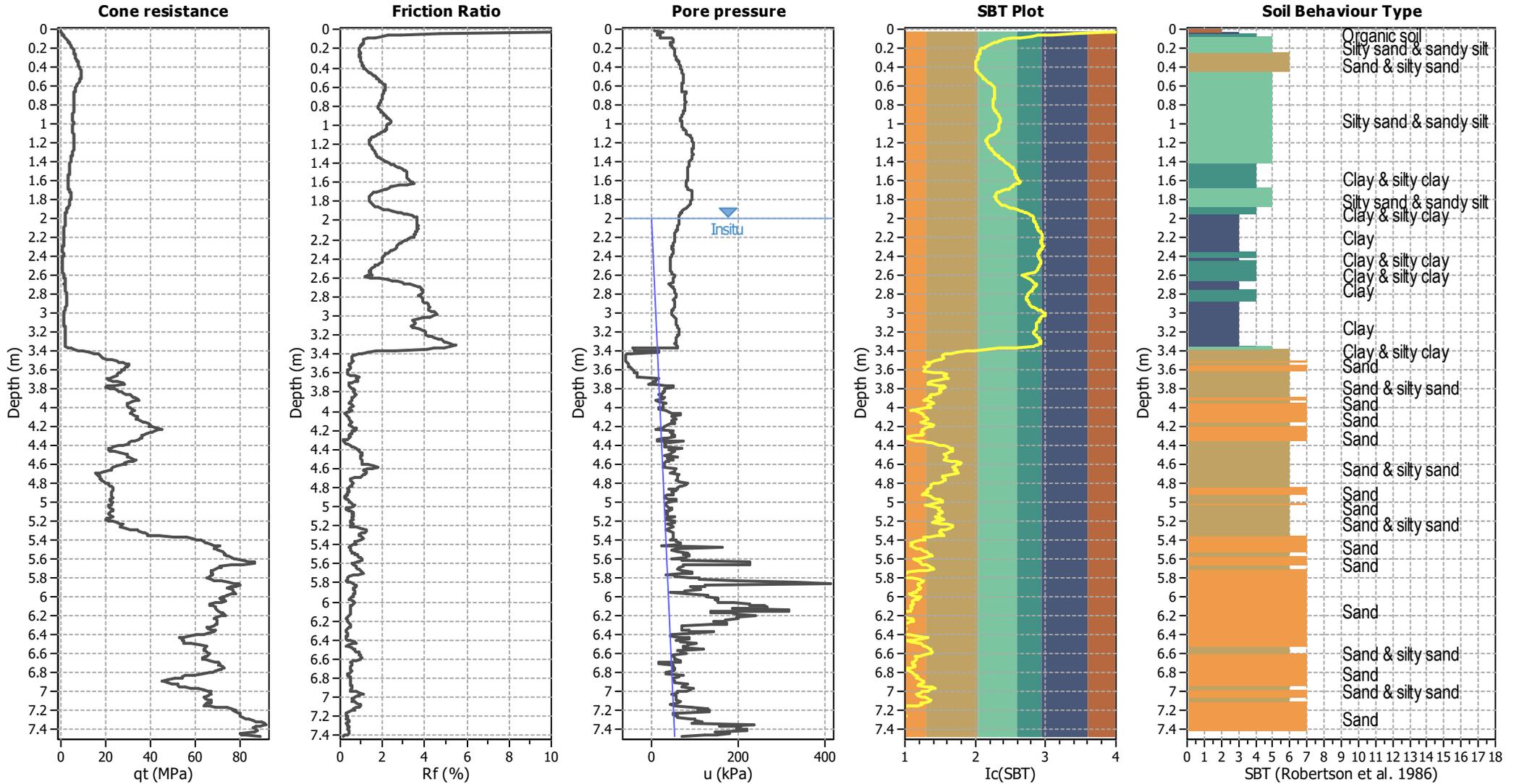
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Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
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### CPT basic interpretation plots



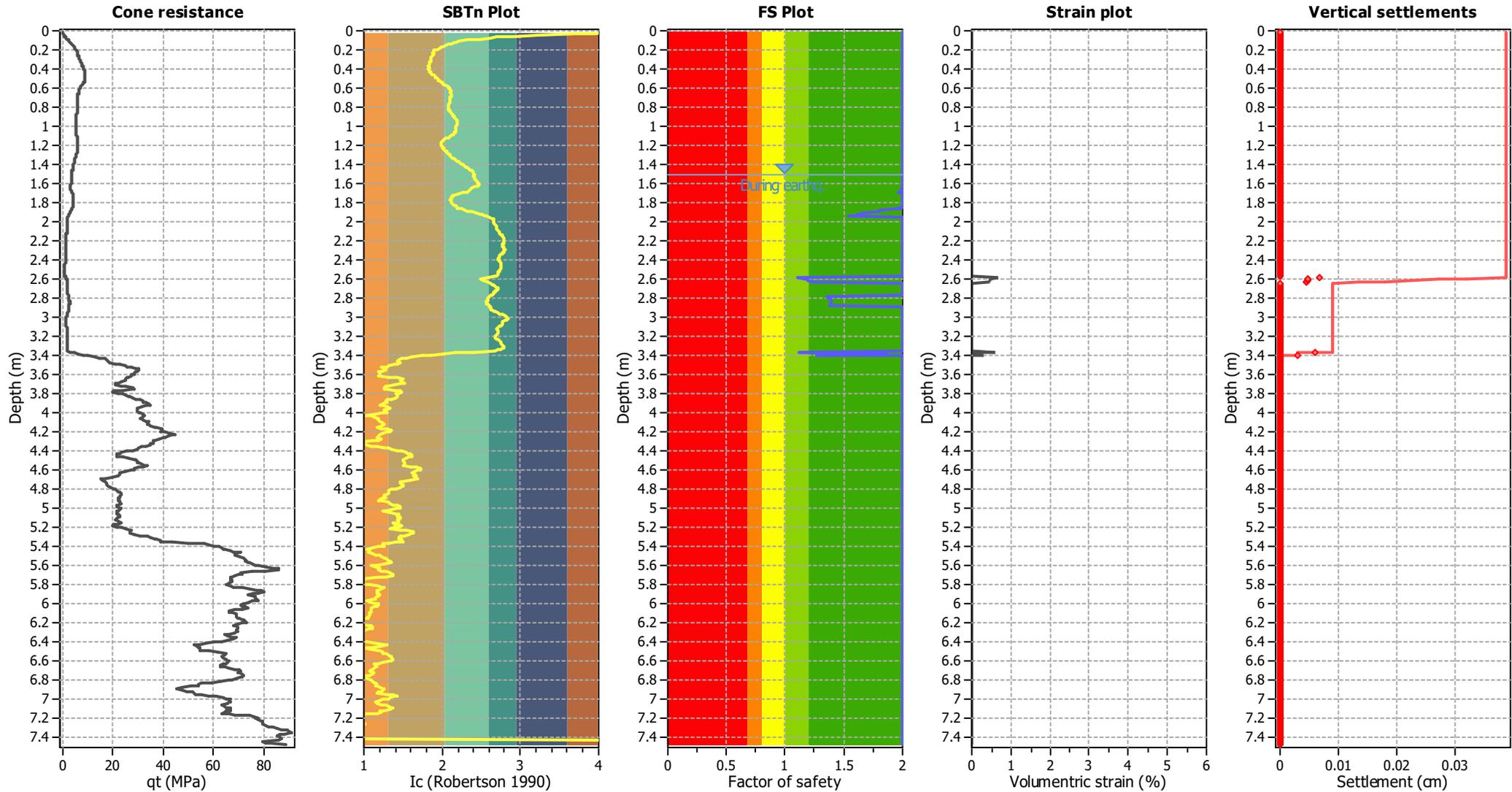
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Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

- qt: Total cone resistance (cone resistance q<sub>c</sub> corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

**LIQUEFACTION ANALYSIS REPORT**

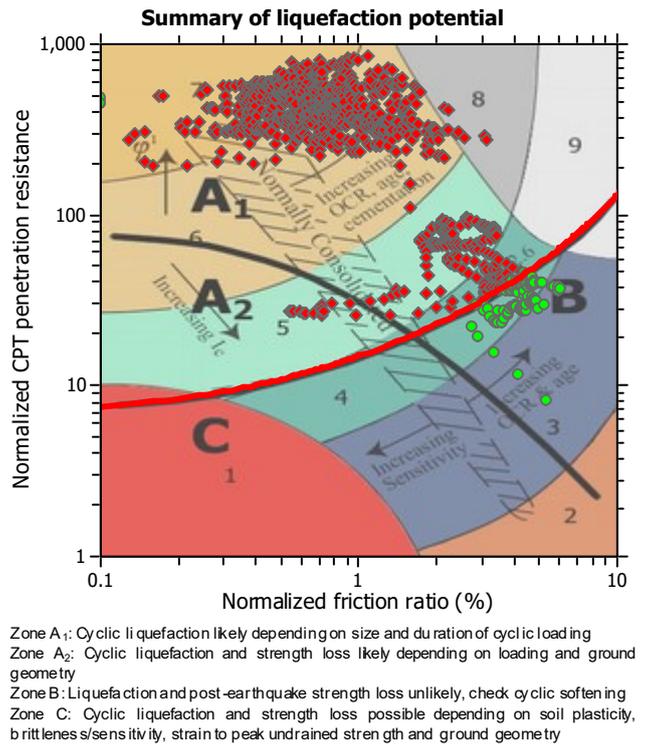
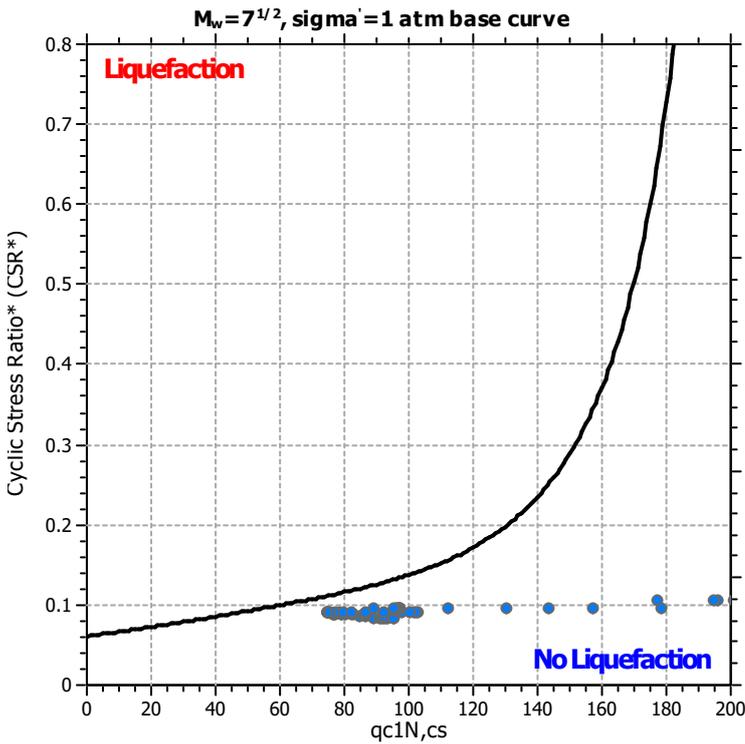
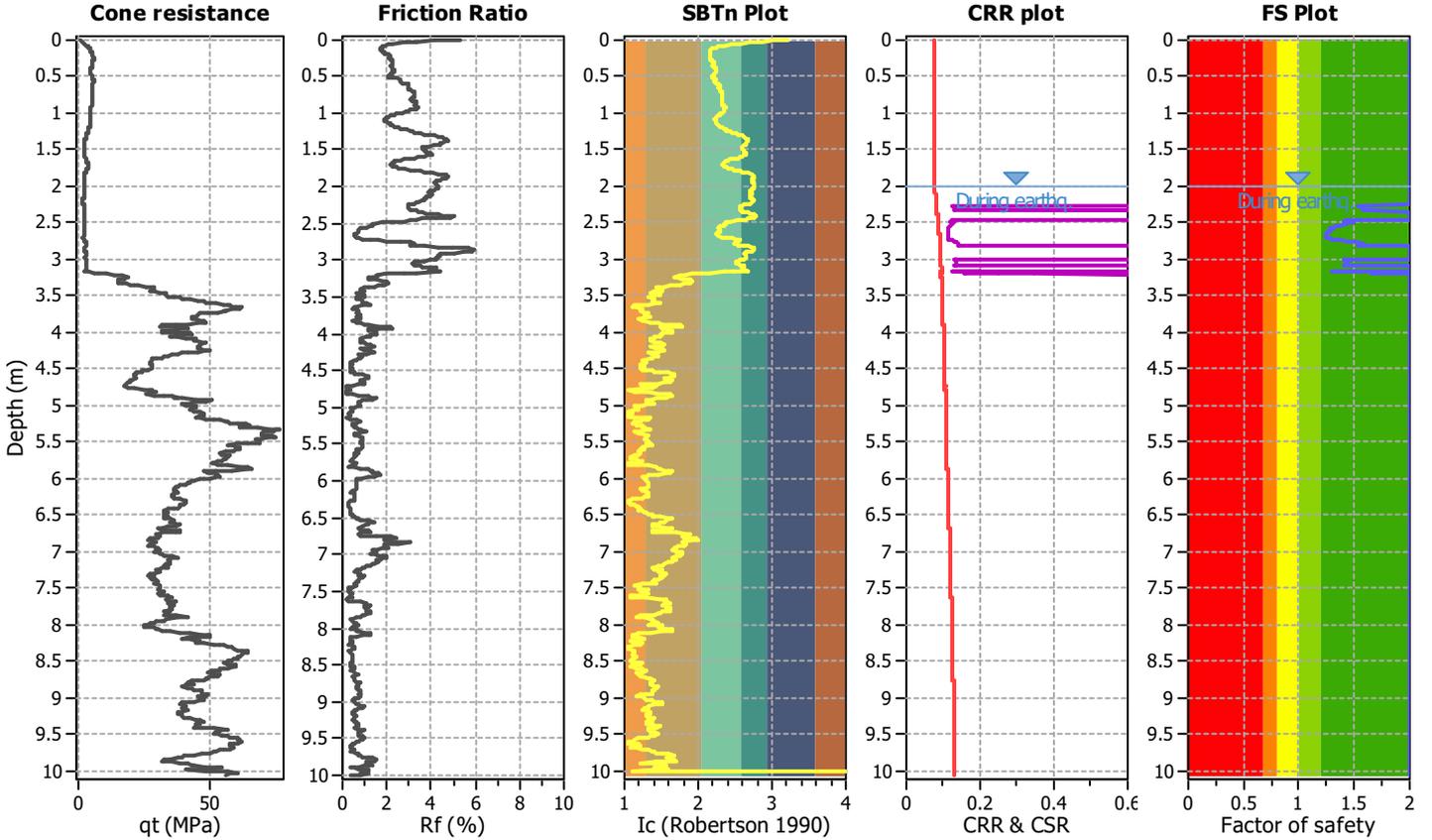
**Project title : K210318**

**Location : 232 Styx Mill Road, Casebrook, Christchurch**

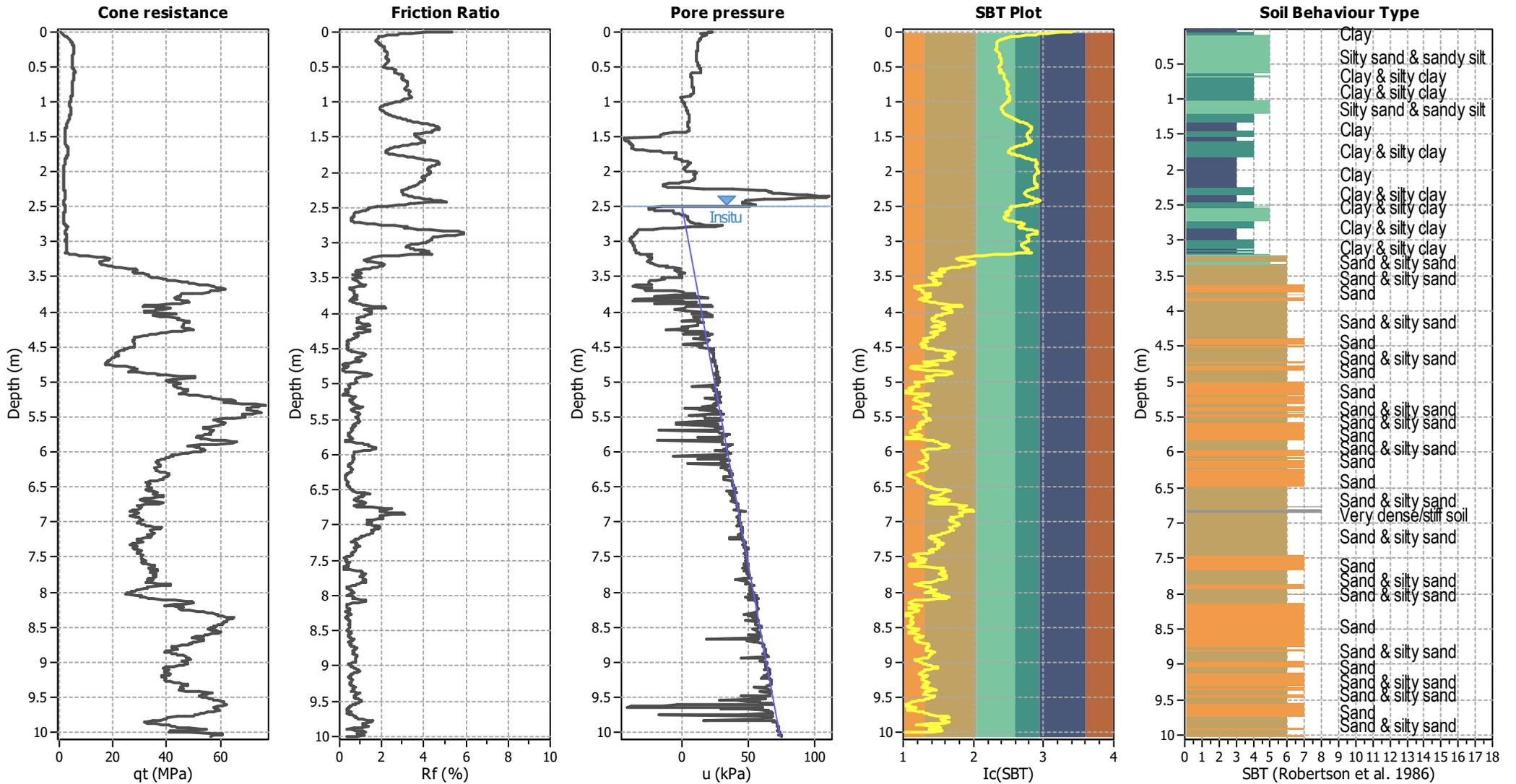
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Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.13	Unit weight calculation:	Based on SBT	$K_g$ applied:	Yes		



### CPT basic interpretation plots



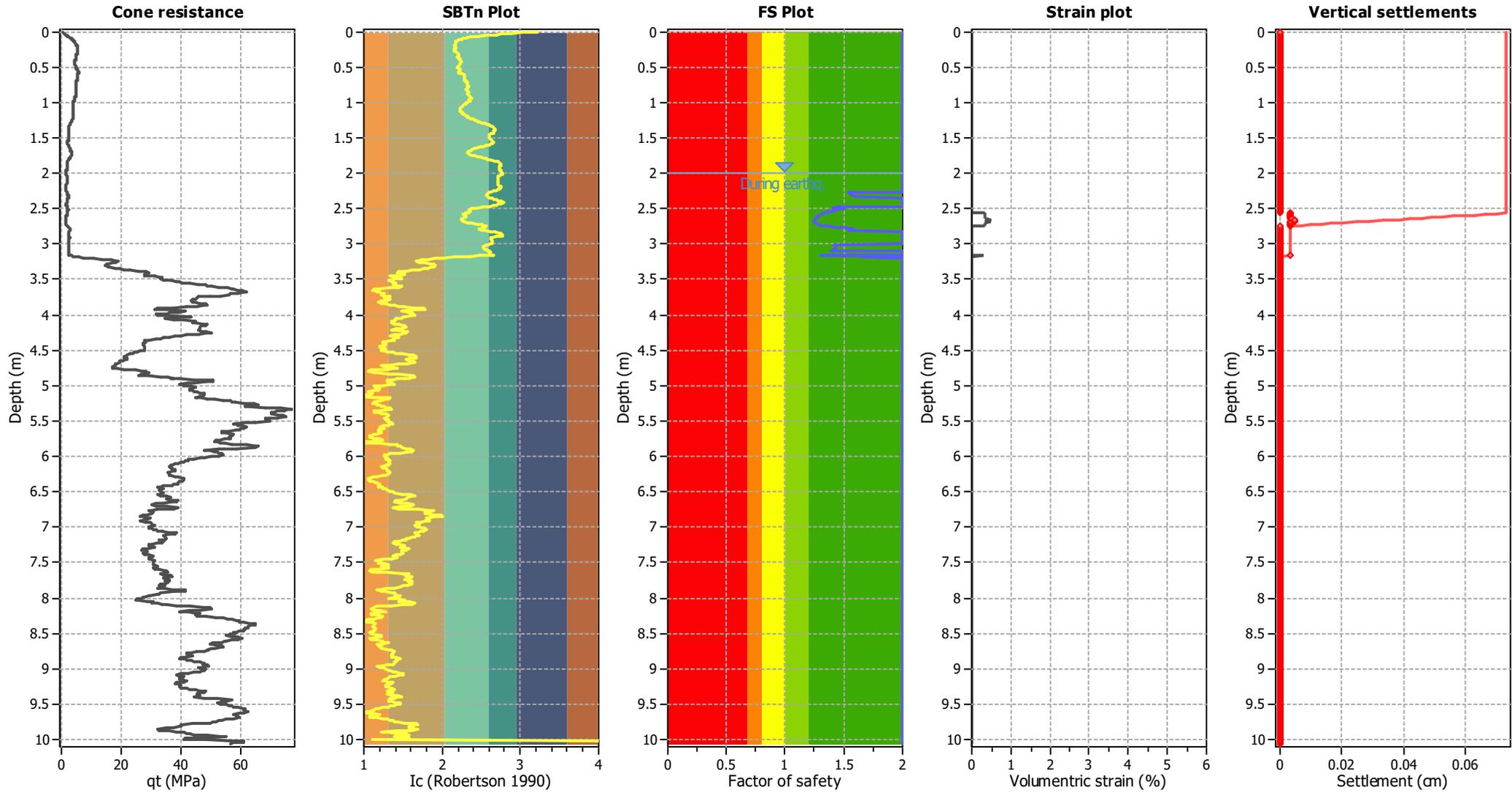
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Points to test:	Based on Ic value	Ic cut-off value:	2.60	$K_0$ applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

- qt: Total cone resistance (cone resistance q<sub>c</sub> corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

**LIQUEFACTION ANALYSIS REPORT**

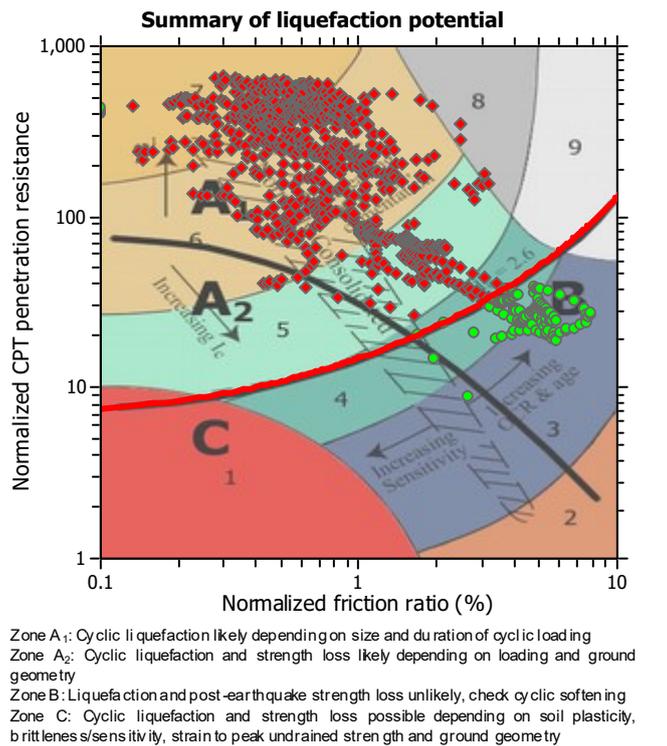
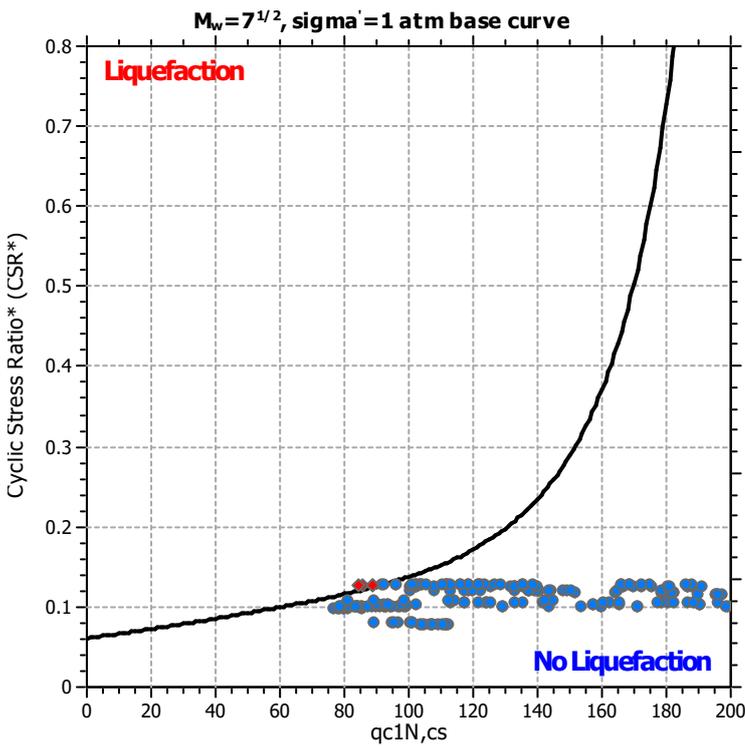
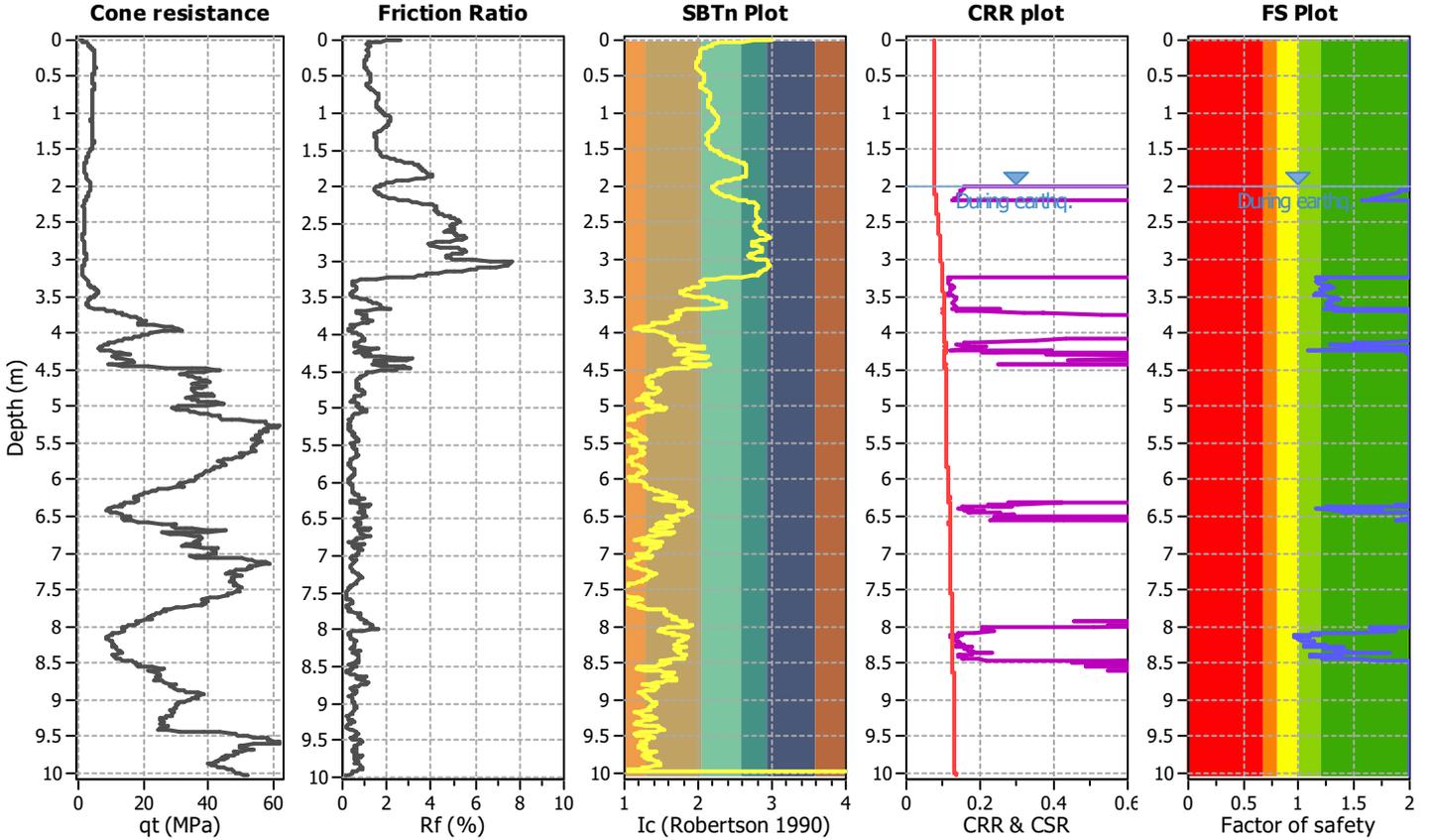
**Project title : K210318**

**Location : 232 Styx Mill Road, Casebrook, Christchurch**

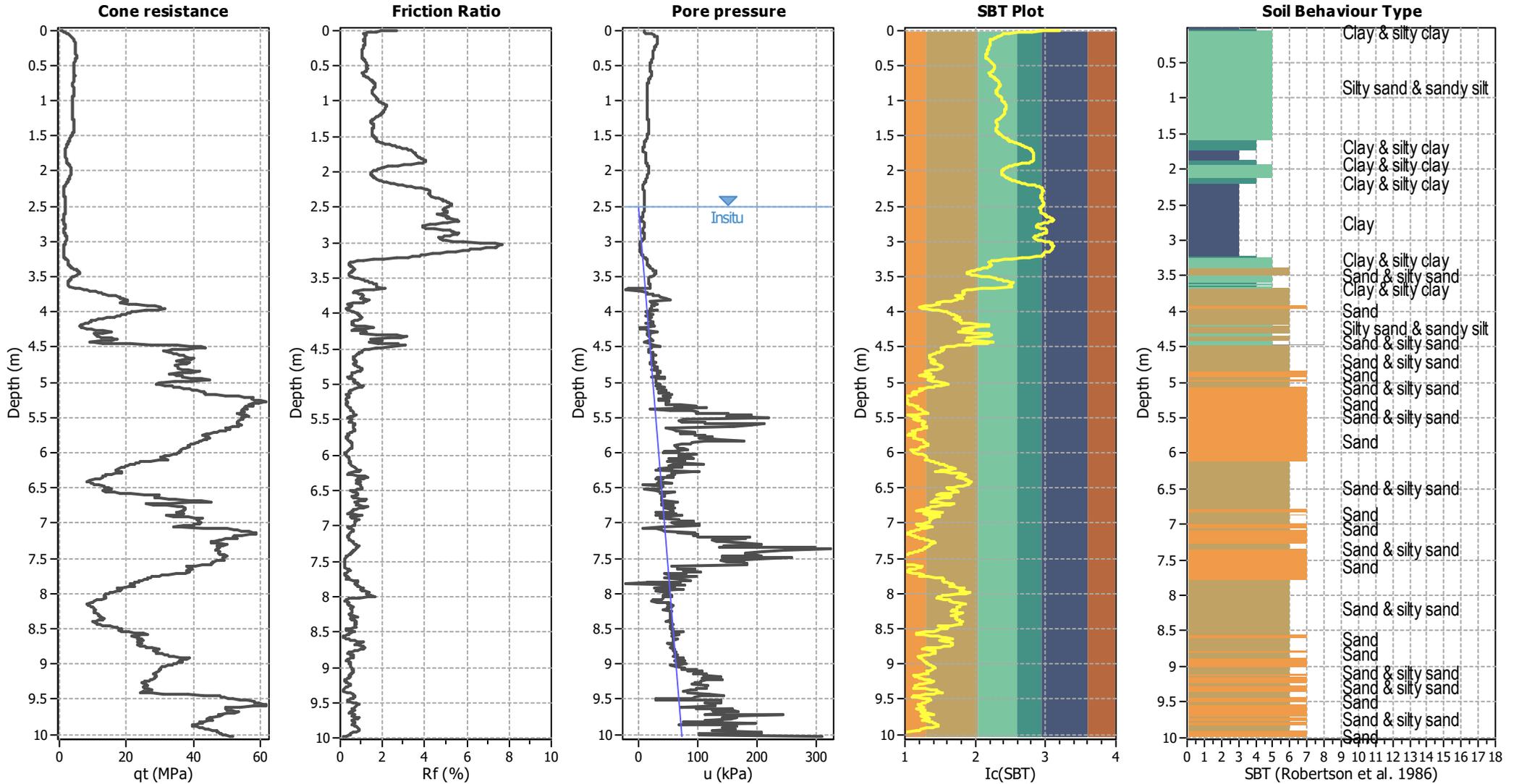
**CPT file : CPT-04 SLS1**

**Input parameters and analysis data**

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Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.13	Unit weight calculation:	Based on SBT	$K_g$ applied:	Yes		



### CPT basic interpretation plots



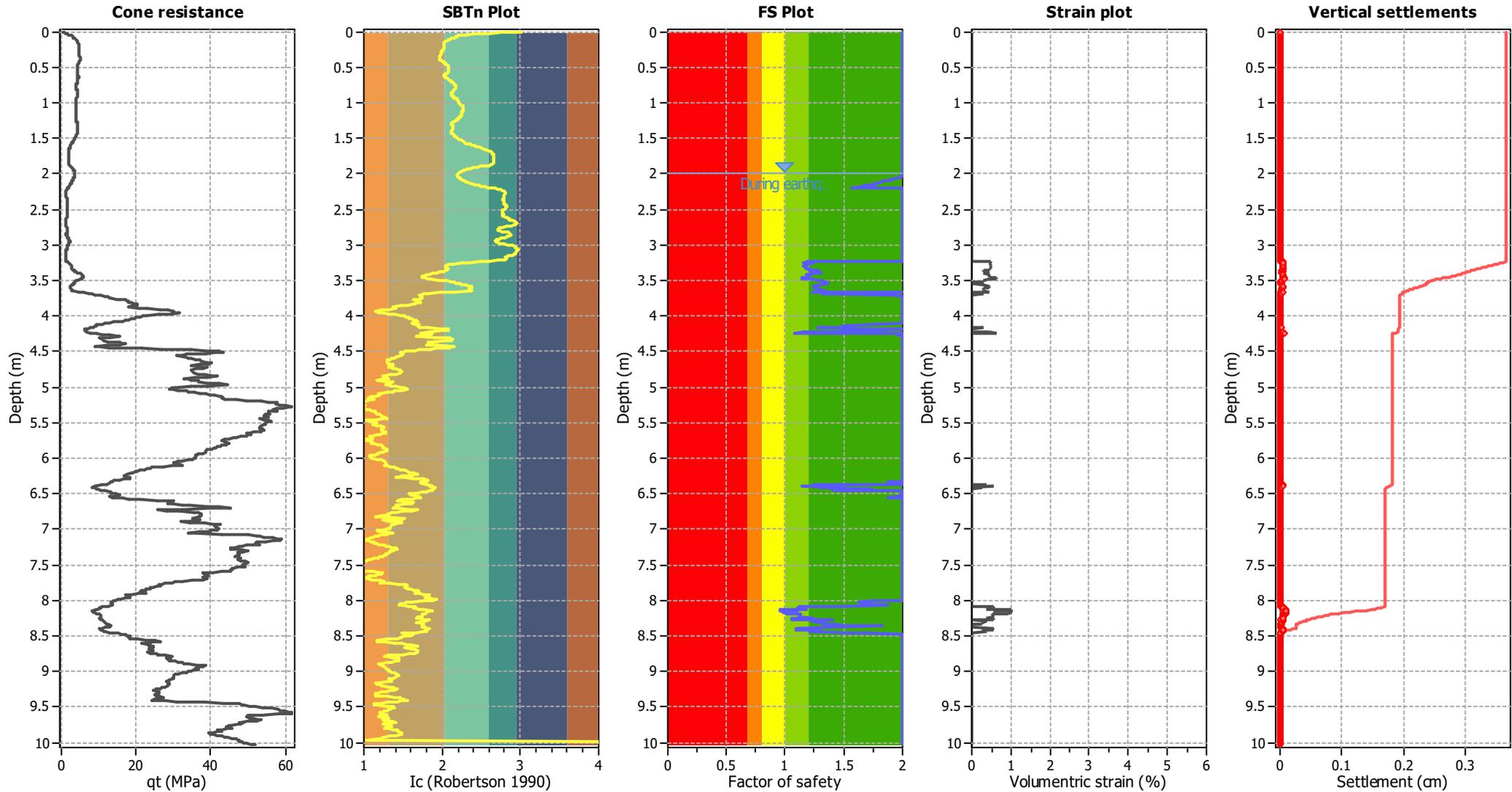
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Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K <sub>0</sub> applied:	Yes
Earthquake magnitude M <sub>w</sub> :	7.50	Unit weight calculation:	Based on SBT	Clay like beha vior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

- q<sub>t</sub>: Total cone resistance (cone resistance q<sub>c</sub> corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

**LIQUEFACTION ANALYSIS REPORT**

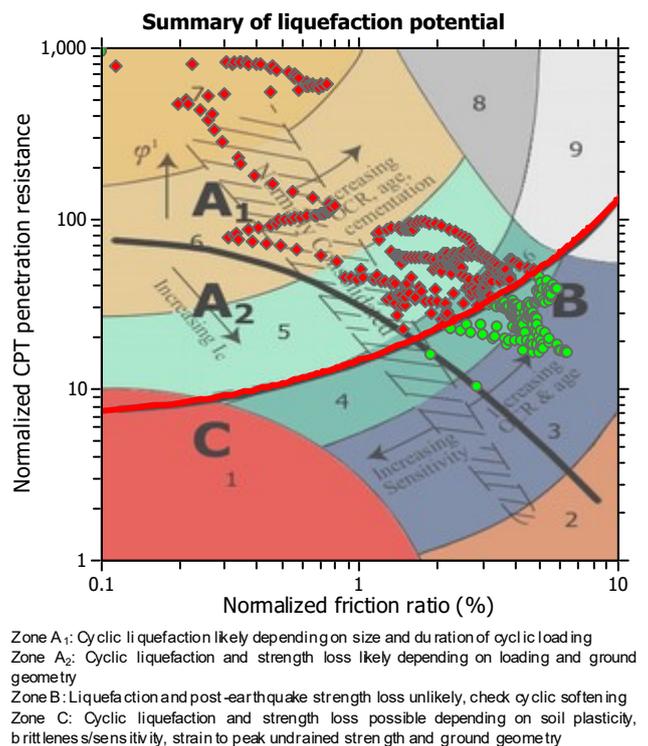
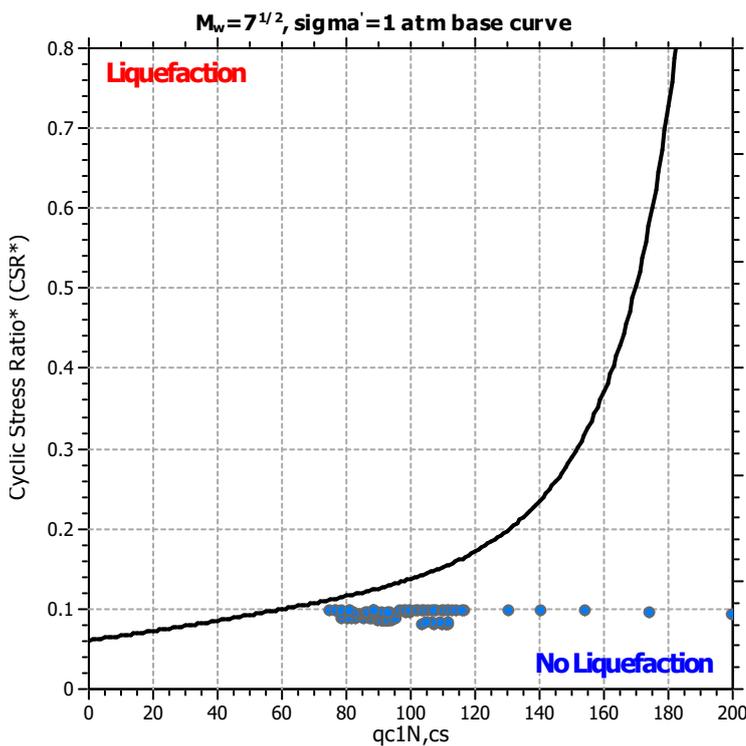
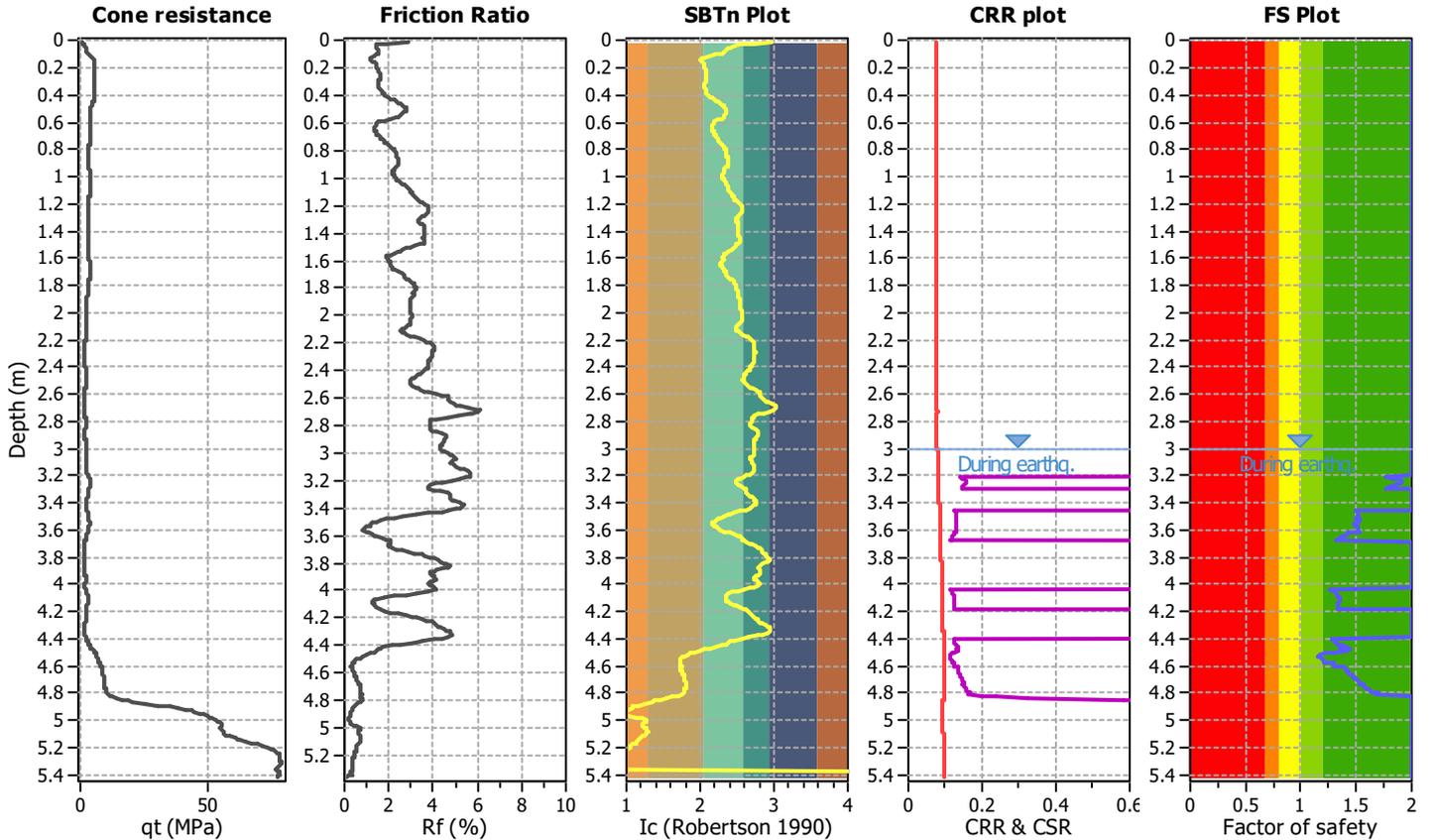
**Project title : K210318**

**Location : 232 Styx Mill Road, Casebrook, Christchurch**

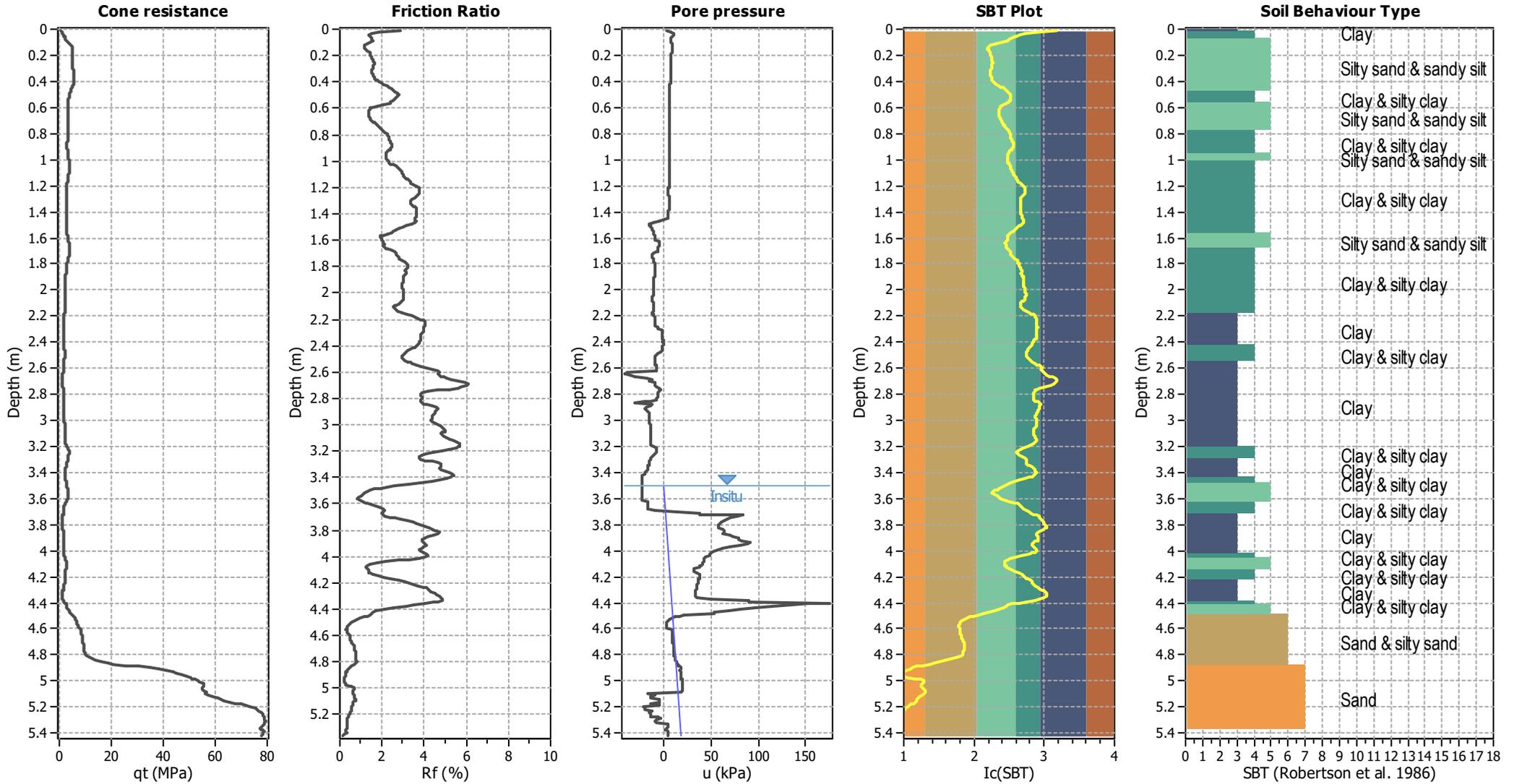
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**Input parameters and analysis data**

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Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.00 m	Fill height:	N/A	applied:	Sands only
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.13	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes	MSF method:	Method based



### CPT basic interpretation plots



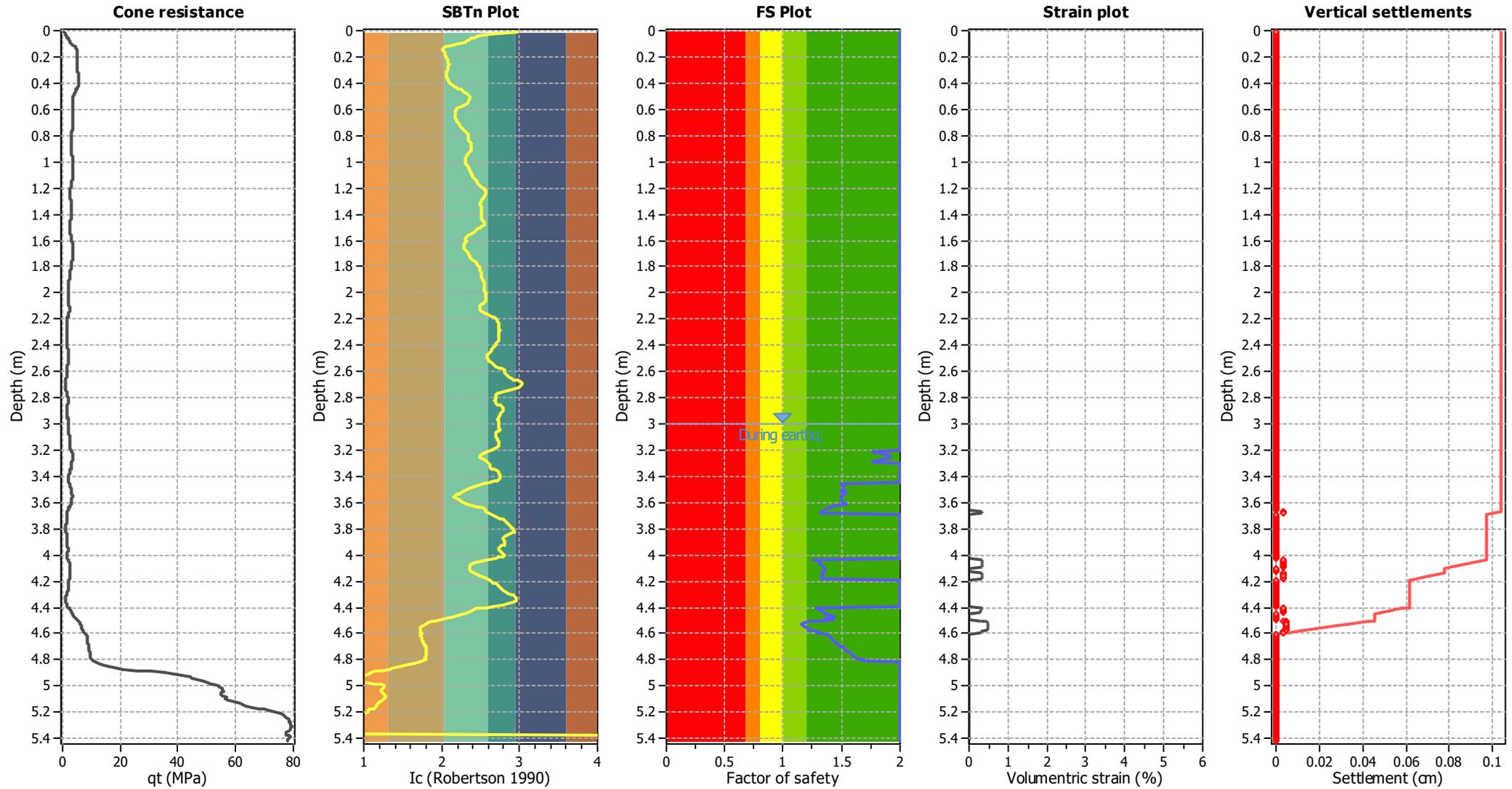
#### Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 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:	No
Depth to water table (insitu):	3.50 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

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

**LIQUEFACTION ANALYSIS REPORT**

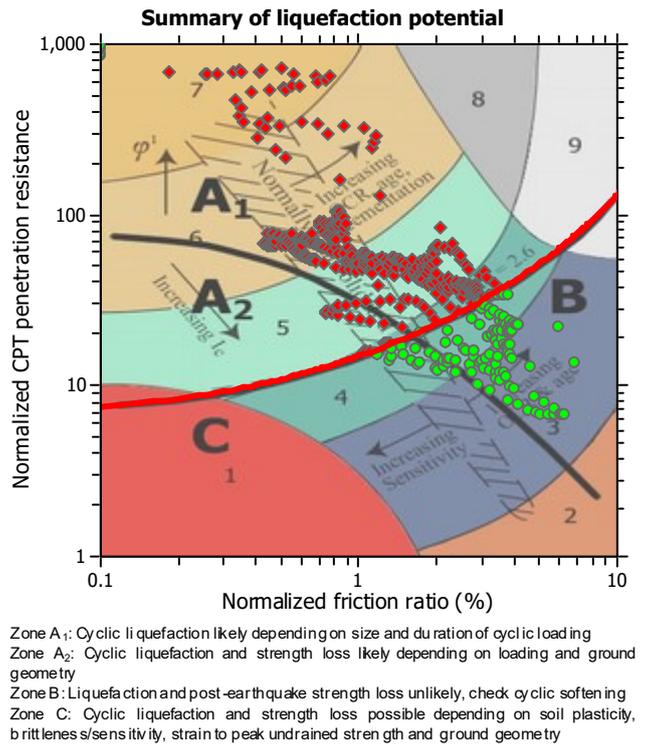
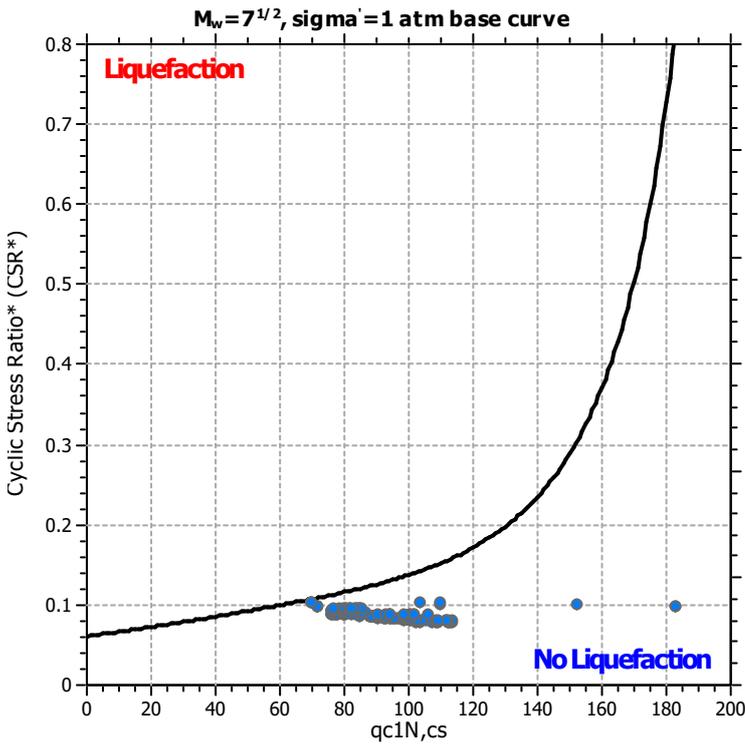
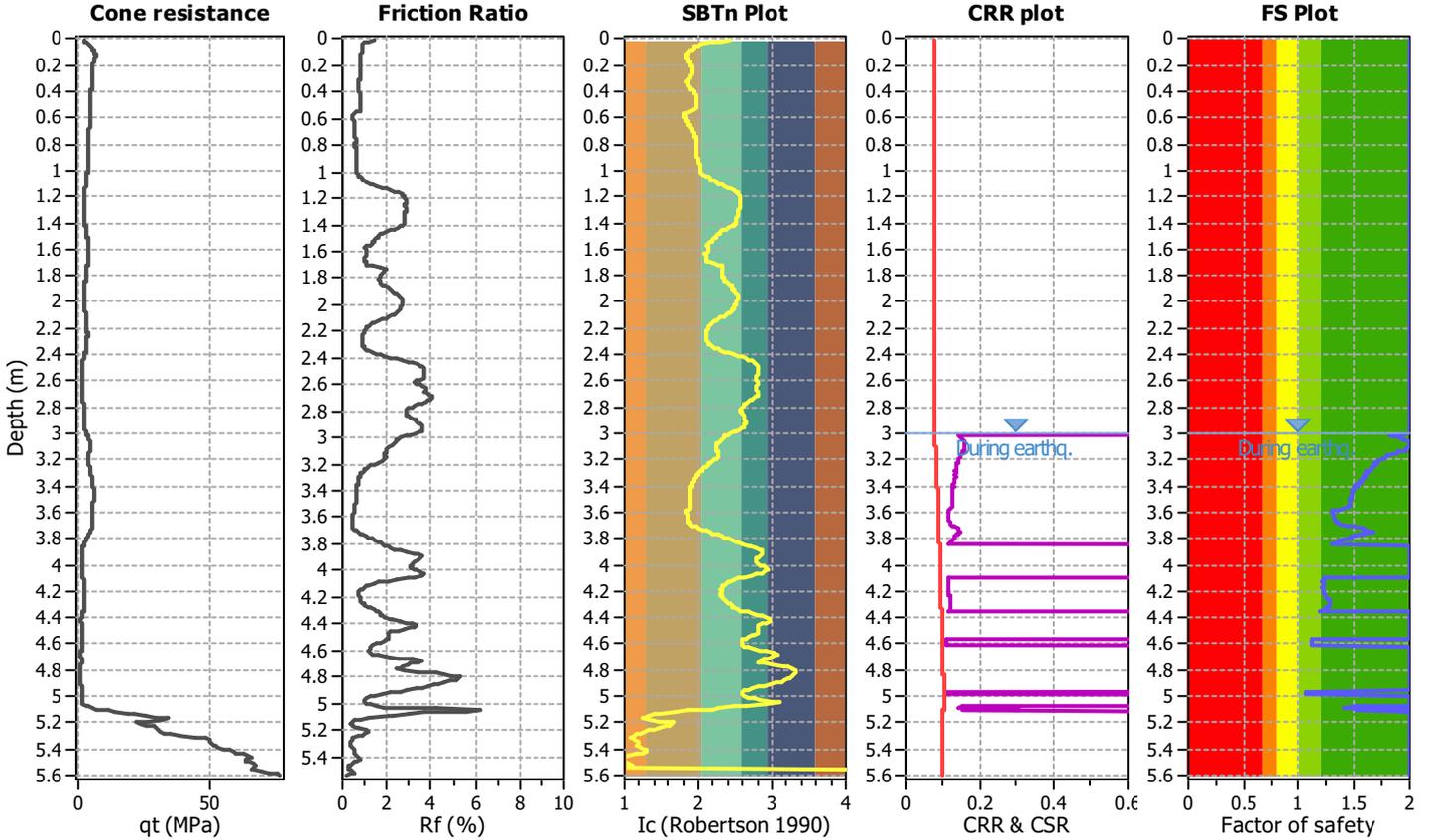
**Project title : K210318**

**Location : 232 Styx Mill Road, Casebrook, Christchurch**

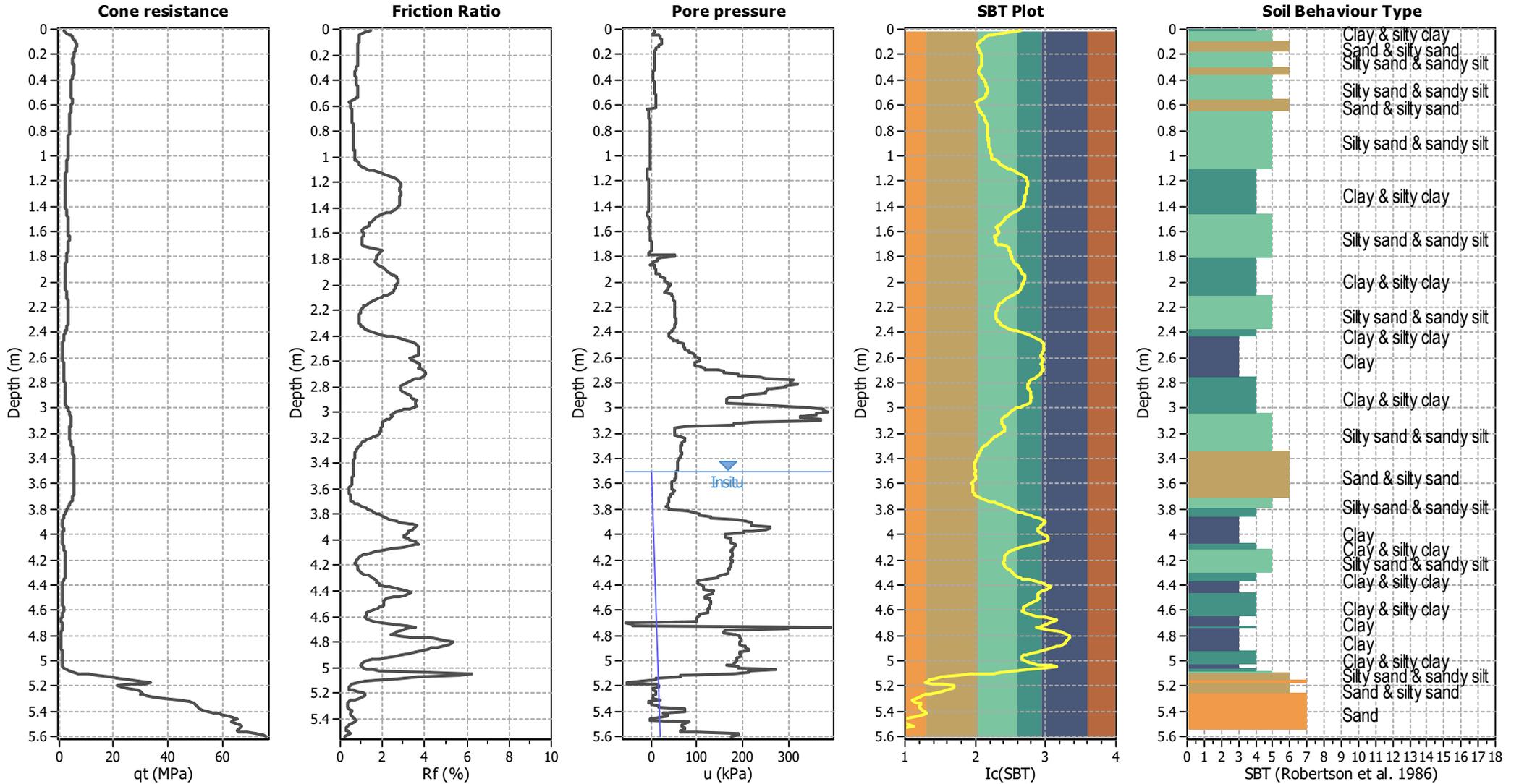
**CPT file : CPT-06 SLS1**

**Input parameters and analysis data**

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Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.00 m	Fill height:	N/A	applied:	Sands only
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.13	Unit weight calculation:	Based on SBT	$K_g$ applied:	Yes	MSF method:	Method based



### CPT basic interpretation plots



#### Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 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	$K_v$ 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:	No
Depth to water table (insitu):	3.50 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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



**LIQUEFACTION ANALYSIS REPORT**

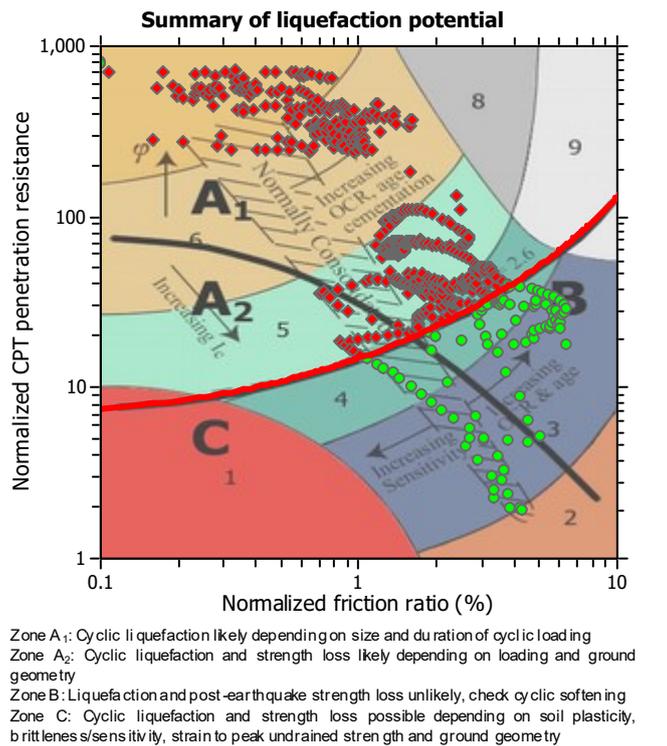
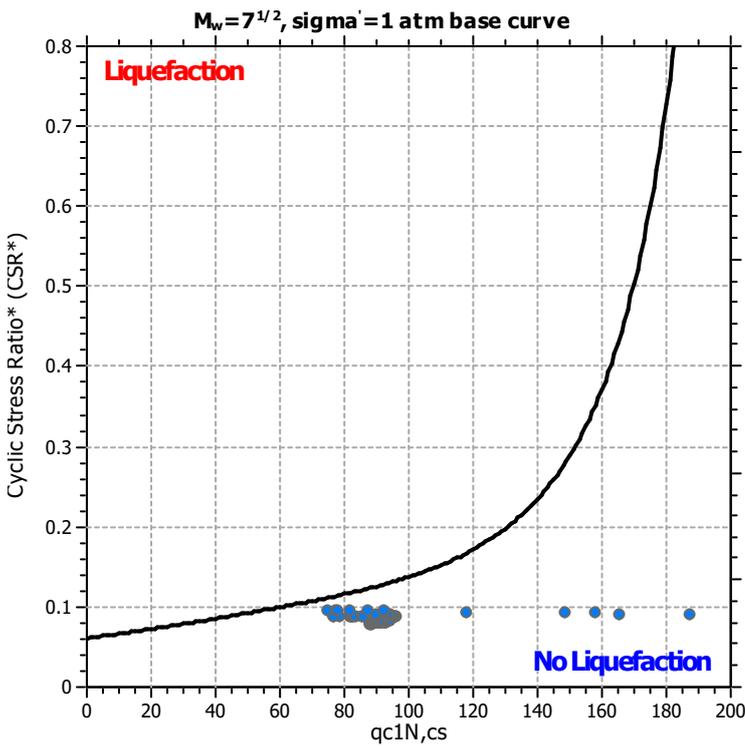
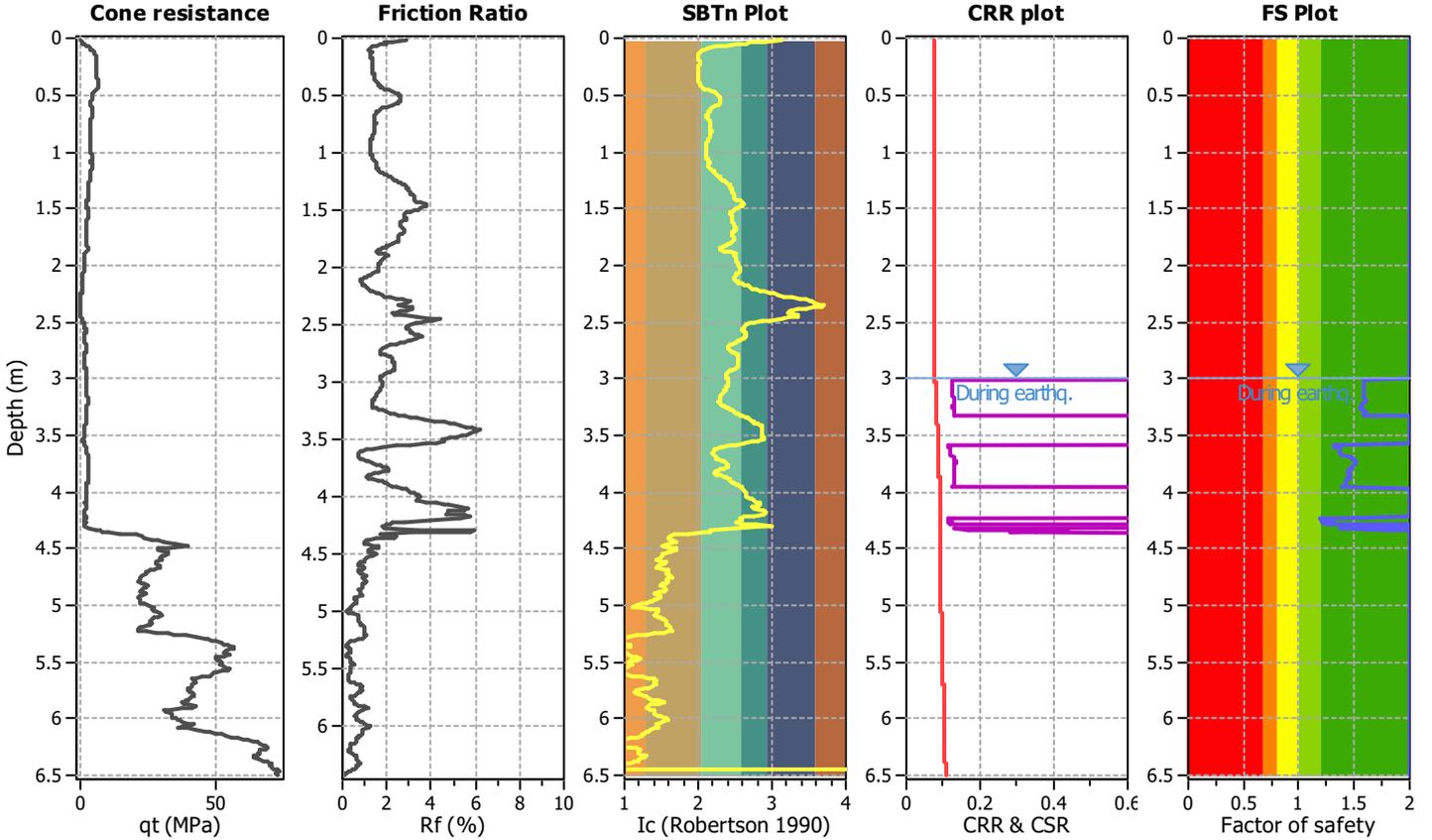
**Project title : K210318**

**Location : 232 Styx Mill Road, Casebrook, Christchurch**

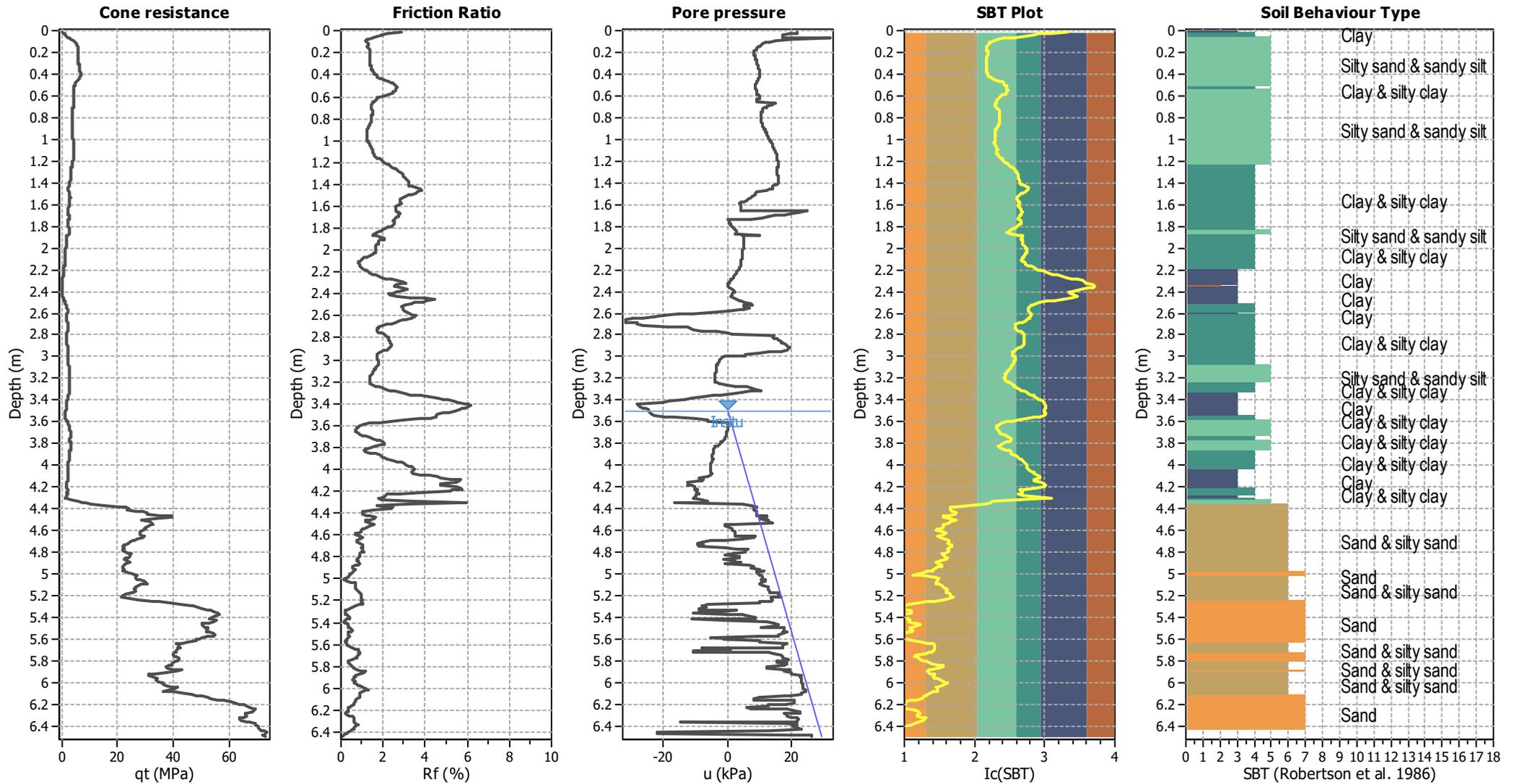
**CPT file : CPT-07 SLS1**

**Input parameters and analysis data**

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Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.13	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes		



### CPT basic interpretation plots



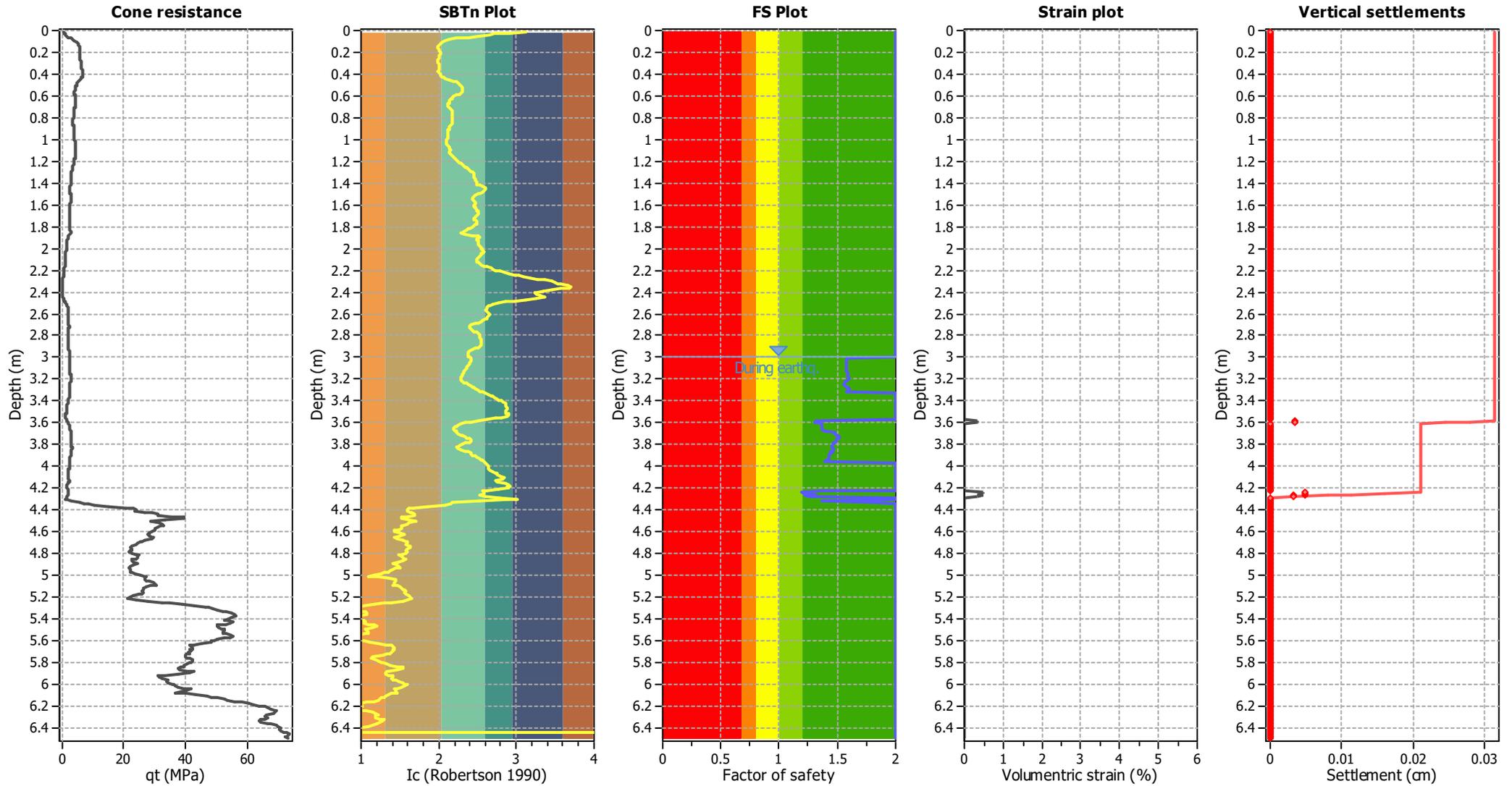
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Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	$K_v$ applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

- qt: Total cone resistance (cone resistance q corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

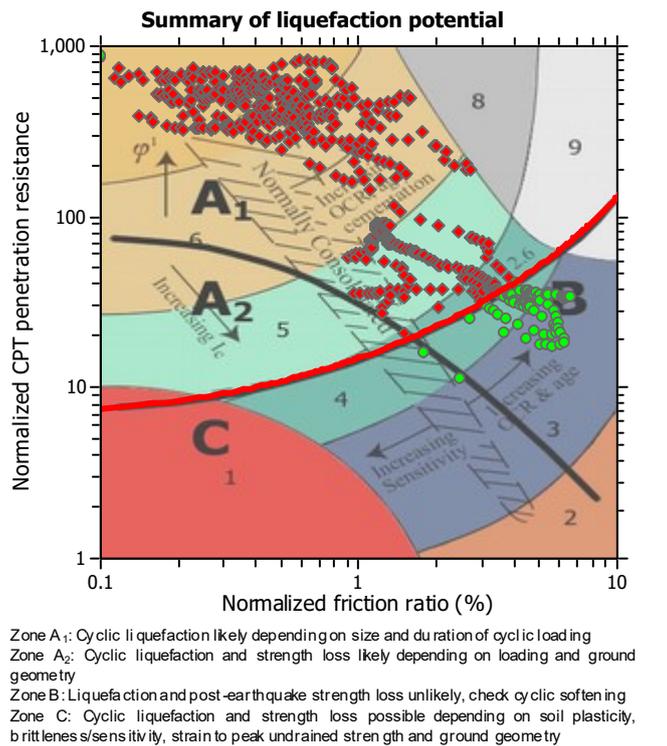
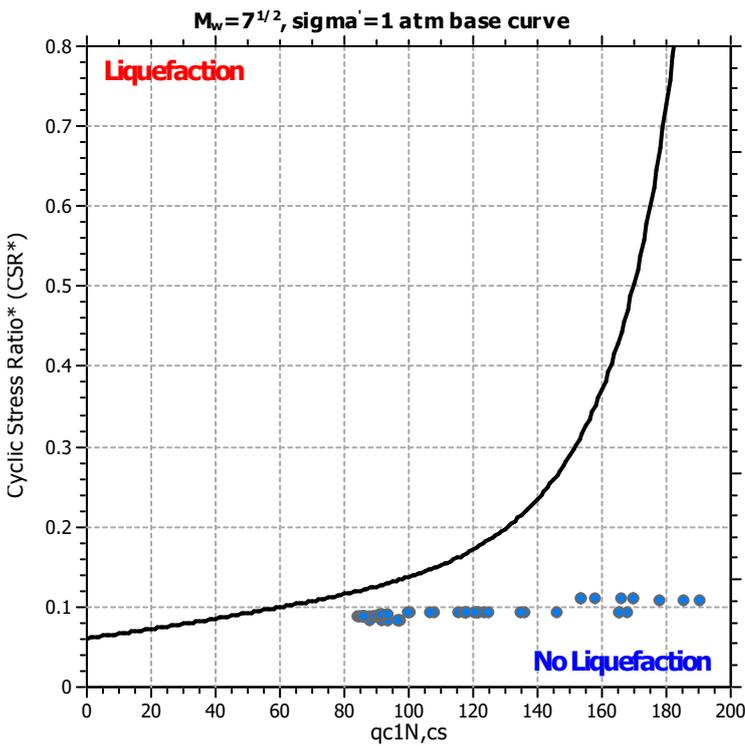
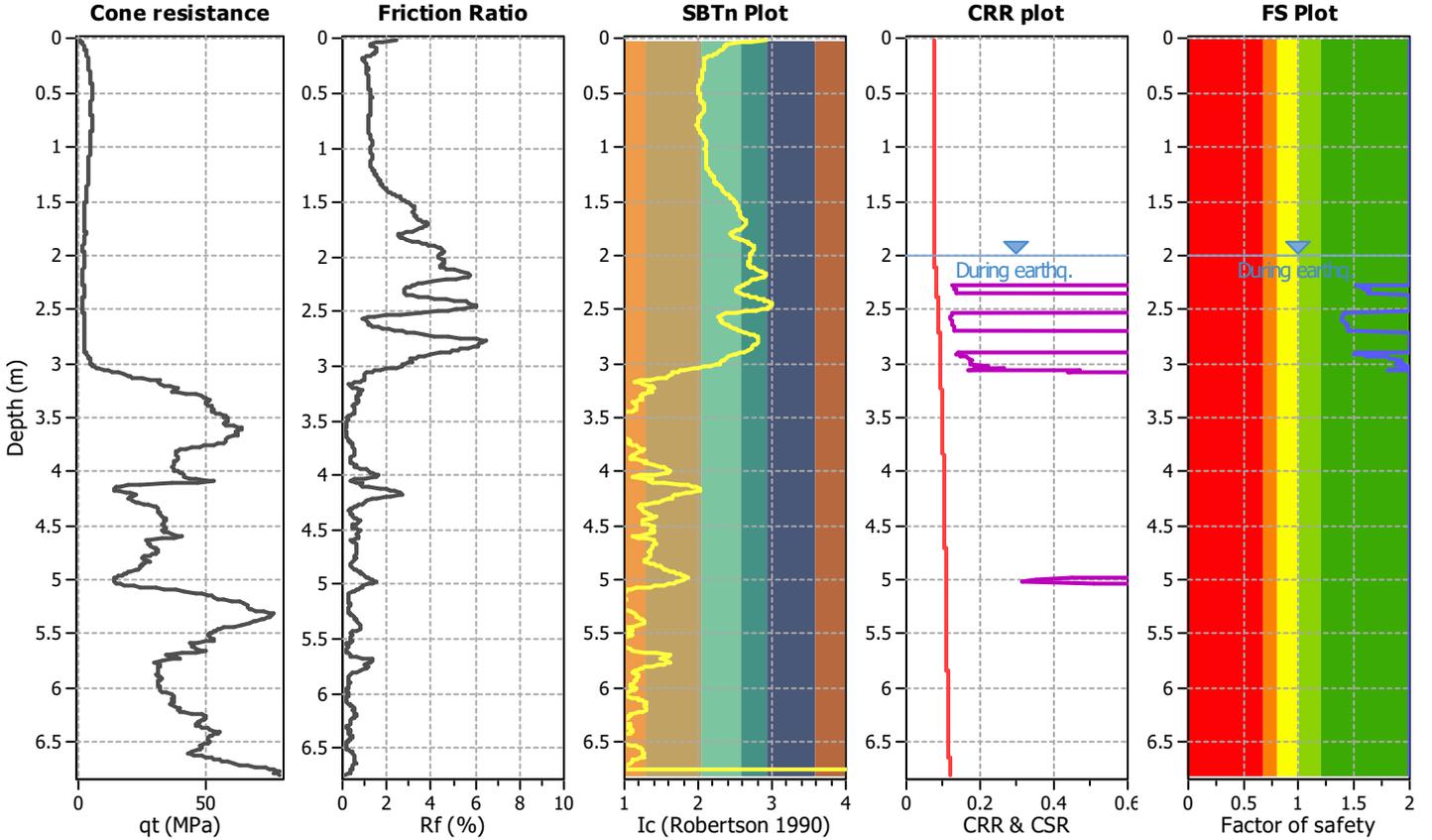
**LIQUEFACTION ANALYSIS REPORT**

**Project title : K210318**  
**CPT file : CPT-08 SLS1**

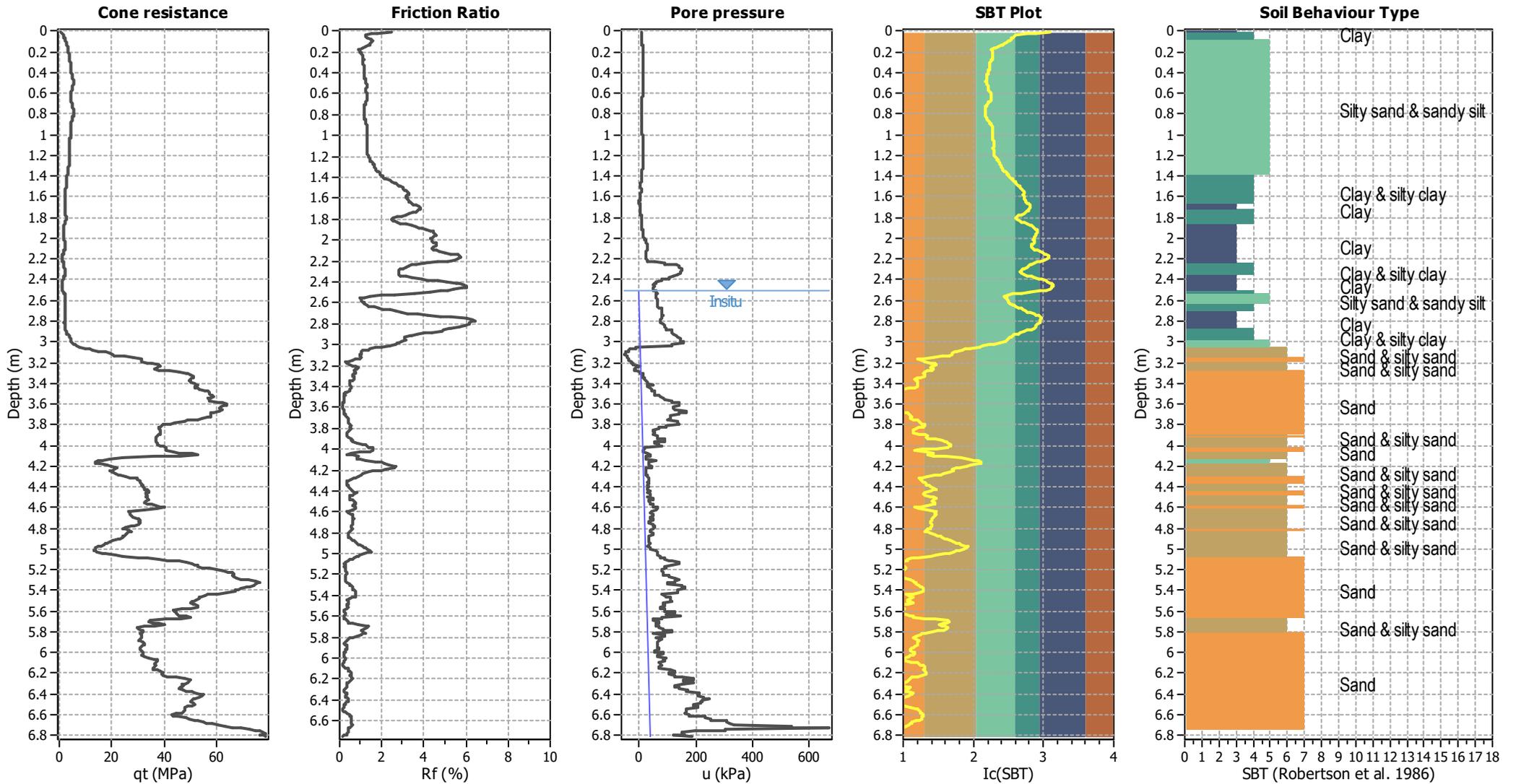
**Location : 232 Styx Mill Road, Casebrook, Christchurch**

**Input parameters and analysis data**

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Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.13	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes		



### CPT basic interpretation plots



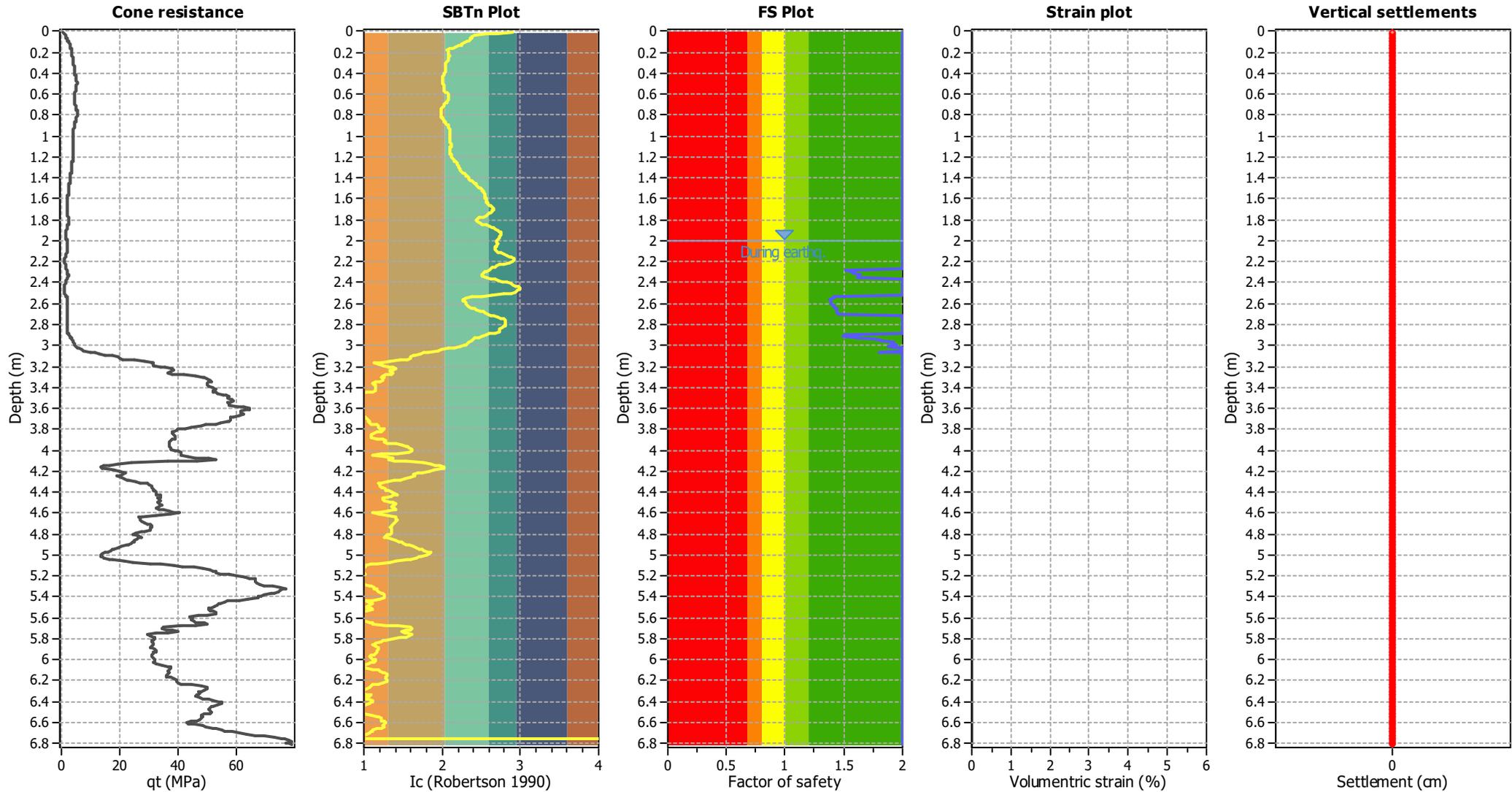
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Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	$K_p$ applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

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

**LIQUEFACTION ANALYSIS REPORT**

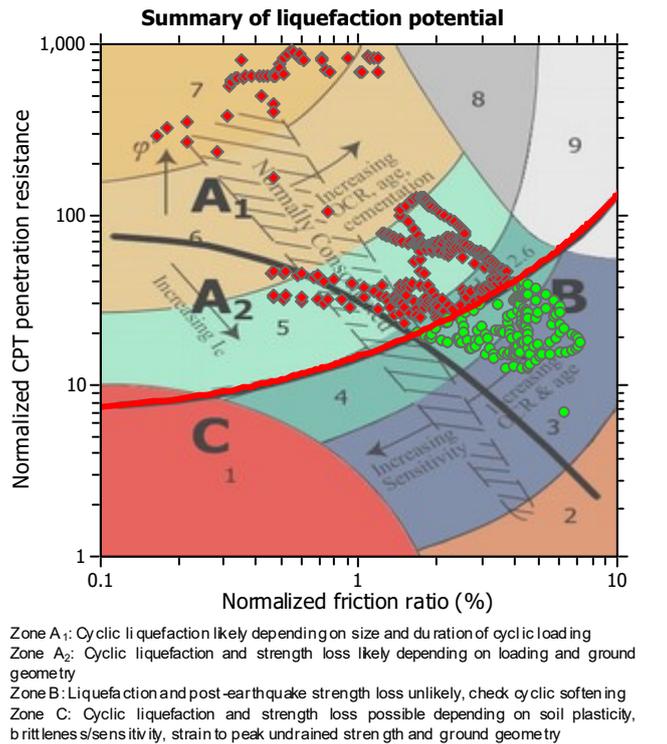
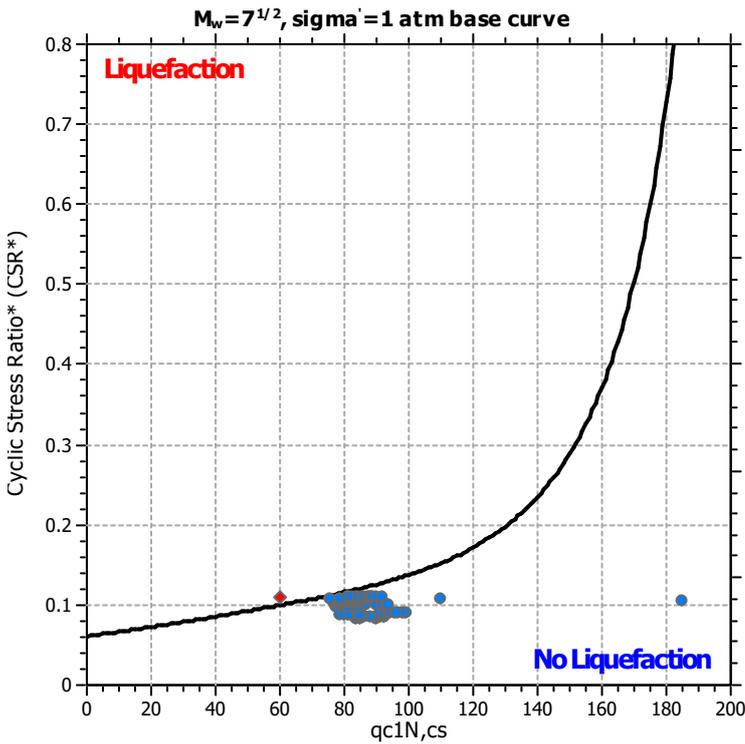
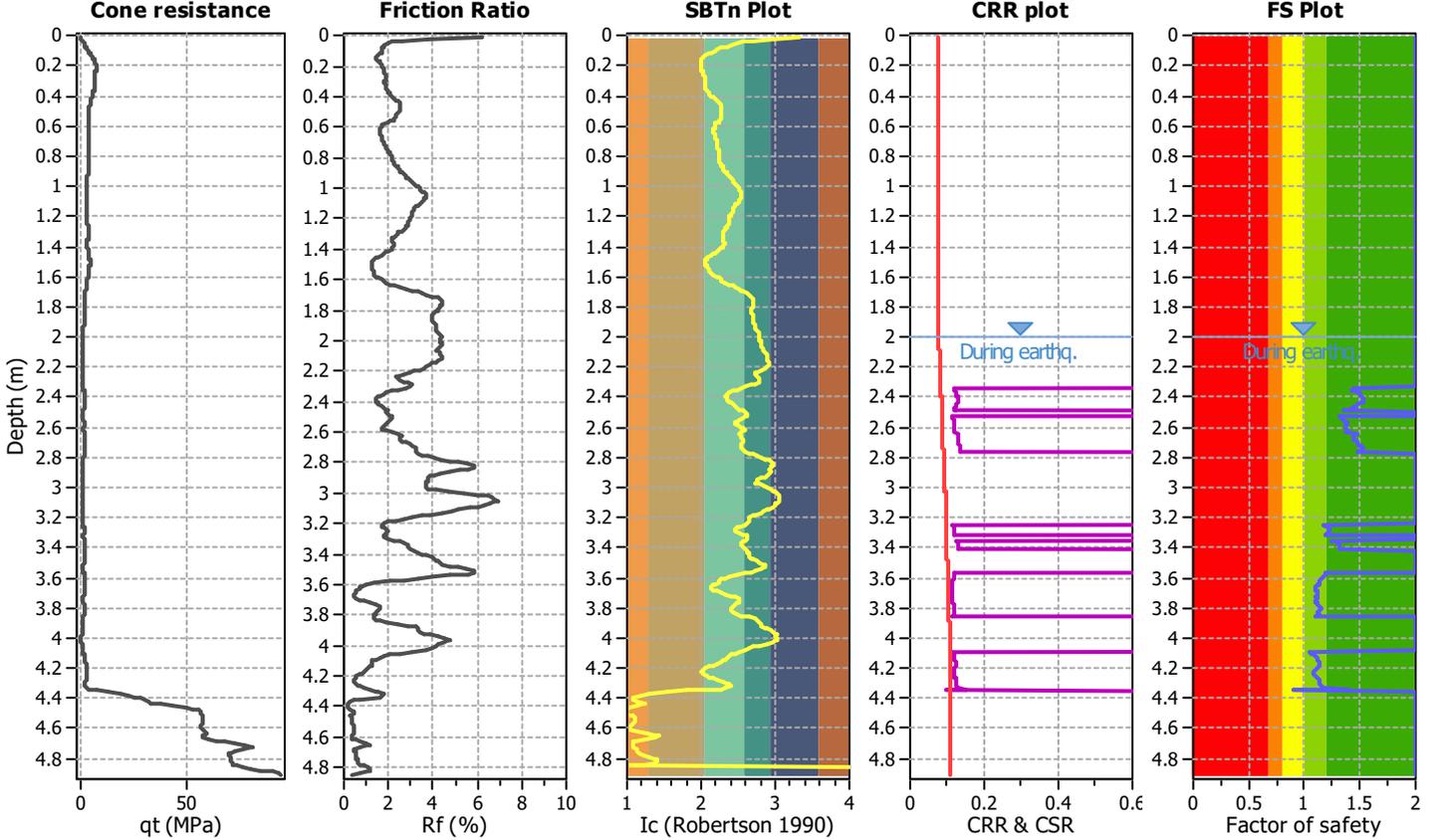
**Project title : K210318**

**Location : 232 Styx Mill Road, Casebrook, Christchurch**

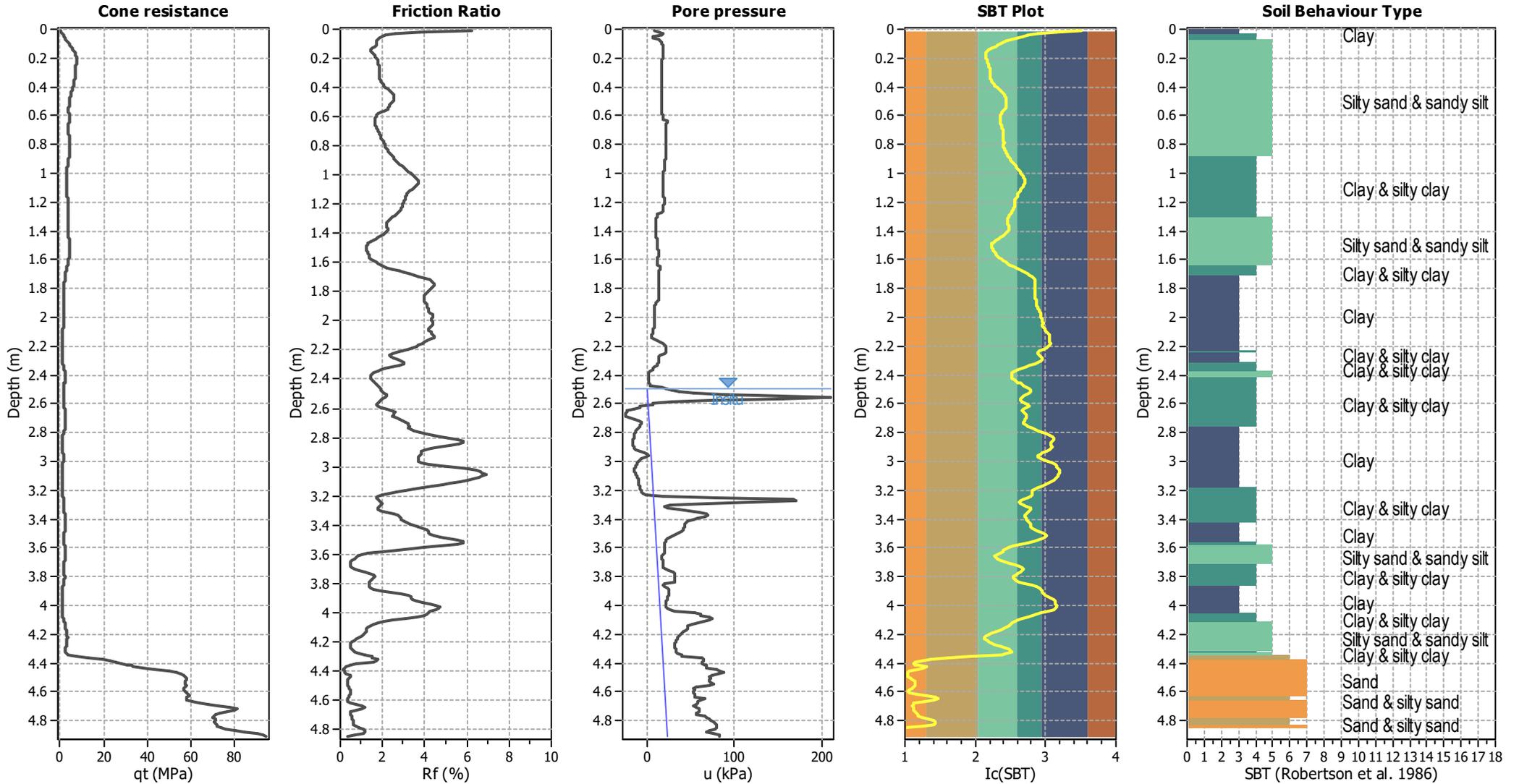
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Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.13	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes	MSF method:	Method based



### CPT basic interpretation plots



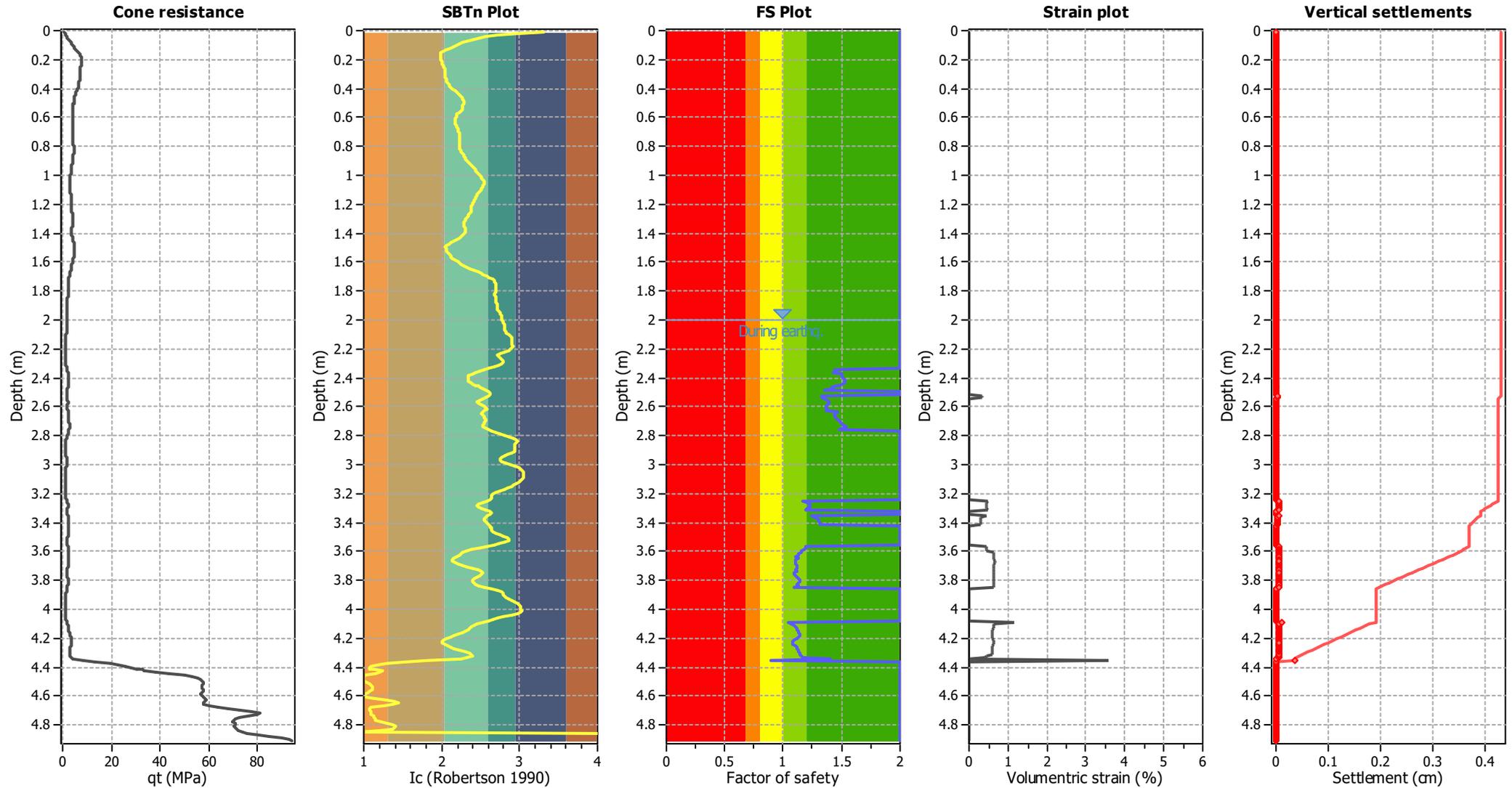
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Points to test:	Based on Ic value	Ic cut-off value:	2.60	$K_v$ applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

- qt: Total cone resistance (cone resistance q<sub>c</sub> corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

**LIQUEFACTION ANALYSIS REPORT**

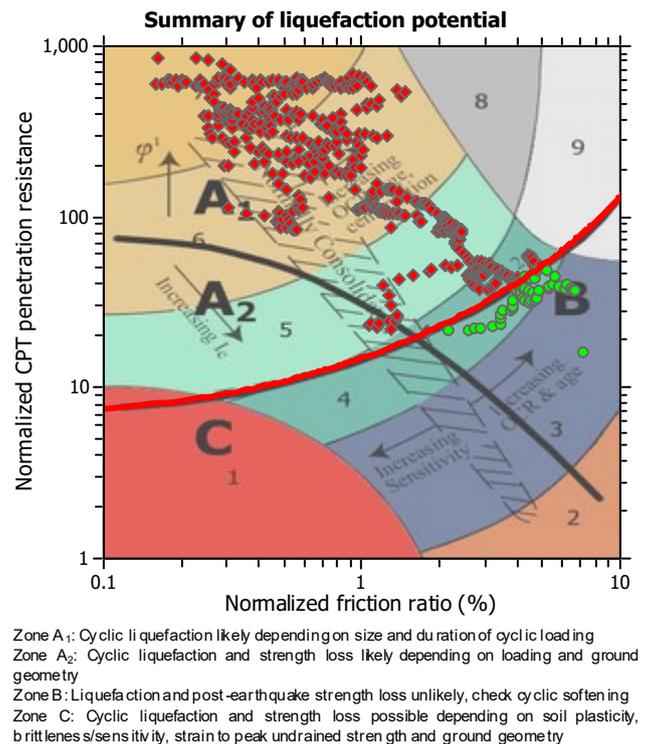
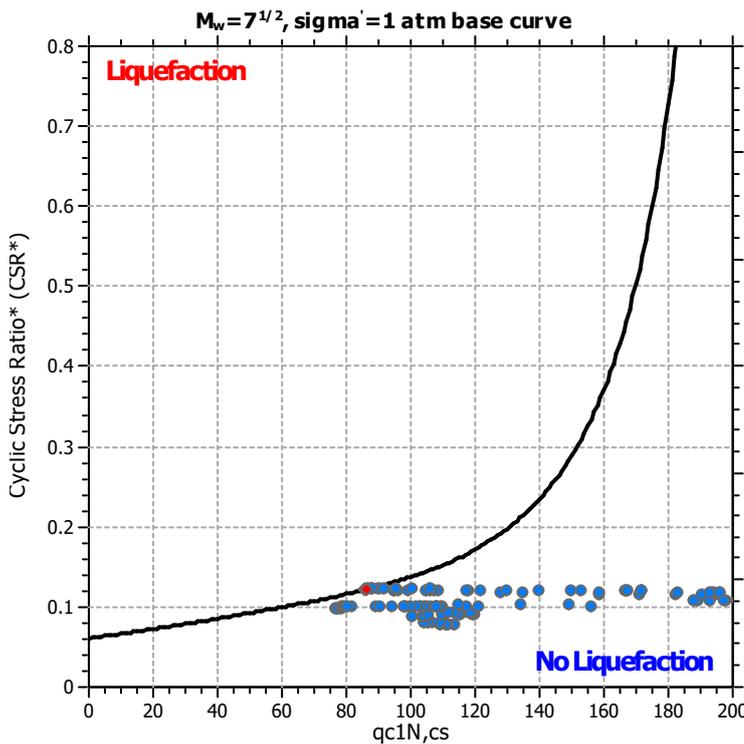
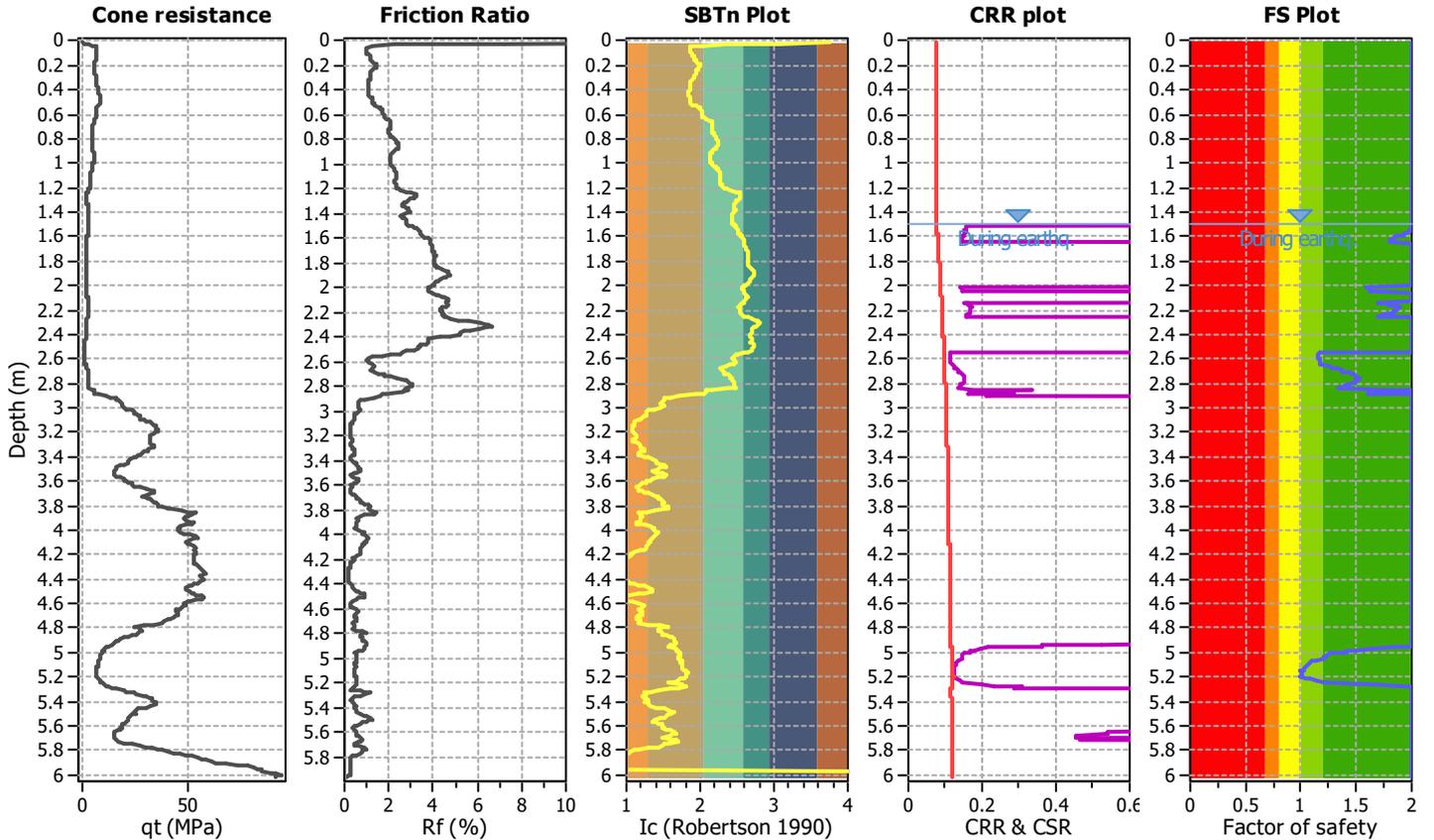
**Project title : K210318**

**Location : 232 Styx Mill Road, Casebrook, Christchurch**

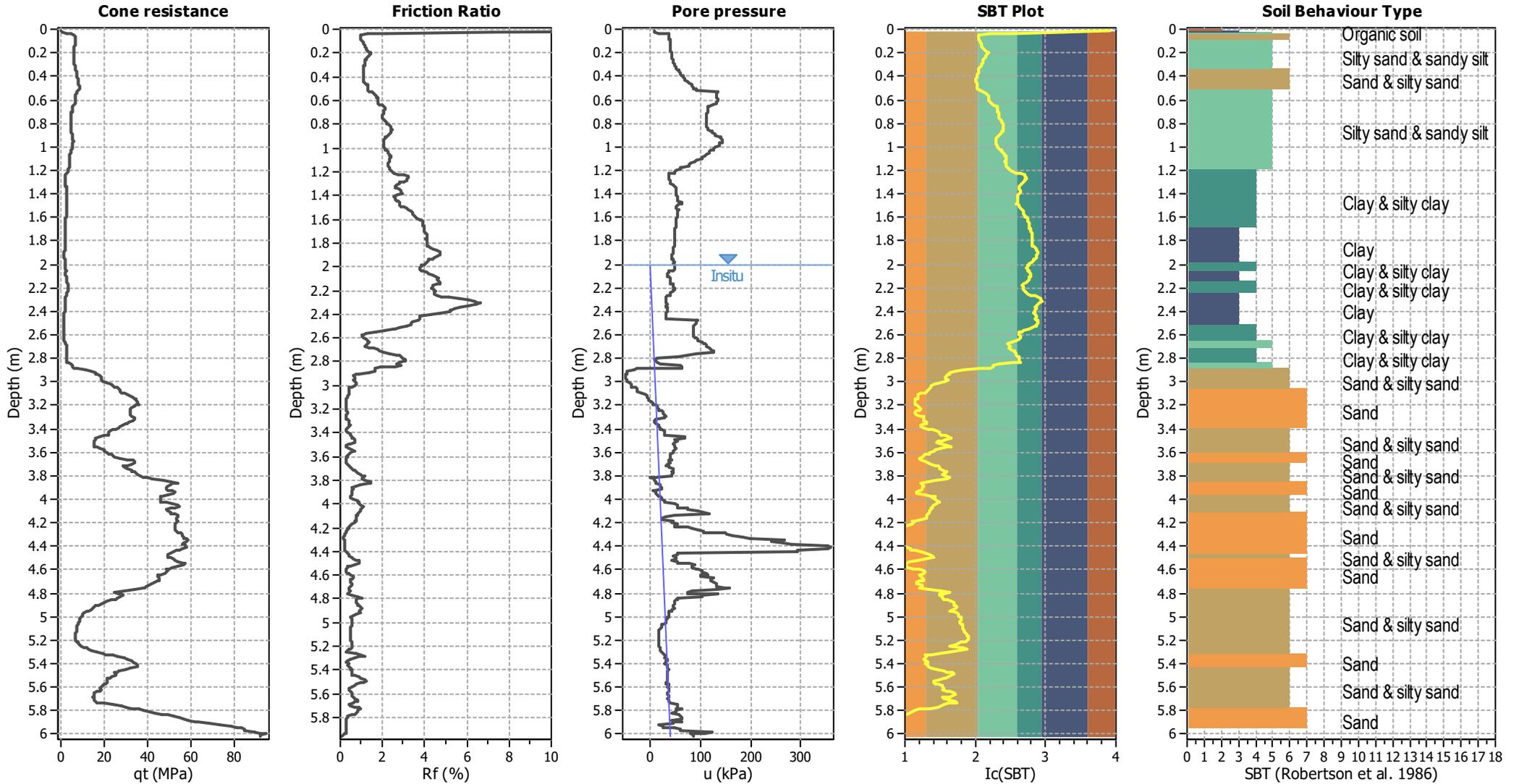
**CPT file : CPT-10 SLS1**

**Input parameters and analysis data**

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Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.13	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes	MSF method:	Method based



### CPT basic interpretation plots



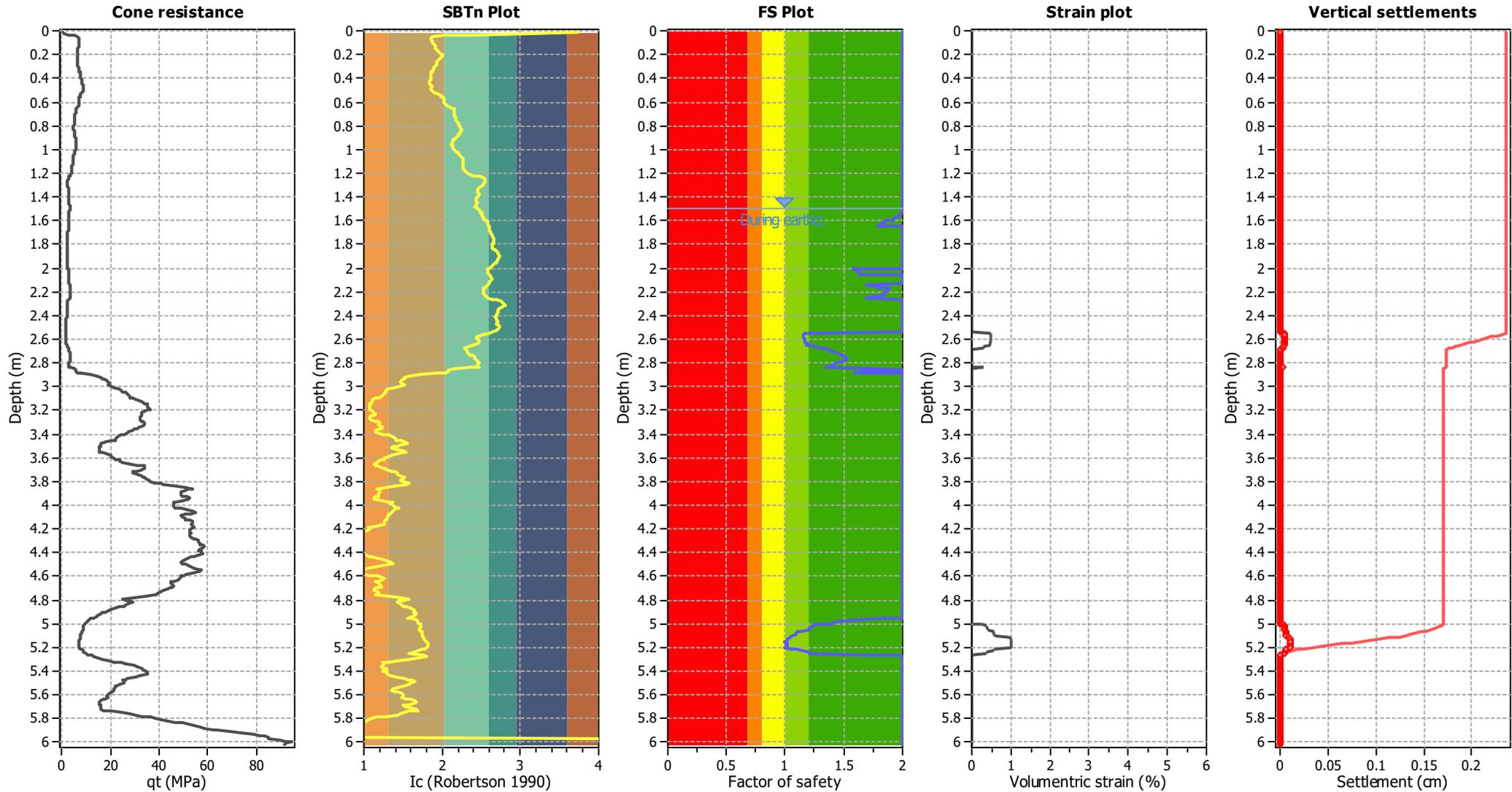
#### Input parameters and analysis data

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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	$K_v$ 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:	No
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

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

**LIQUEFACTION ANALYSIS REPORT**

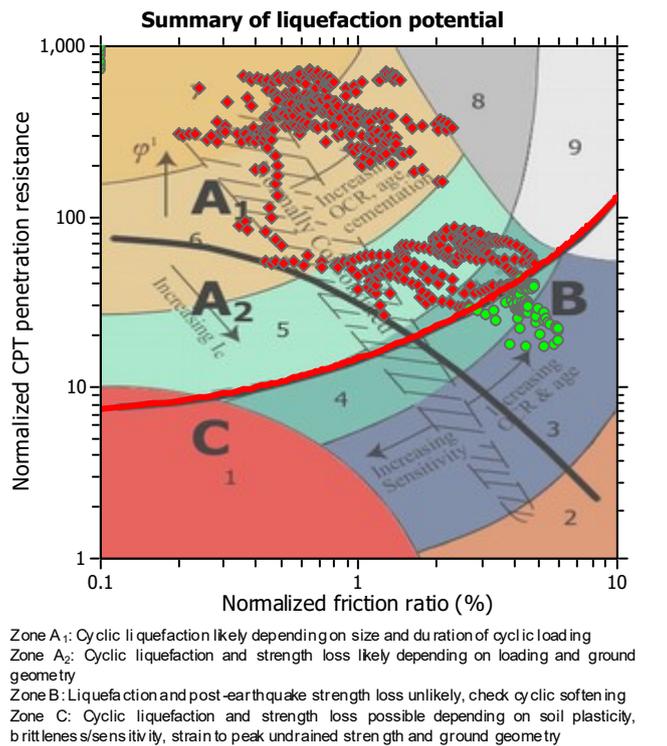
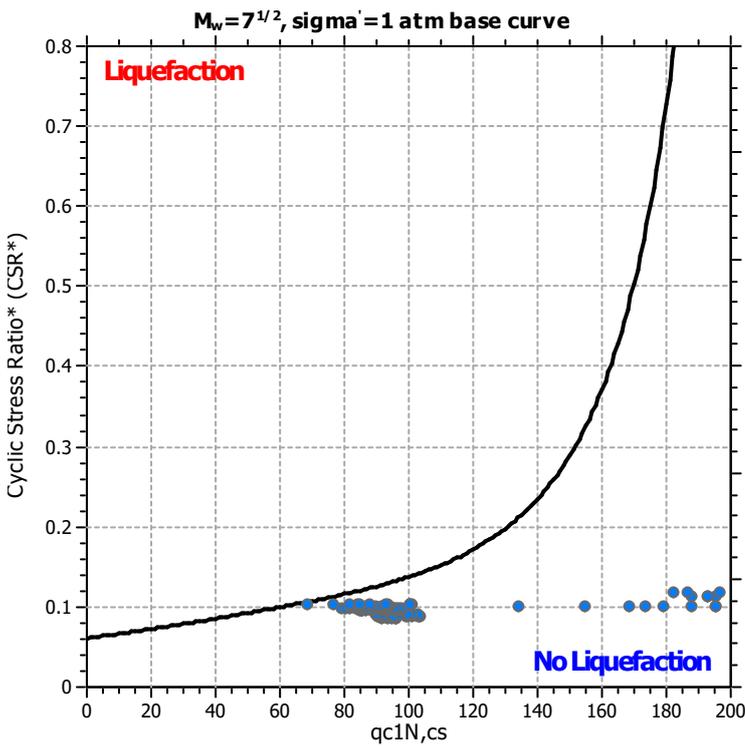
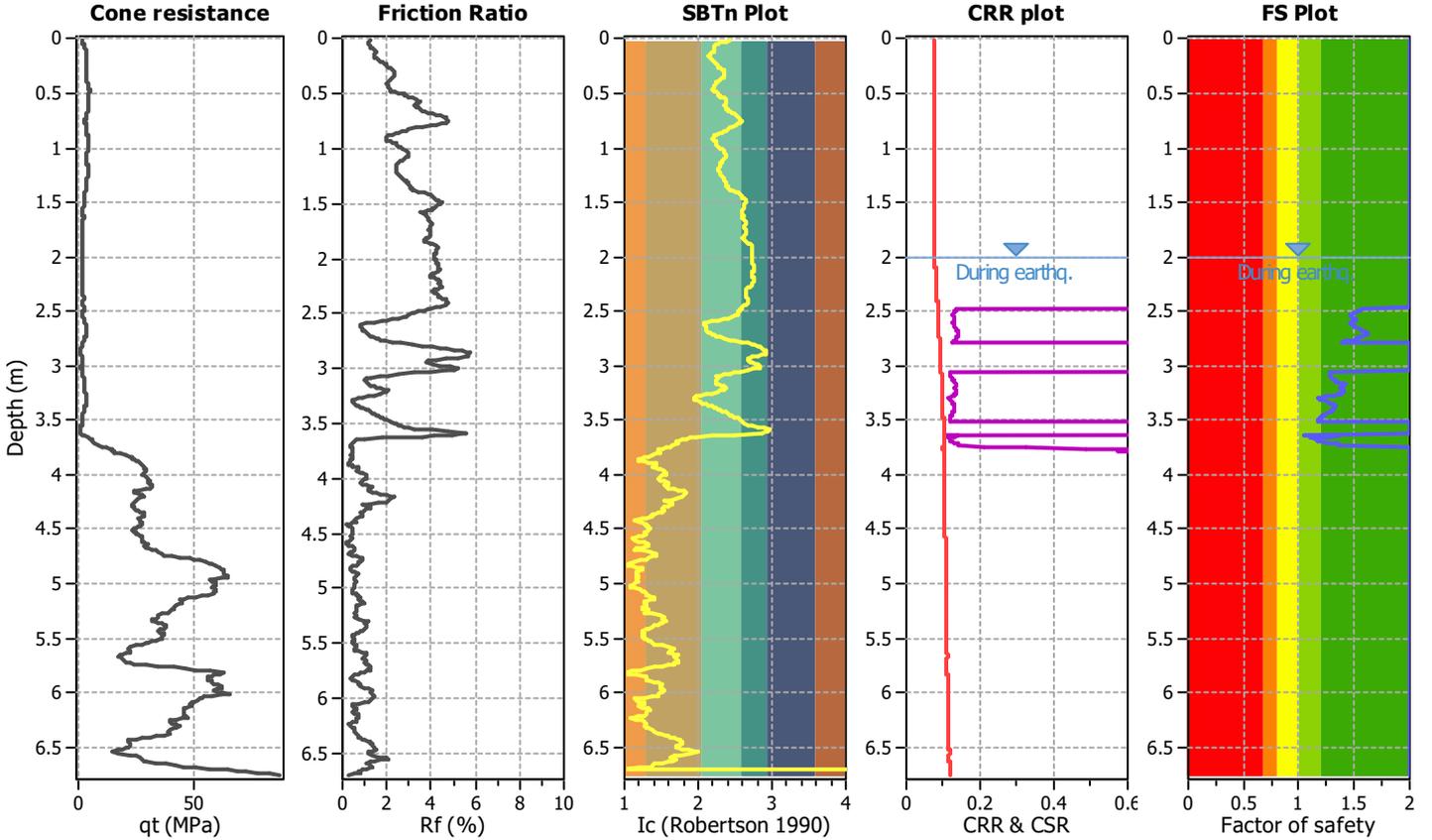
**Project title : K210318**

**Location : 232 Styx Mill Road, Casebrook, Christchurch**

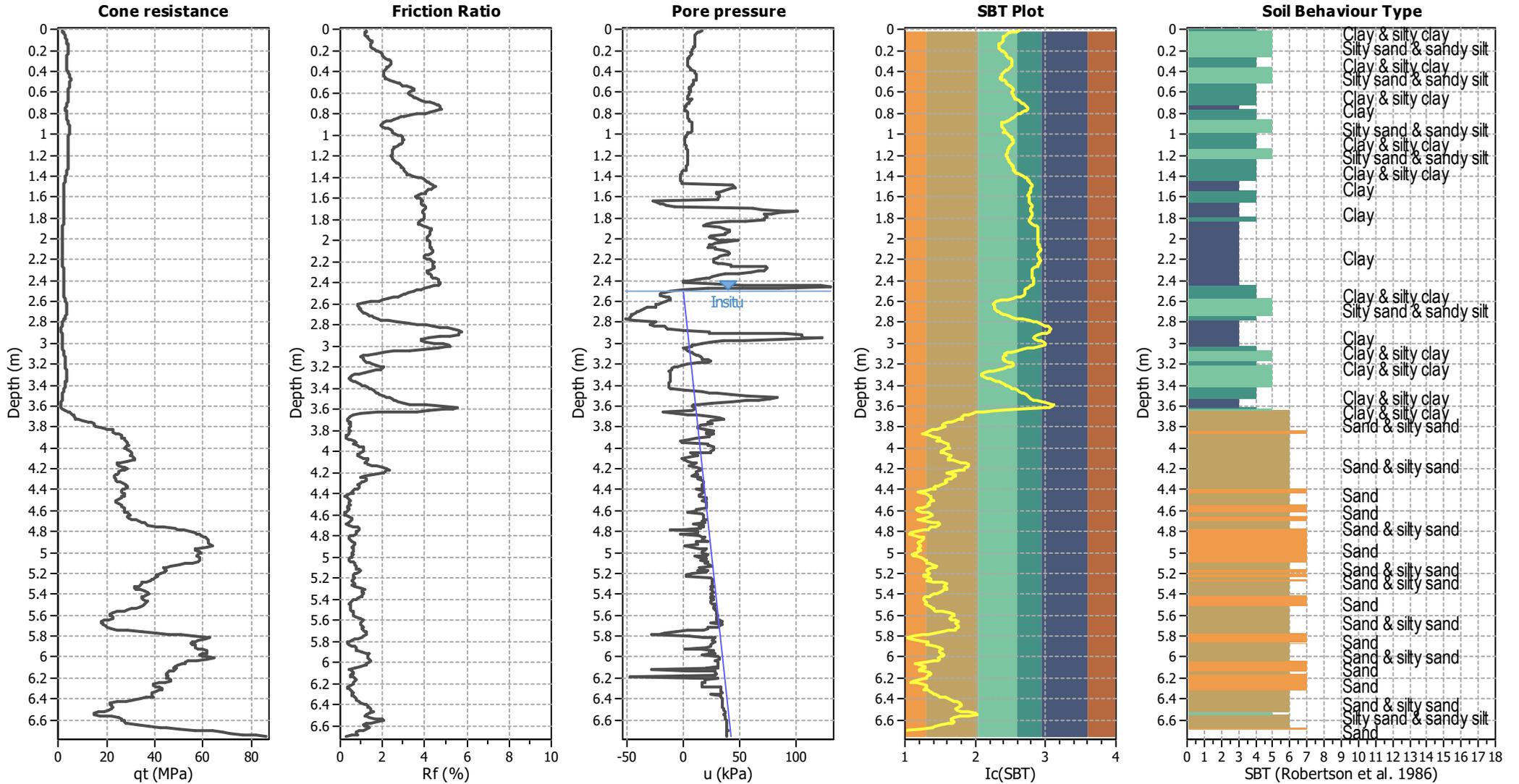
**CPT file : CPT-11 SLS1**

**Input parameters and analysis data**

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Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.13	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes		



### CPT basic interpretation plots



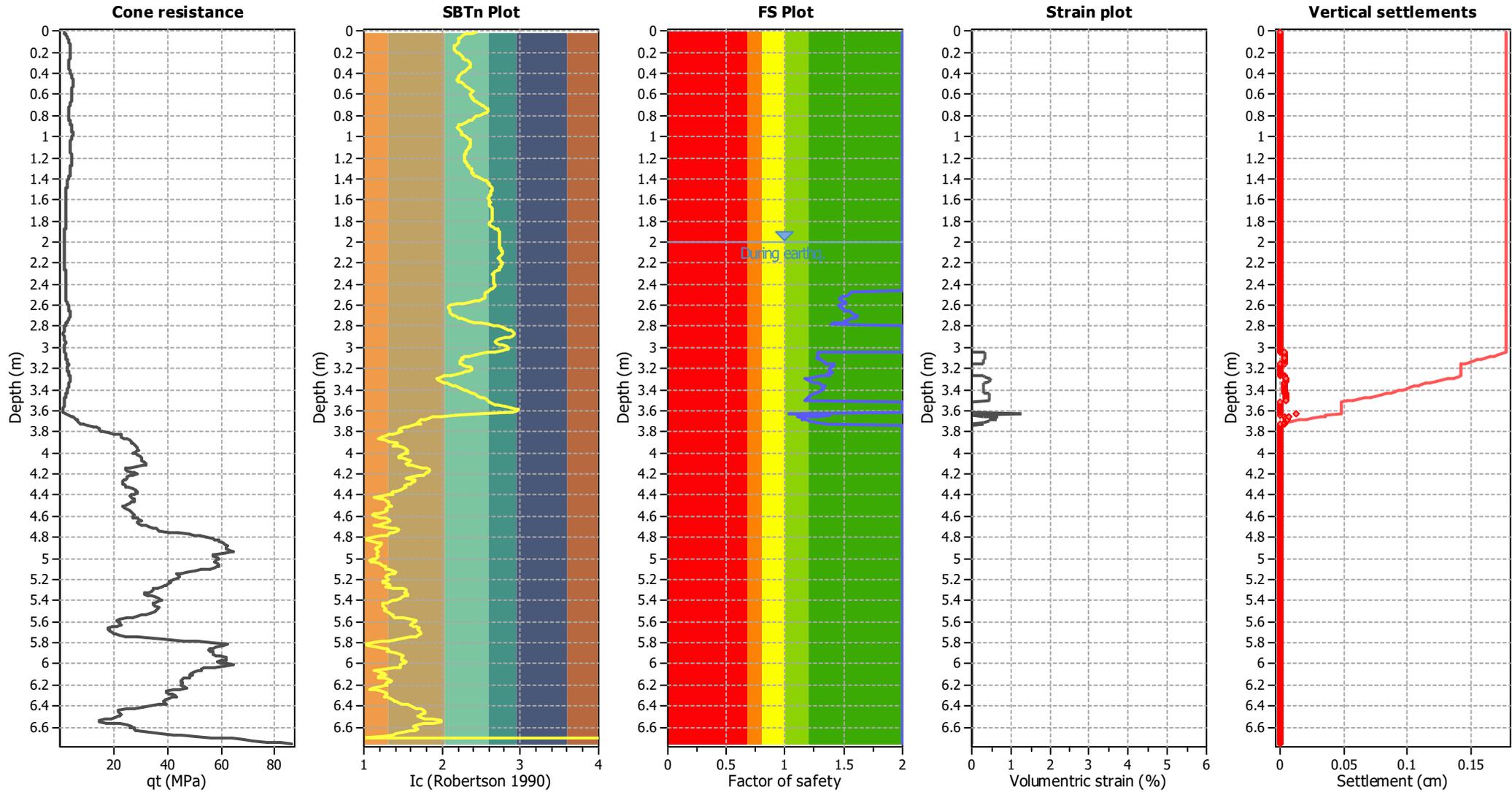
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Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	$K_v$ applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

- qt: Total cone resistance (cone resistance q<sub>c</sub> corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

**LIQUEFACTION ANALYSIS REPORT**

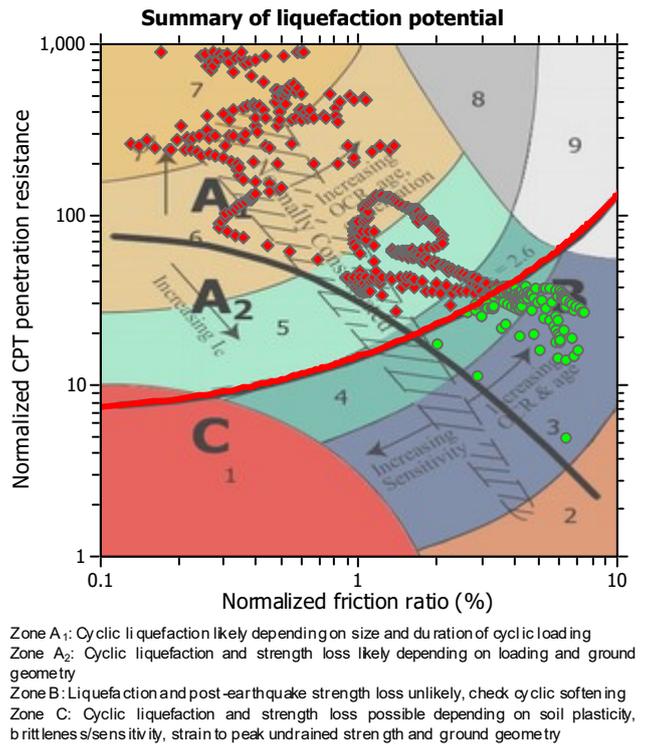
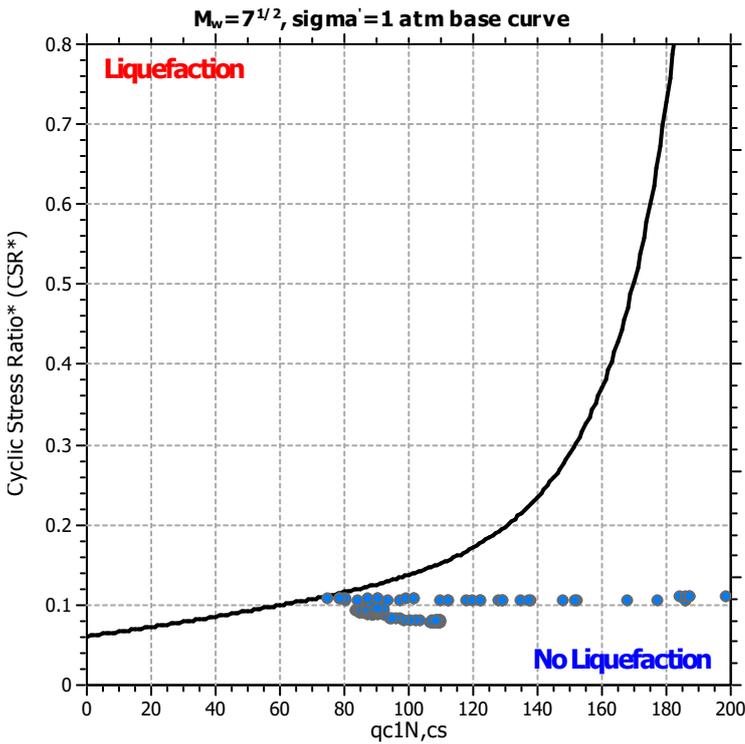
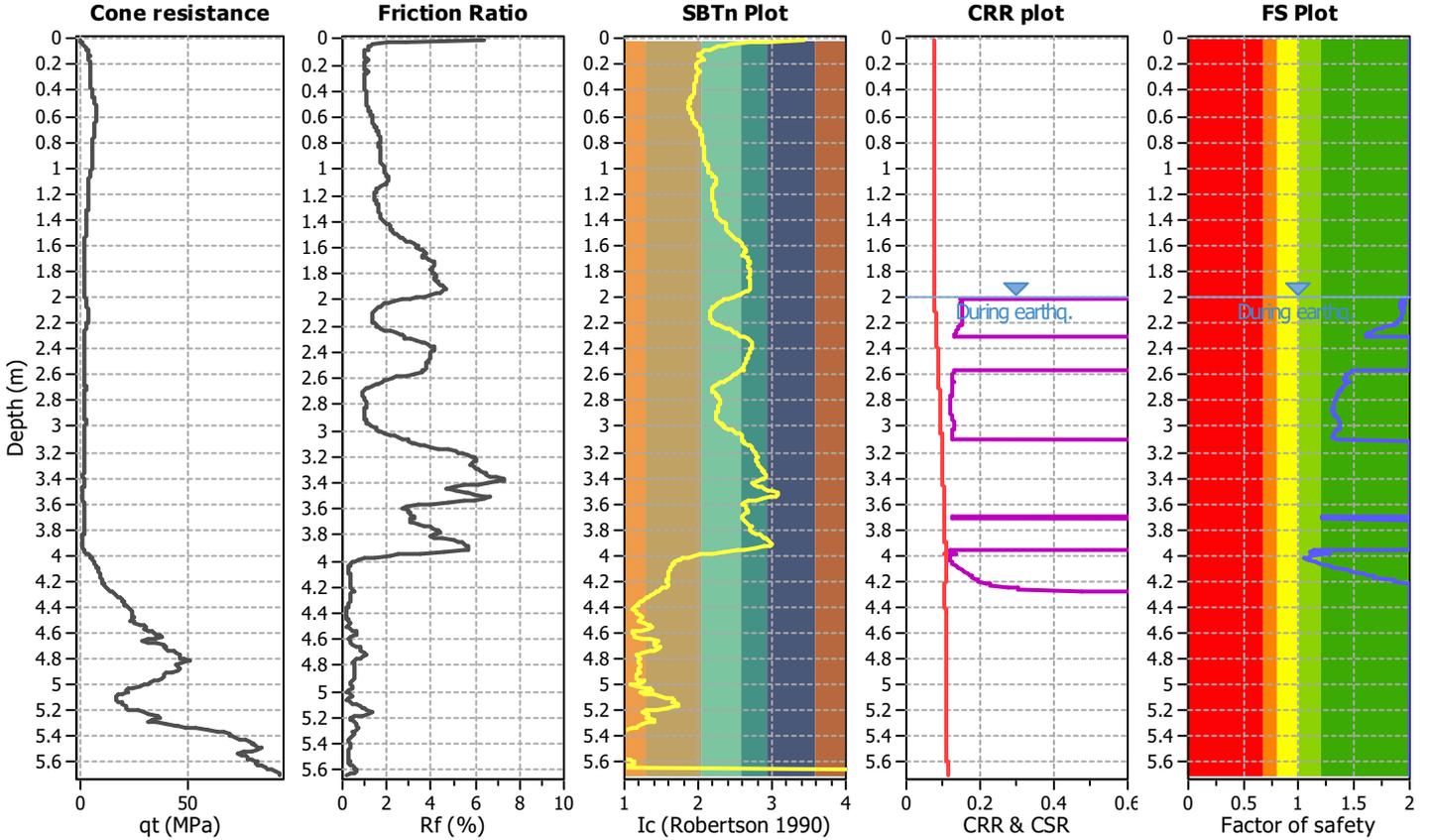
**Project title : K210318**

**Location : 232 Styx Mill Road, Casebrook, Christchurch**

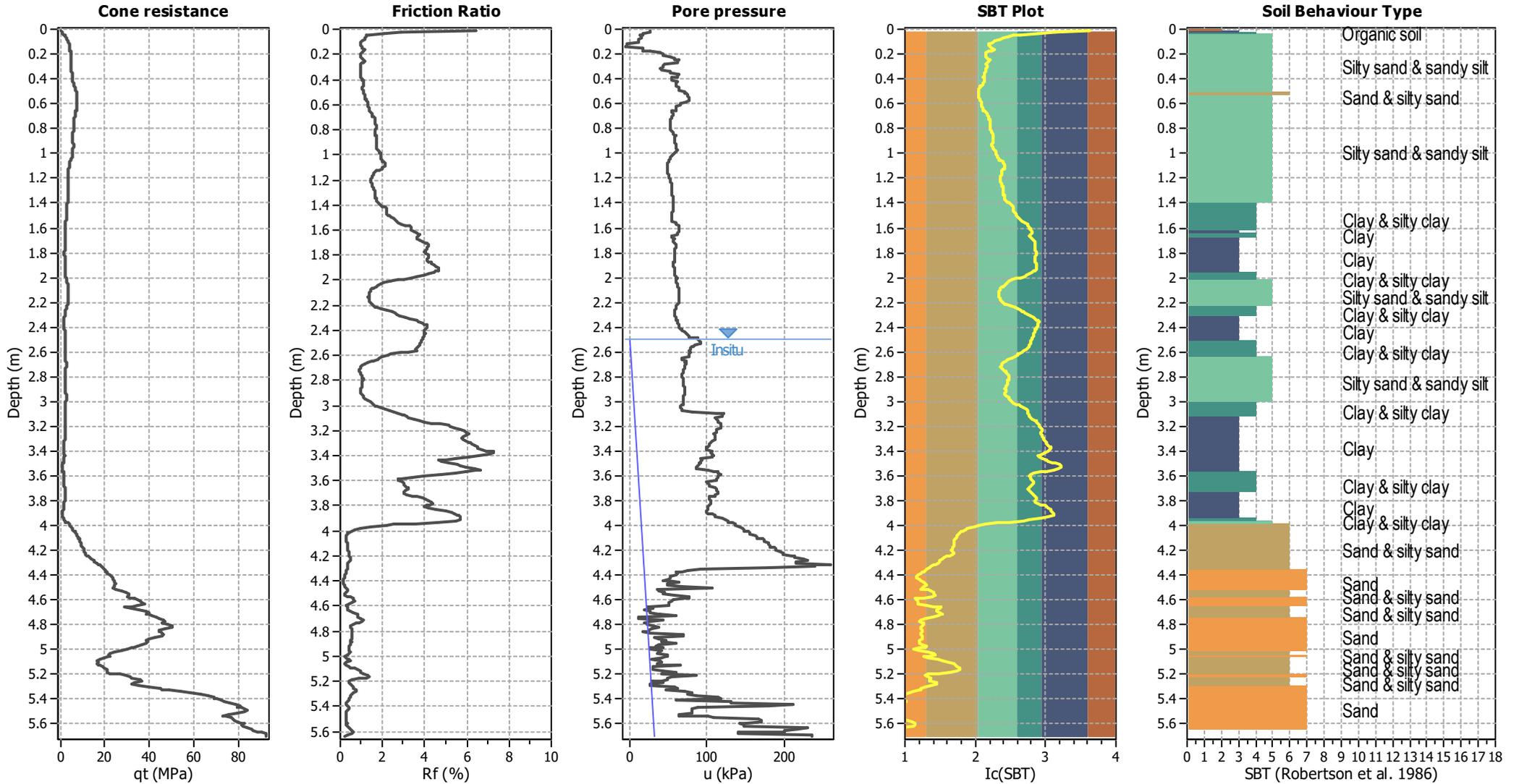
**CPT file : CPT-12 SLS1**

**Input parameters and analysis data**

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Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.00 m	Fill height:	N/A	applied:	Sands only
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.13	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes	MSF method:	Method based



### CPT basic interpretation plots



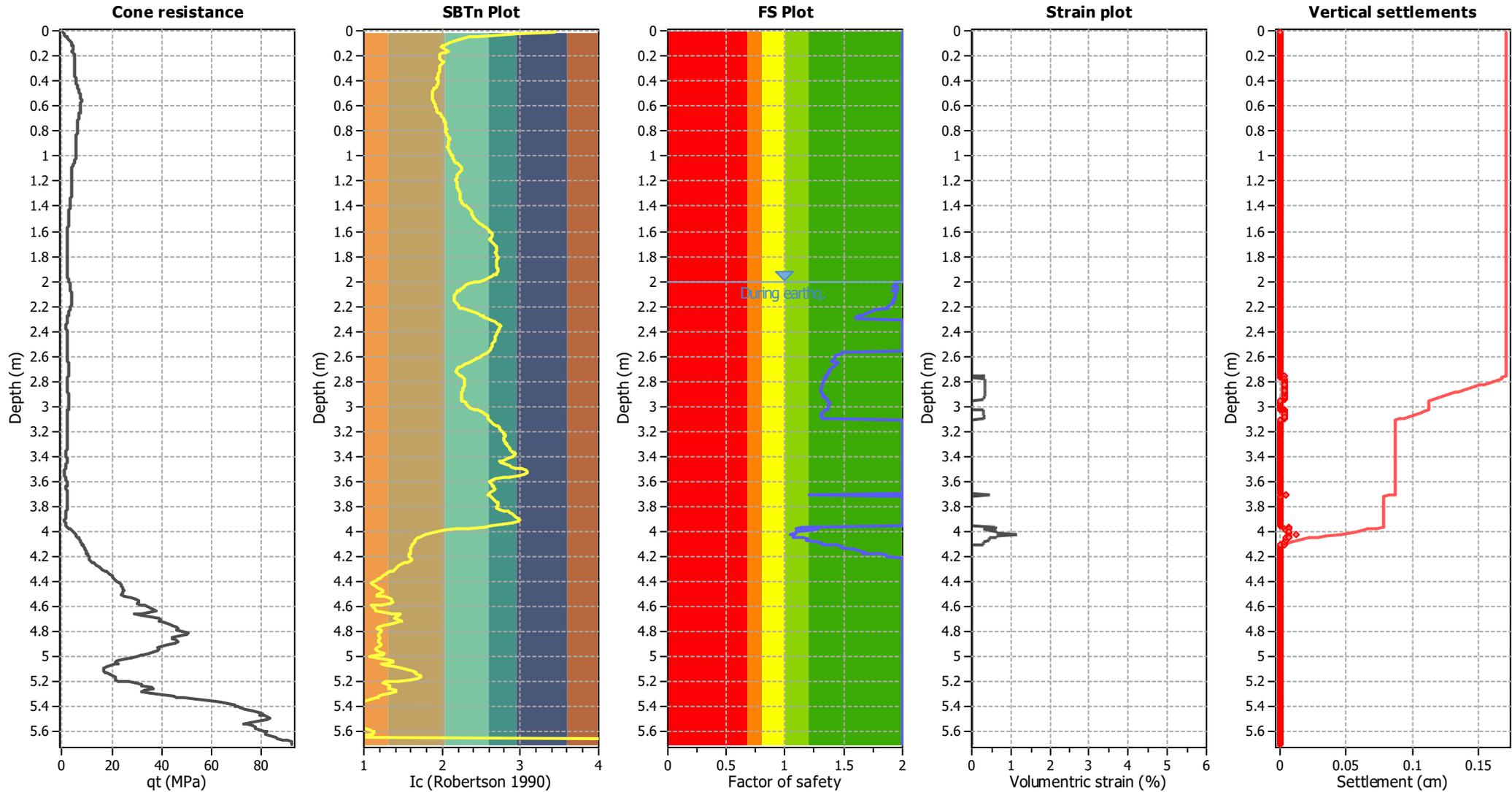
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Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	$K_v$ applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

- qt: Total cone resistance (cone resistance q<sub>c</sub> corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

**LIQUEFACTION ANALYSIS REPORT**

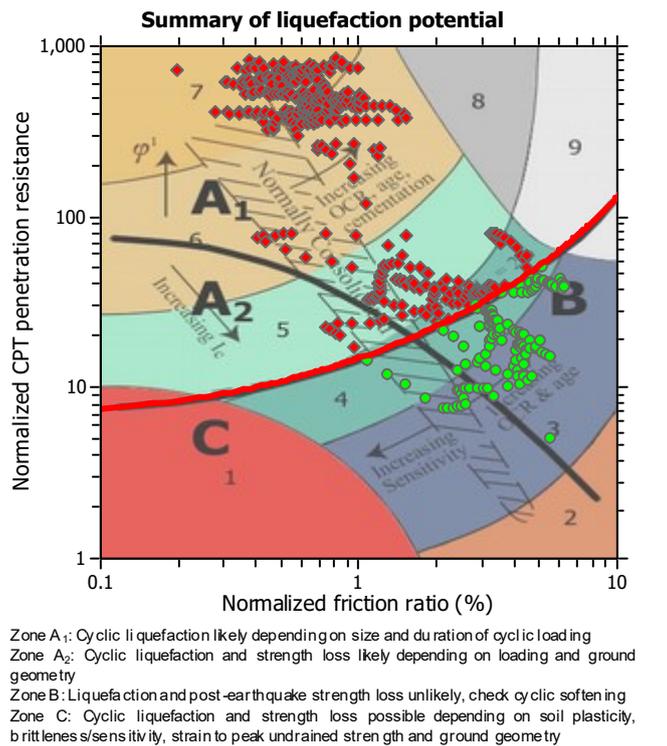
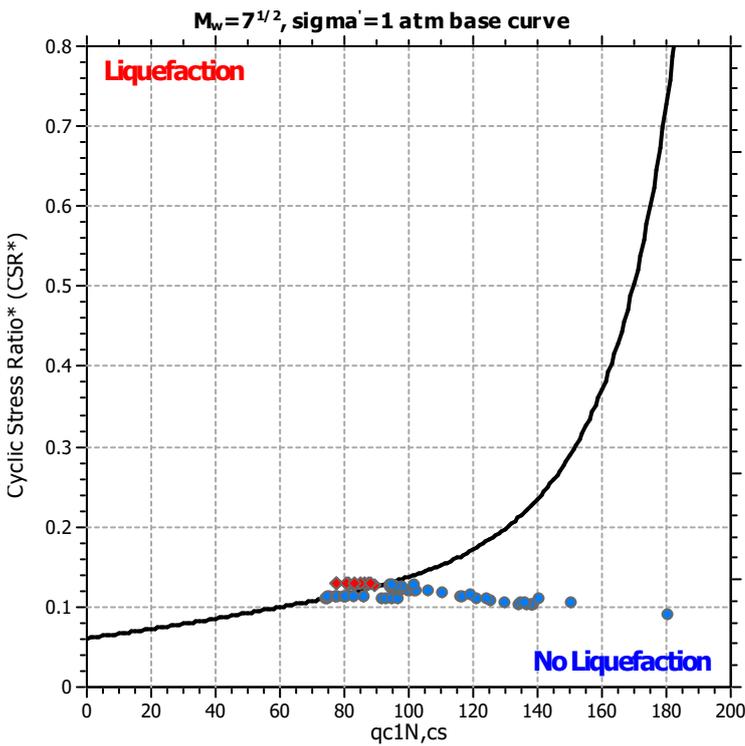
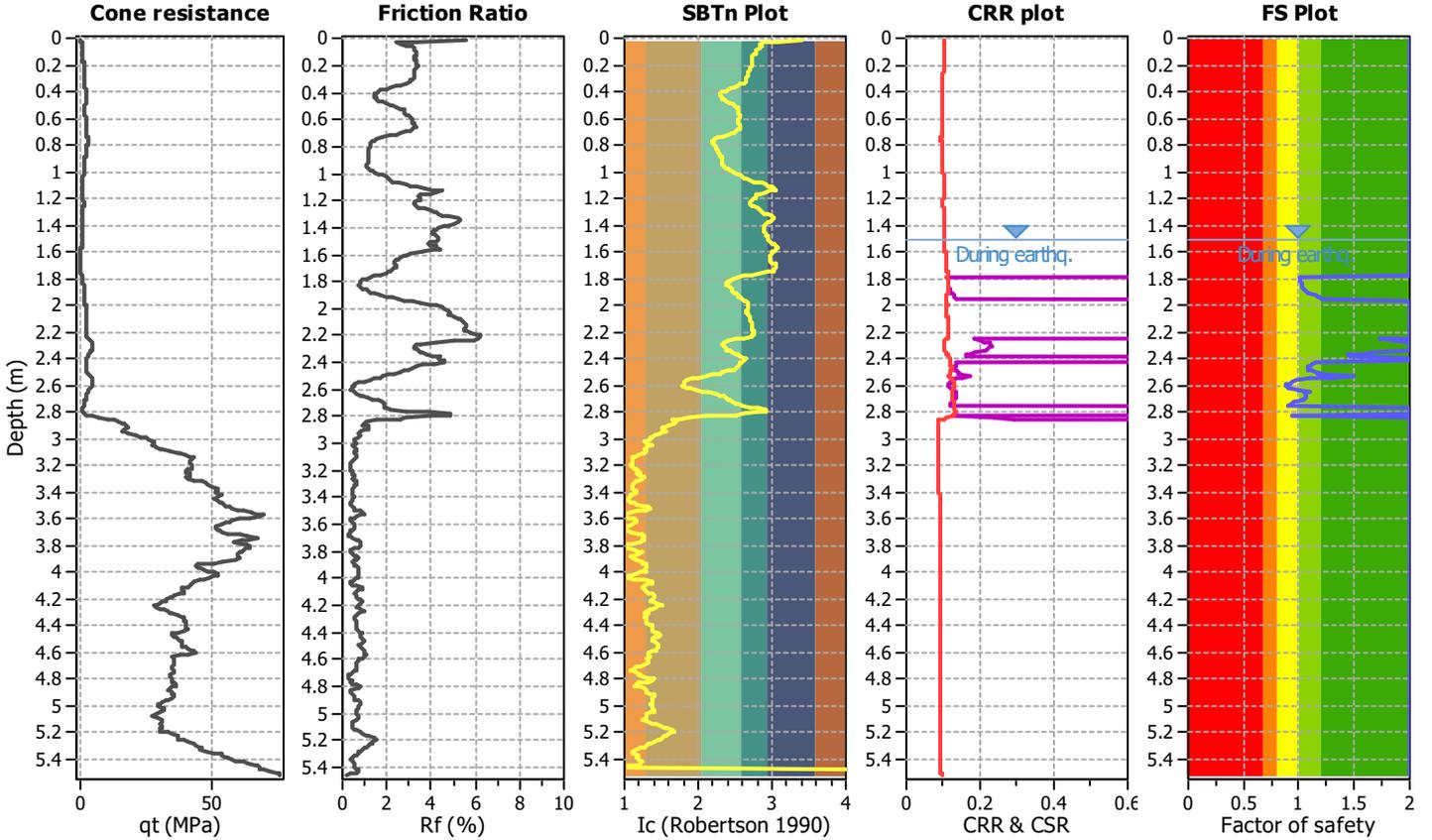
**Project title : K210318**

**Location : 232 Styx Mill Road, Casebrook, Christchurch**

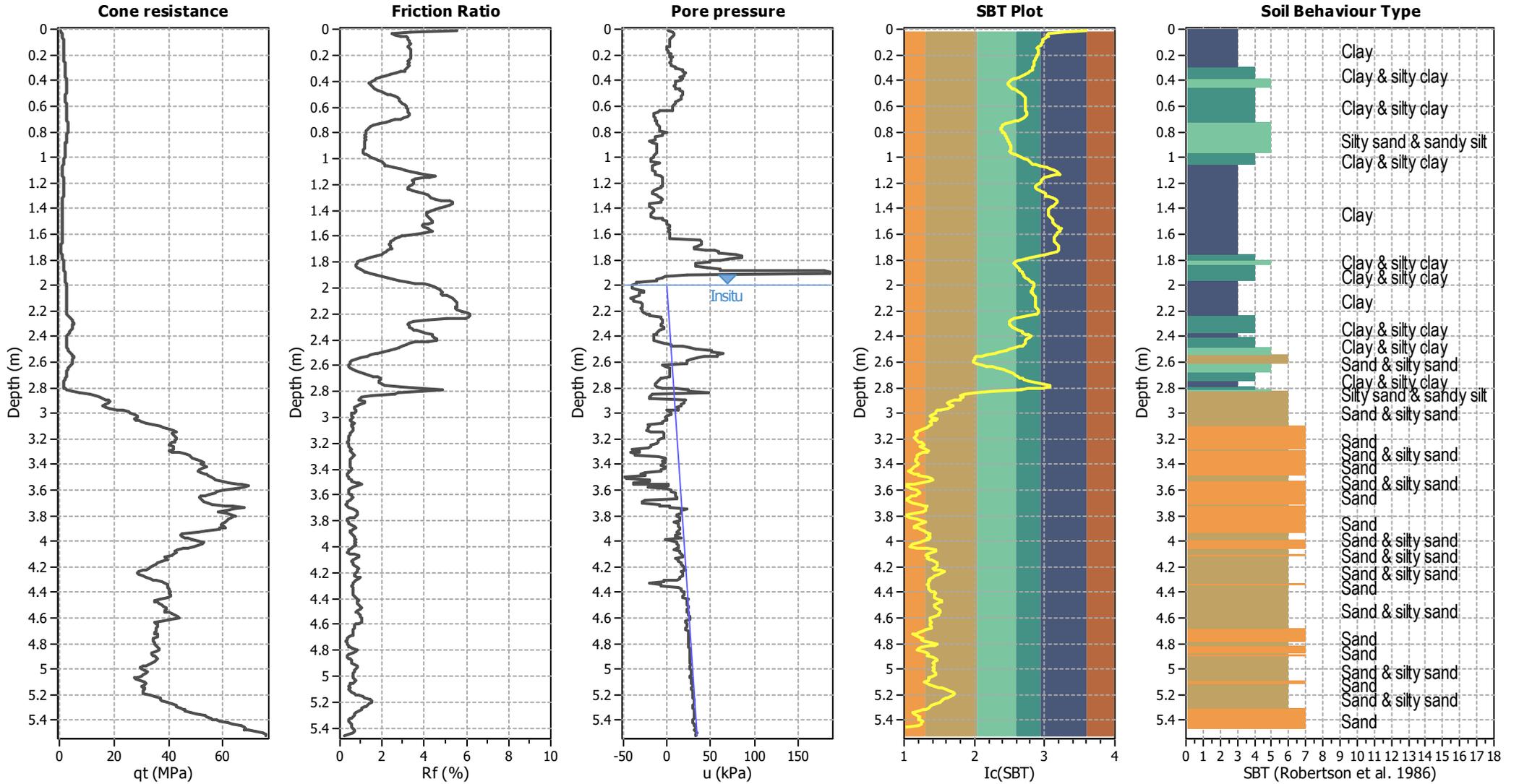
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**Input parameters and analysis data**

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Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.50 m	Fill height:	N/A	applied:	Sands only
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	$K_g$ applied:	Yes	MSF method:	Method based



### CPT basic interpretation plots



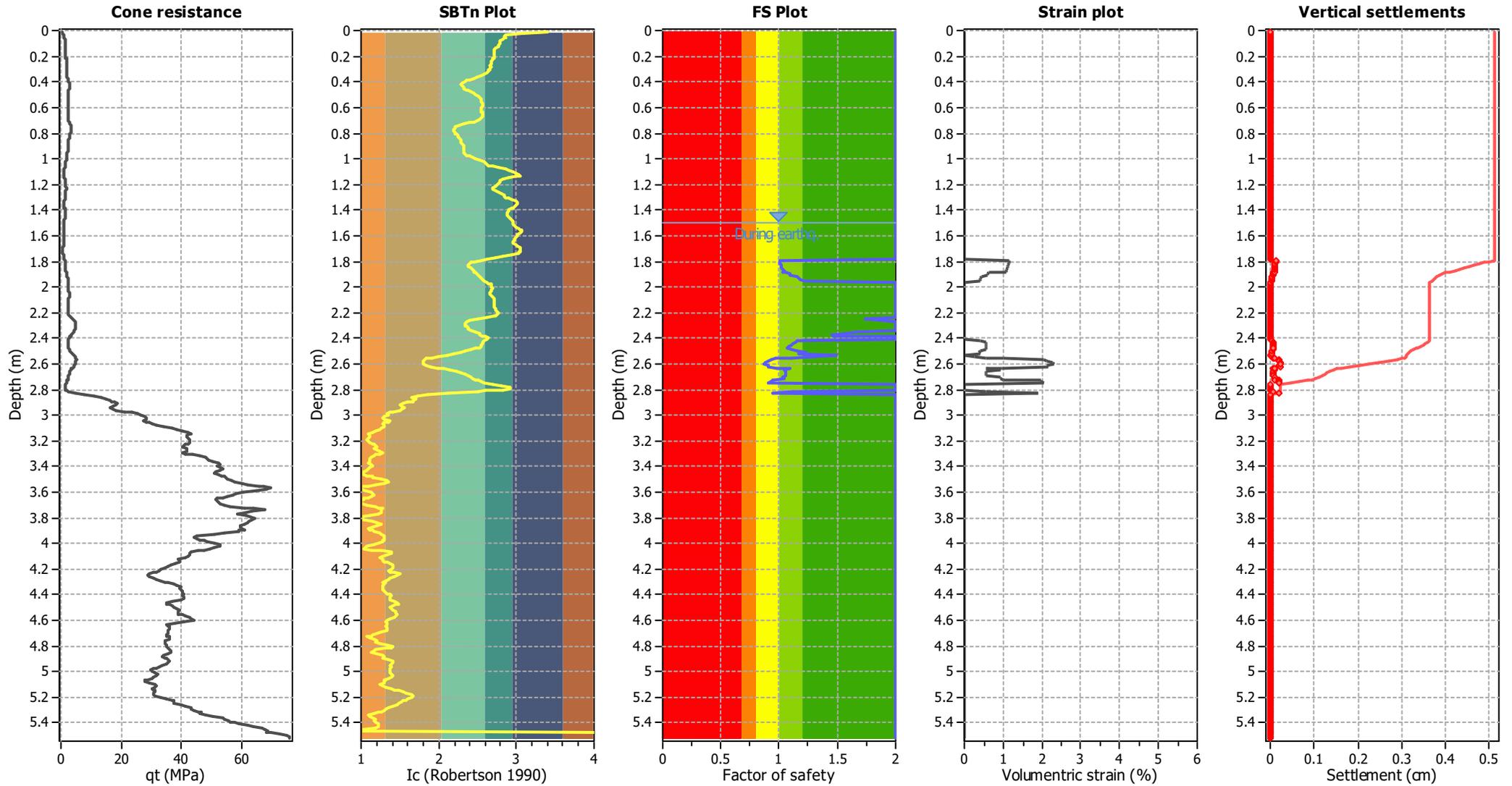
#### Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	$K_0$ 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:	No
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

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

**LIQUEFACTION ANALYSIS REPORT**

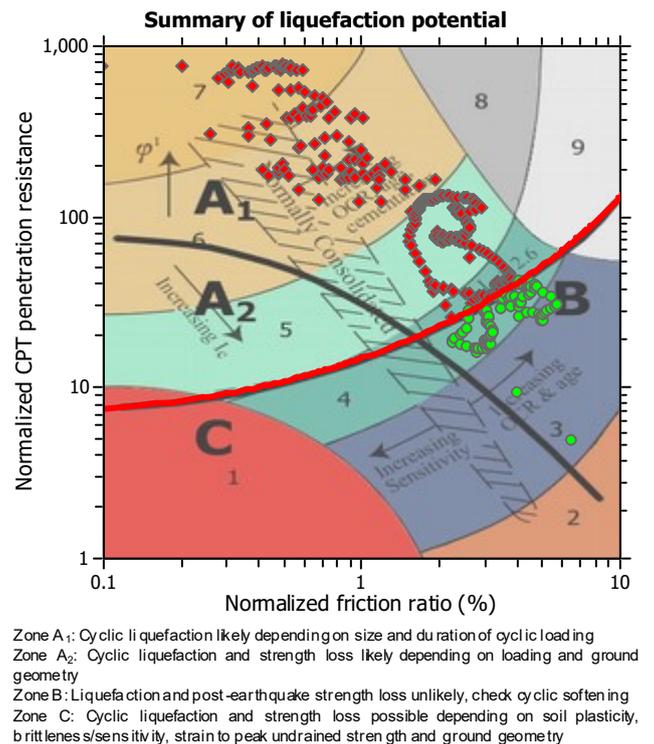
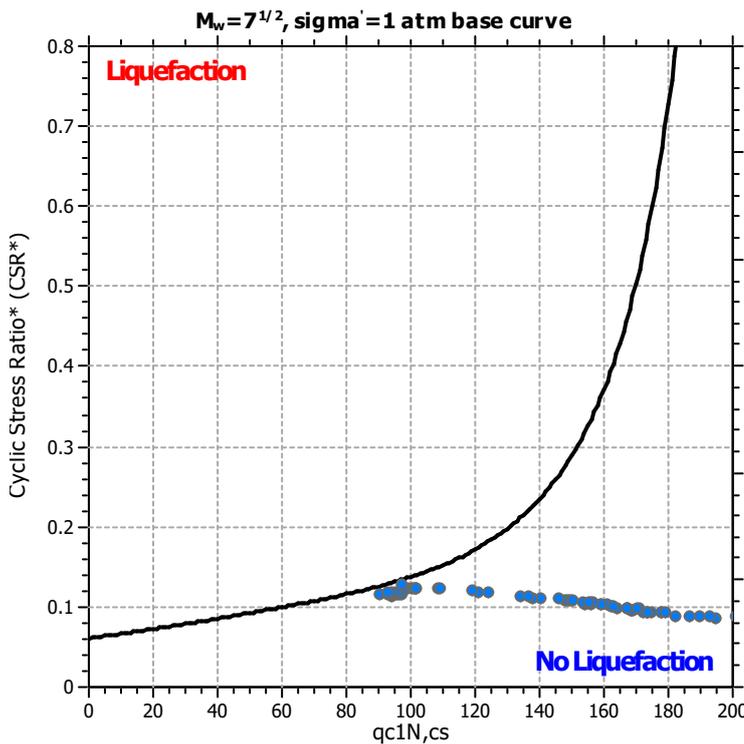
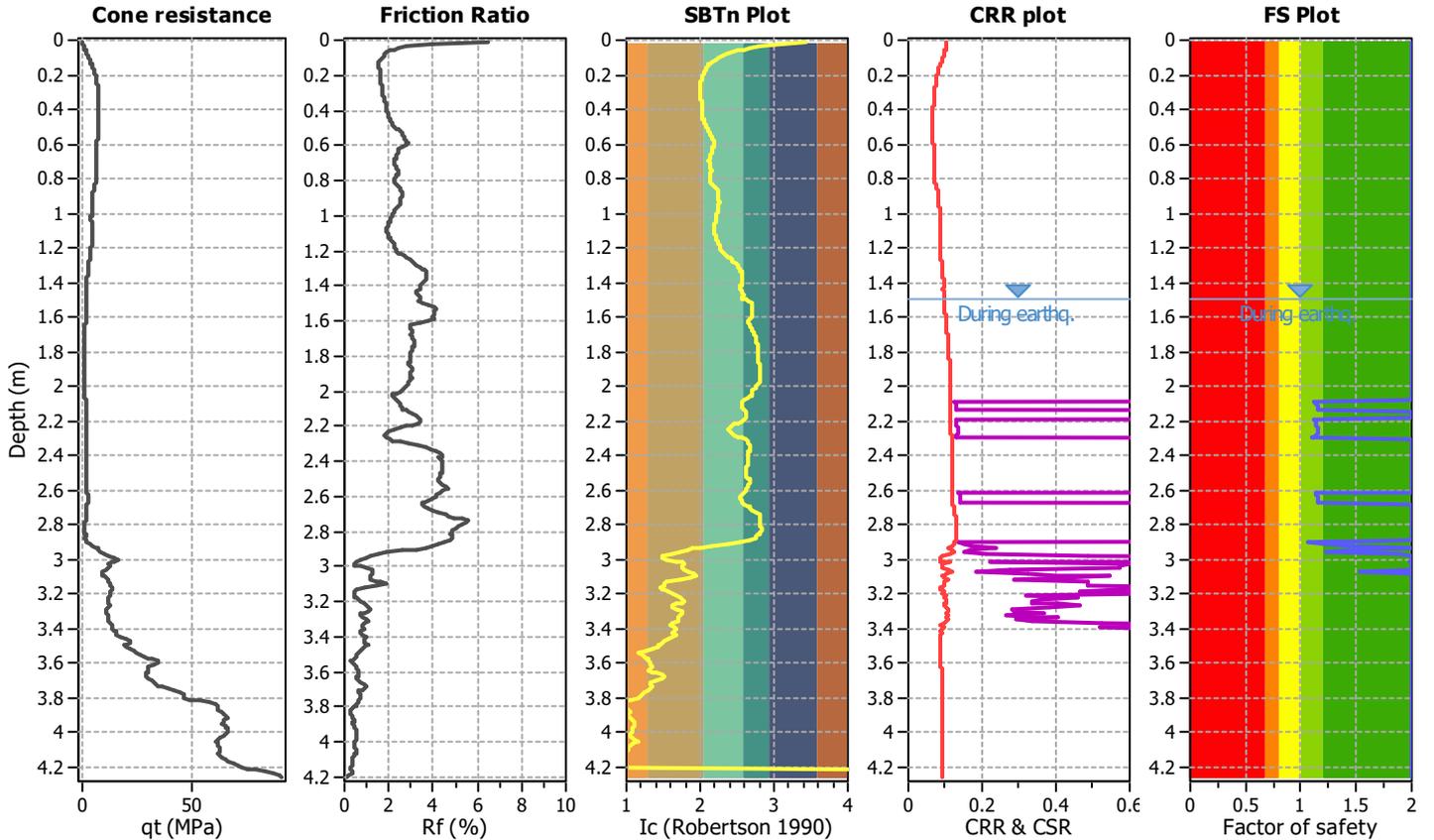
**Project title : K210318**

**Location : 232 Styx Mill Road, Casebrook, Christchurch**

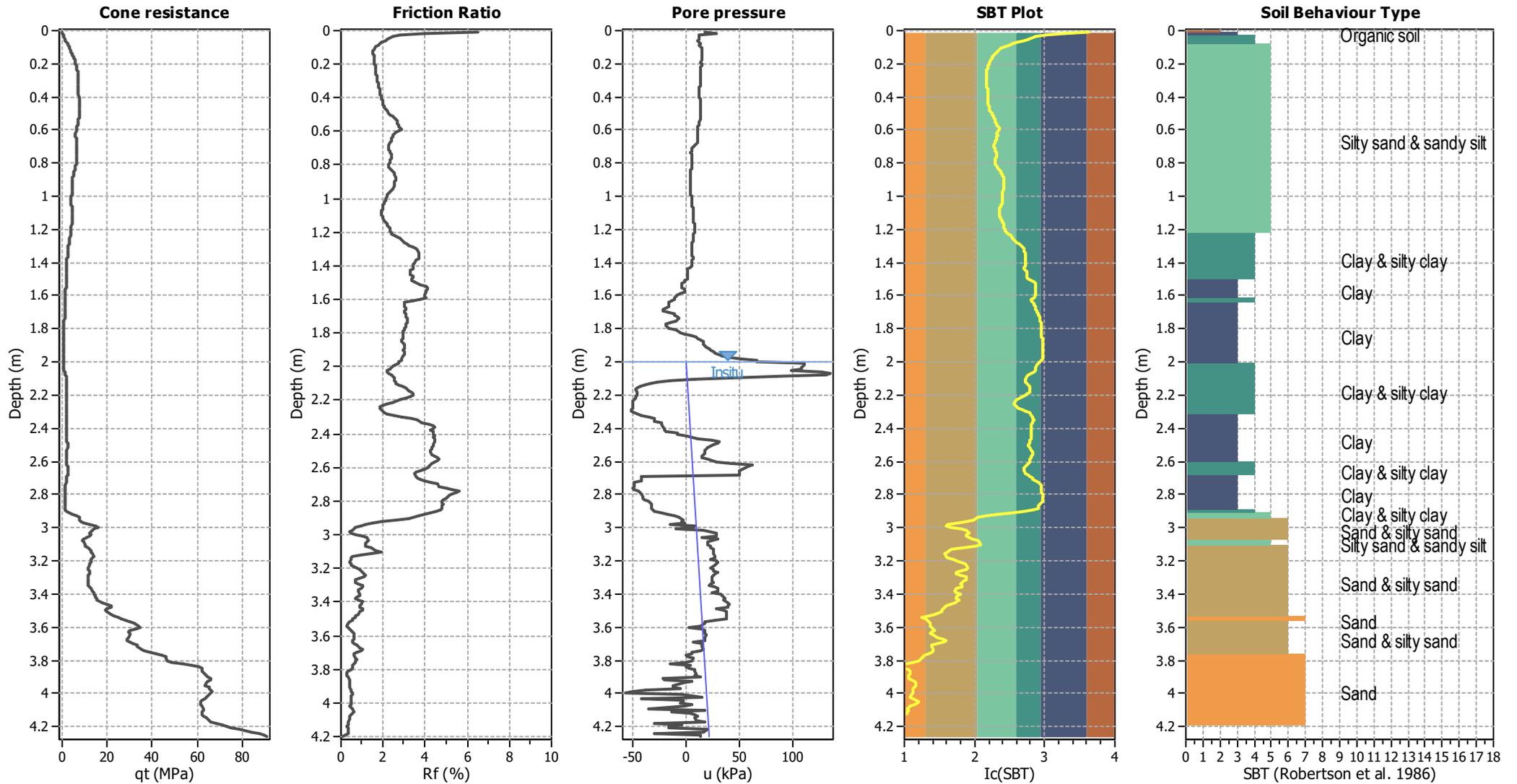
**CPT file : CPT-01 SLS2**

**Input parameters and analysis data**

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Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude $M_w$ :	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes		



### CPT basic interpretation plots



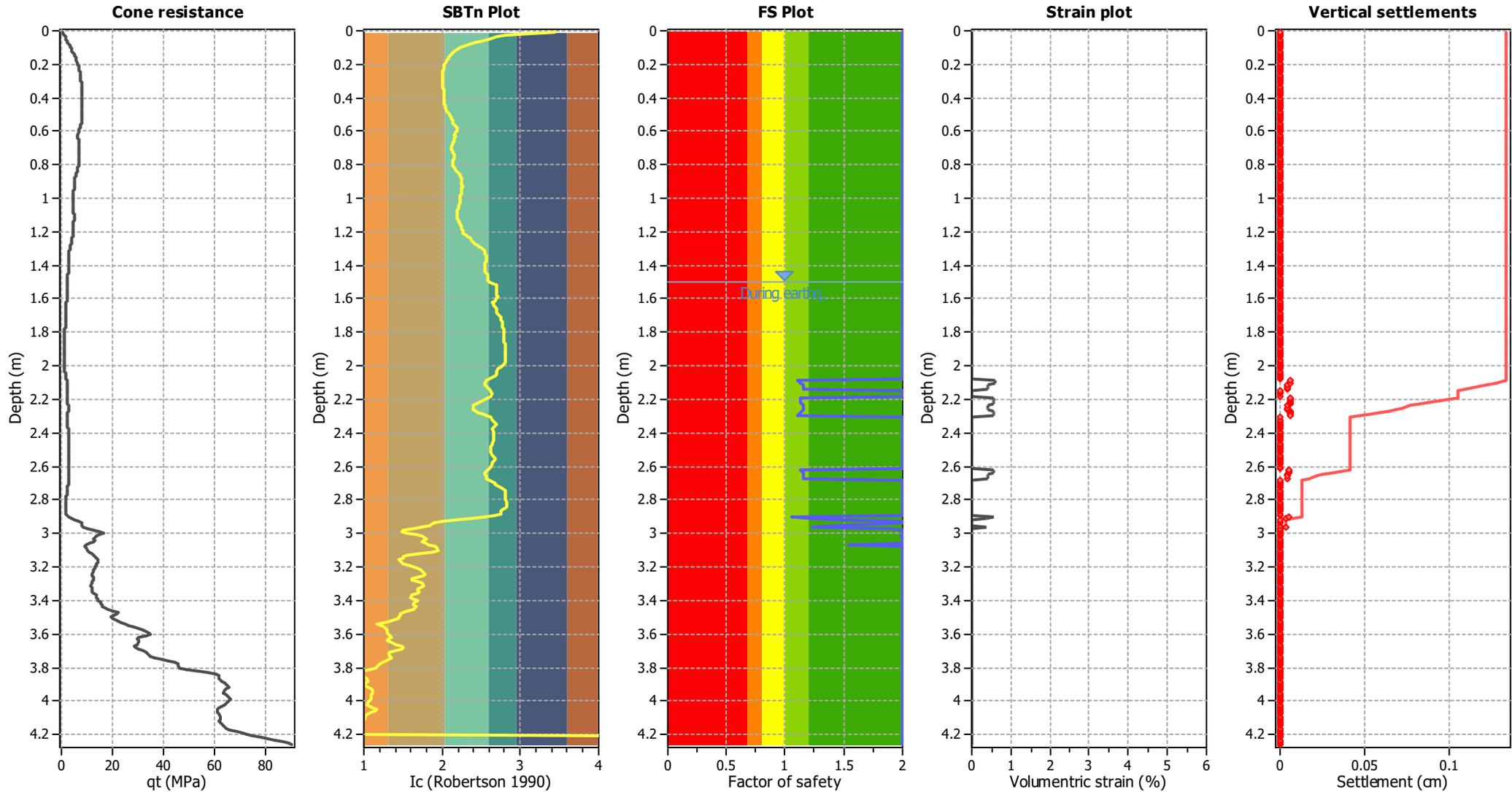
#### Input parameters and analysis data

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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	$K_v$ 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:	No
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

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

**LIQUEFACTION ANALYSIS REPORT**

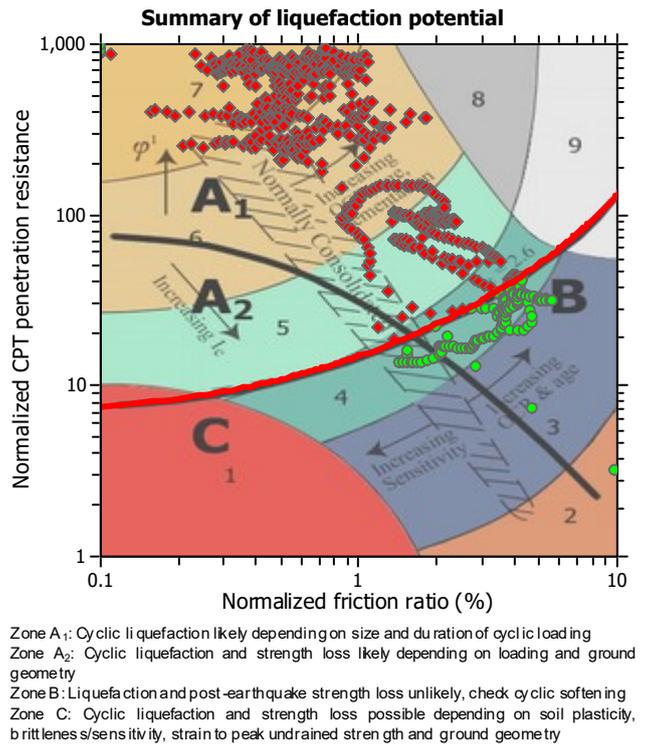
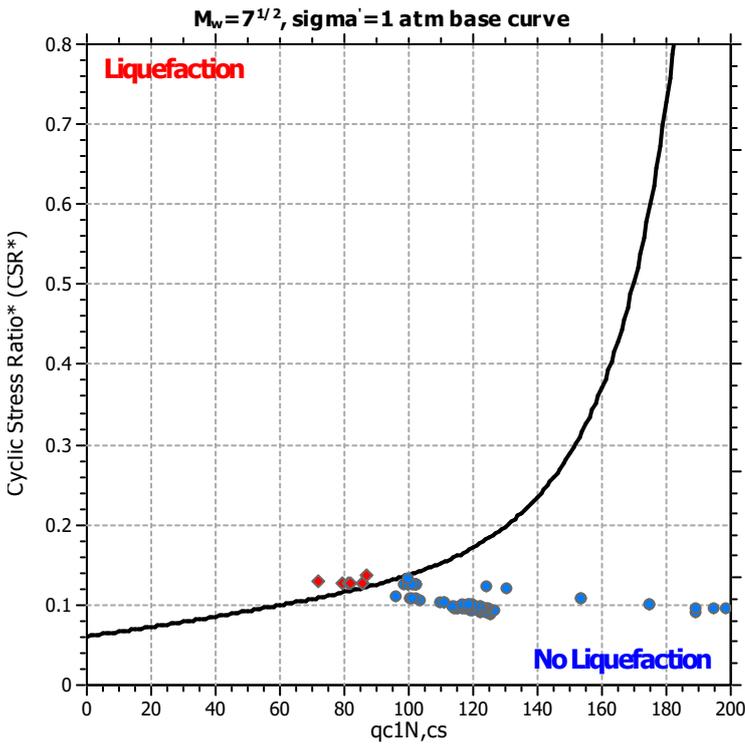
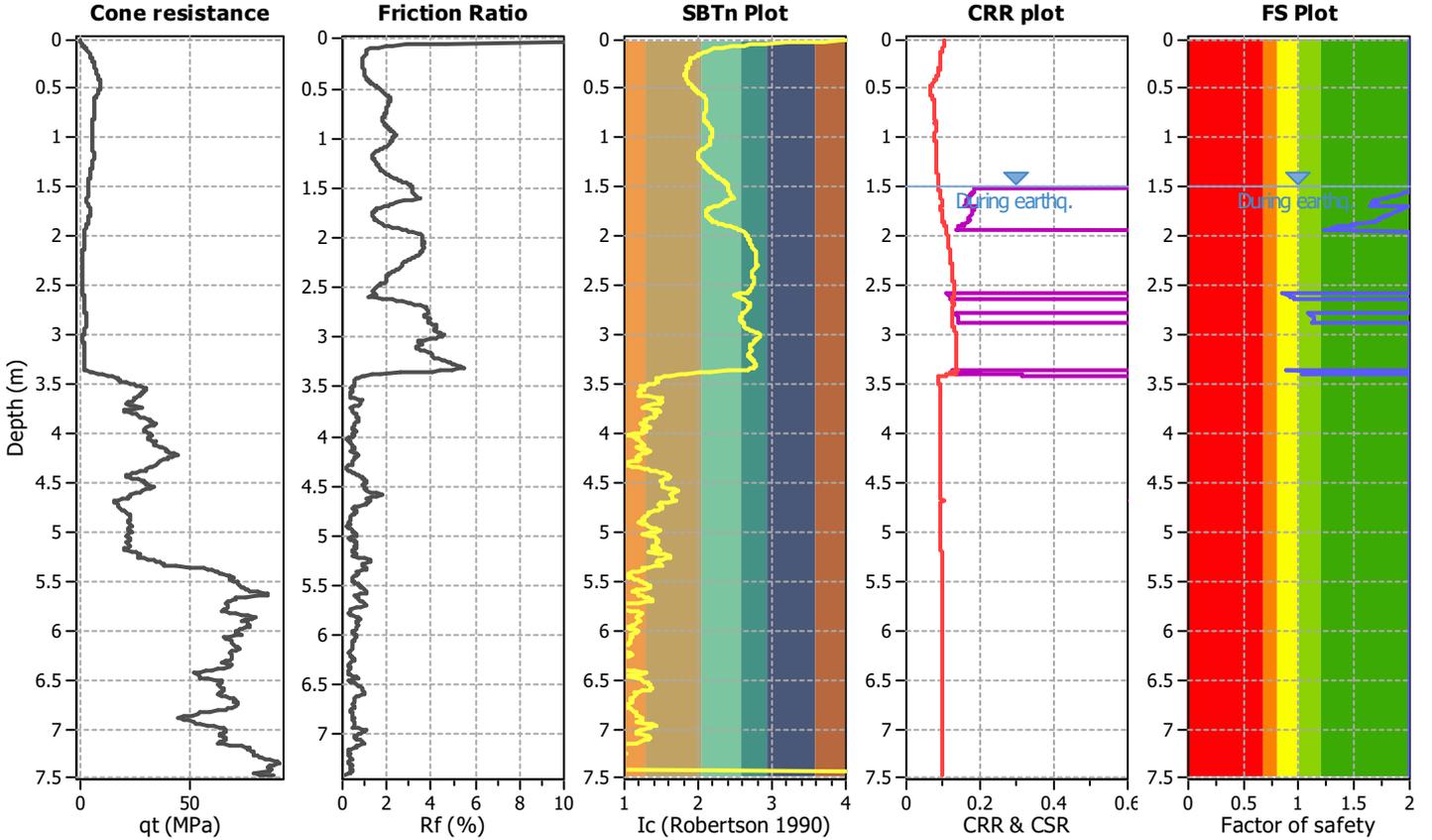
**Project title : K210318**

**Location : 232 Styx Mill Road, Casebrook, Christchurch**

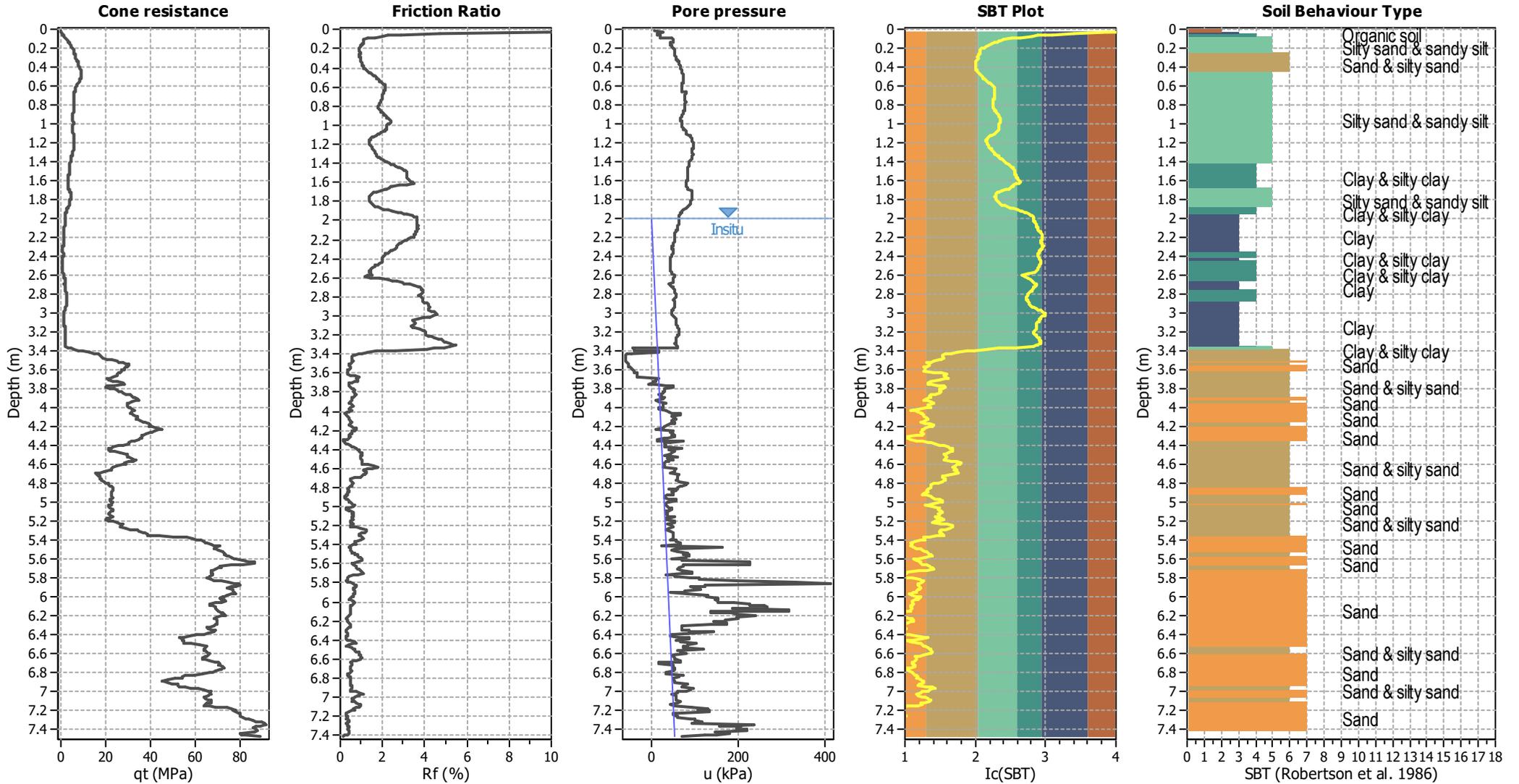
**CPT file : CPT-02 SLS2**

**Input parameters and analysis data**

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Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.50 m	Fill height:	N/A	applied:	Sands only
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes	MSF method:	Method based



### CPT basic interpretation plots



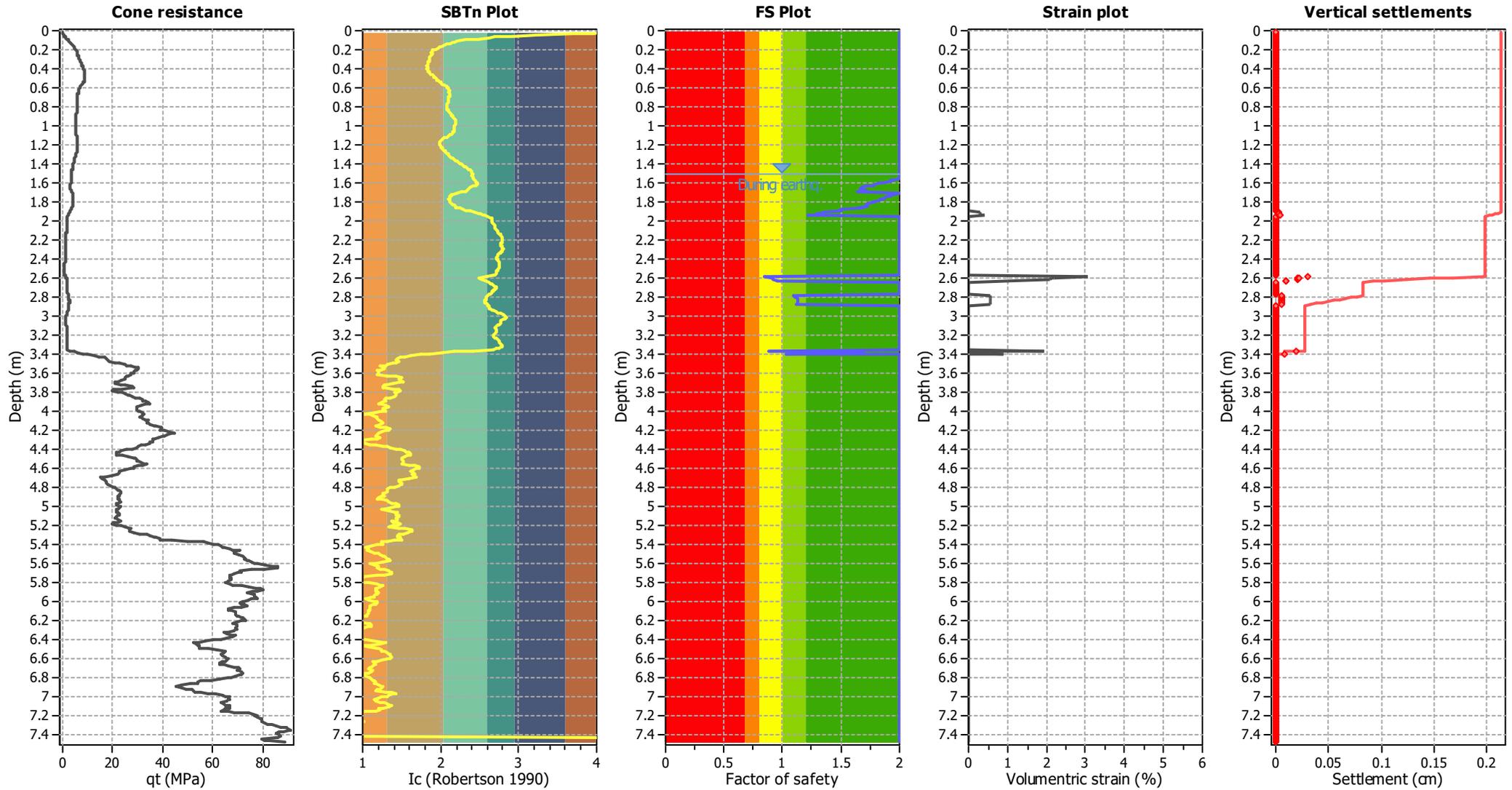
#### Input parameters and analysis data

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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	$K_v$ 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:	No
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

- qt: Total cone resistance (cone resistance q<sub>c</sub> corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

**LIQUEFACTION ANALYSIS REPORT**

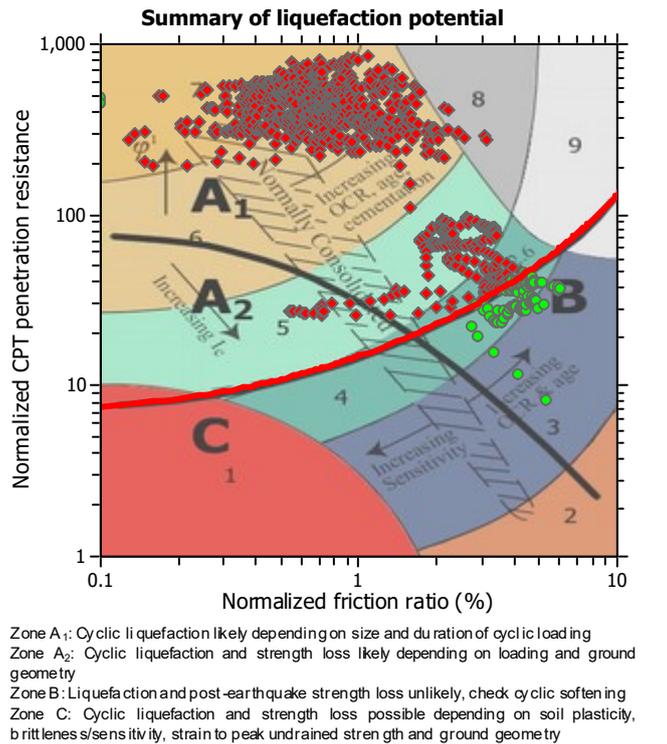
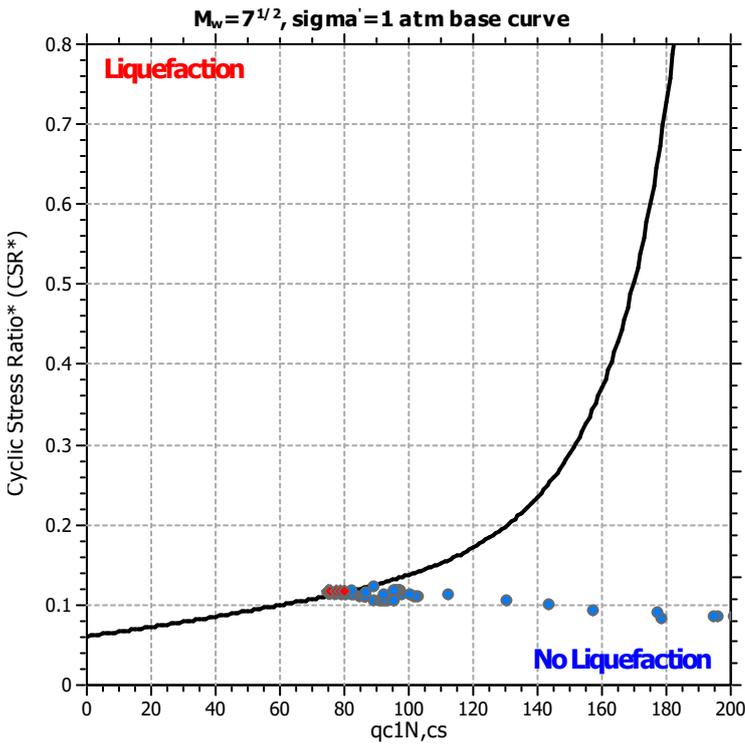
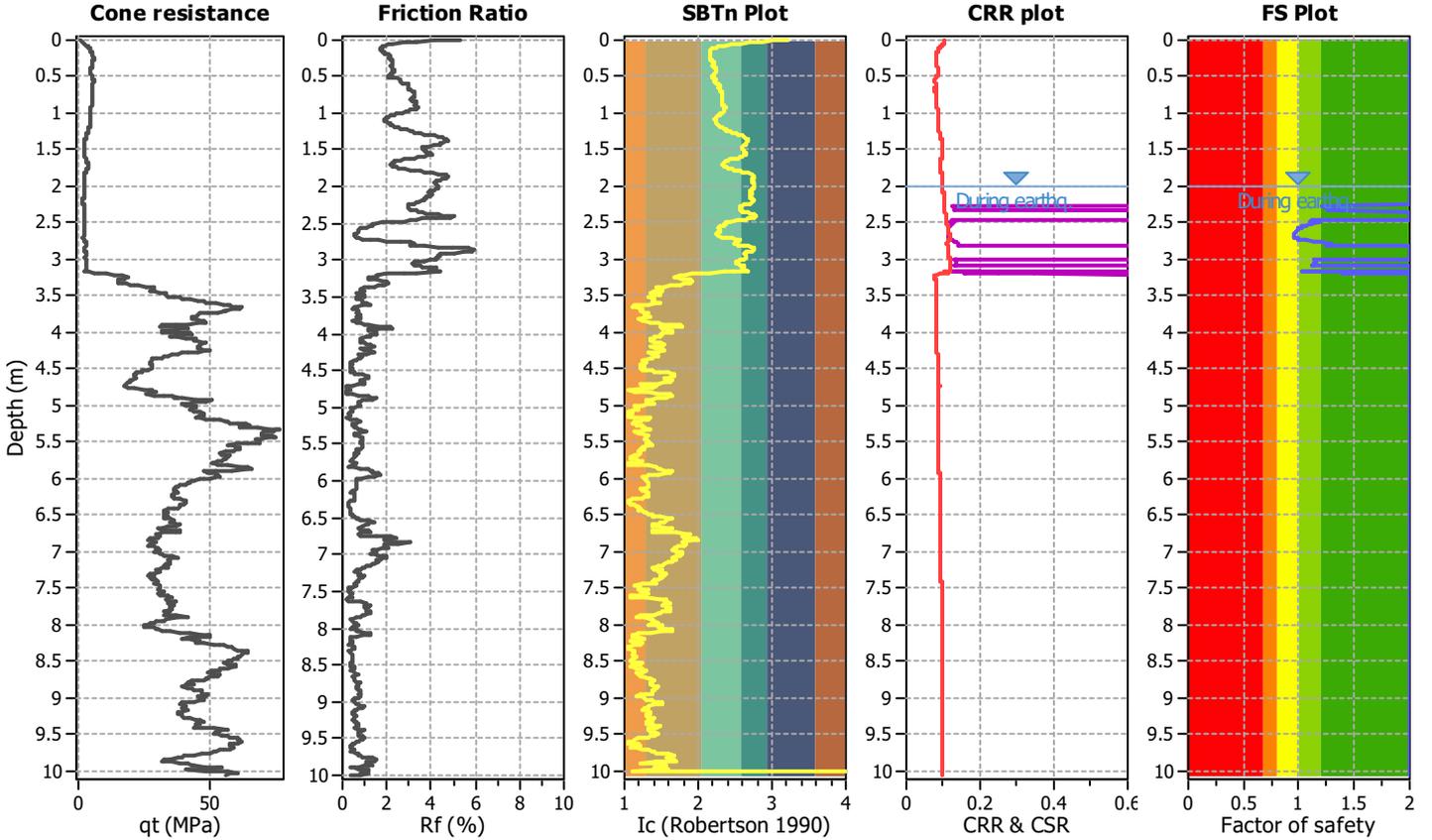
**Project title : K210318**

**Location : 232 Styx Mill Road, Casebrook, Christchurch**

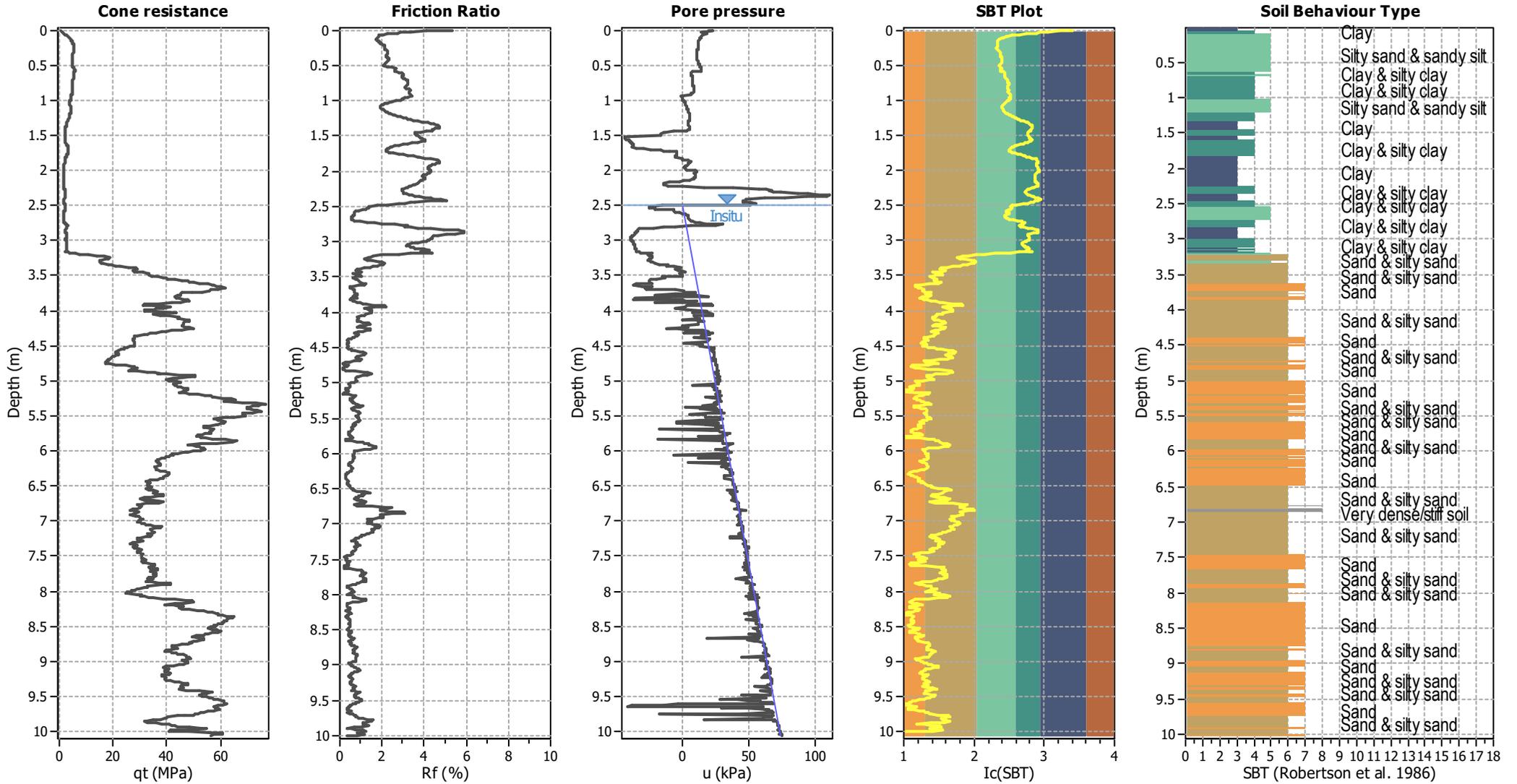
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Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude $M_w$ :	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes		



### CPT basic interpretation plots



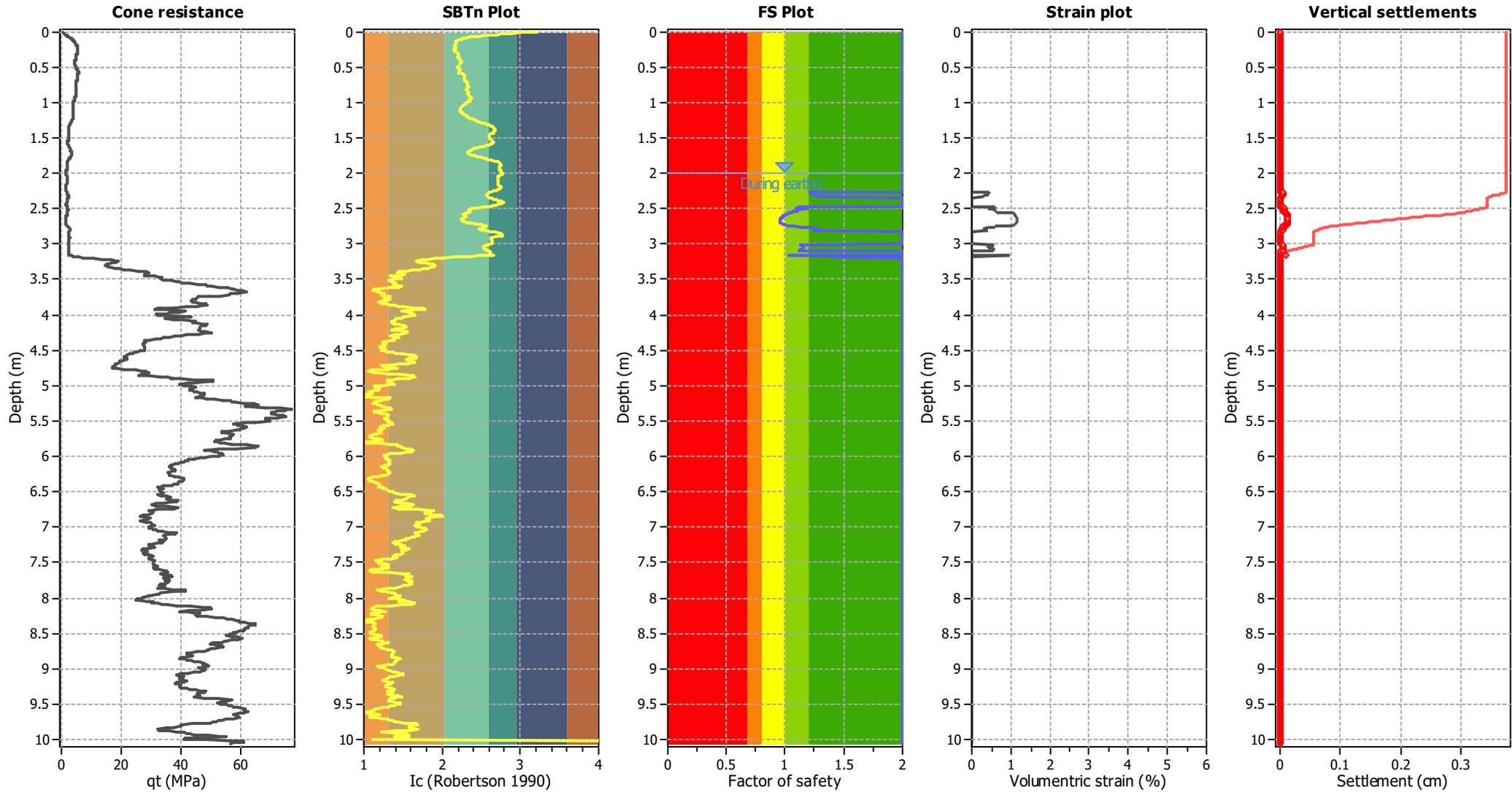
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Points to test:	Based on Ic value	Ic cut-off value:	2.60	$K_0$ applied:	Yes
Earthquake magnitude $M_w$ :	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

- qt: Total cone resistance (cone resistance q<sub>c</sub> corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

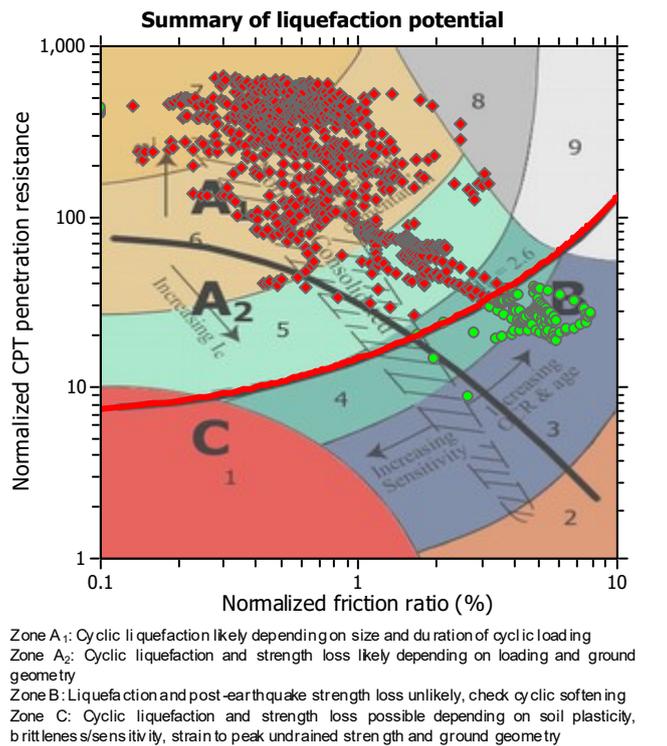
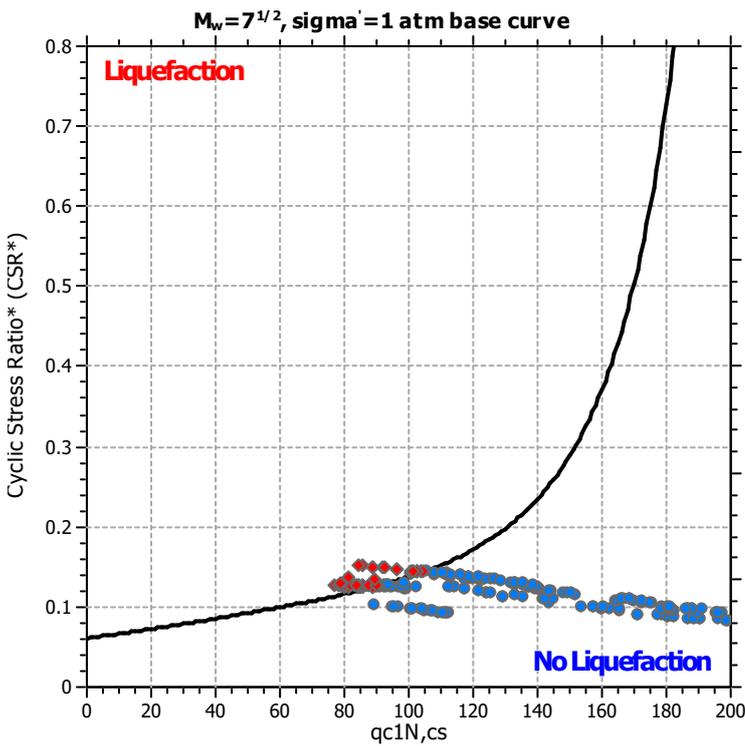
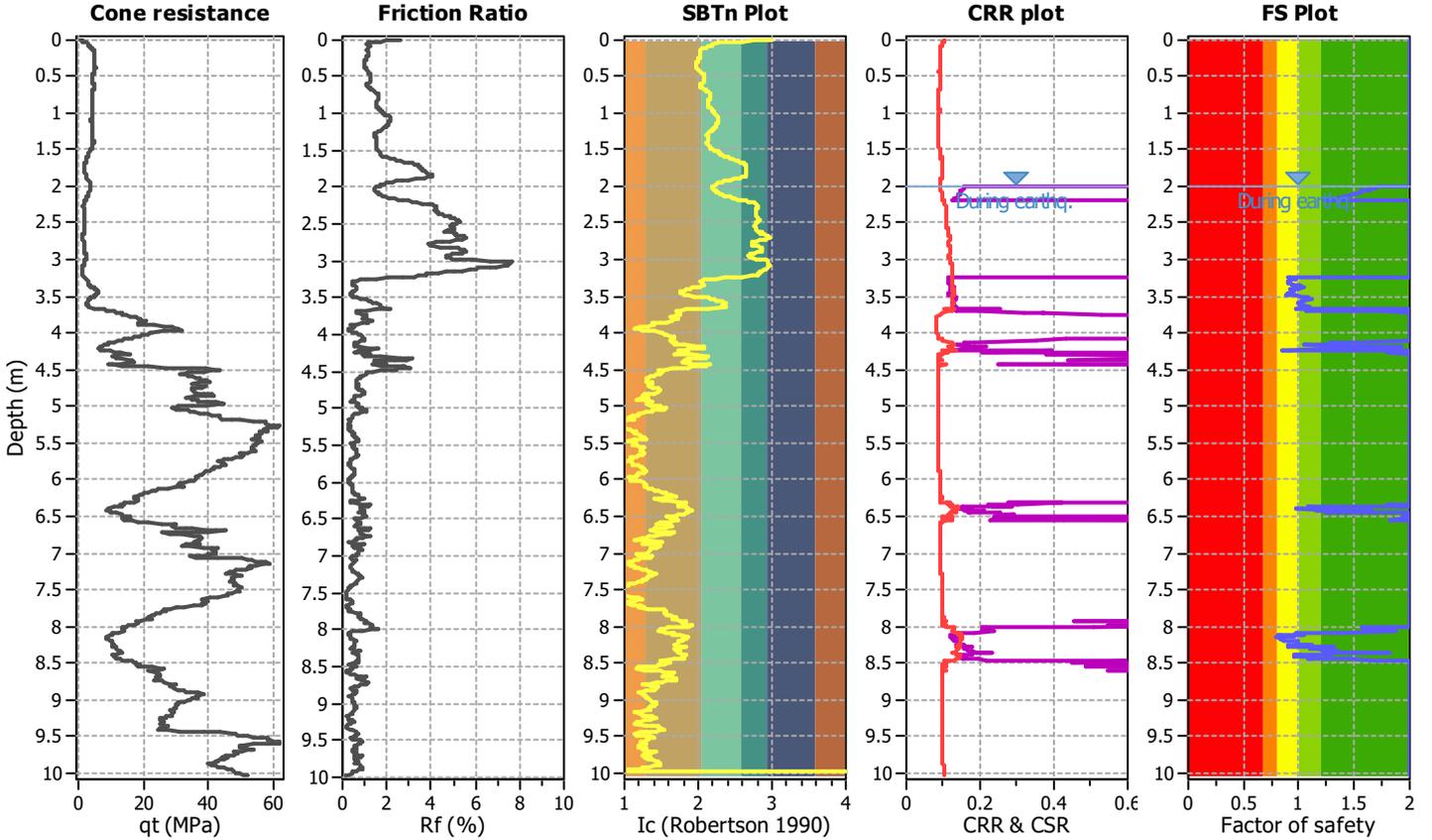
**LIQUEFACTION ANALYSIS REPORT**

**Project title : K210318**  
**CPT file : CPT-04 SLS2**

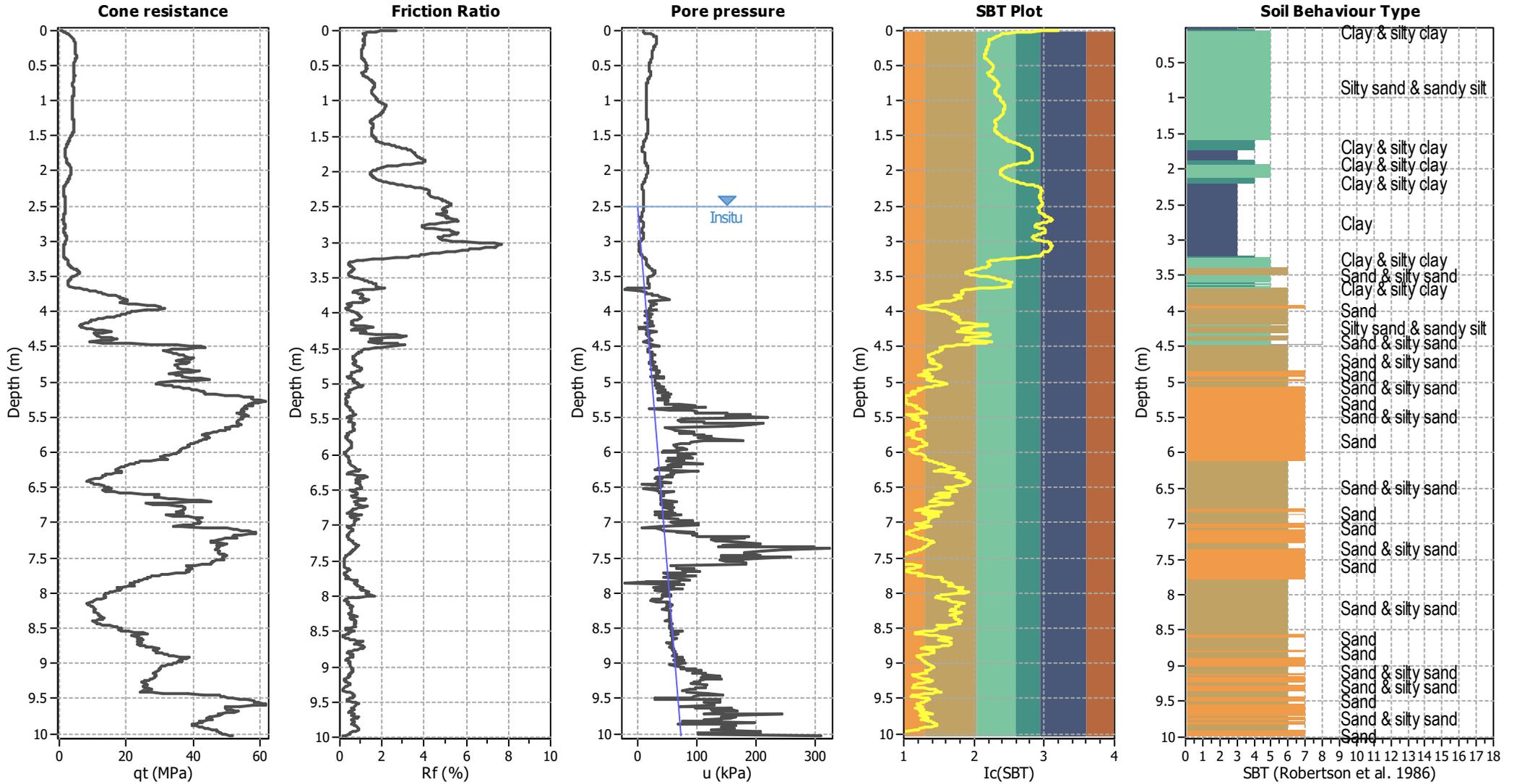
**Location : 232 Styx Mill Road, Casebrook, Christchurch**

**Input parameters and analysis data**

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Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude $M_w$ :	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes		



### CPT basic interpretation plots



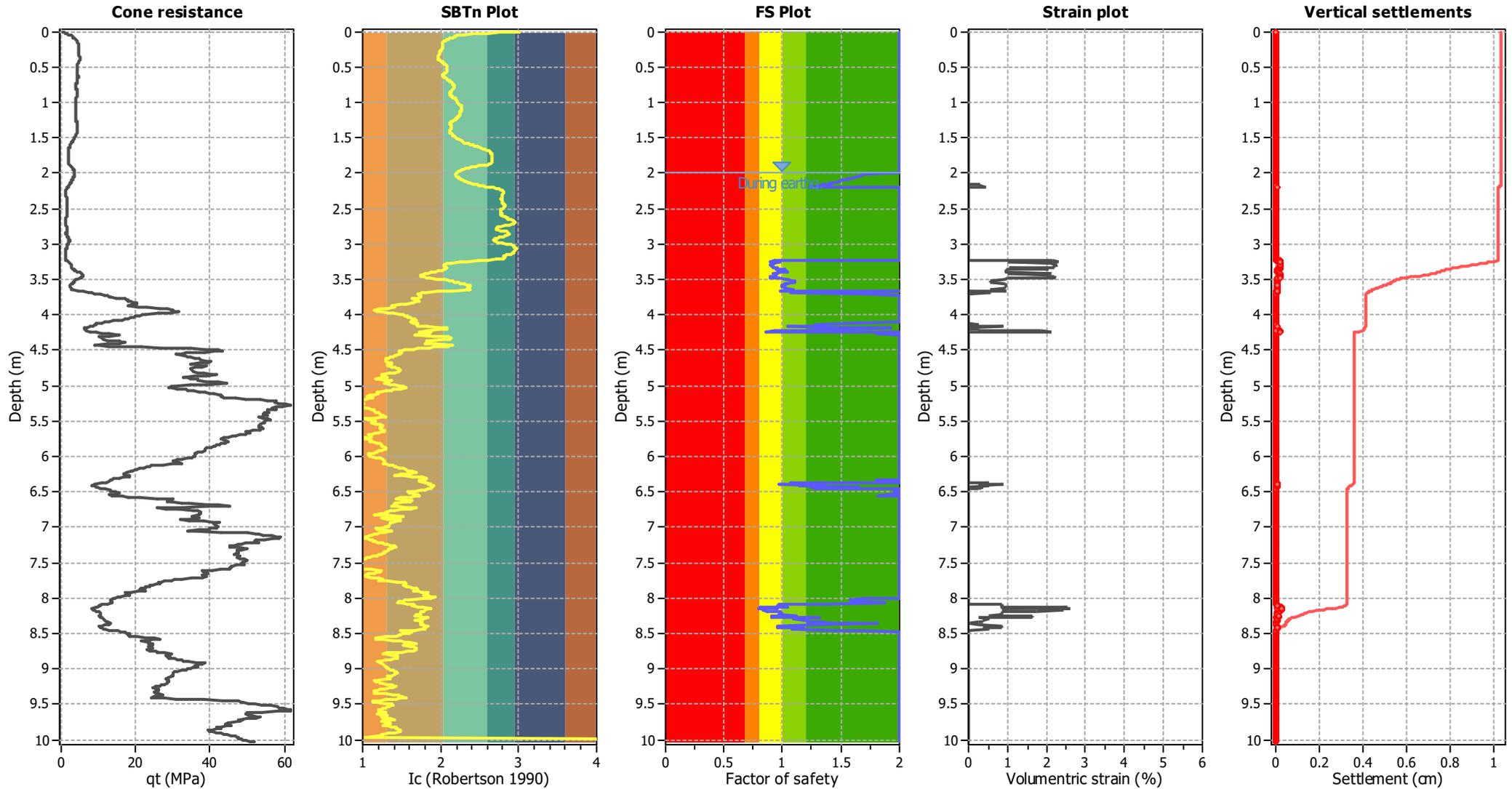
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Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	$K_0$ applied:	Yes
Earthquake magnitude $M_w$ :	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

- qt: Total cone resistance (cone resistance  $q_c$  corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

**LIQUEFACTION ANALYSIS REPORT**

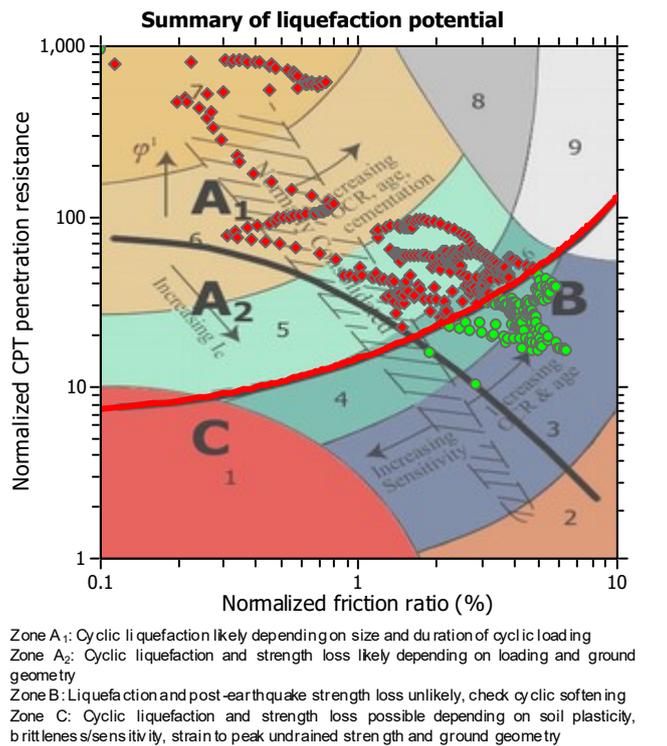
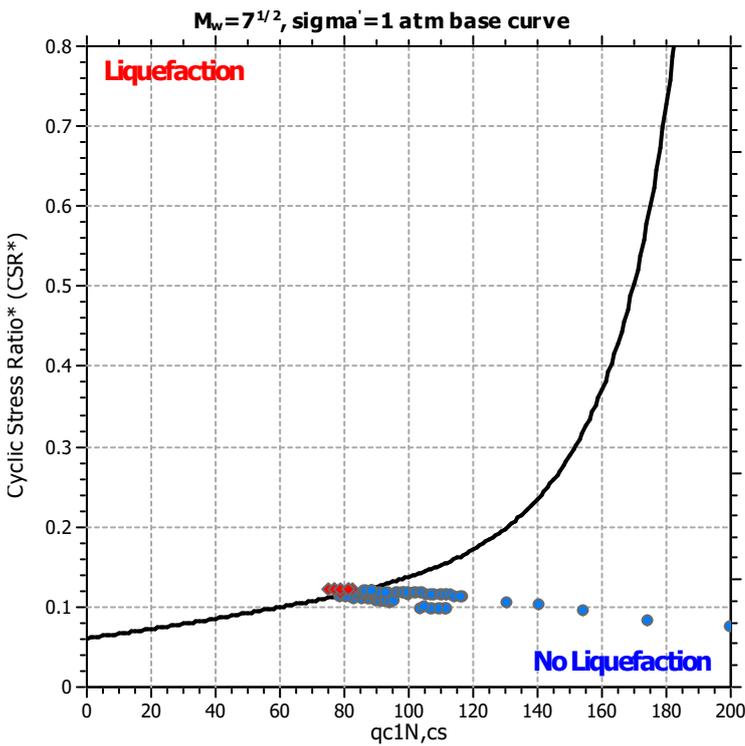
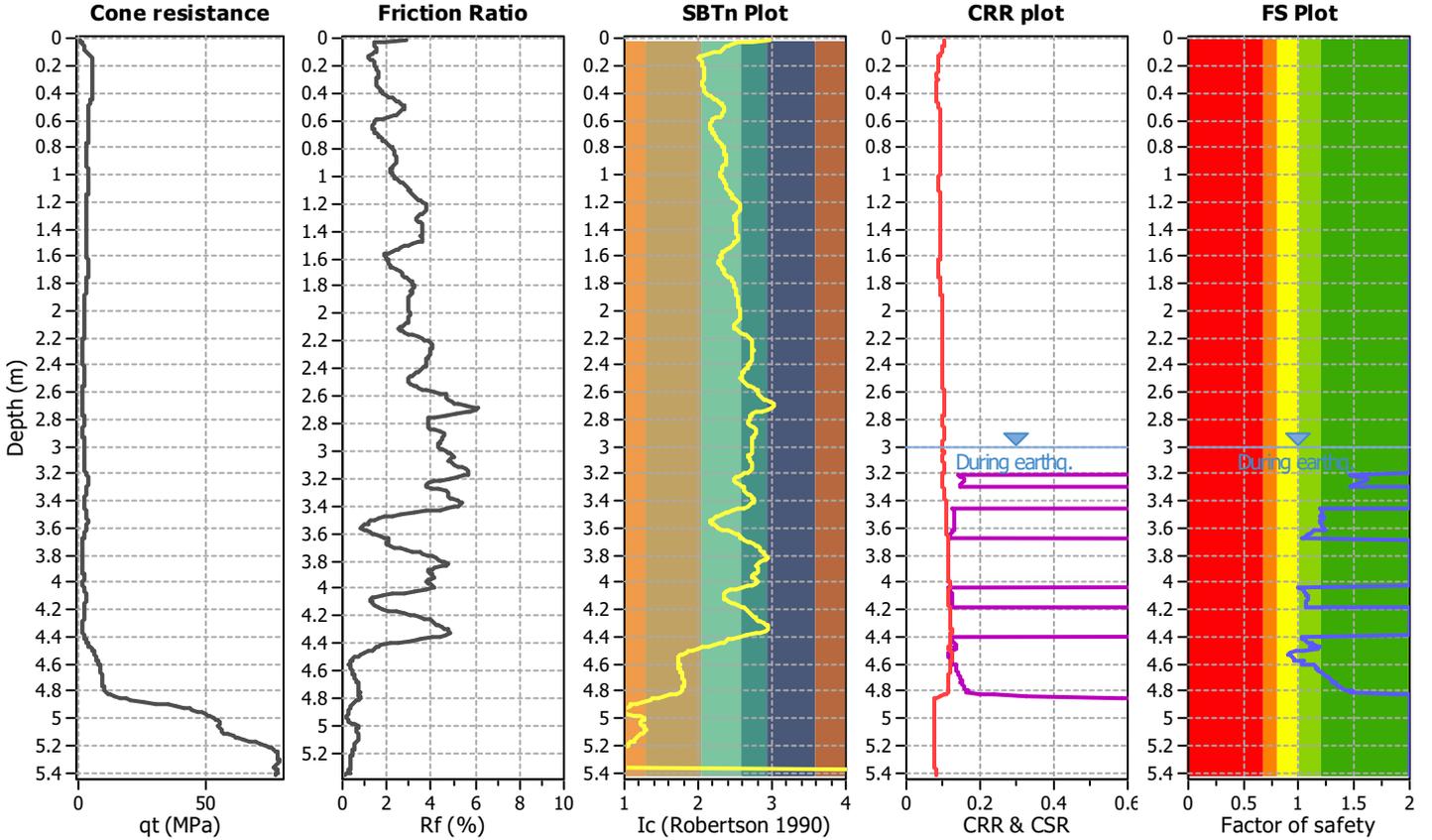
**Project title : K210318**

**Location : 232 Styx Mill Road, Casebrook, Christchurch**

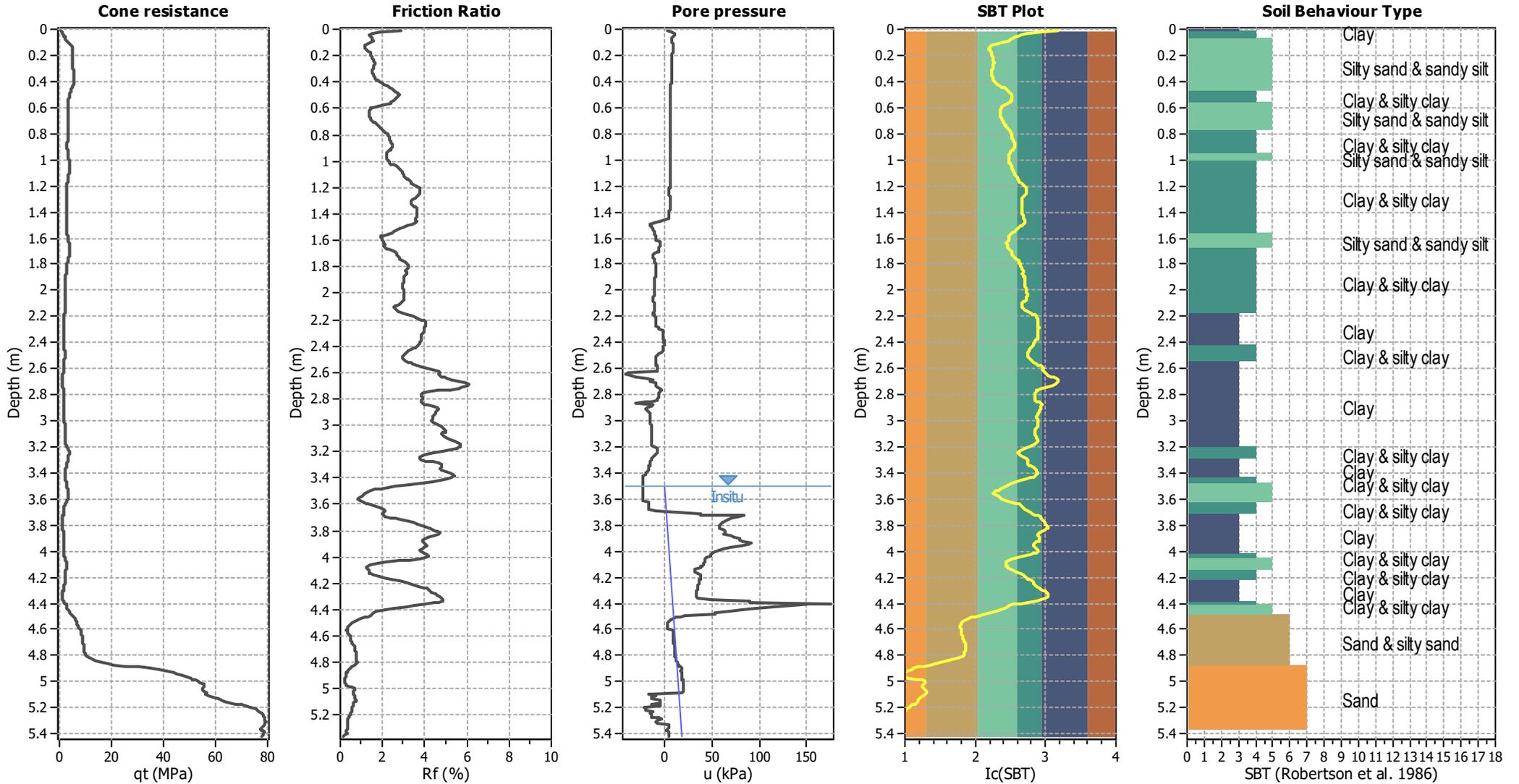
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**Input parameters and analysis data**

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Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes	MSF method:	Method based



### CPT basic interpretation plots



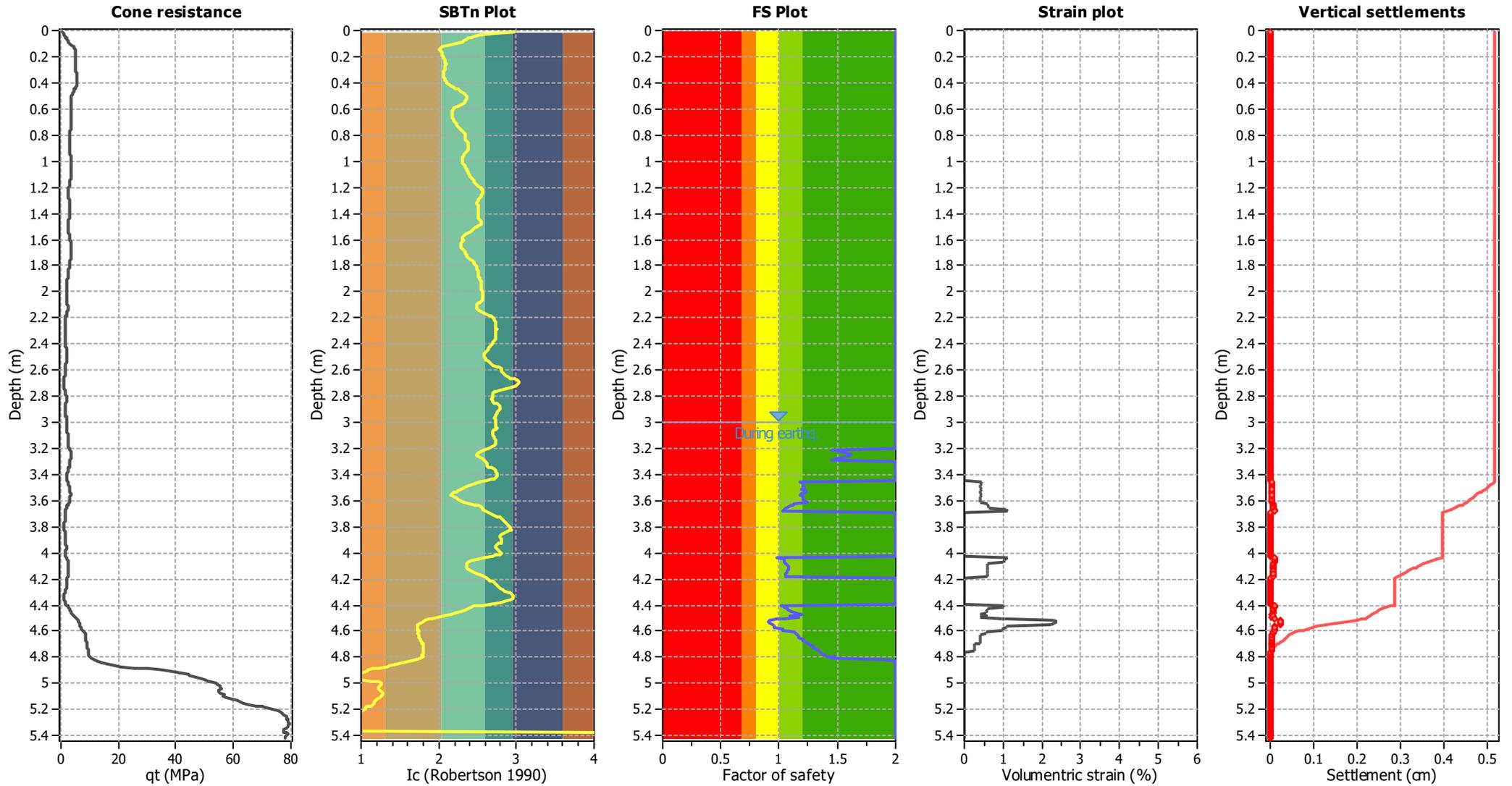
#### Input parameters and analysis data

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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:	No
Depth to water table (insitu):	3.50 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

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

**LIQUEFACTION ANALYSIS REPORT**

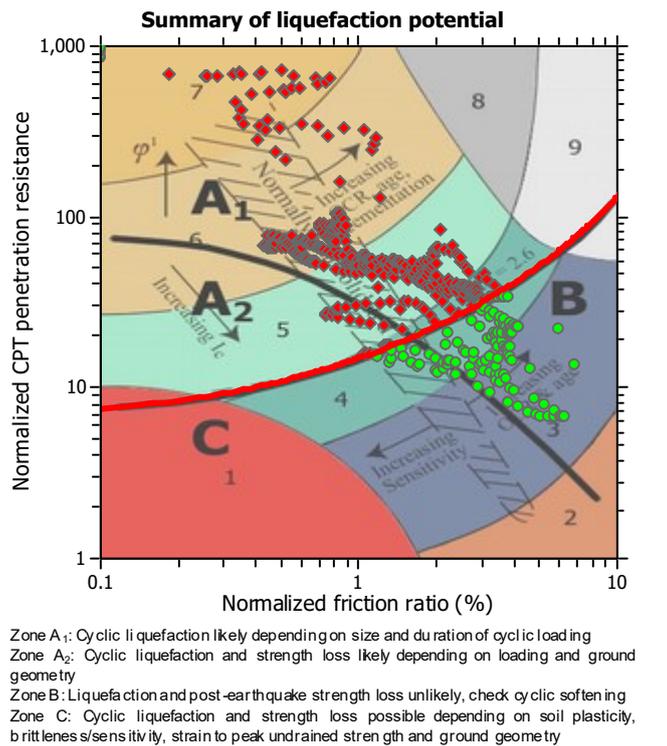
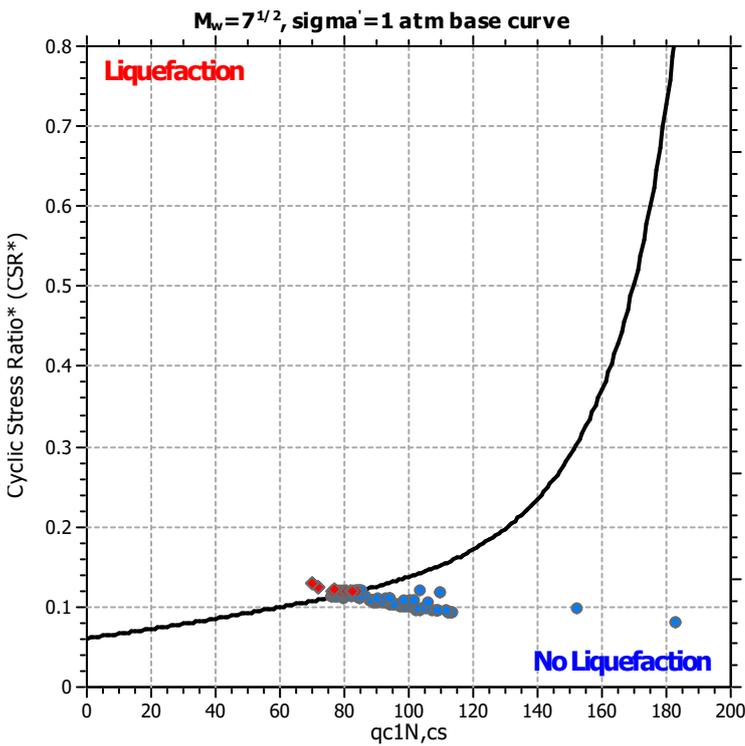
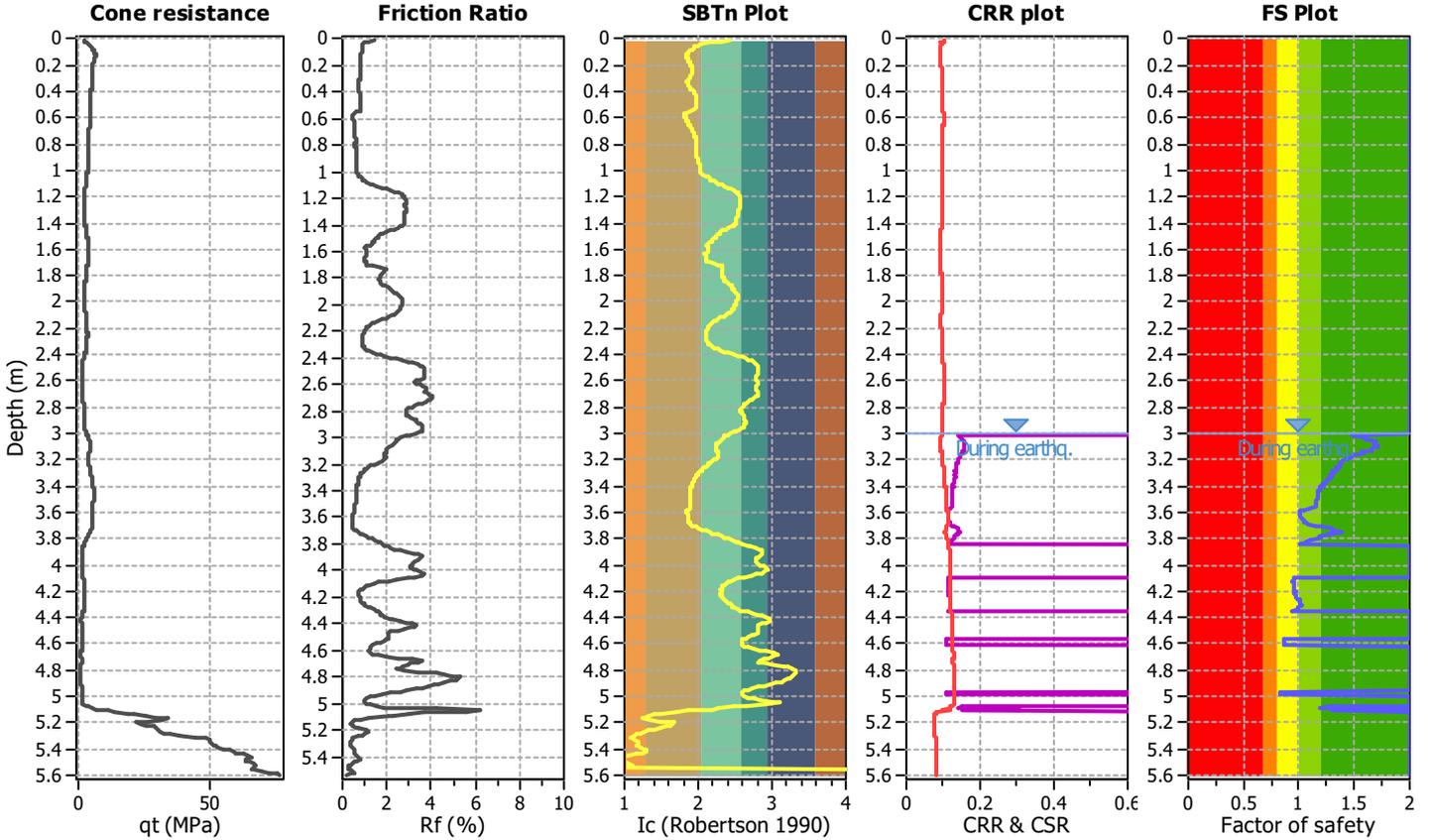
**Project title : K210318**

**Location : 232 Styx Mill Road, Casebrook, Christchurch**

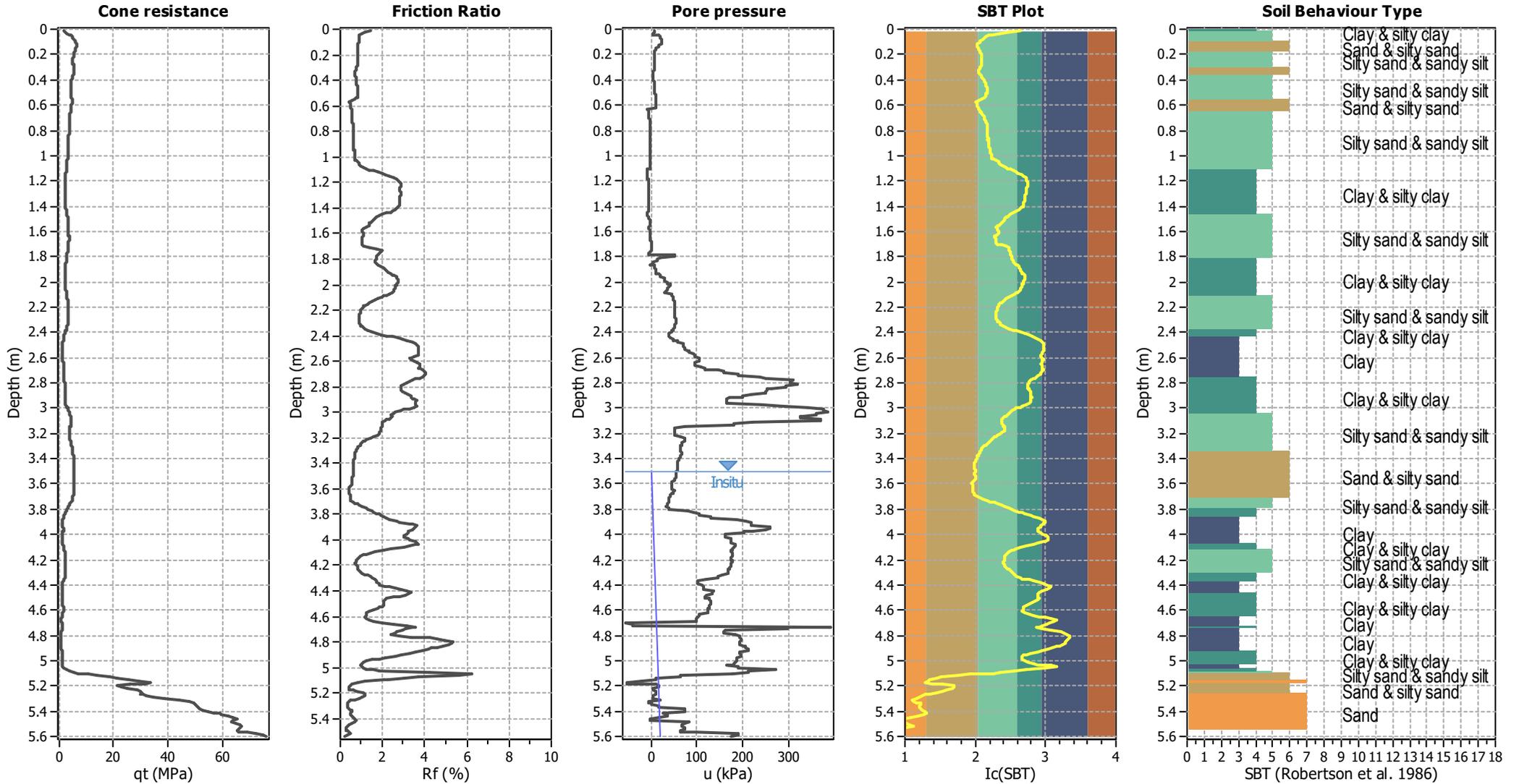
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**Input parameters and analysis data**

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Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.00 m	Fill height:	N/A	applied:	Sands only
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes	MSF method:	Method based



### CPT basic interpretation plots



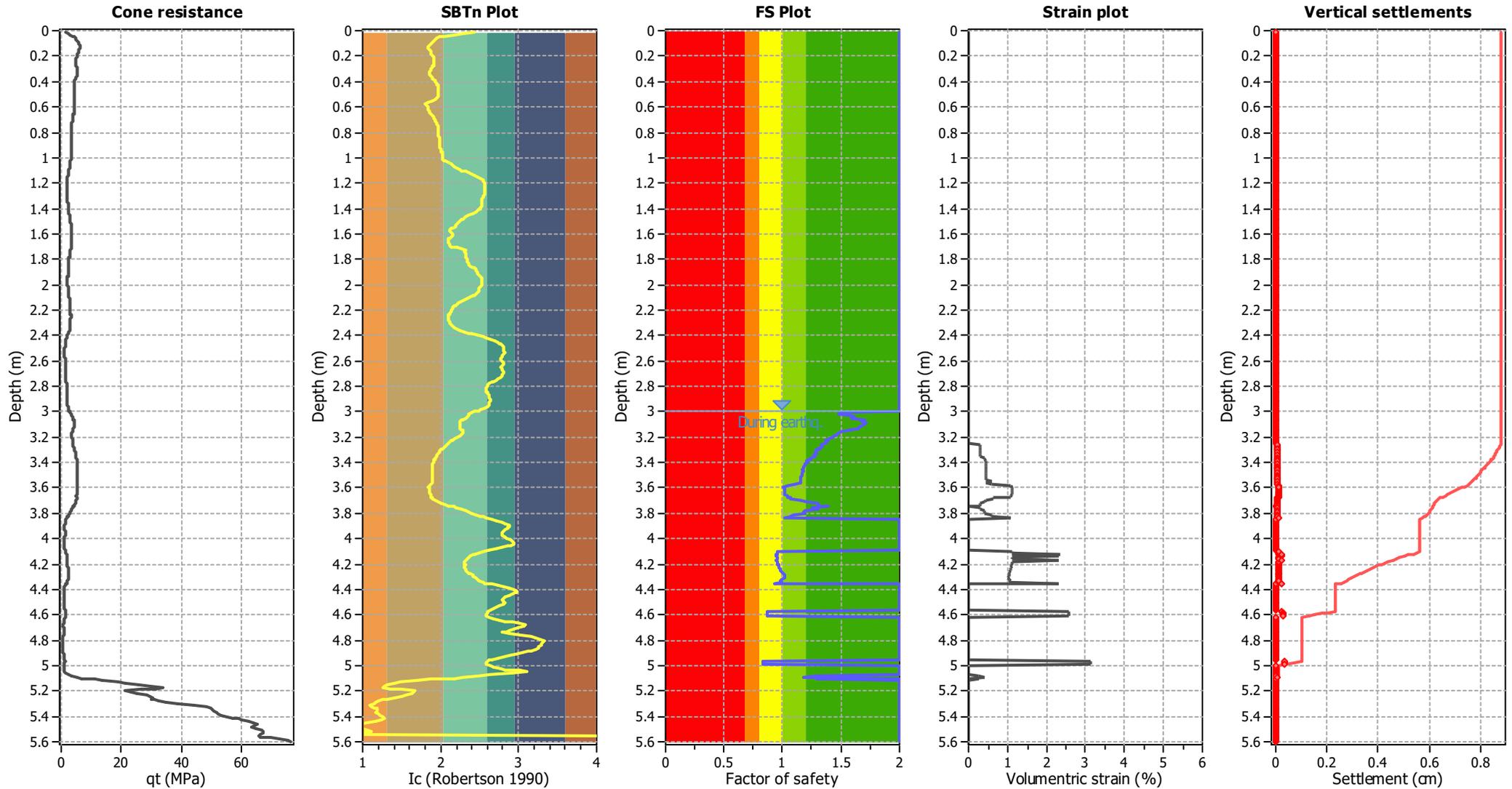
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Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	$K_v$ applied:	Yes
Earthquake magnitude $M_w$ :	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

- qt: Total cone resistance (cone resistance q<sub>c</sub> corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

**LIQUEFACTION ANALYSIS REPORT**

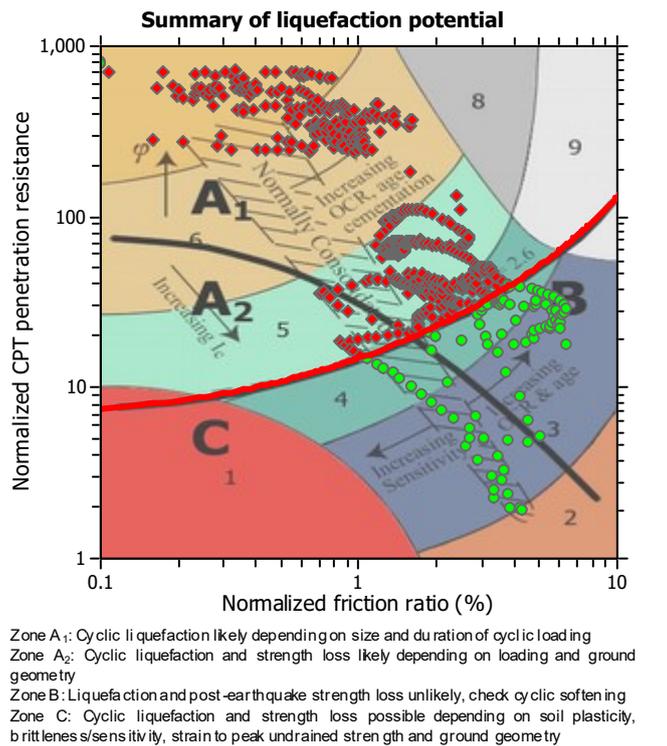
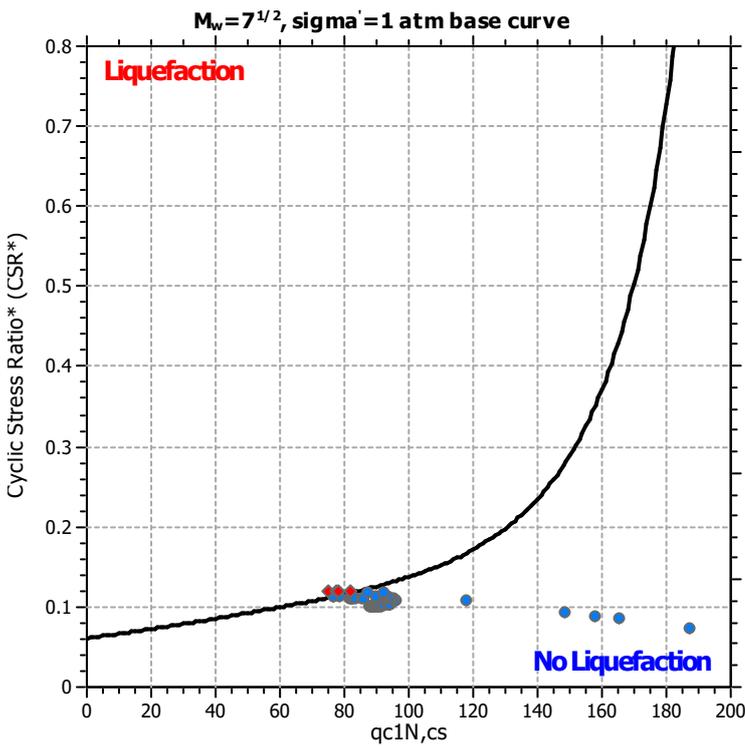
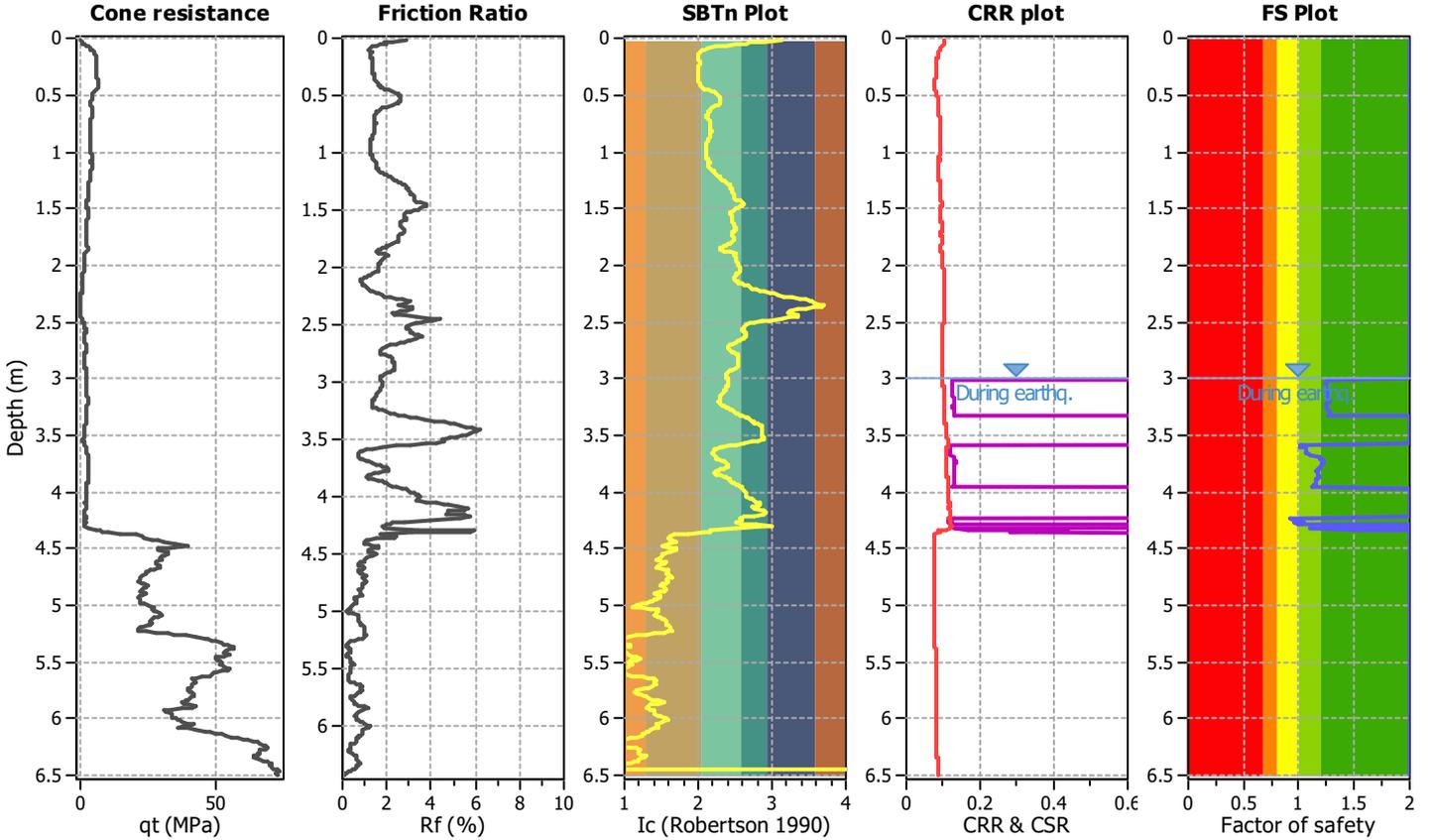
**Project title : K210318**

**Location : 232 Styx Mill Road, Casebrook, Christchurch**

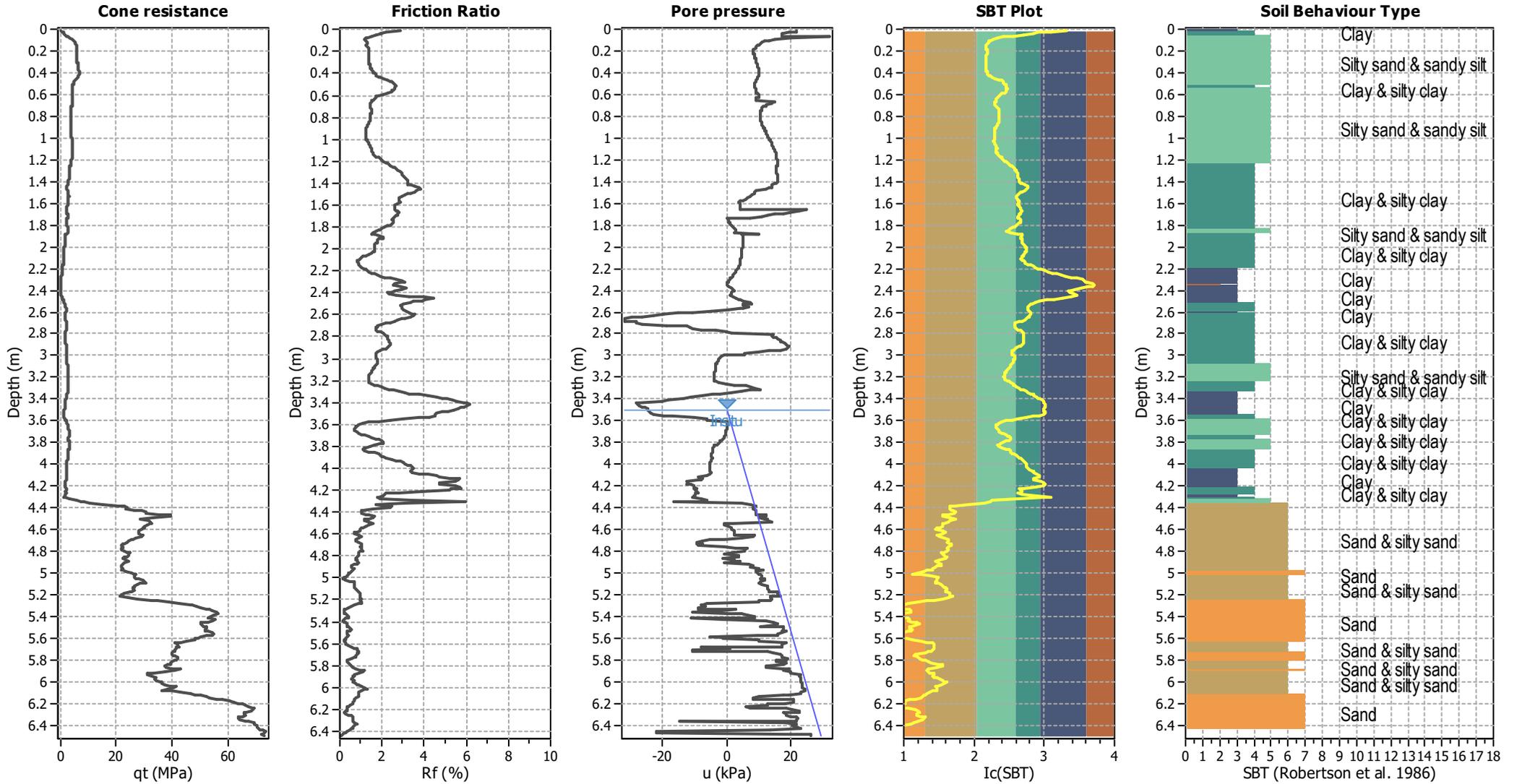
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**Input parameters and analysis data**

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Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude $M_w$ :	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	$K_g$ applied:	Yes		



### CPT basic interpretation plots



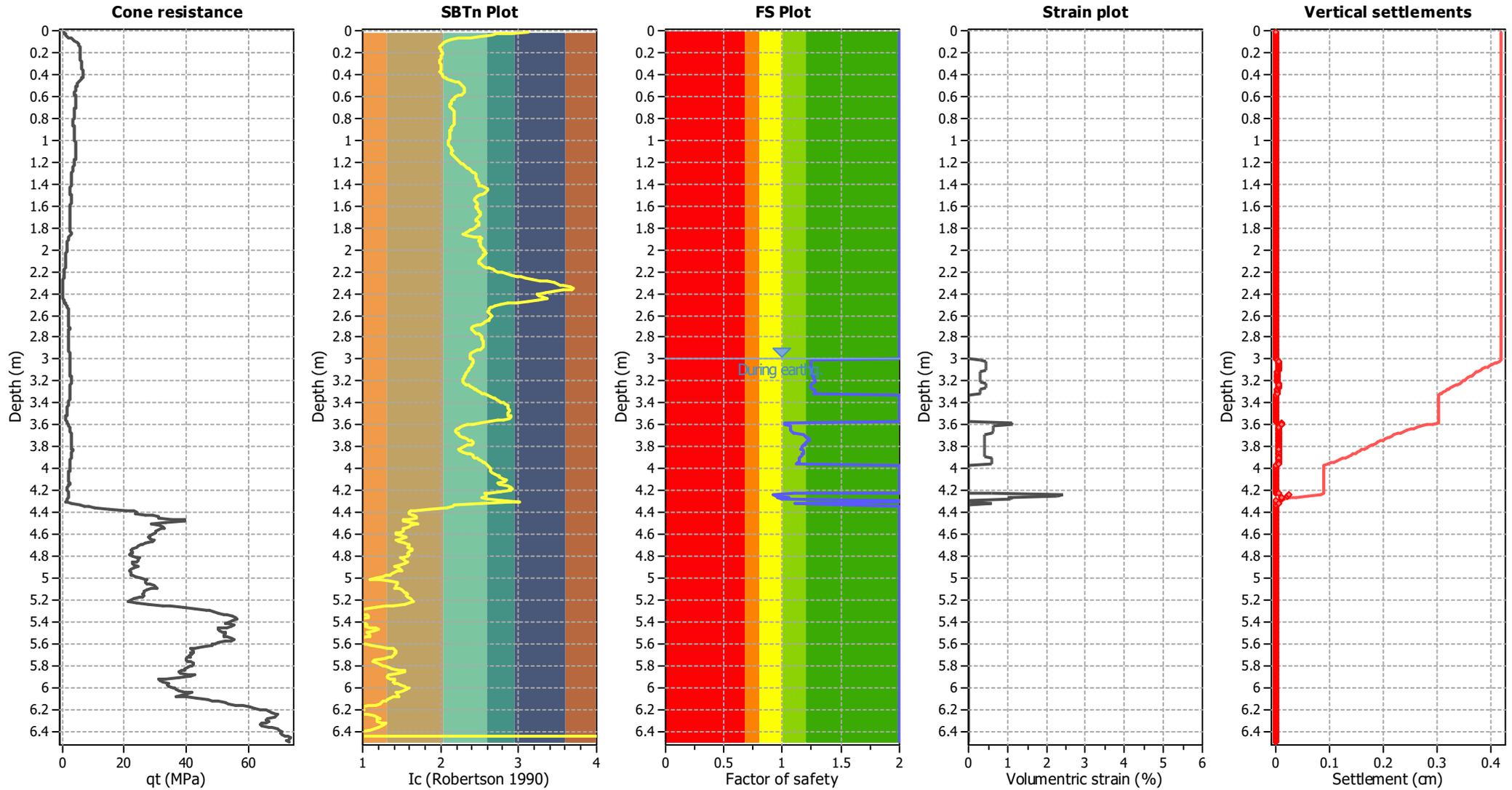
#### Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 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	$K_v$ 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:	No
Depth to water table (insitu):	3.50 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

- qt: Total cone resistance (cone resistance  $q_c$  corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

**LIQUEFACTION ANALYSIS REPORT**

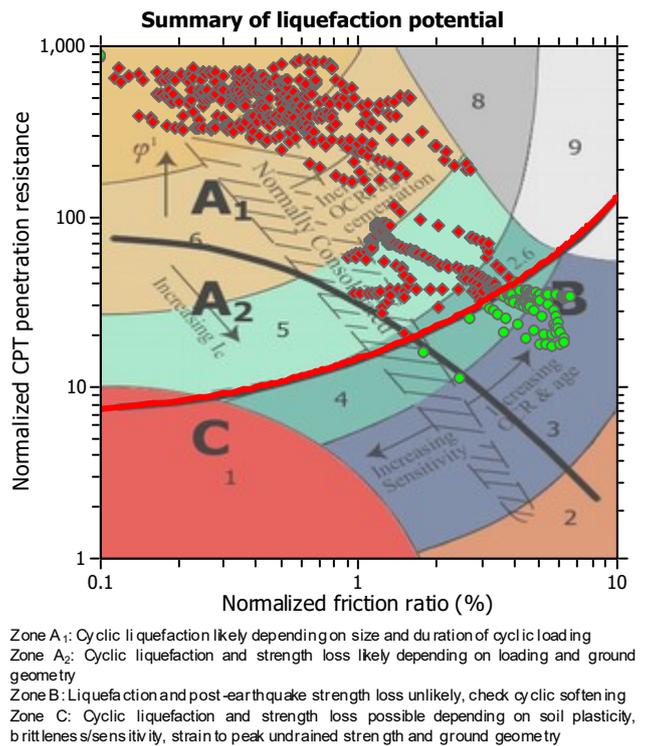
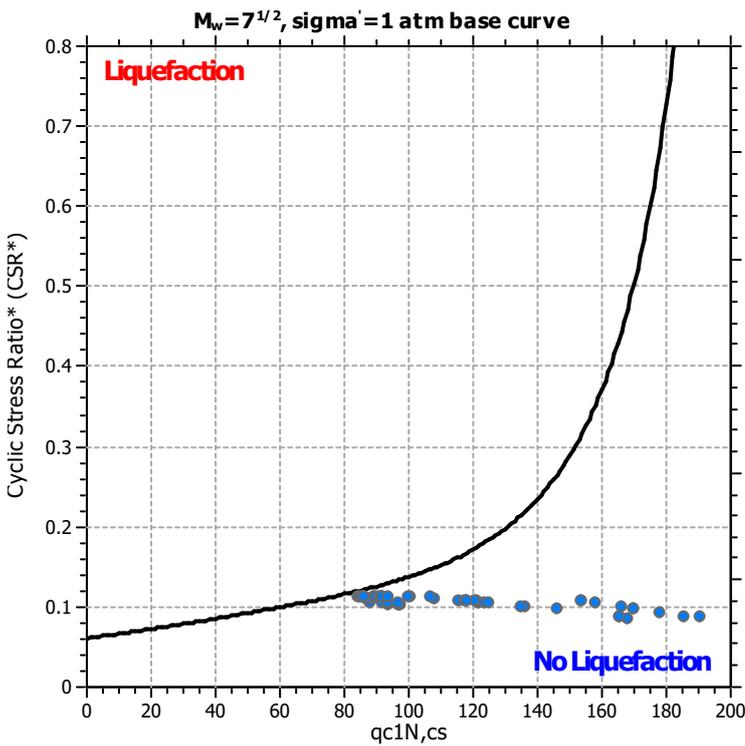
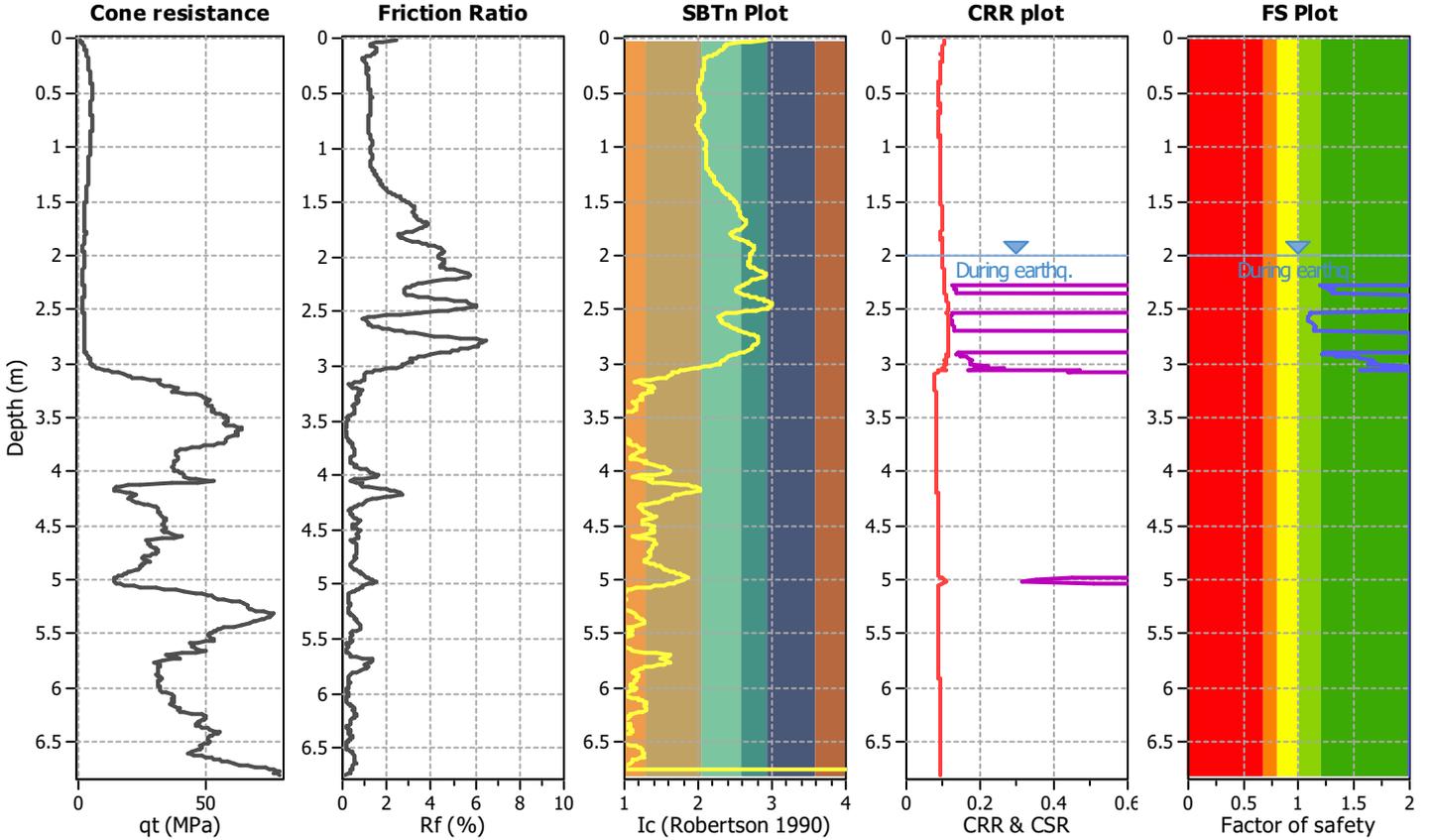
**Project title : K210318**

**Location : 232 Styx Mill Road, Casebrook, Christchurch**

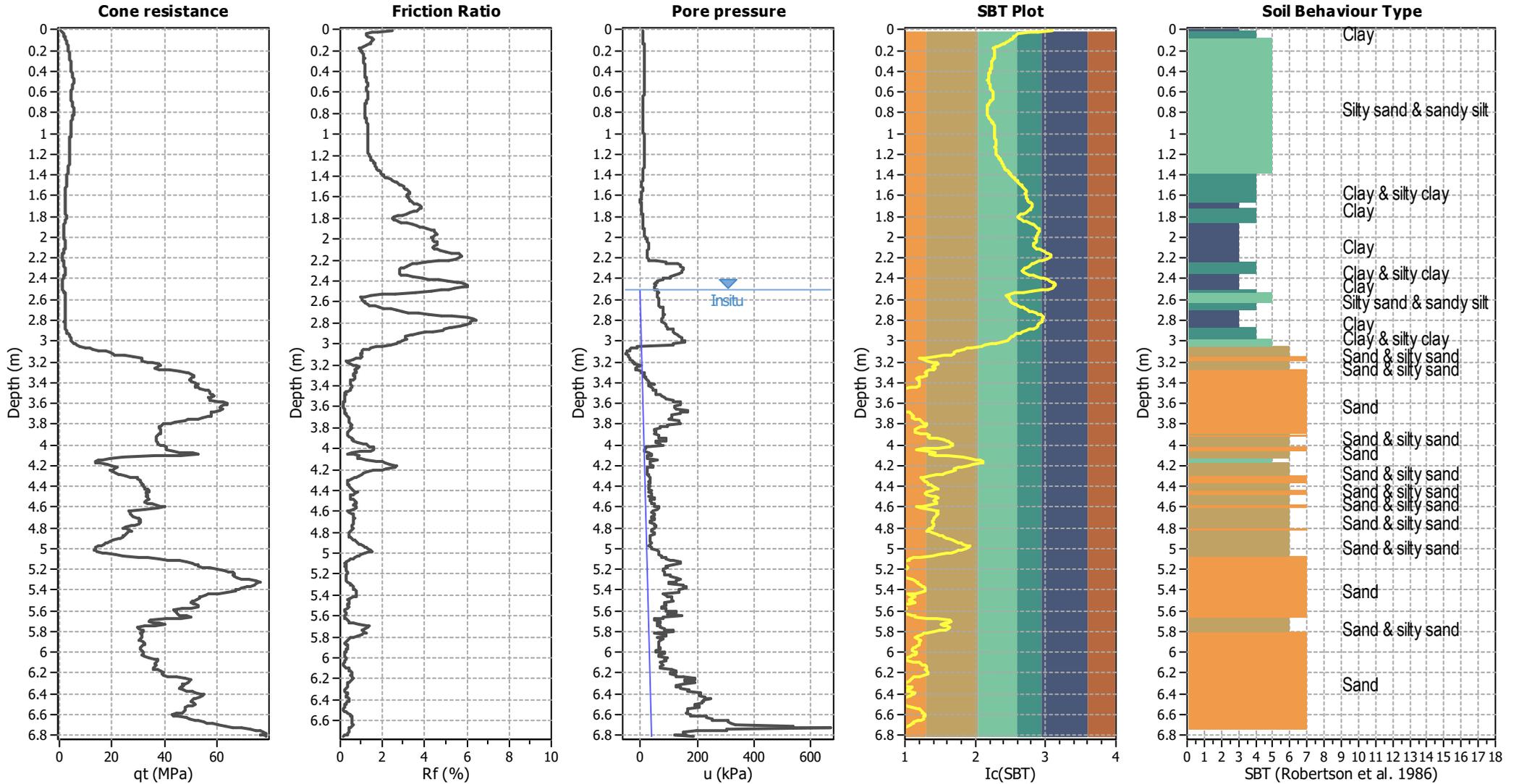
**CPT file : CPT-08 SLS2**

**Input parameters and analysis data**

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Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.00 m	Fill height:	N/A	applied:	Sands only
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes	MSF method:	Method based



### CPT basic interpretation plots



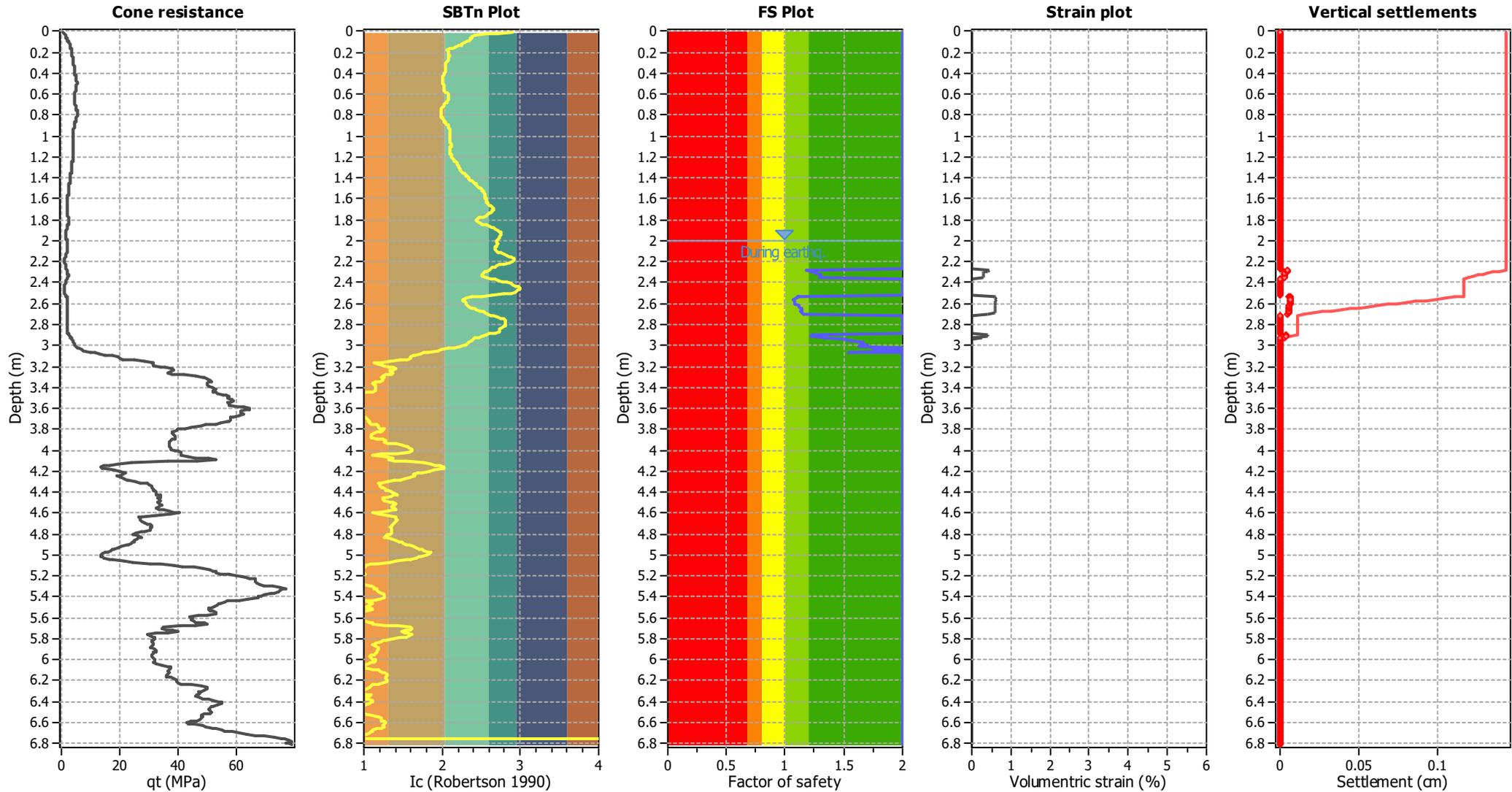
#### Input parameters and analysis data

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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	$K_v$ 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:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

- qt: Total cone resistance (cone resistance  $q_c$  corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

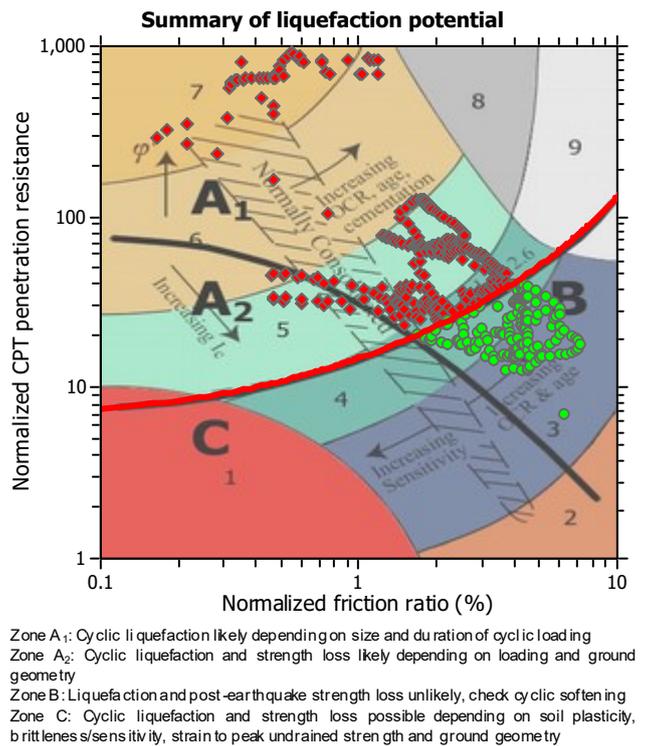
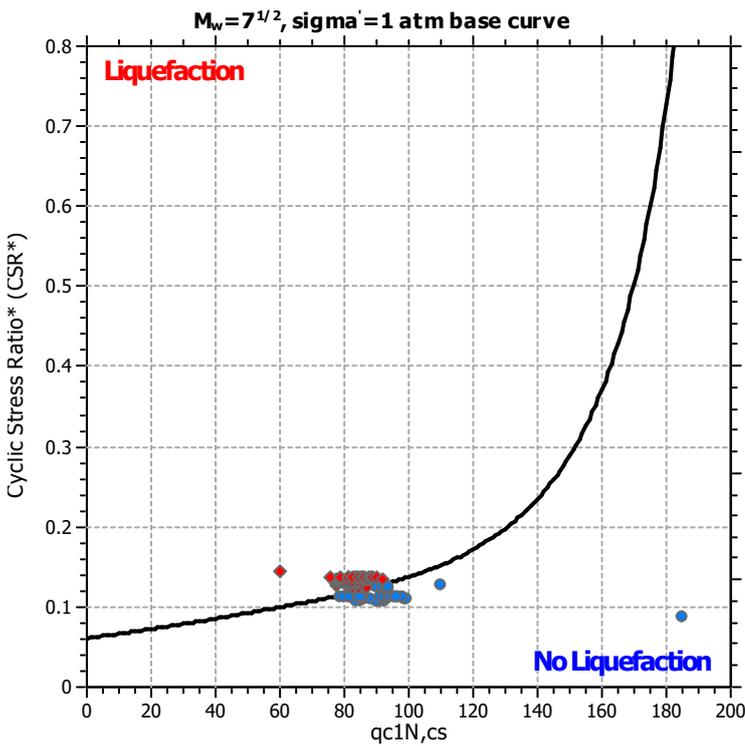
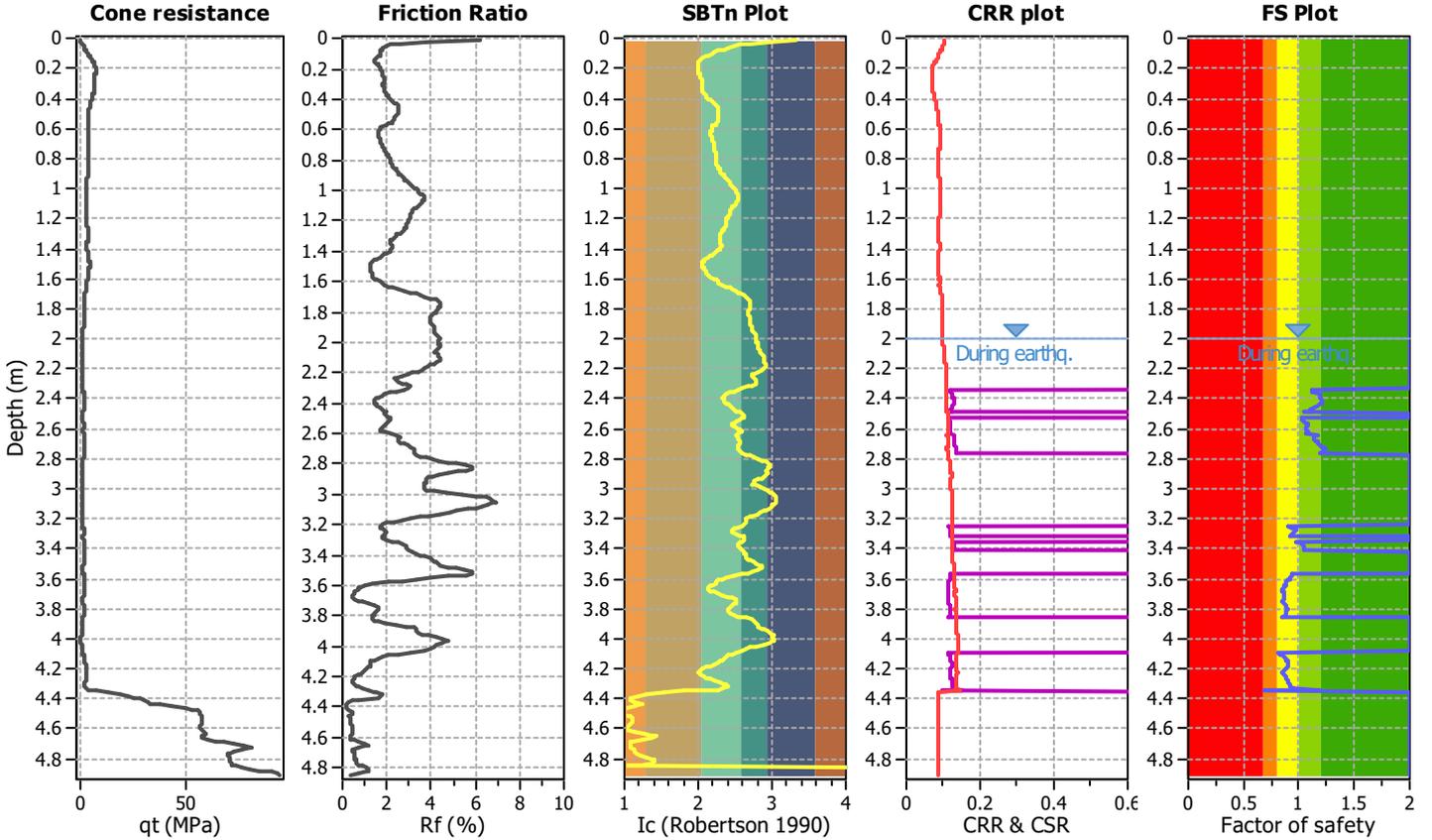
**LIQUEFACTION ANALYSIS REPORT**

**Project title : K210318**  
**CPT file : CPT-09 SLS2**

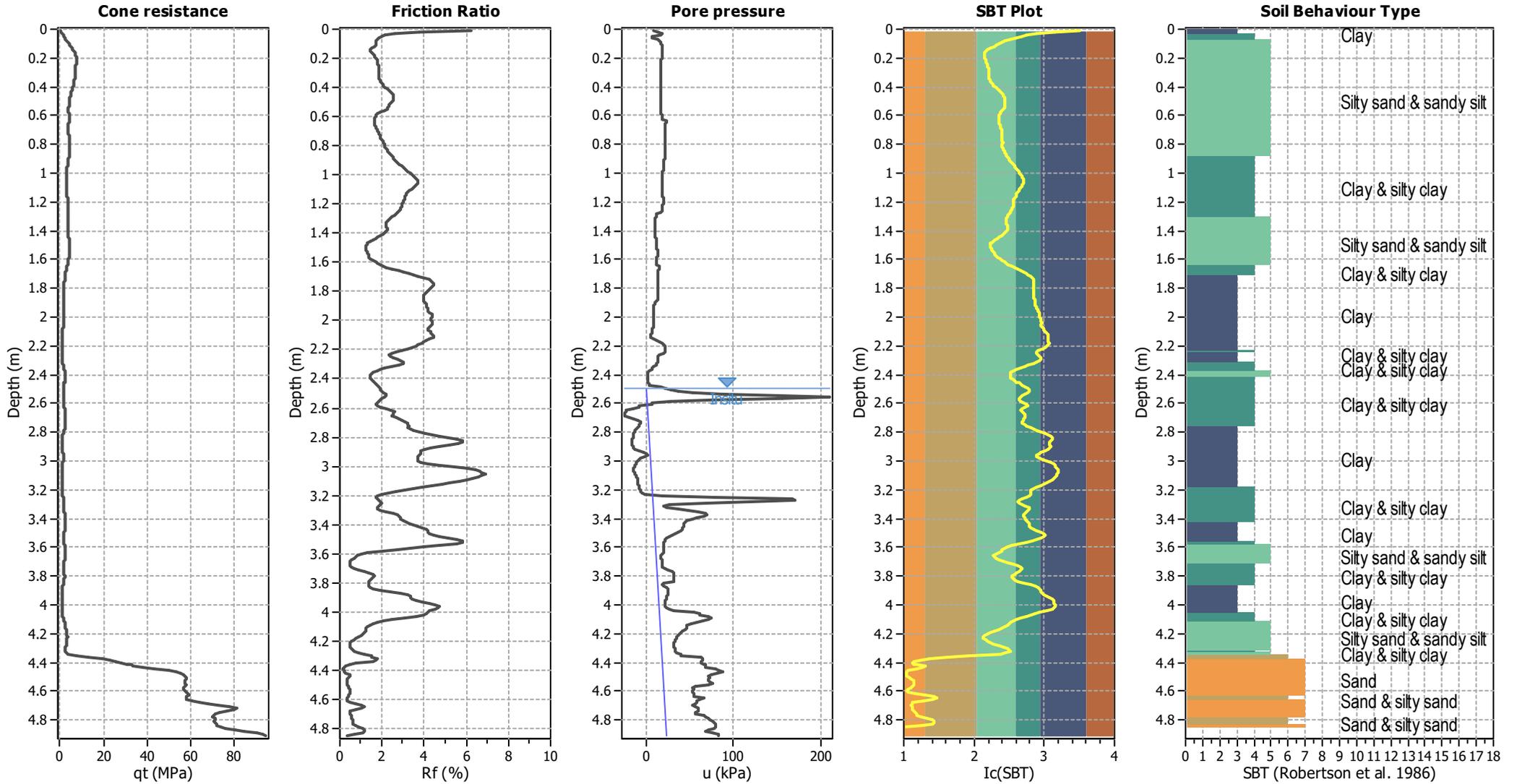
**Location : 232 Styx Mill Road, Casebrook, Christchurch**

**Input parameters and analysis data**

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Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.00 m	Fill height:	N/A	applied:	Sands only
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes	MSF method:	Method based



### CPT basic interpretation plots



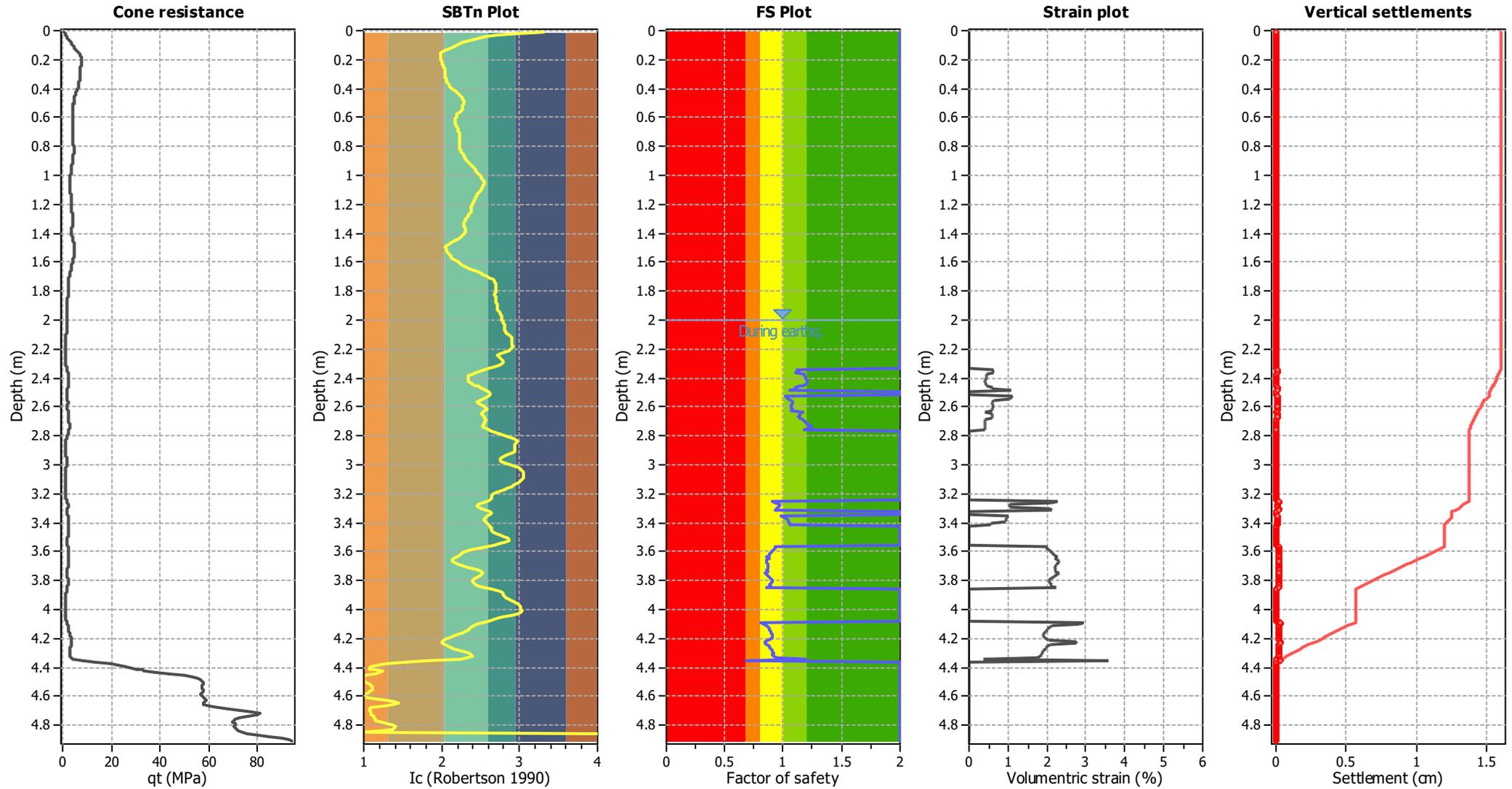
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Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K <sub>v</sub> applied:	Yes
Earthquake magnitude M <sub>w</sub> :	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

- qt: Total cone resistance (cone resistance  $q_c$  corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

**LIQUEFACTION ANALYSIS REPORT**

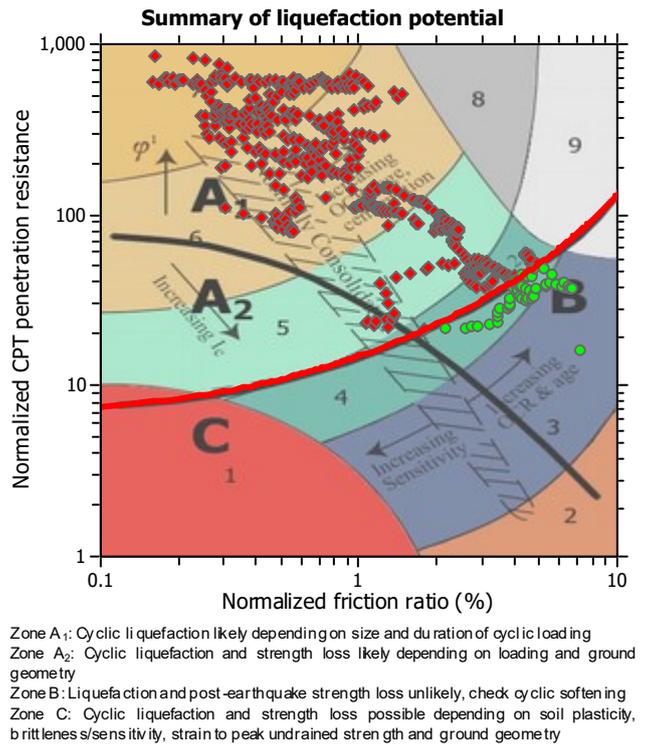
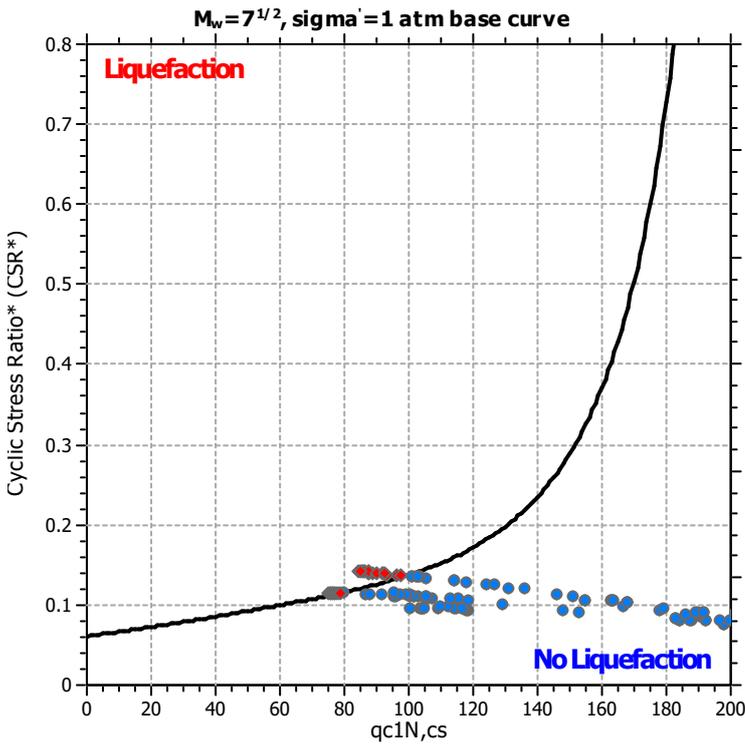
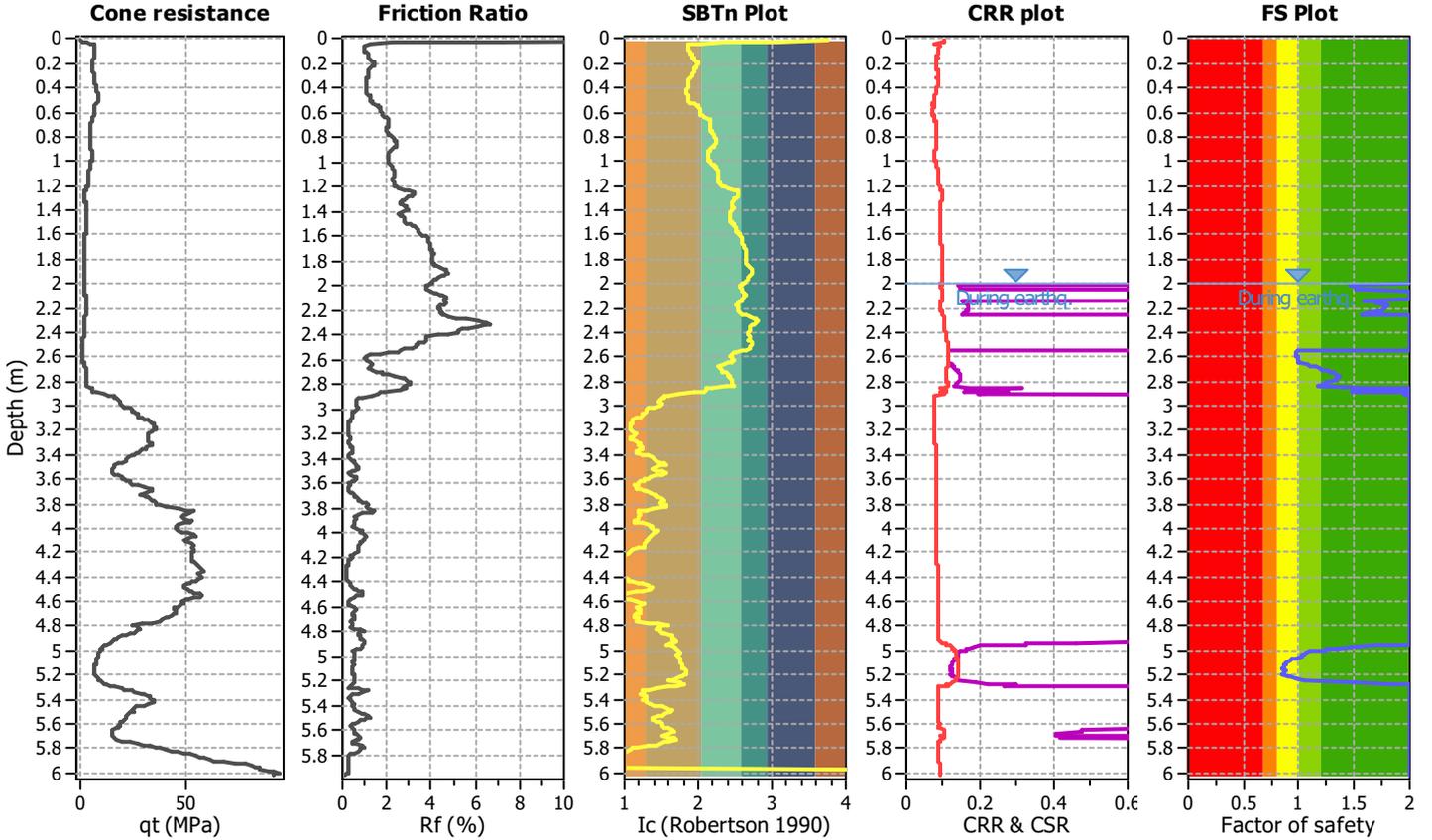
**Project title : K210318**

**Location : 232 Styx Mill Road, Casebrook, Christchurch**

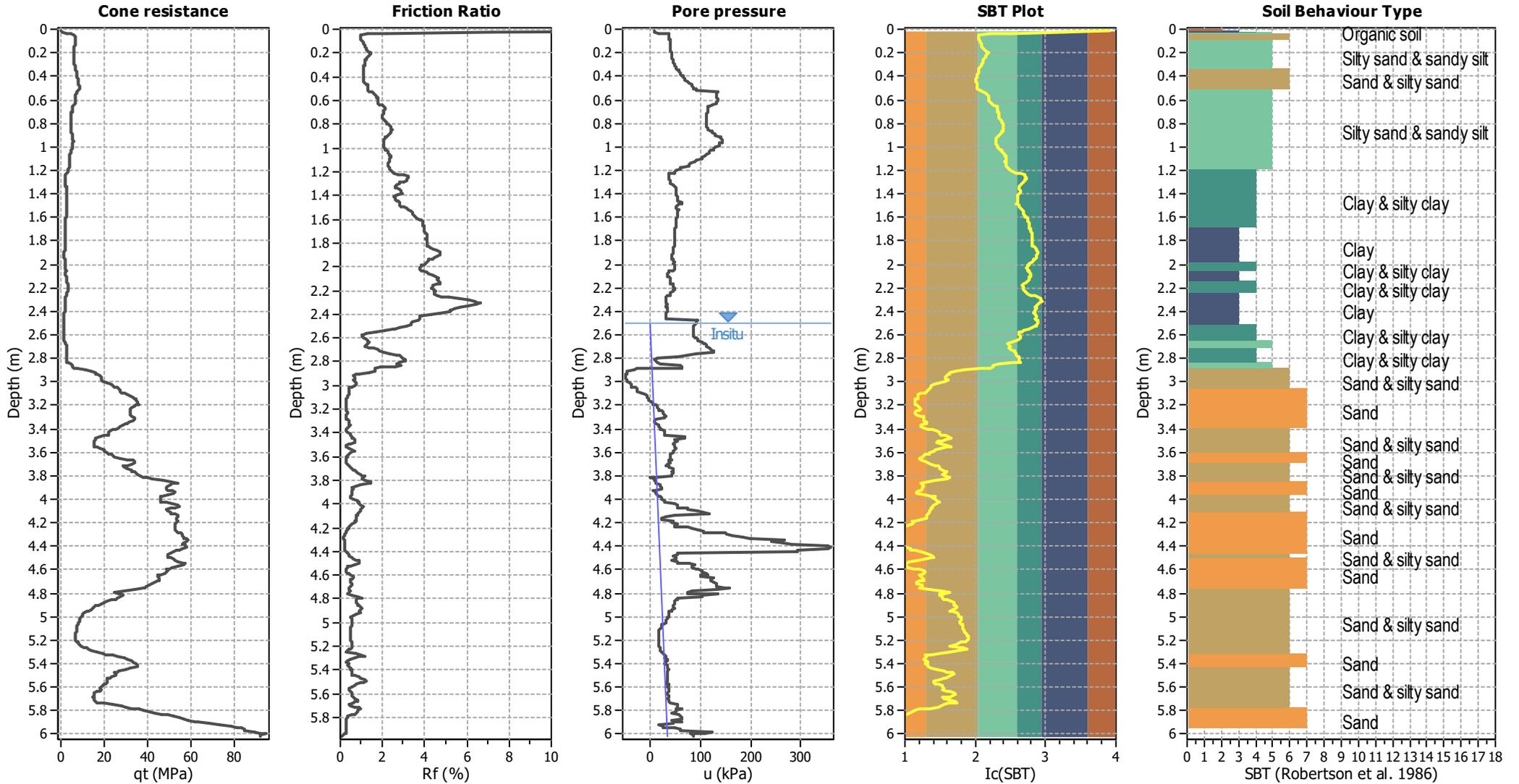
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Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes	MSF method:	Method based



### CPT basic interpretation plots



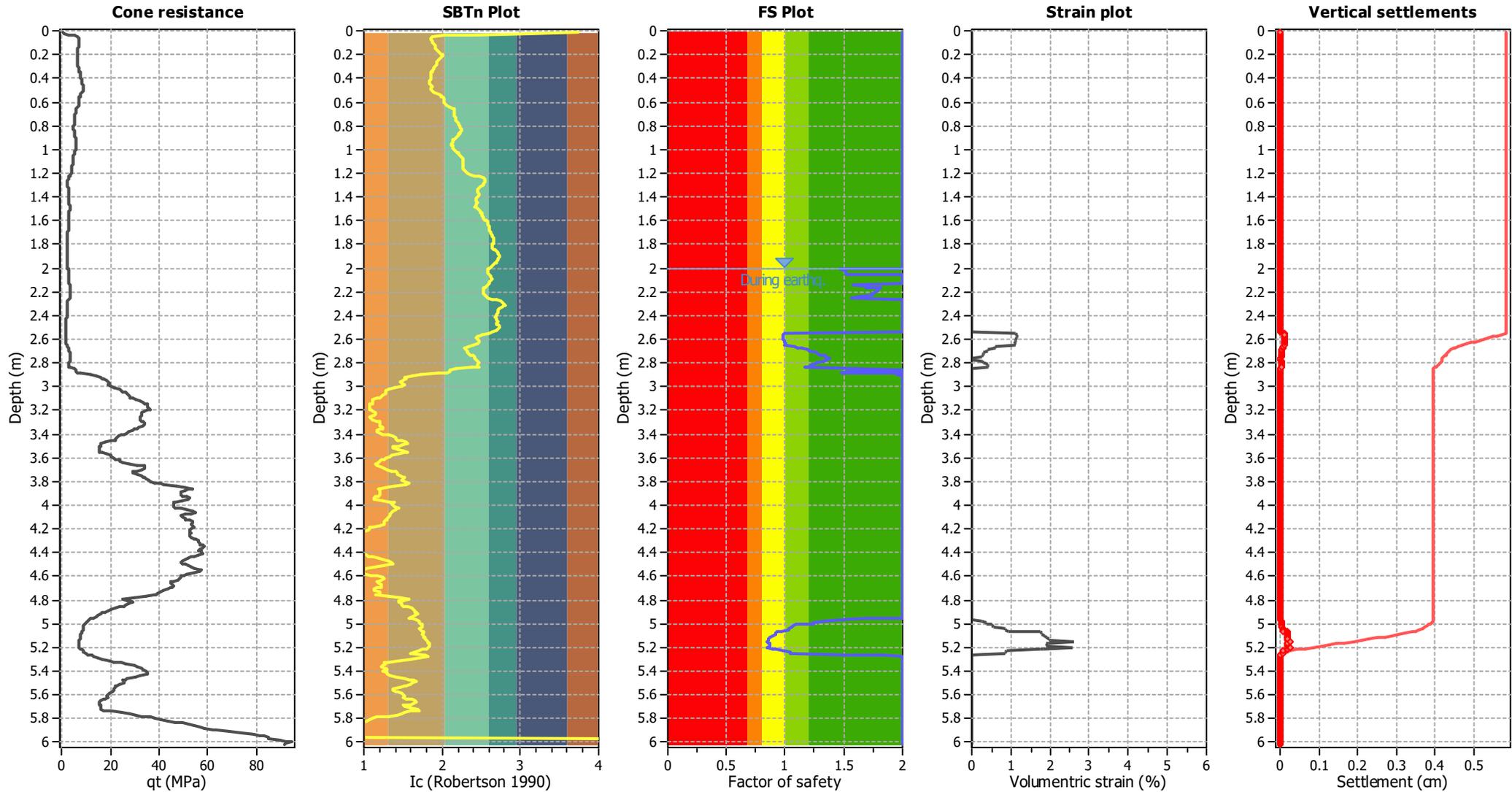
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Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	$K_v$ applied:	Yes
Earthquake magnitude $M_w$ :	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

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

**LIQUEFACTION ANALYSIS REPORT**

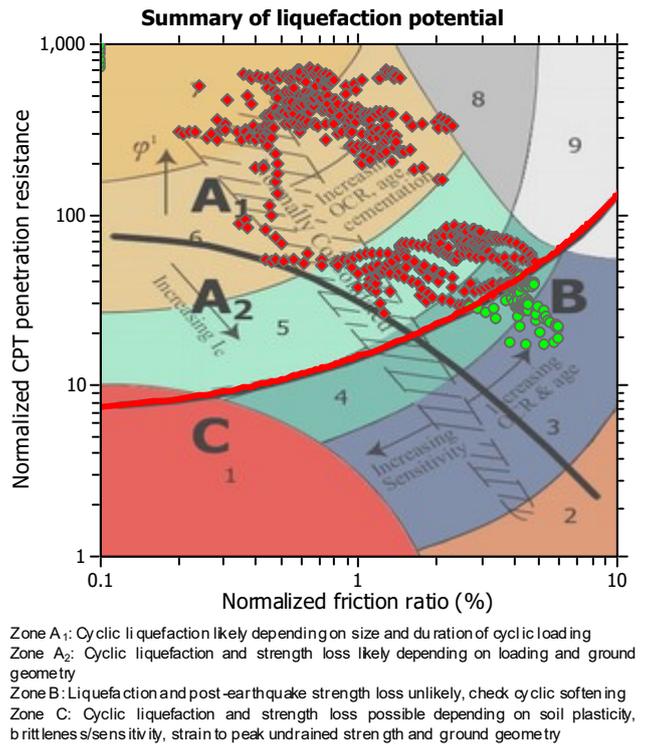
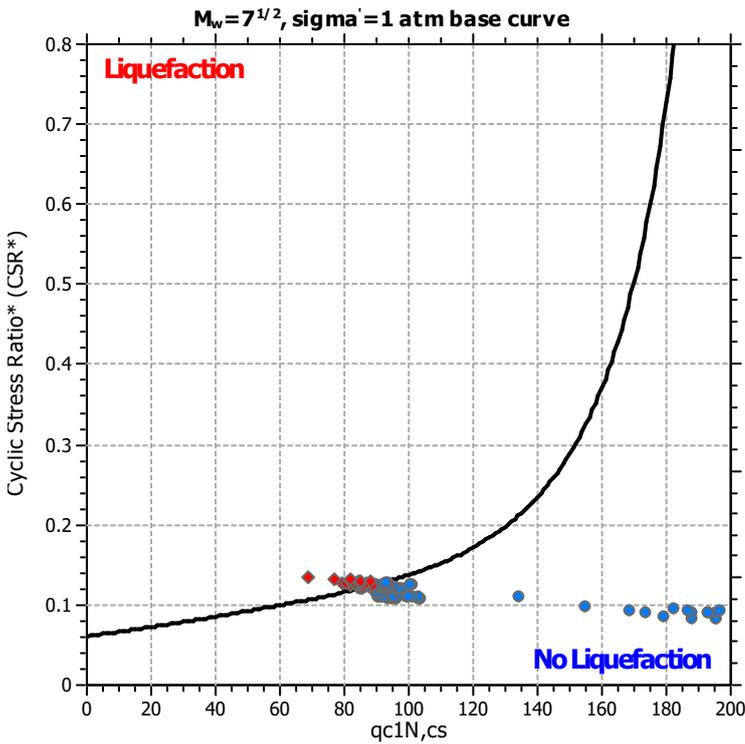
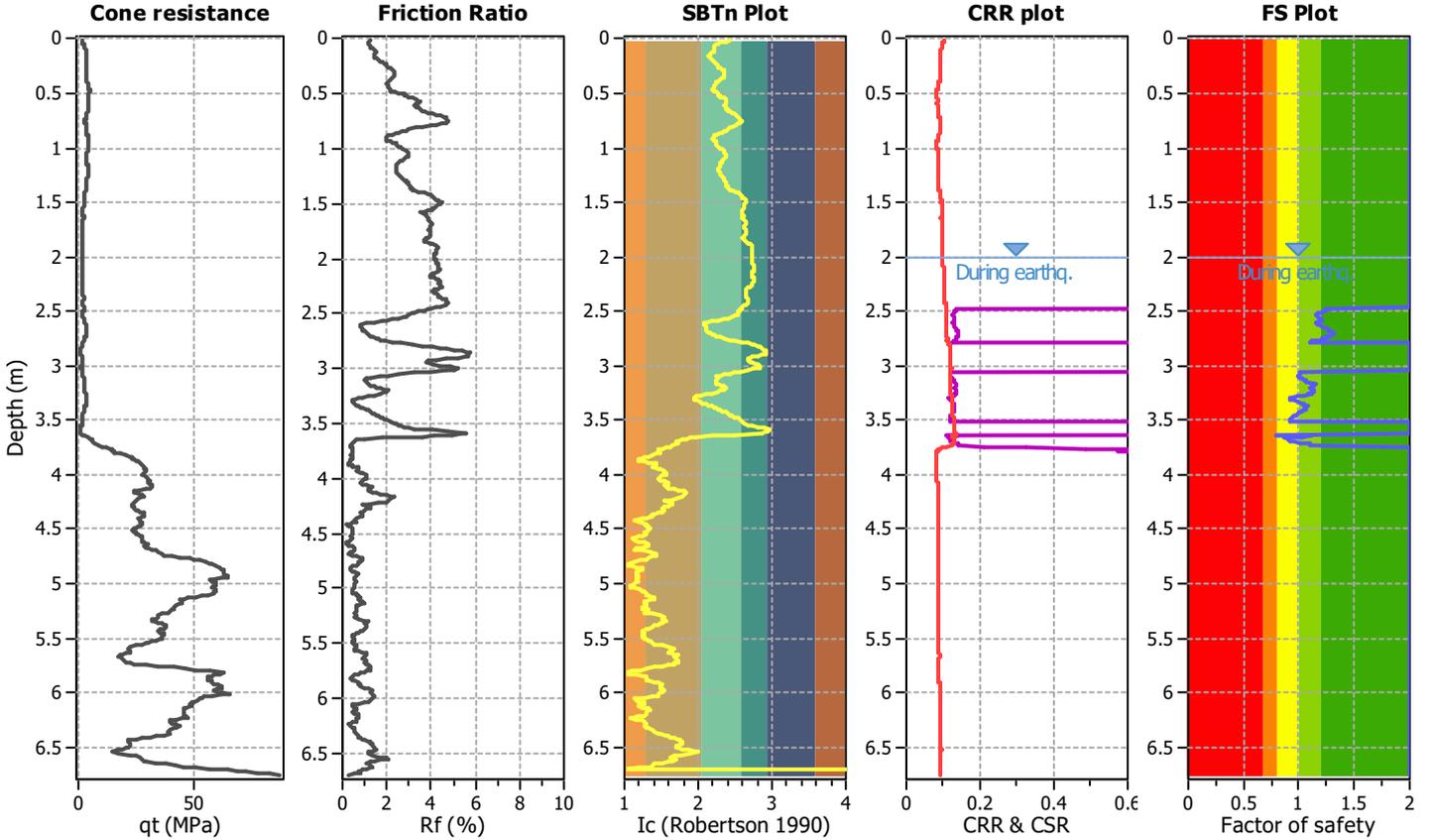
**Project title : K210318**

**Location : 232 Styx Mill Road, Casebrook, Christchurch**

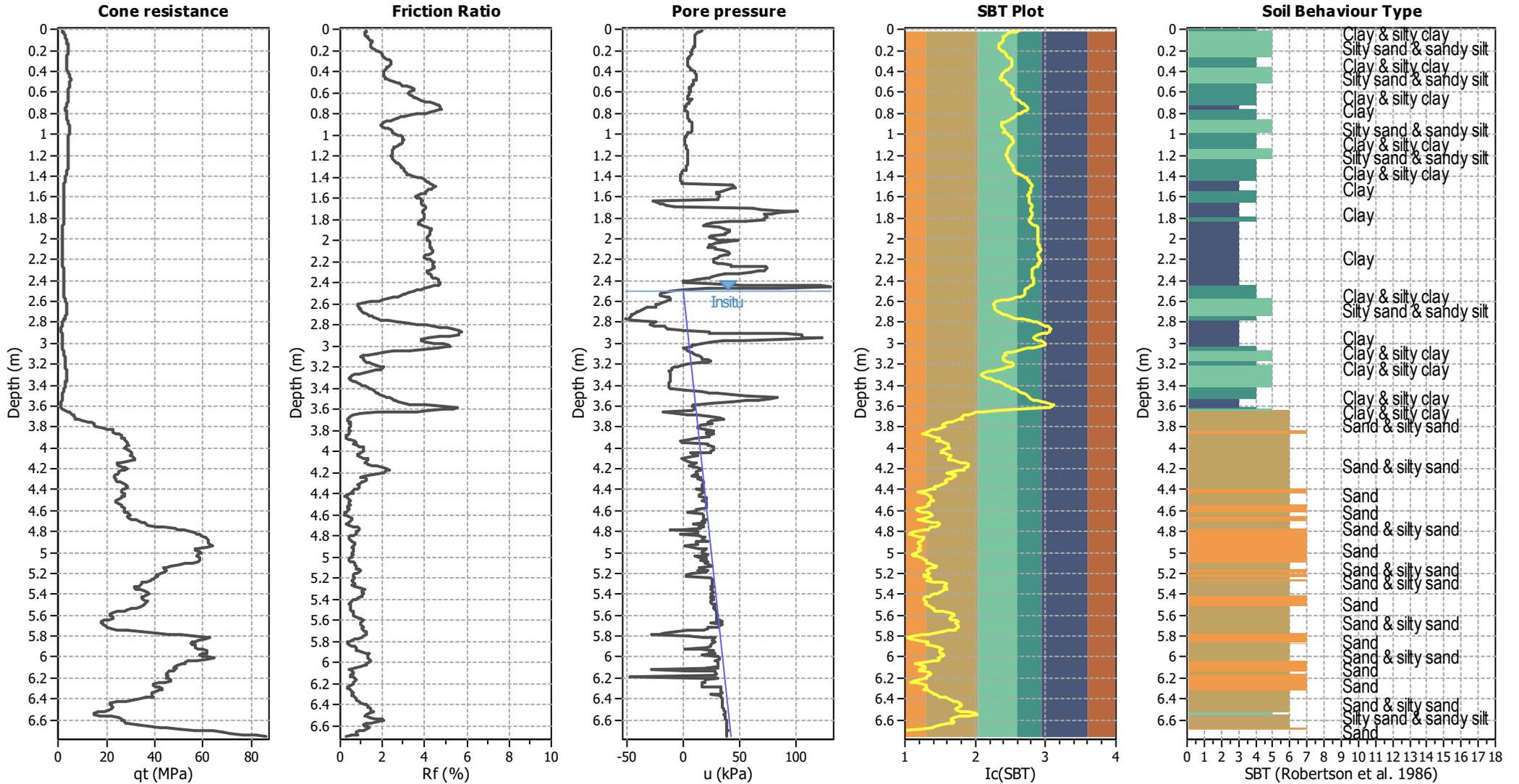
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**Input parameters and analysis data**

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Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude $M_w$ :	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes		



### CPT basic interpretation plots



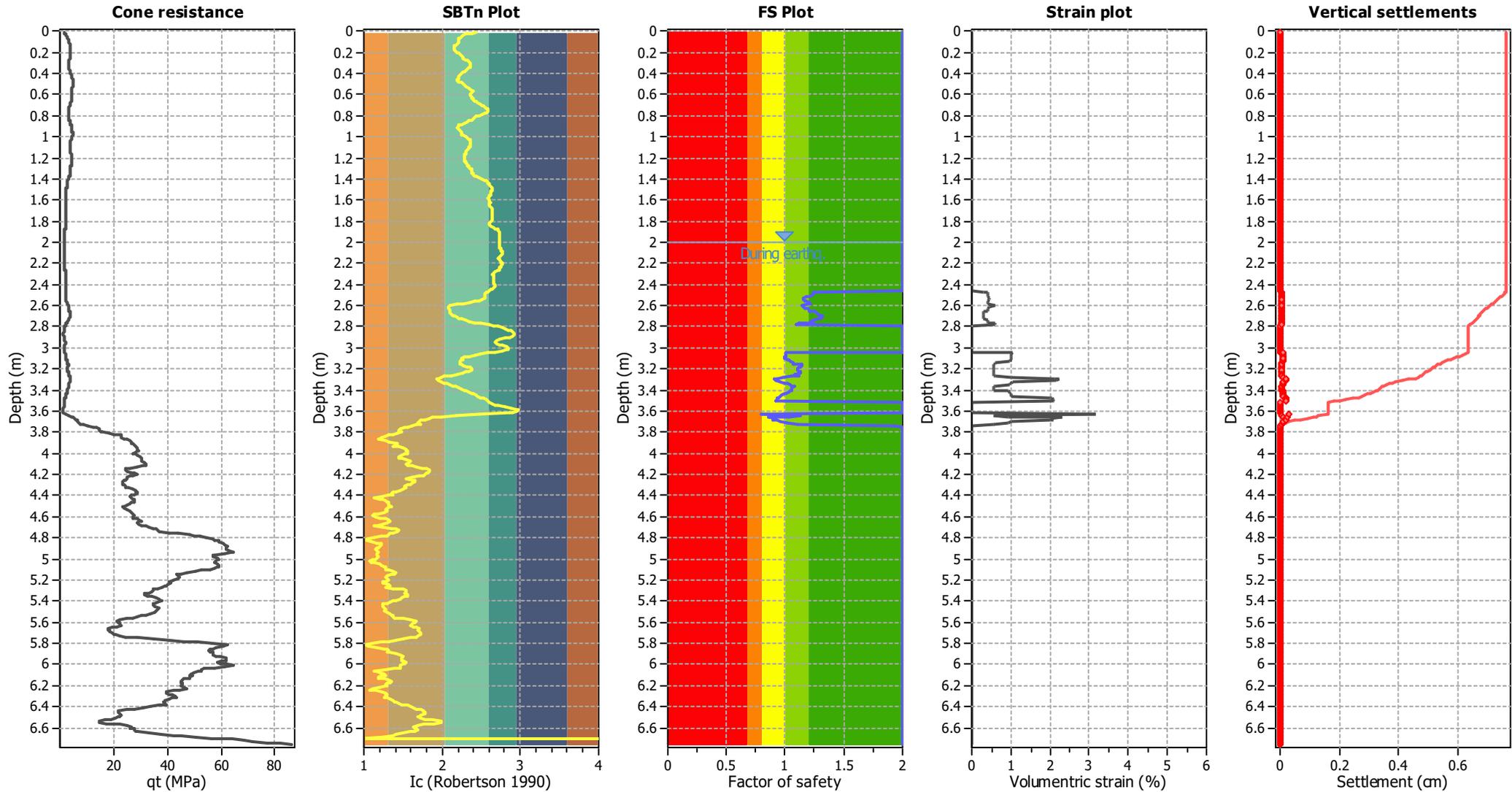
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Points to test:	Based on Ic value	Ic cut-off value:	2.60	$K_v$ applied:	Yes
Earthquake magnitude $M_w$ :	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

- qt: Total cone resistance (cone resistance q<sub>c</sub> corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

**LIQUEFACTION ANALYSIS REPORT**

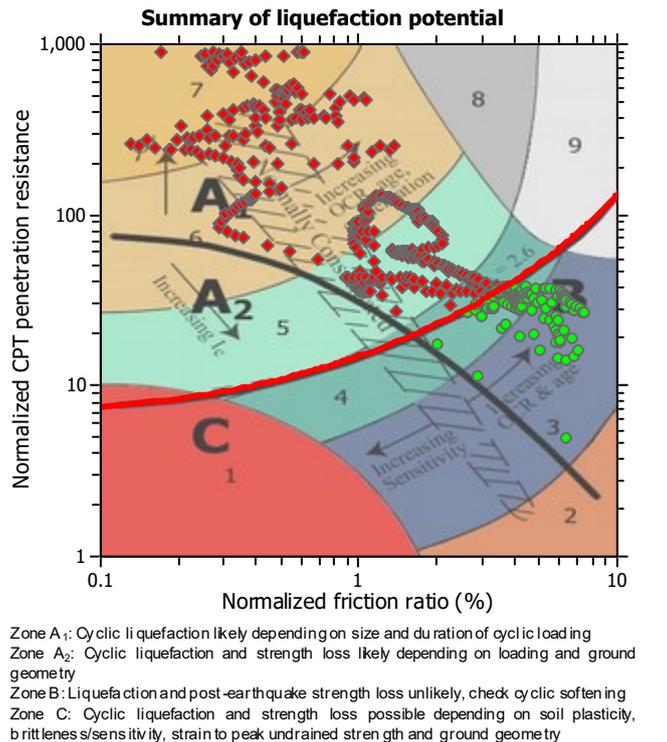
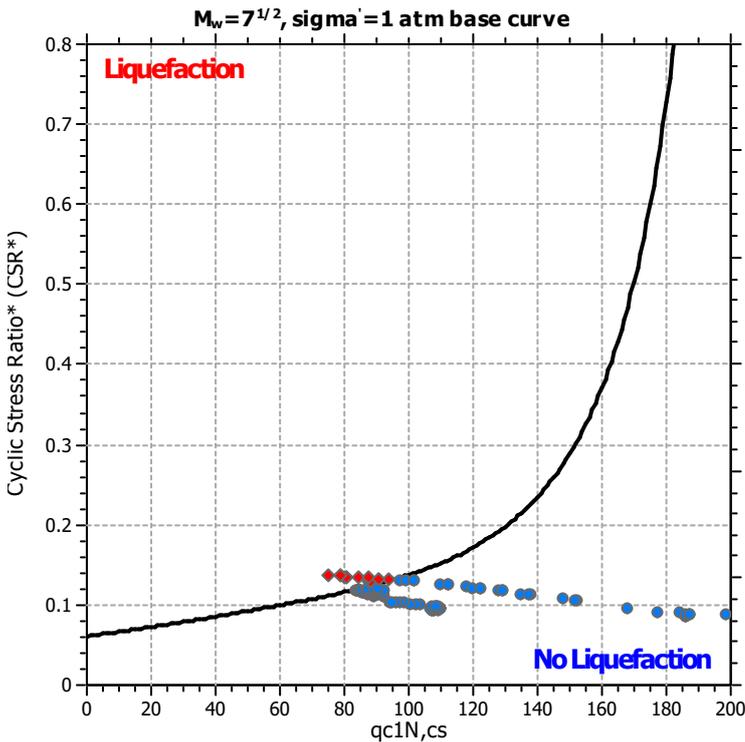
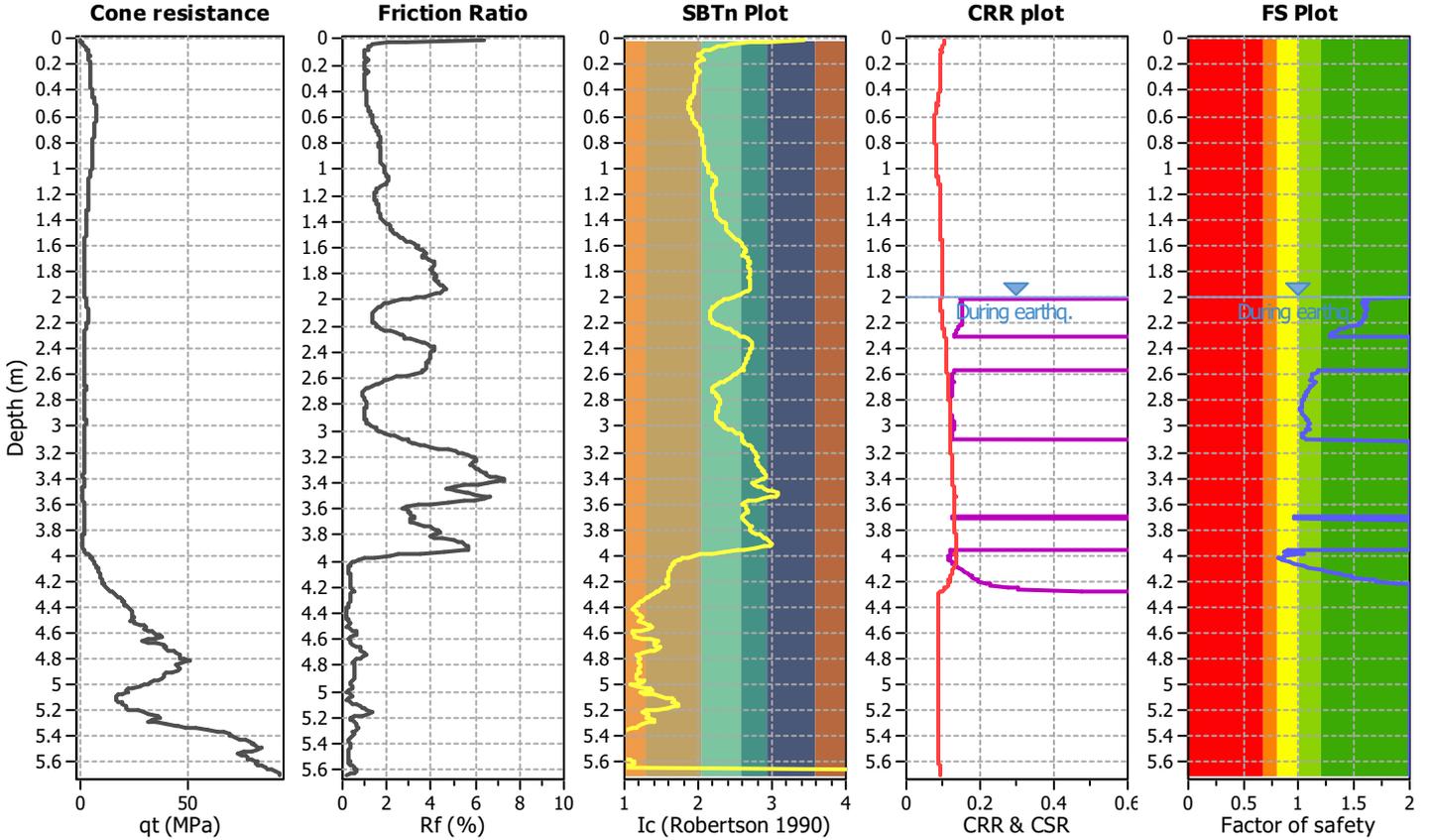
**Project title : K210318**

**Location : 232 Styx Mill Road, Casebrook, Christchurch**

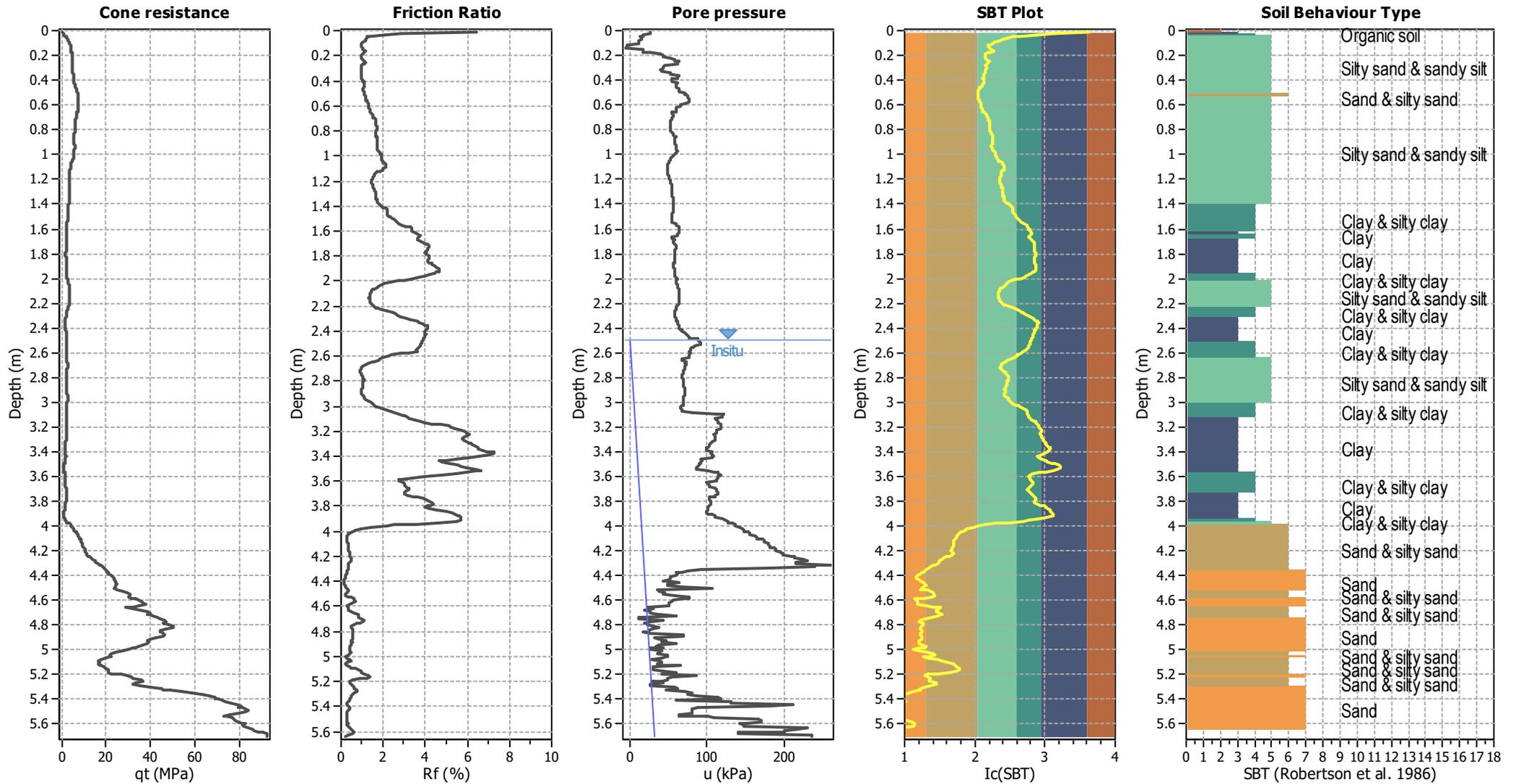
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**Input parameters and analysis data**

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Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes	MSF method:	Method based



### CPT basic interpretation plots



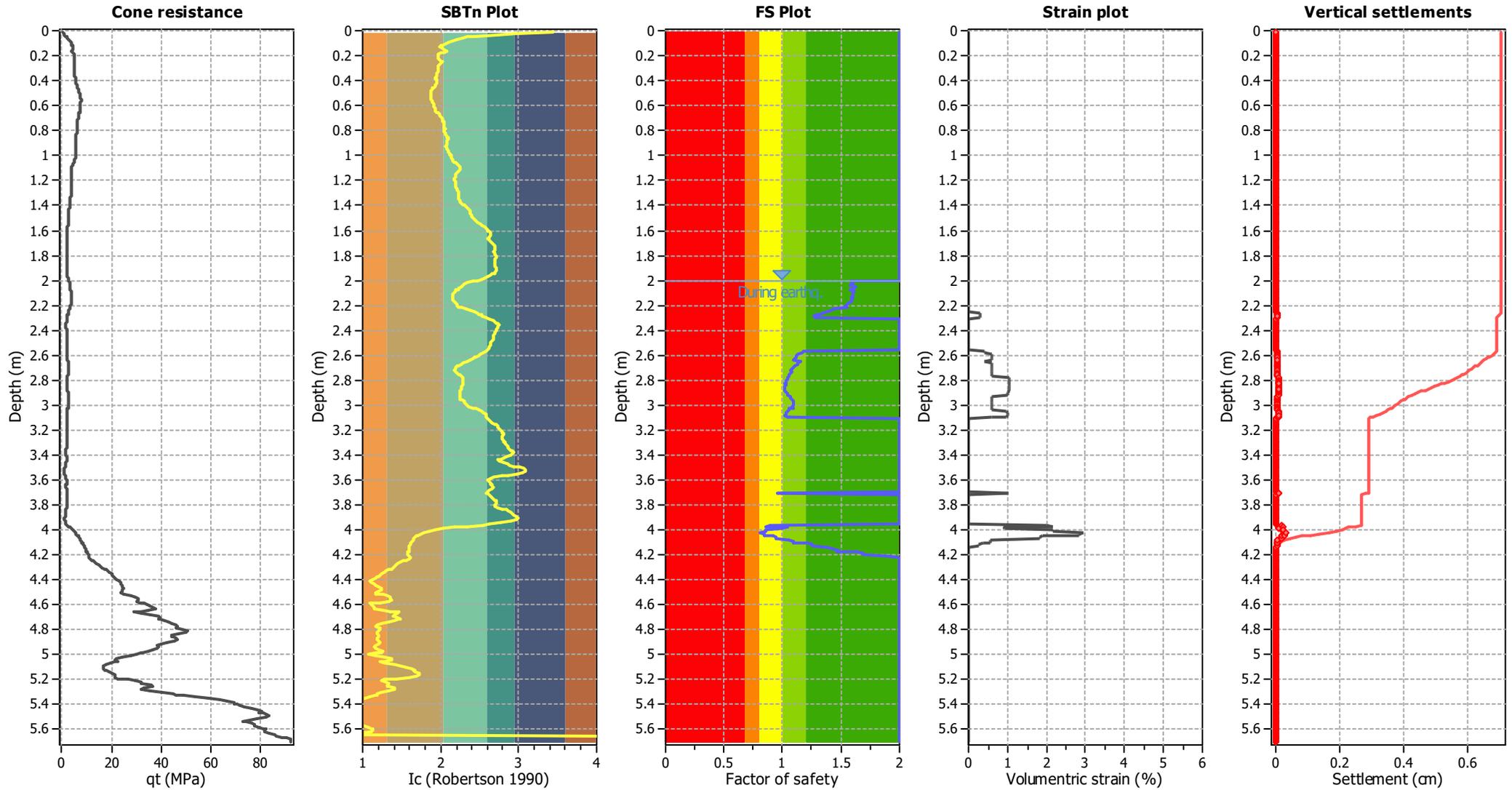
#### Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.00 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	$K_p$ 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:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

- qt: Total cone resistance (cone resistance q<sub>c</sub> corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

**LIQUEFACTION ANALYSIS REPORT**

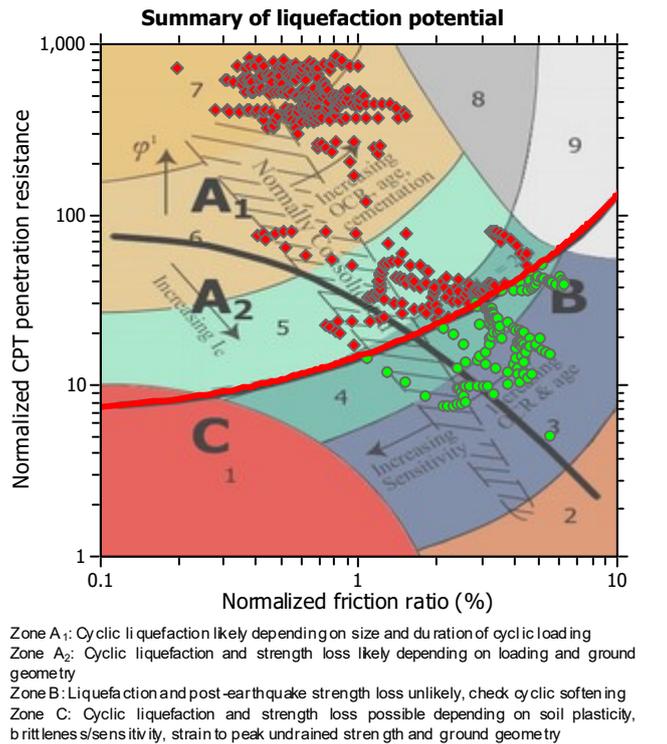
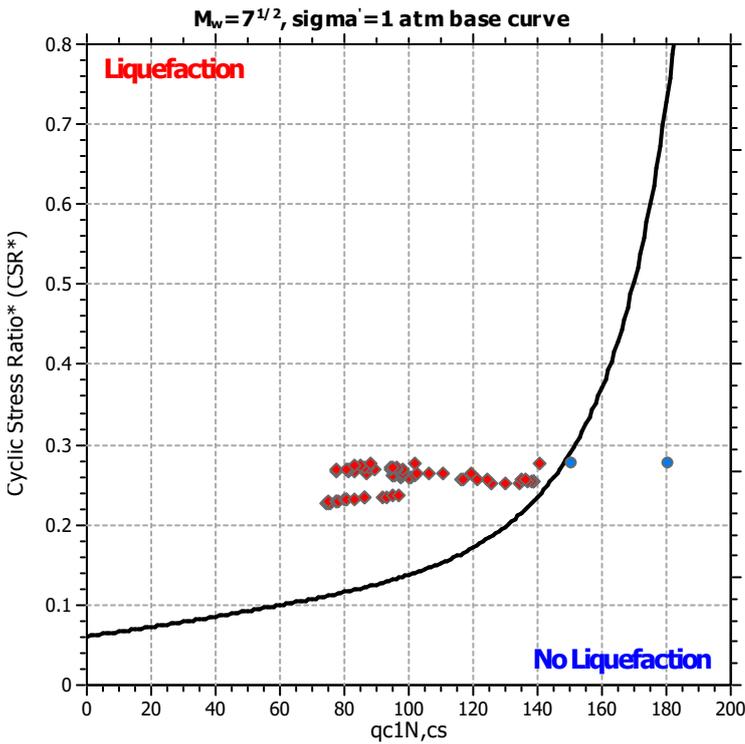
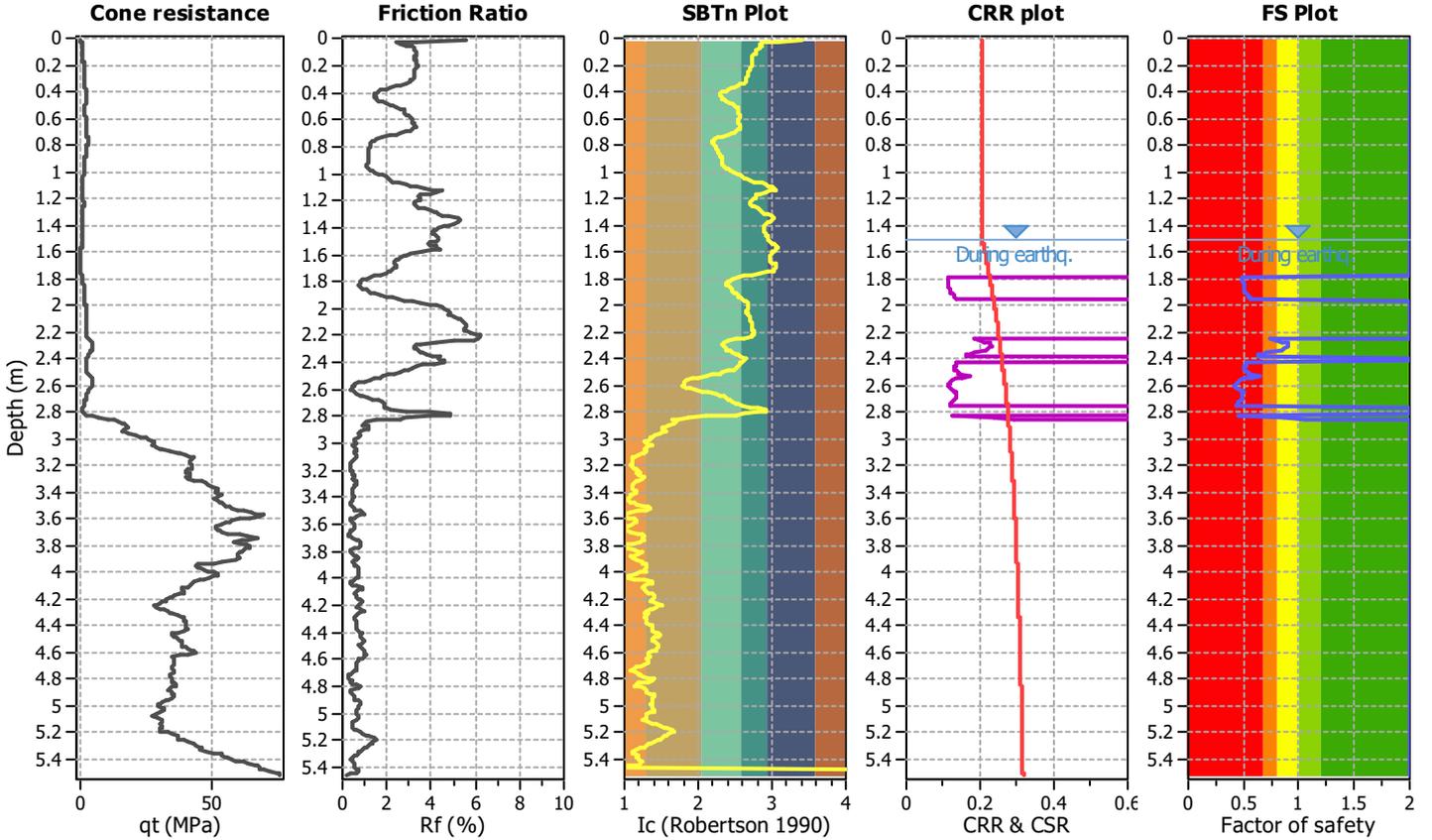
**Project title : K210318**

**Location : 232 Styx Mill Road, Casebrook, Christchurch**

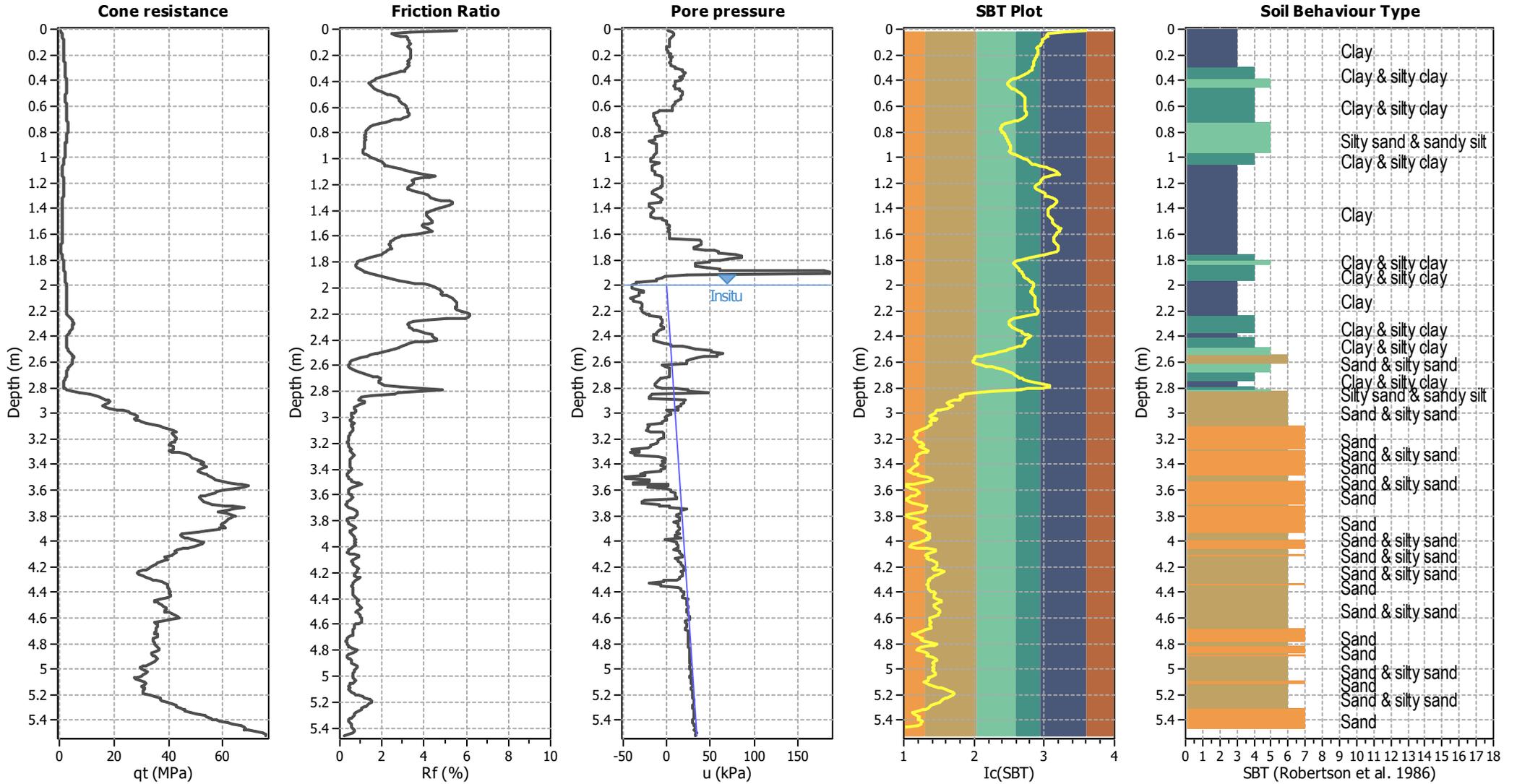
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**Input parameters and analysis data**

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Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.50 m	Fill height:	N/A	applied:	Sands only
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.35	Unit weight calculation:	Based on SBT	$K_g$ applied:	Yes	MSF method:	Method based



### CPT basic interpretation plots



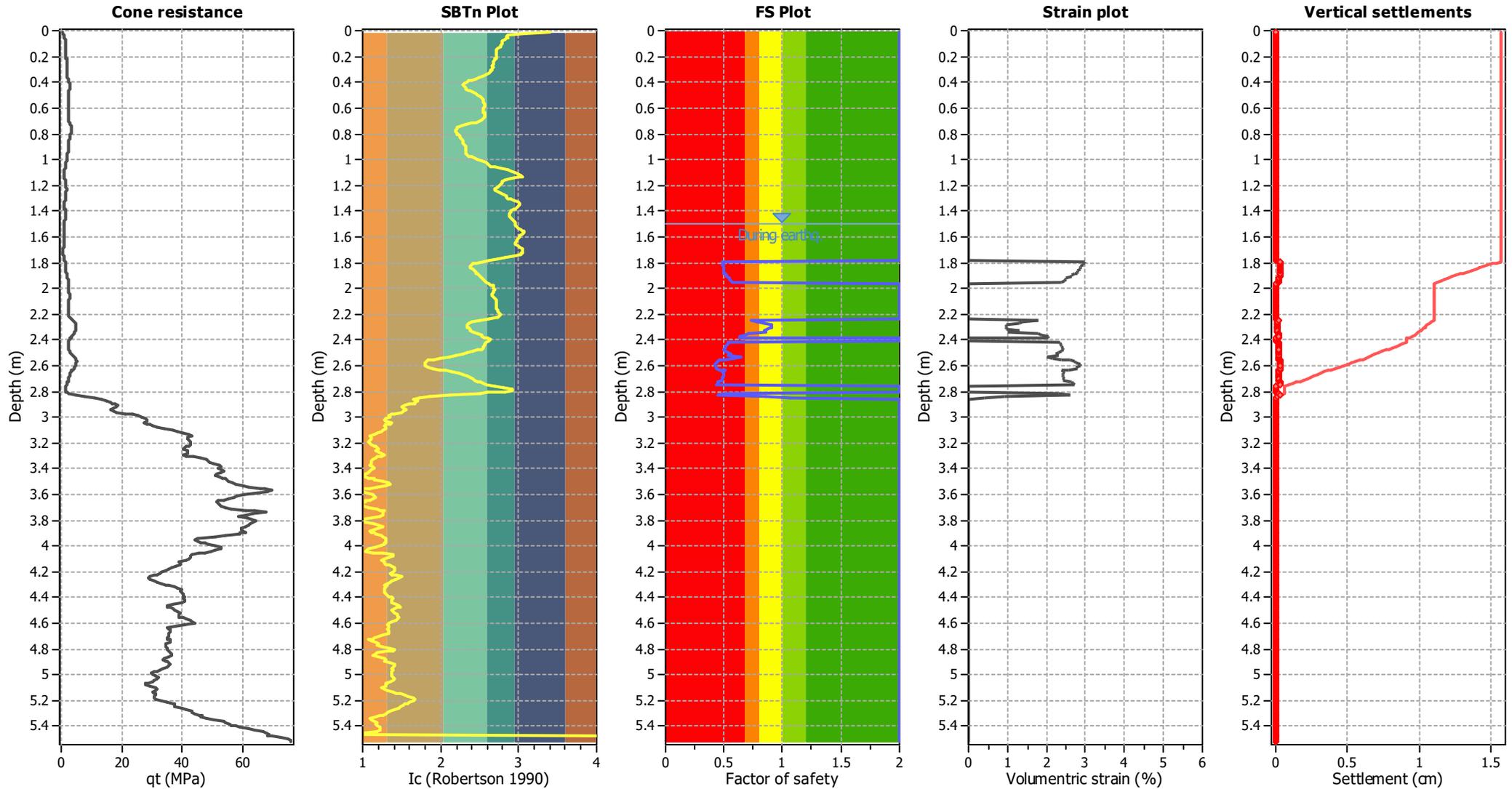
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Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	$K_v$ applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

- qt: Total cone resistance (cone resistance  $q_c$  corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

**LIQUEFACTION ANALYSIS REPORT**

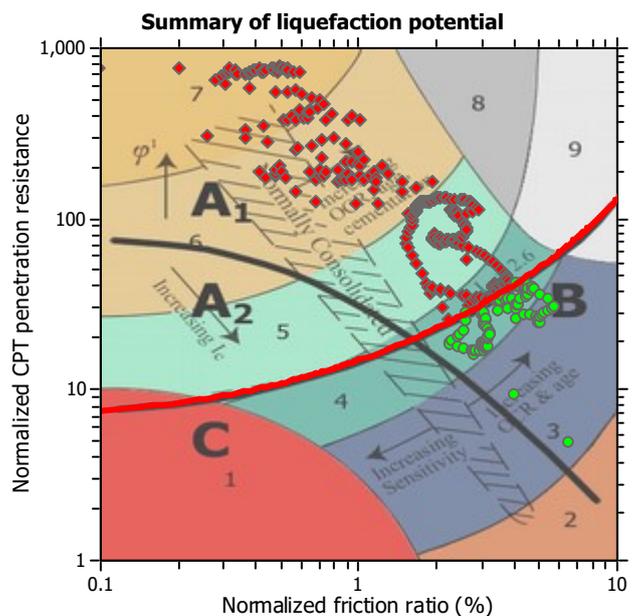
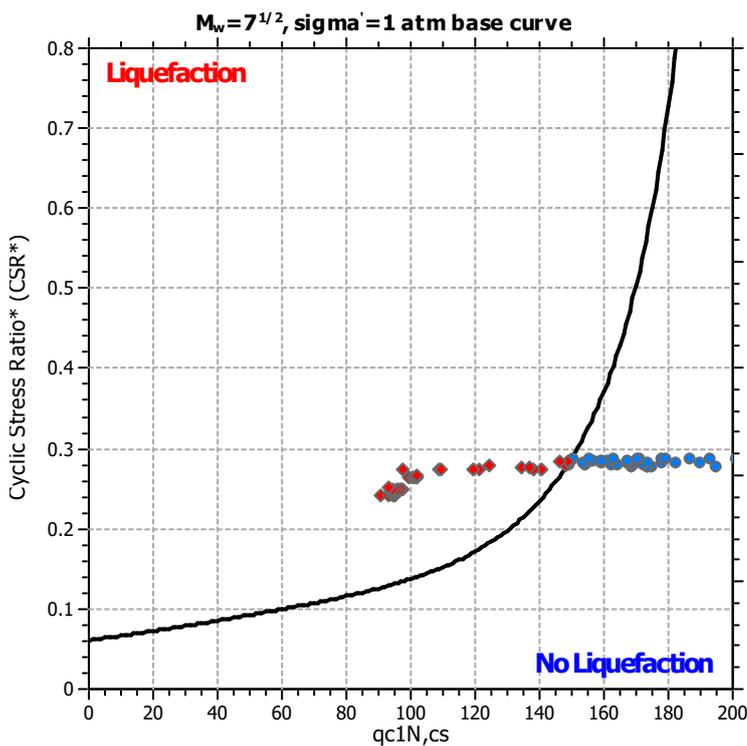
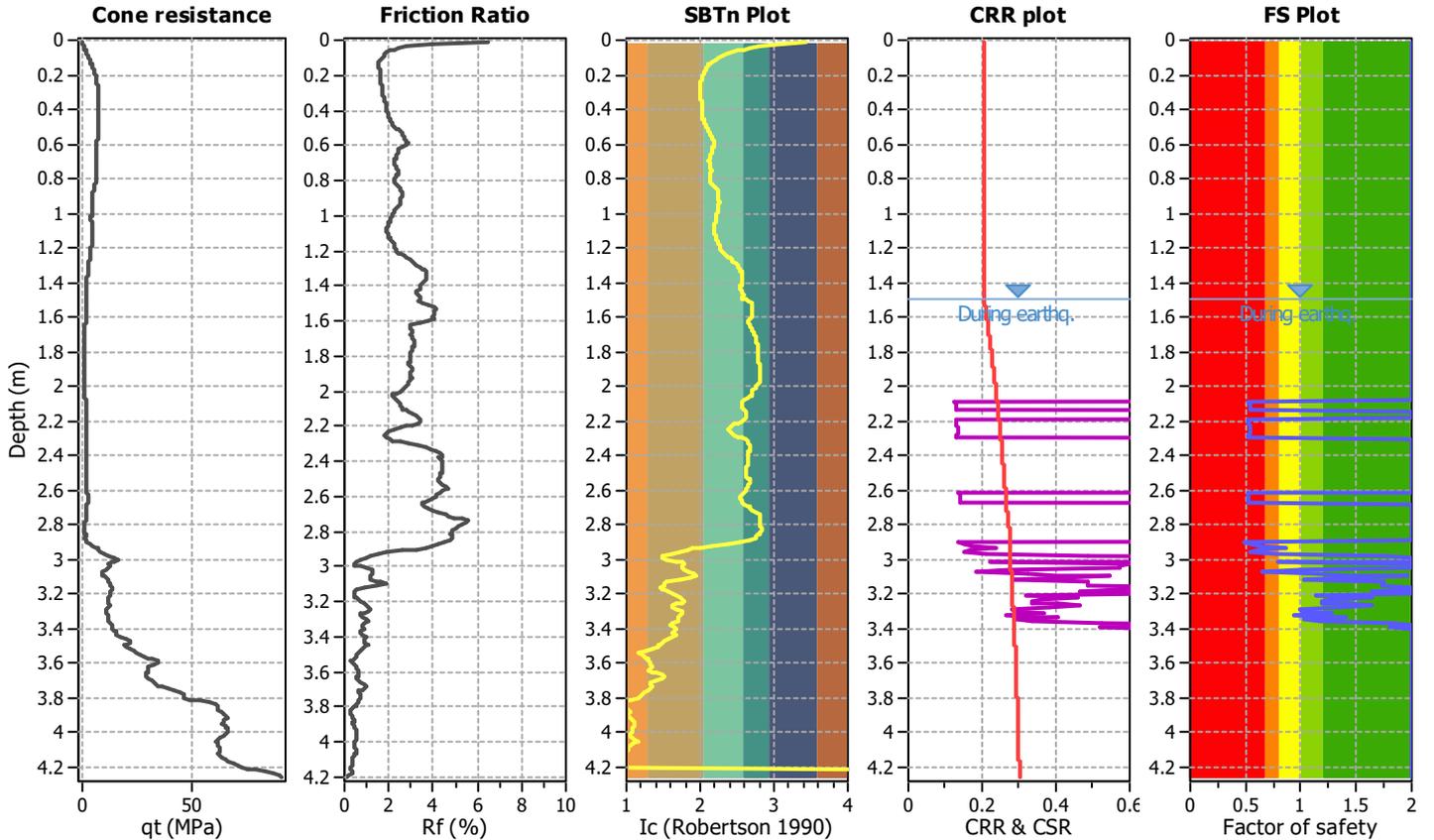
**Project title : K210318**

**Location : 232 Styx Mill Road, Casebrook, Christchurch**

**CPT file : CPT-01 ULS**

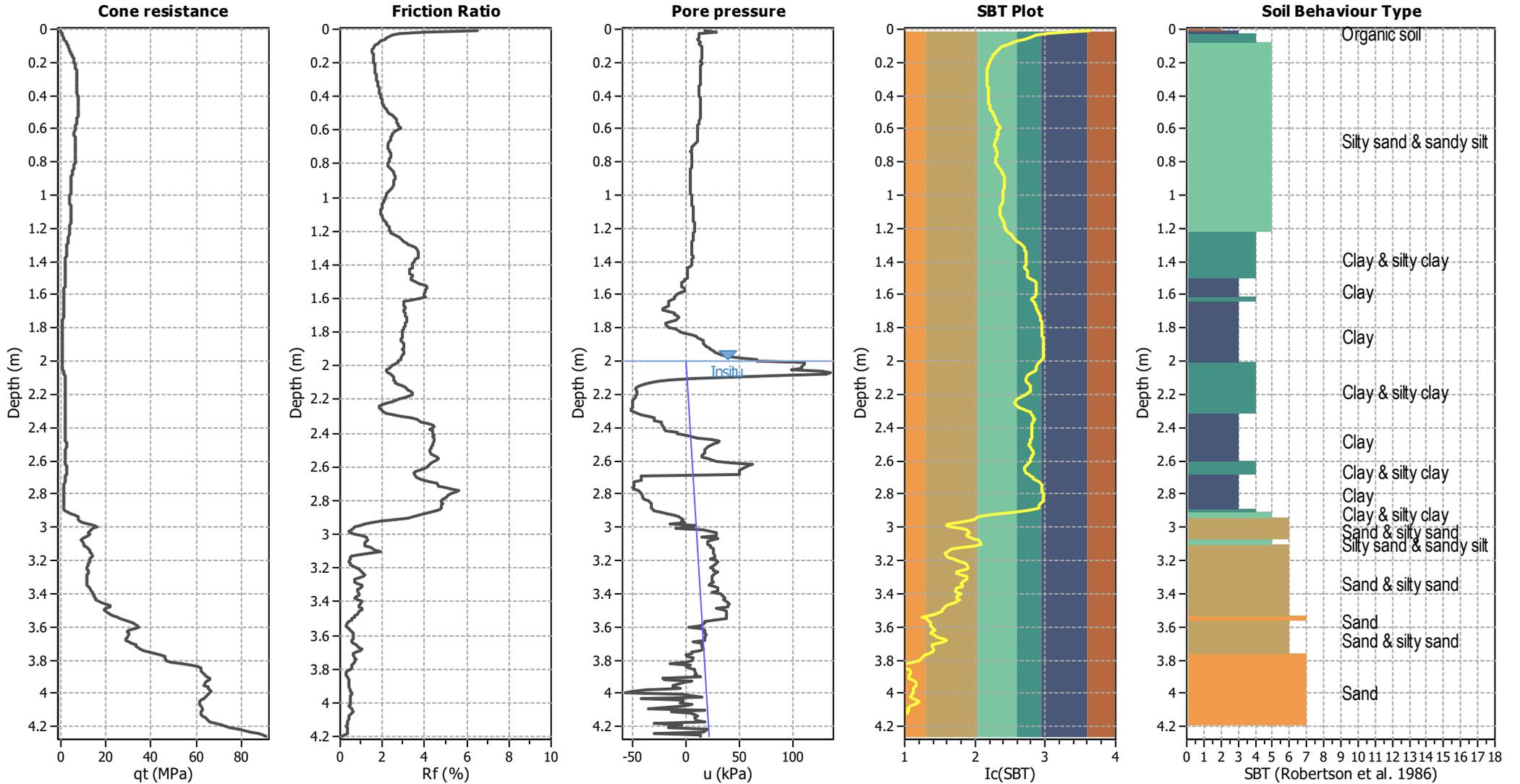
**Input parameters and analysis data**

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.00 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.35	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes		



Zone A<sub>1</sub>: Cyclic liquefaction likely depending on size and duration of cyclic loading  
 Zone A<sub>2</sub>: Cyclic liquefaction and strength loss likely depending on loading and ground geometry  
 Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening  
 Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

### CPT basic interpretation plots



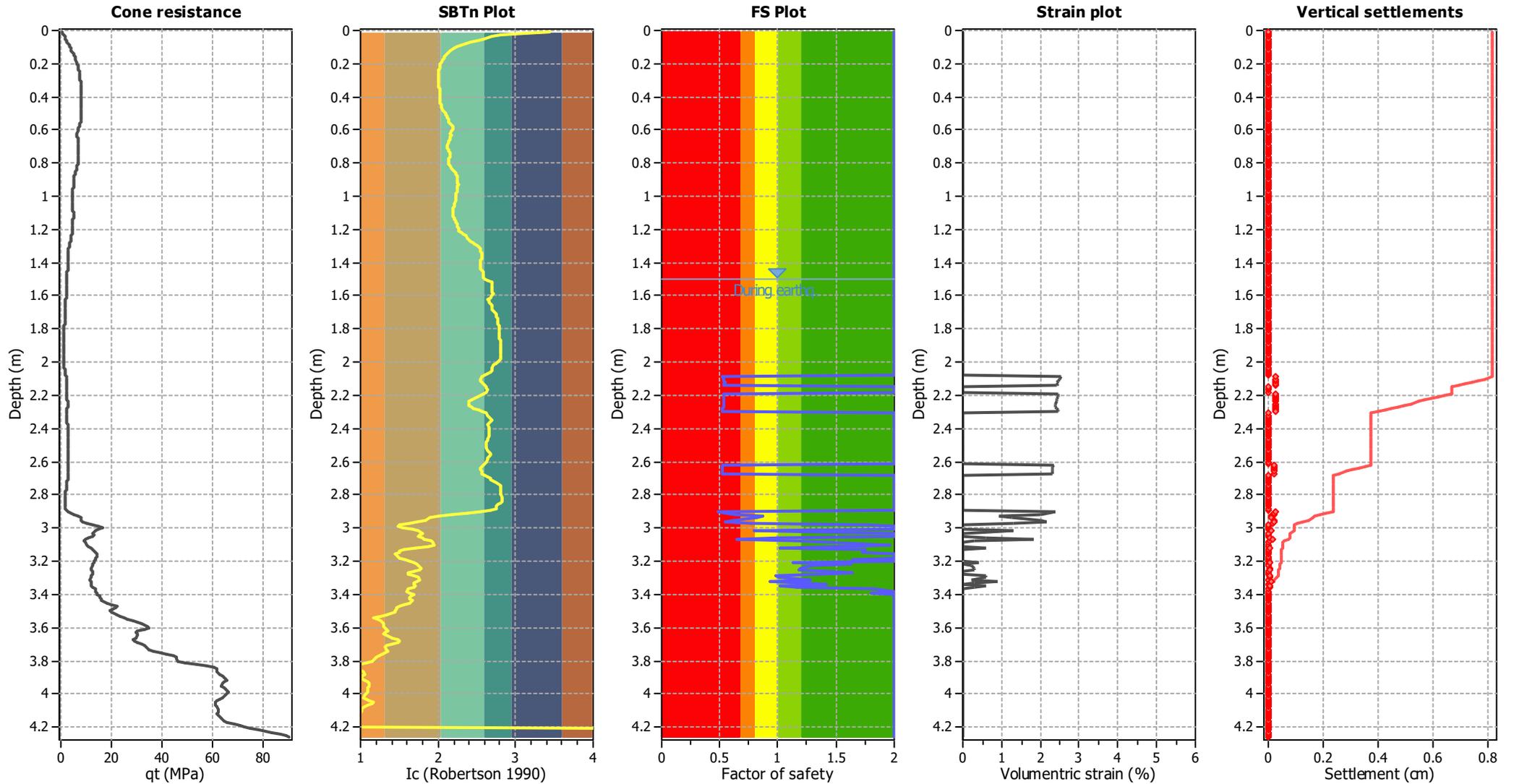
#### Input parameters and analysis data

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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	$K_v$ applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

- qt: Total cone resistance (cone resistance q<sub>c</sub> corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

**LIQUEFACTION ANALYSIS REPORT**

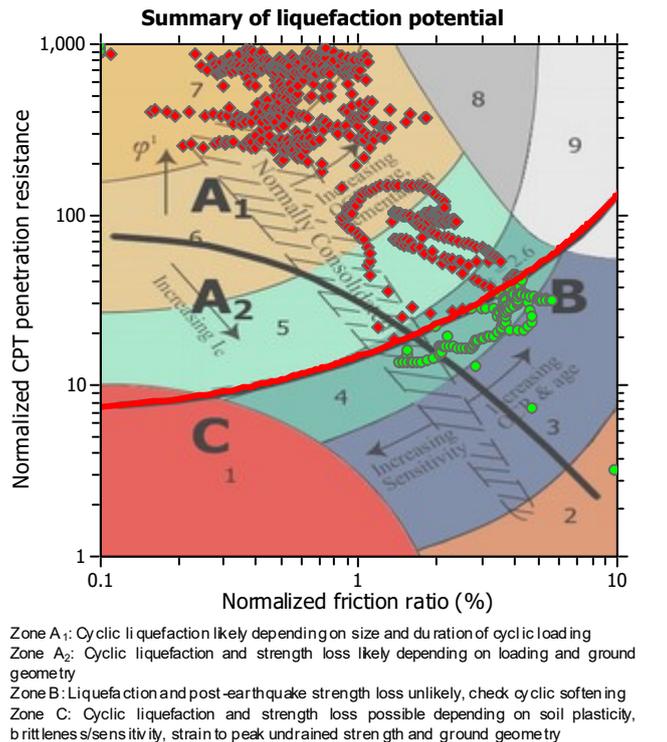
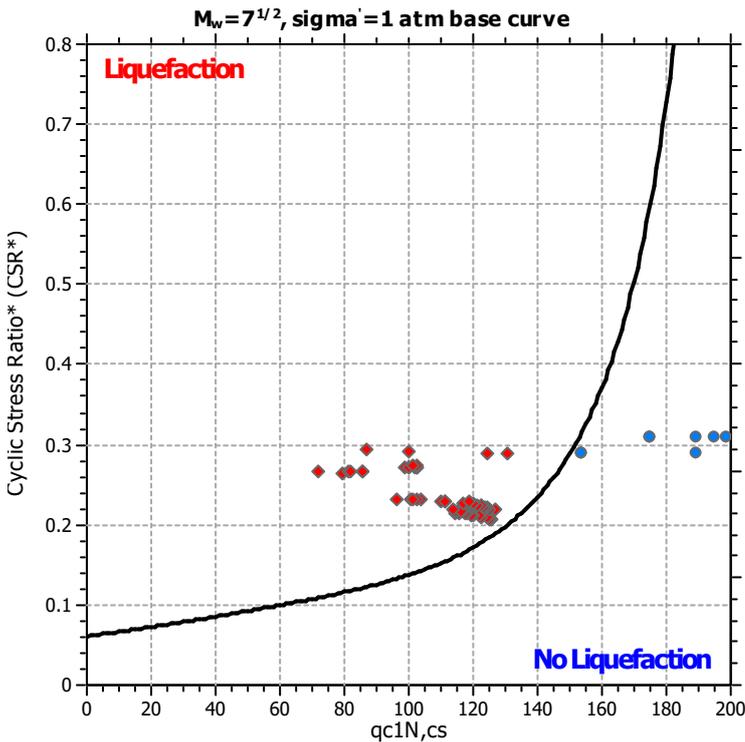
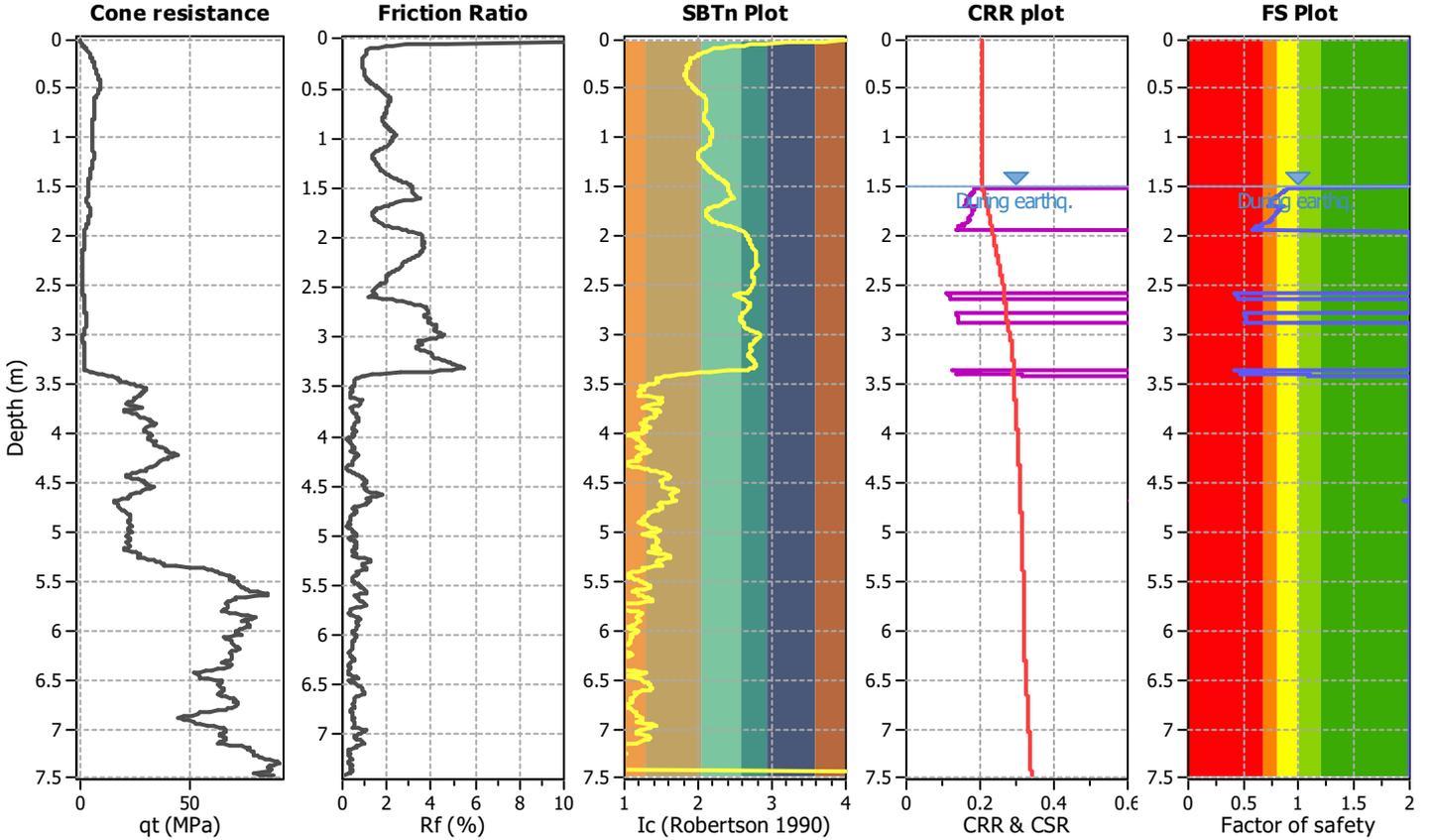
**Project title : K210318**

**Location : 232 Styx Mill Road, Casebrook, Christchurch**

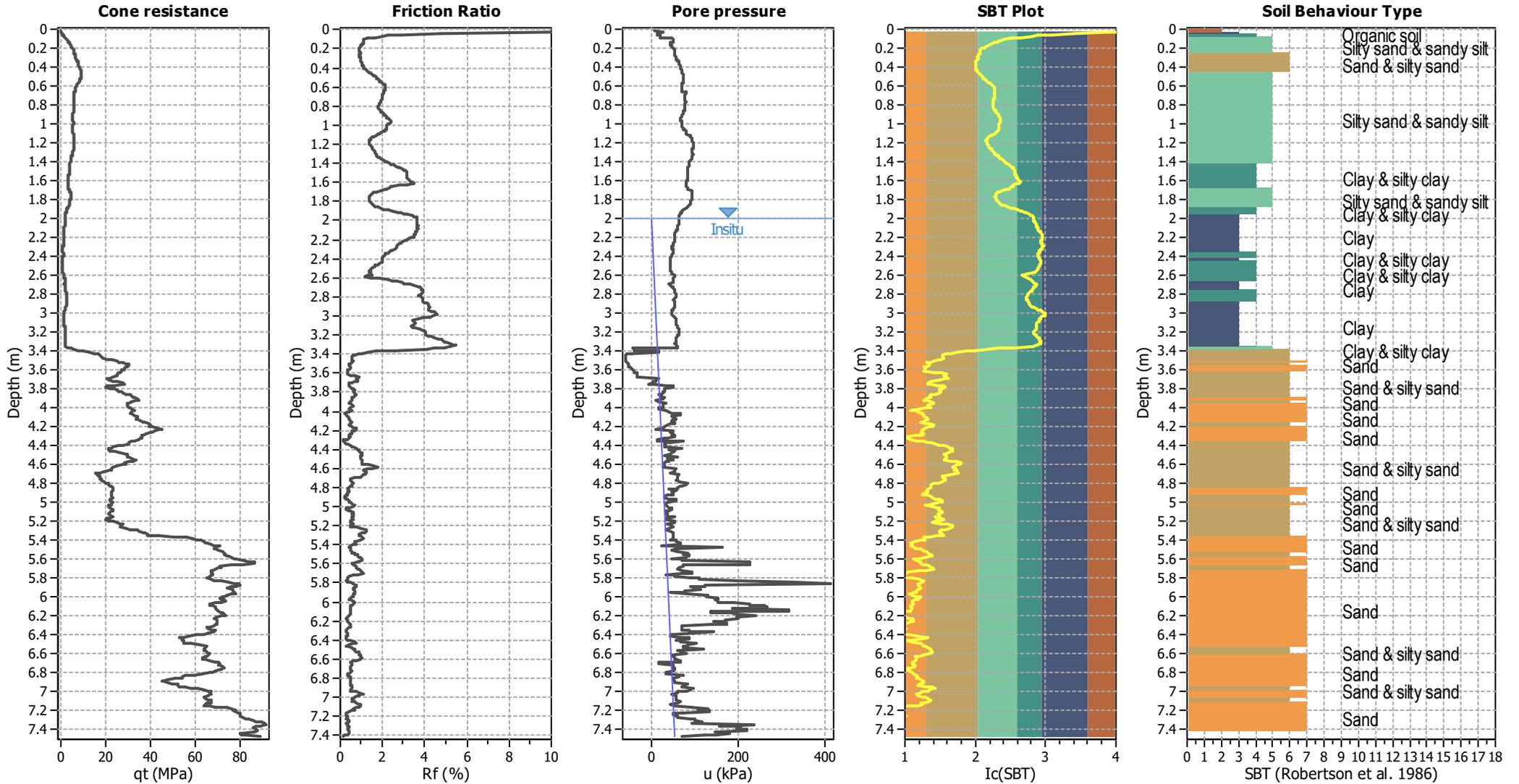
**CPT file : CPT-02 ULS**

**Input parameters and analysis data**

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Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.35	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes		



### CPT basic interpretation plots



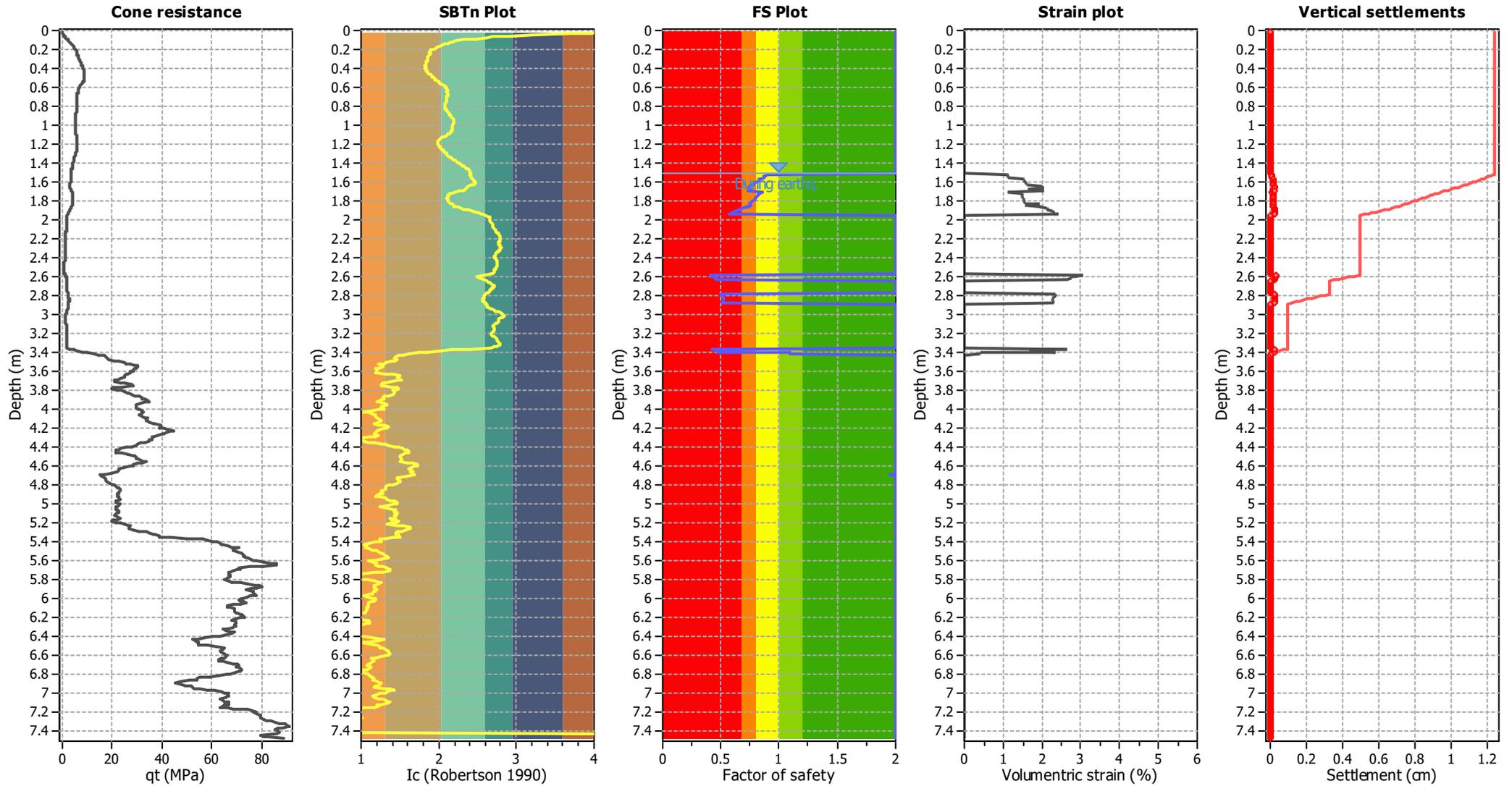
#### Input parameters and analysis data

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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	$K_v$ applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

- qt: Total cone resistance (cone resistance q<sub>c</sub> corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

**LIQUEFACTION ANALYSIS REPORT**

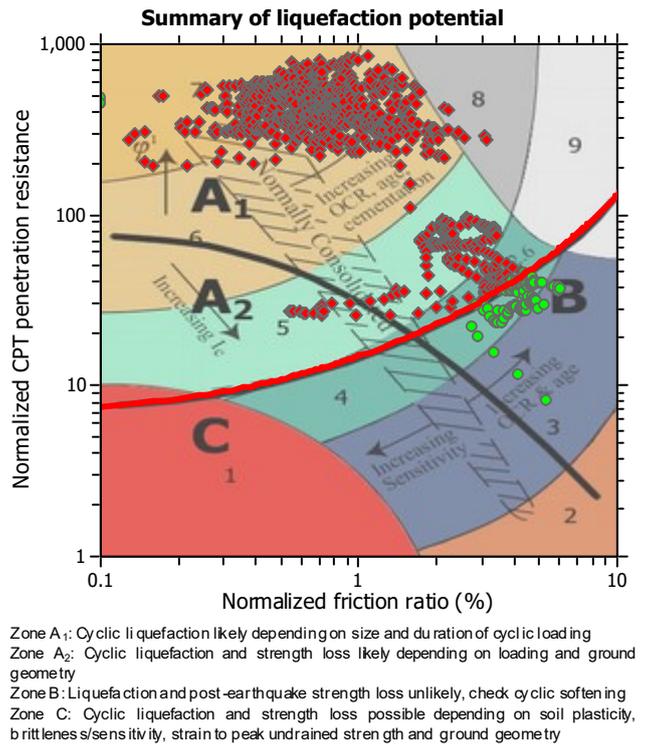
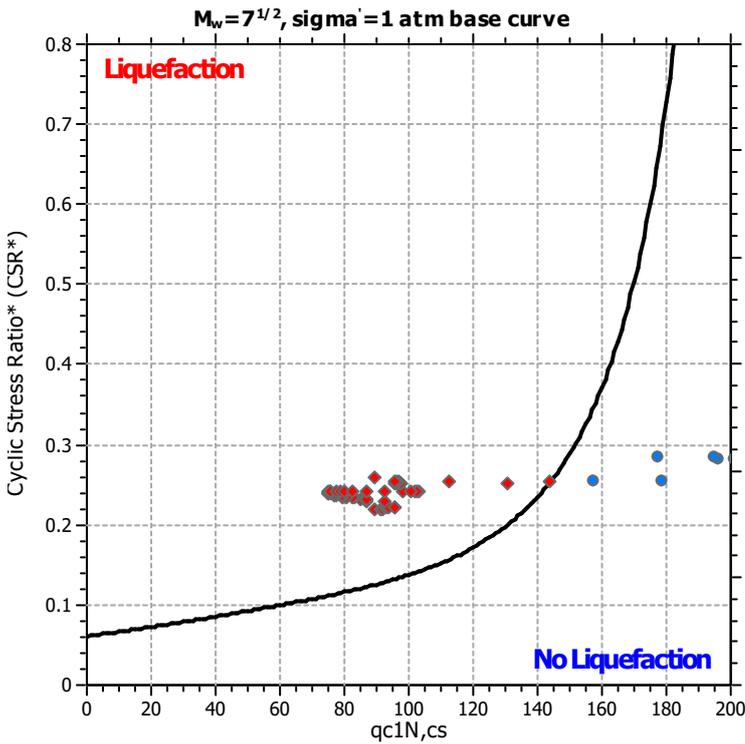
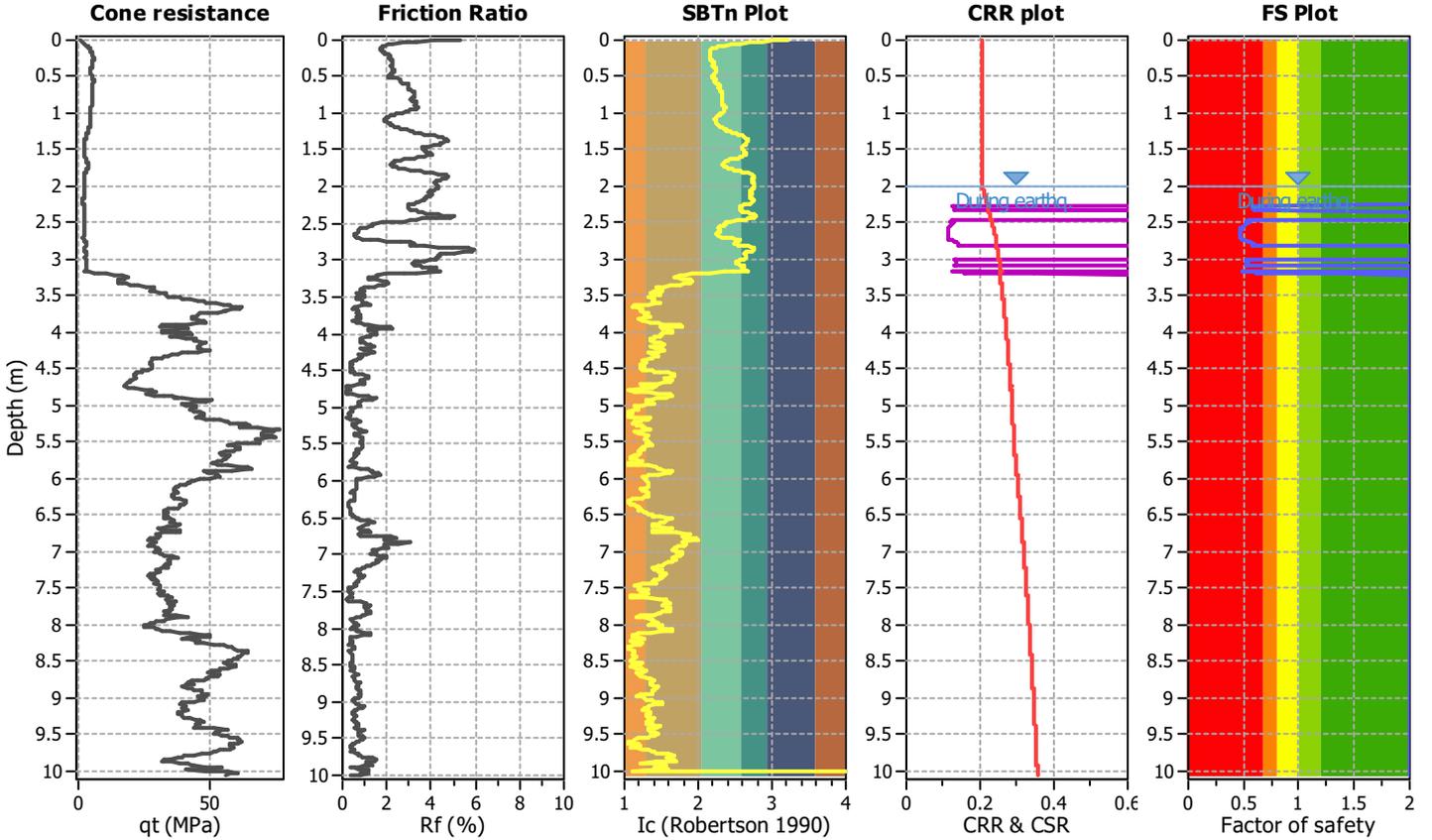
**Project title : K210318**

**Location : 232 Styx Mill Road, Casebrook, Christchurch**

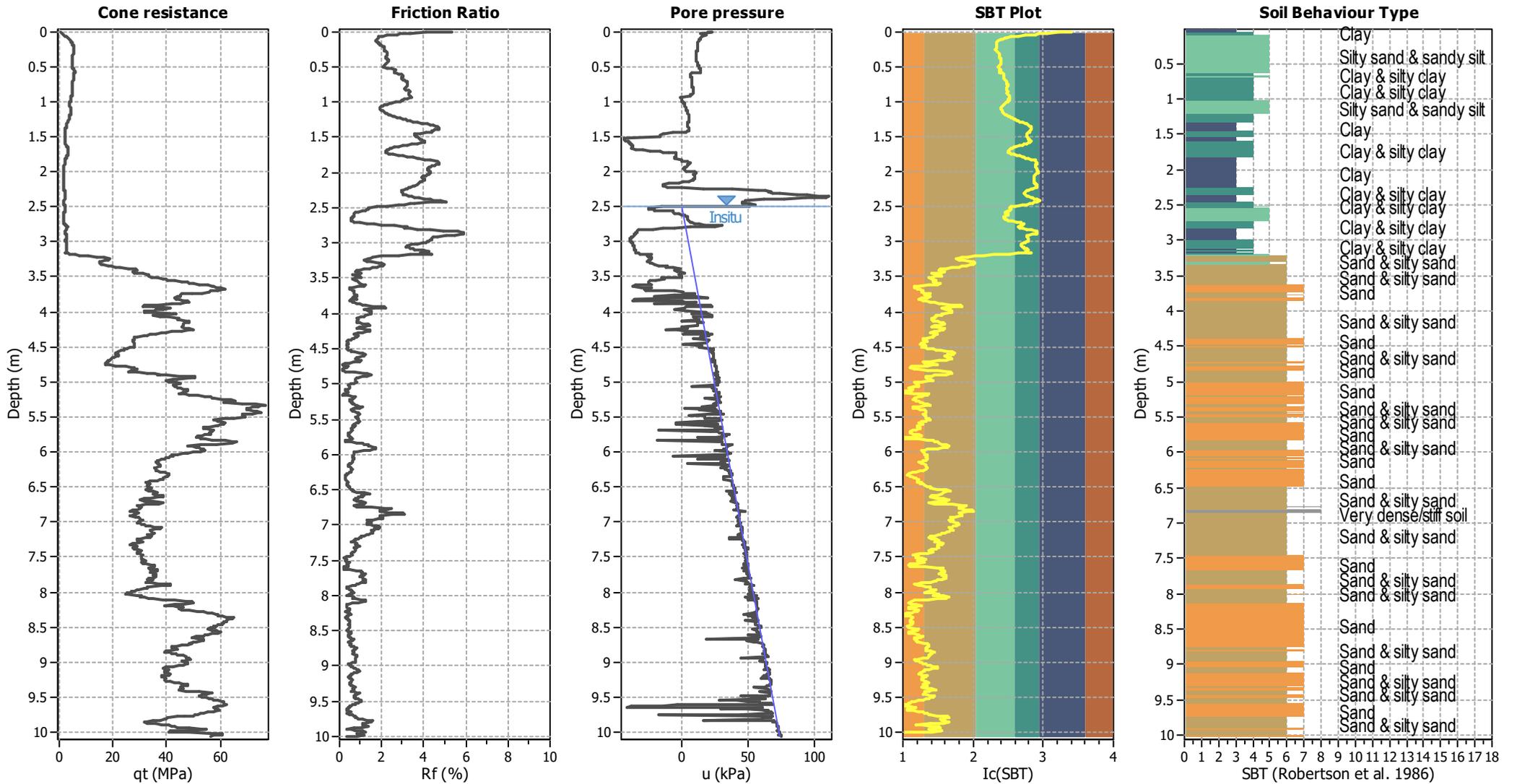
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**Input parameters and analysis data**

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Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.35	Unit weight calculation:	Based on SBT	$K_g$ applied:	Yes		



### CPT basic interpretation plots



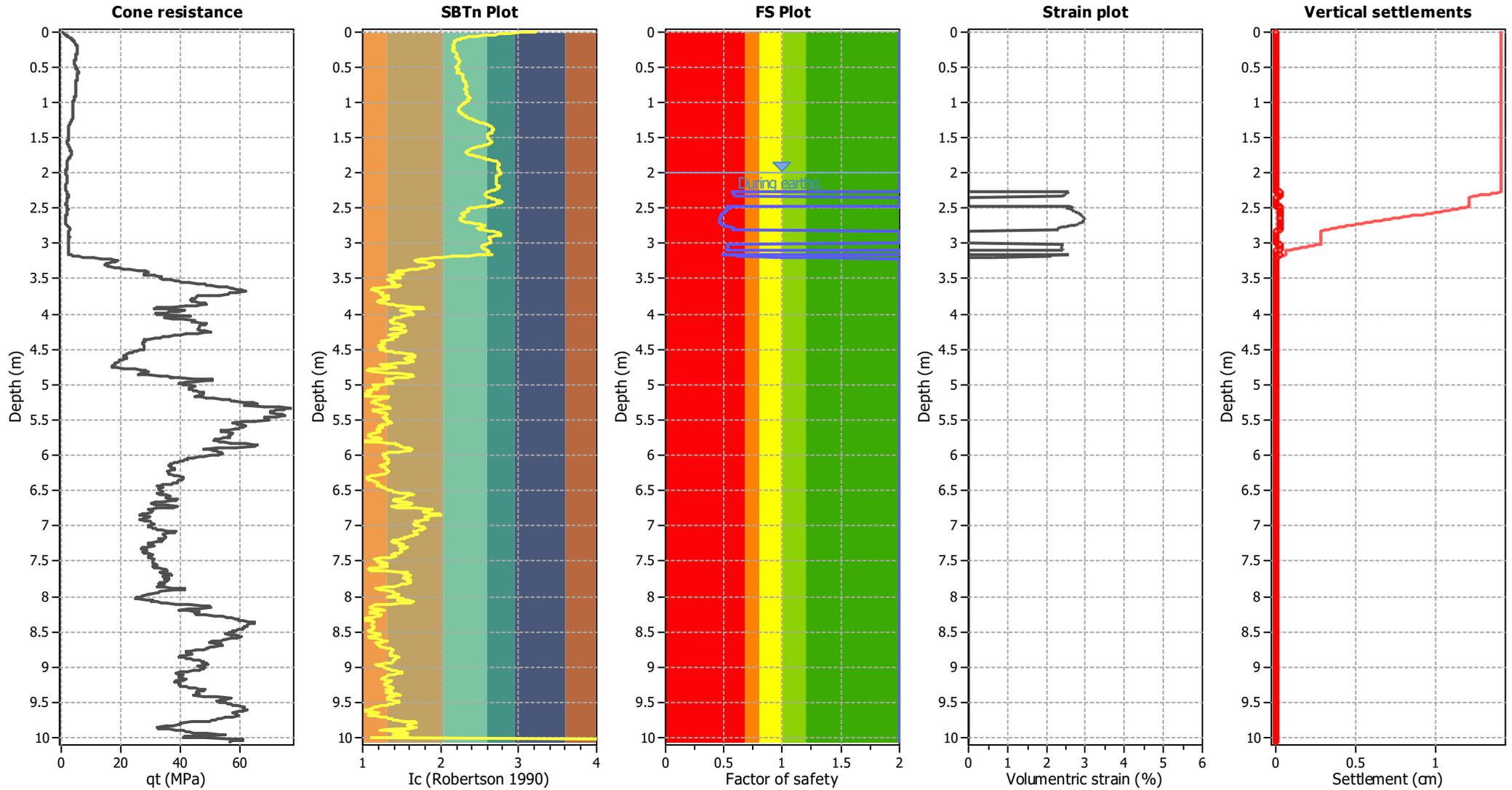
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Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	$K_0$ applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

- qt: Total cone resistance (cone resistance q<sub>c</sub> corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

**LIQUEFACTION ANALYSIS REPORT**

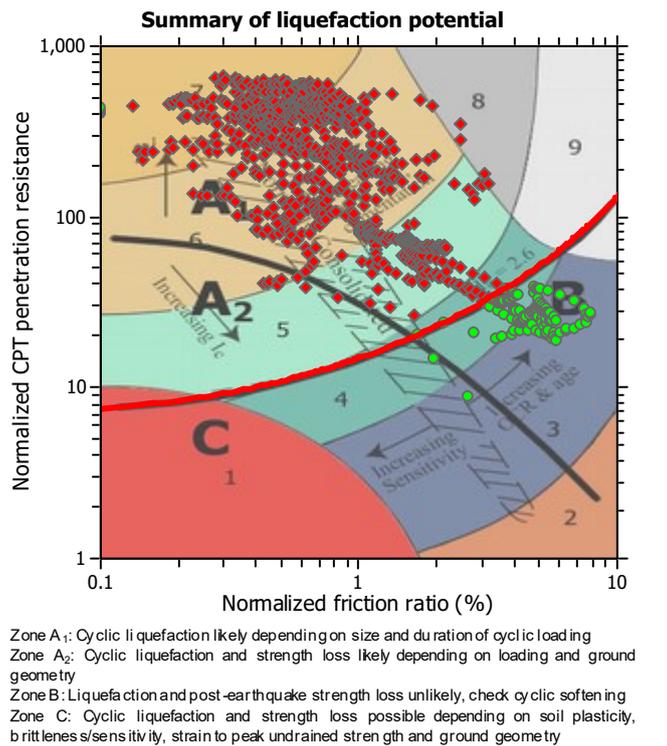
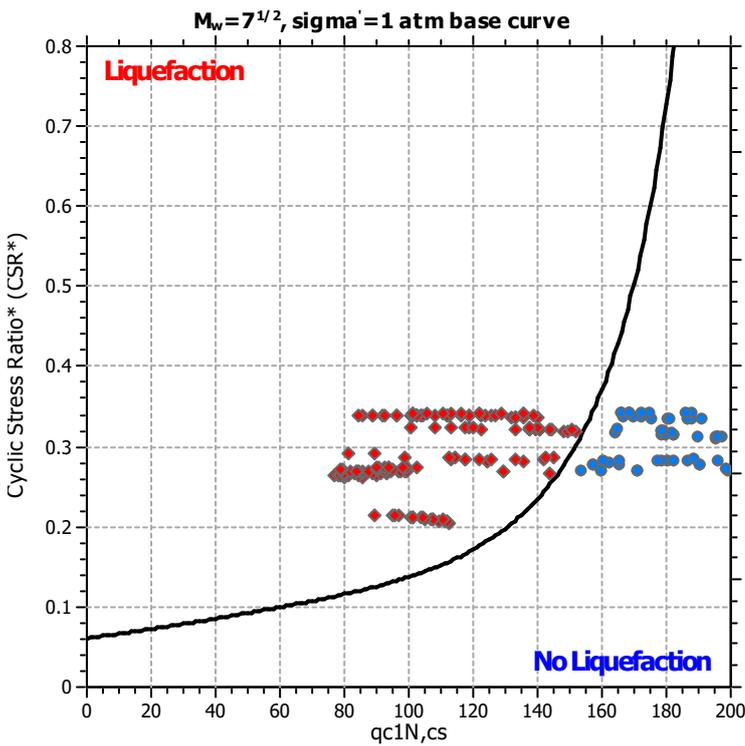
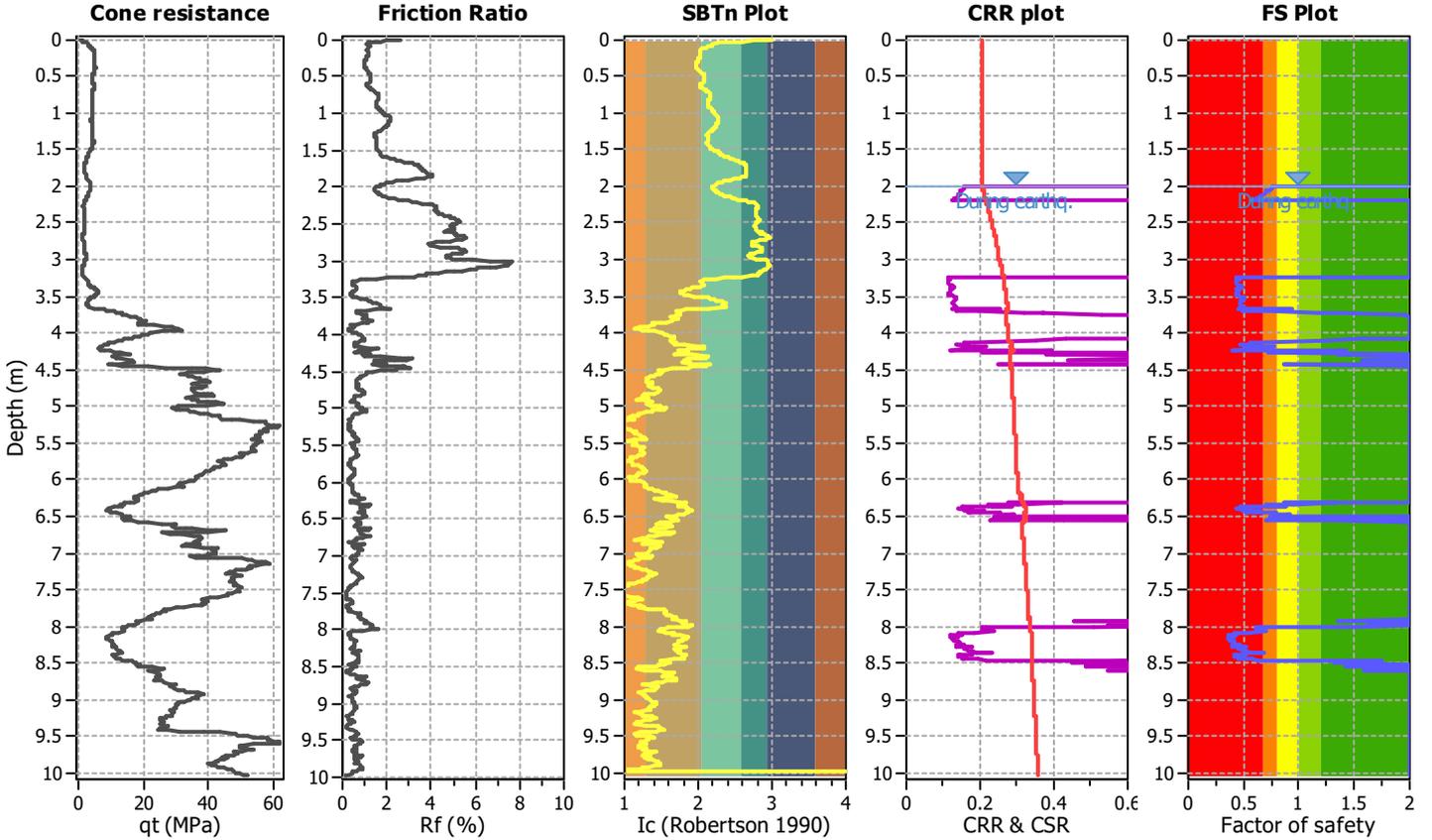
**Project title : K210318**

**Location : 232 Styx Mill Road, Casebrook, Christchurch**

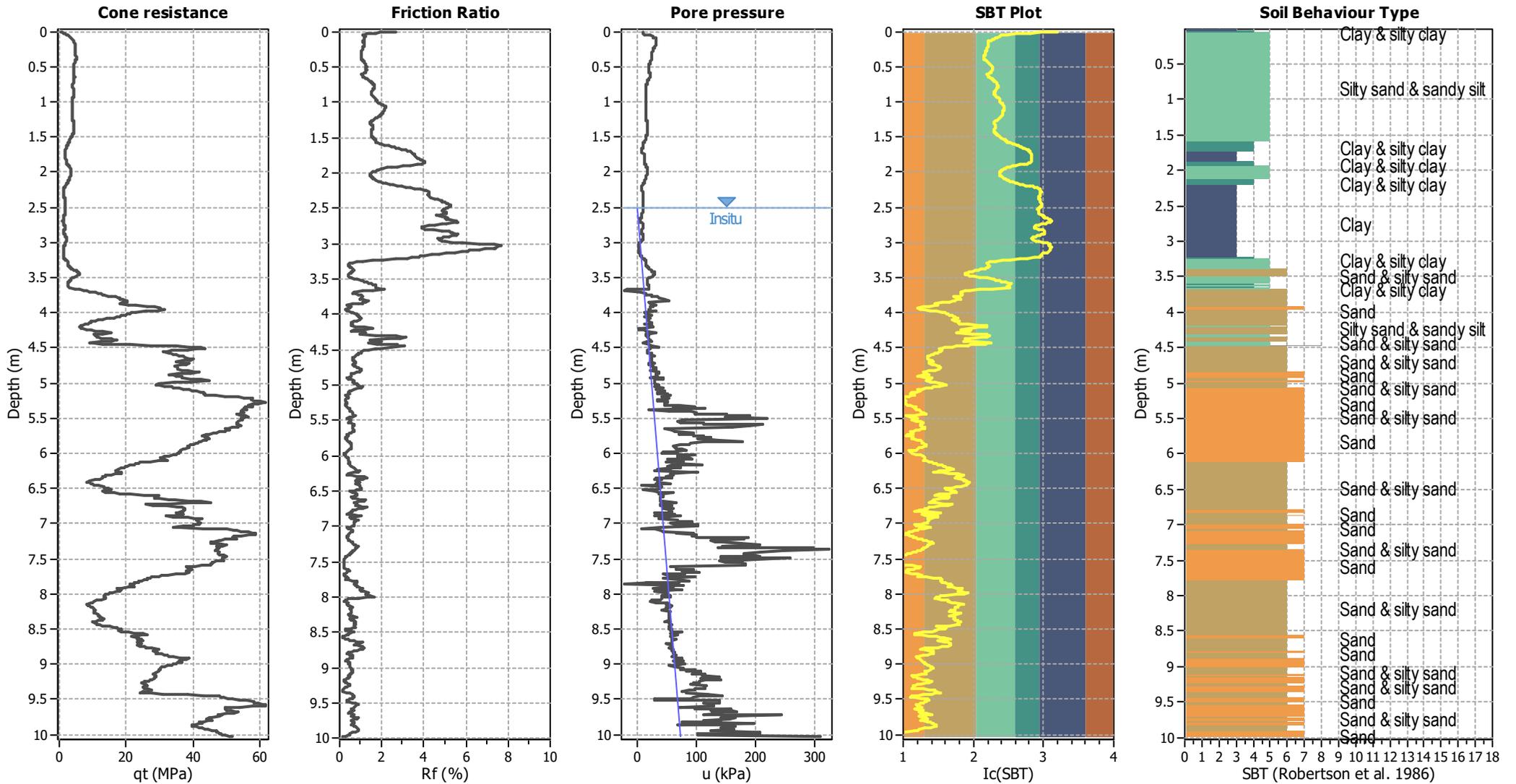
**CPT file : CPT-04 ULS**

**Input parameters and analysis data**

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Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.35	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes		



### CPT basic interpretation plots



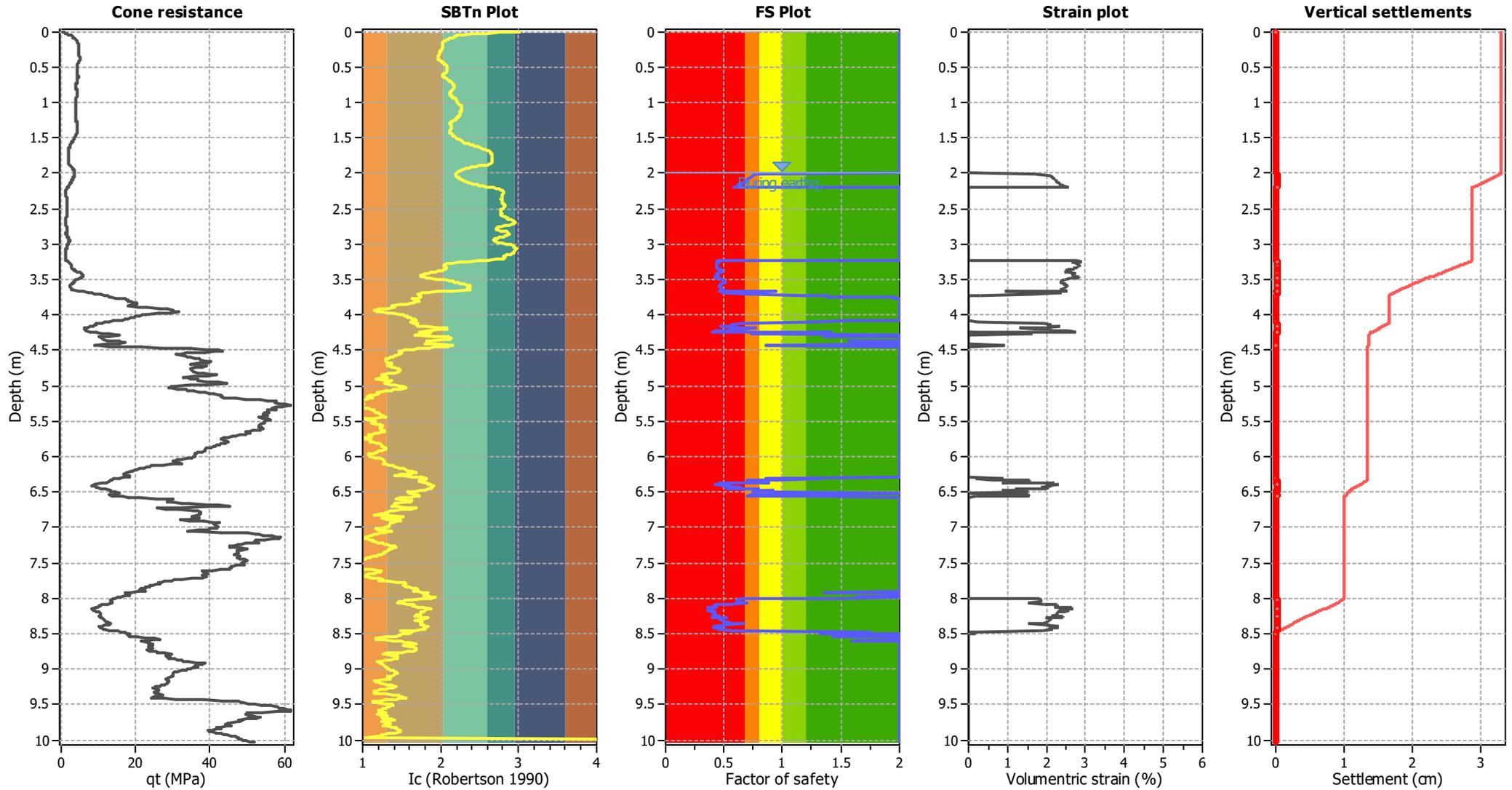
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Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	$K_0$ applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

- qt: Total cone resistance (cone resistance  $q_c$  corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

**LIQUEFACTION ANALYSIS REPORT**

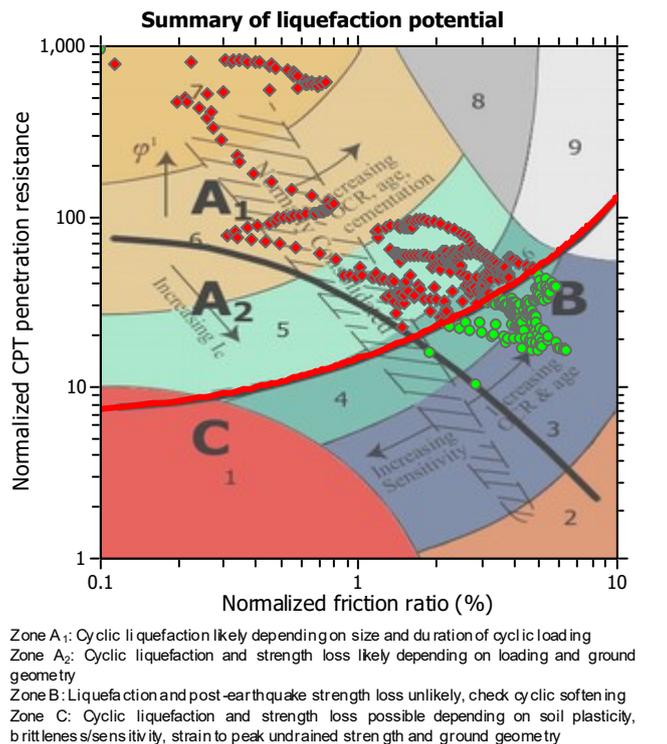
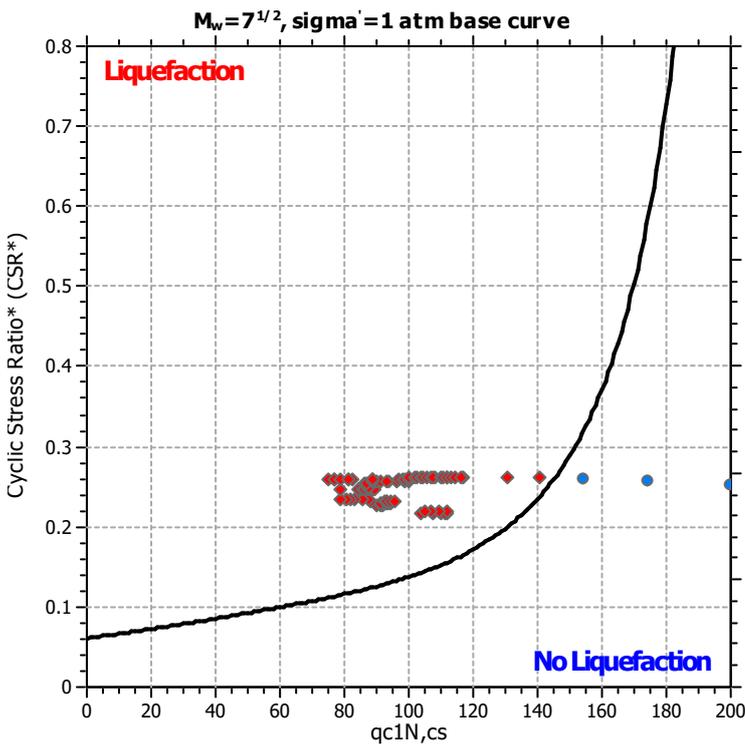
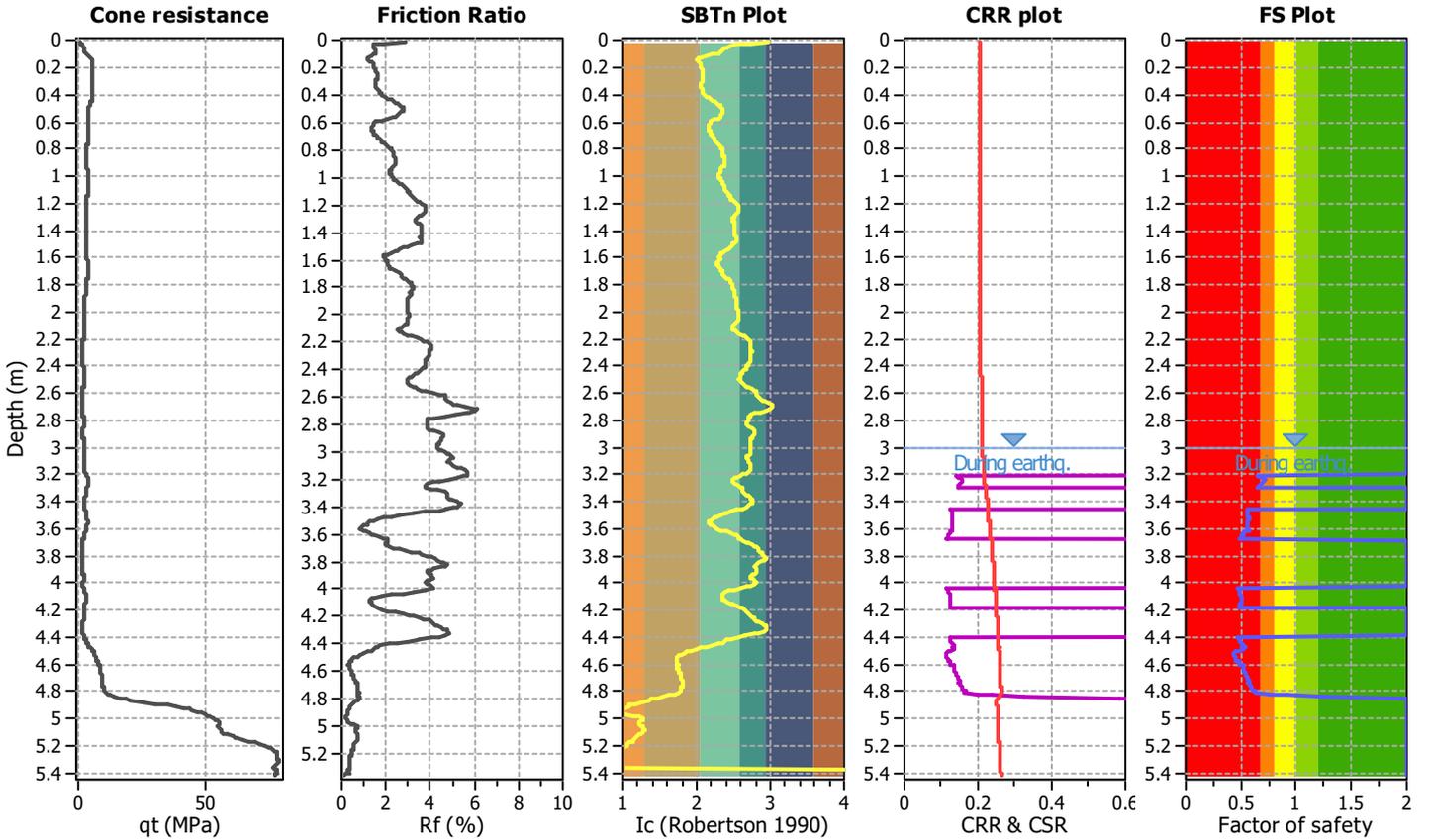
**Project title : K210318**

**Location : 232 Styx Mill Road, Casebrook, Christchurch**

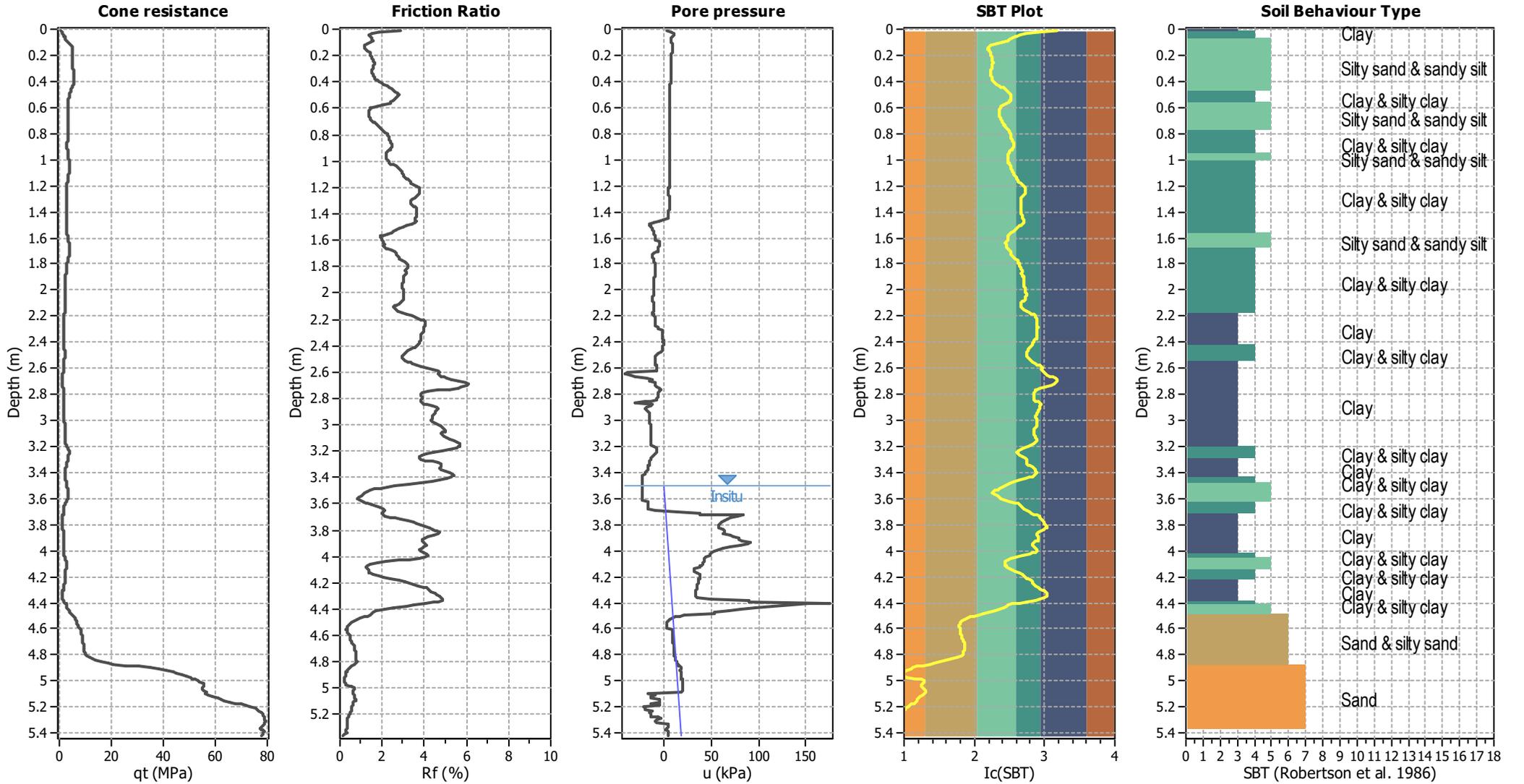
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**Input parameters and analysis data**

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Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.00 m	Fill height:	N/A	applied:	Sands only
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.35	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes	MSF method:	Method based



### CPT basic interpretation plots



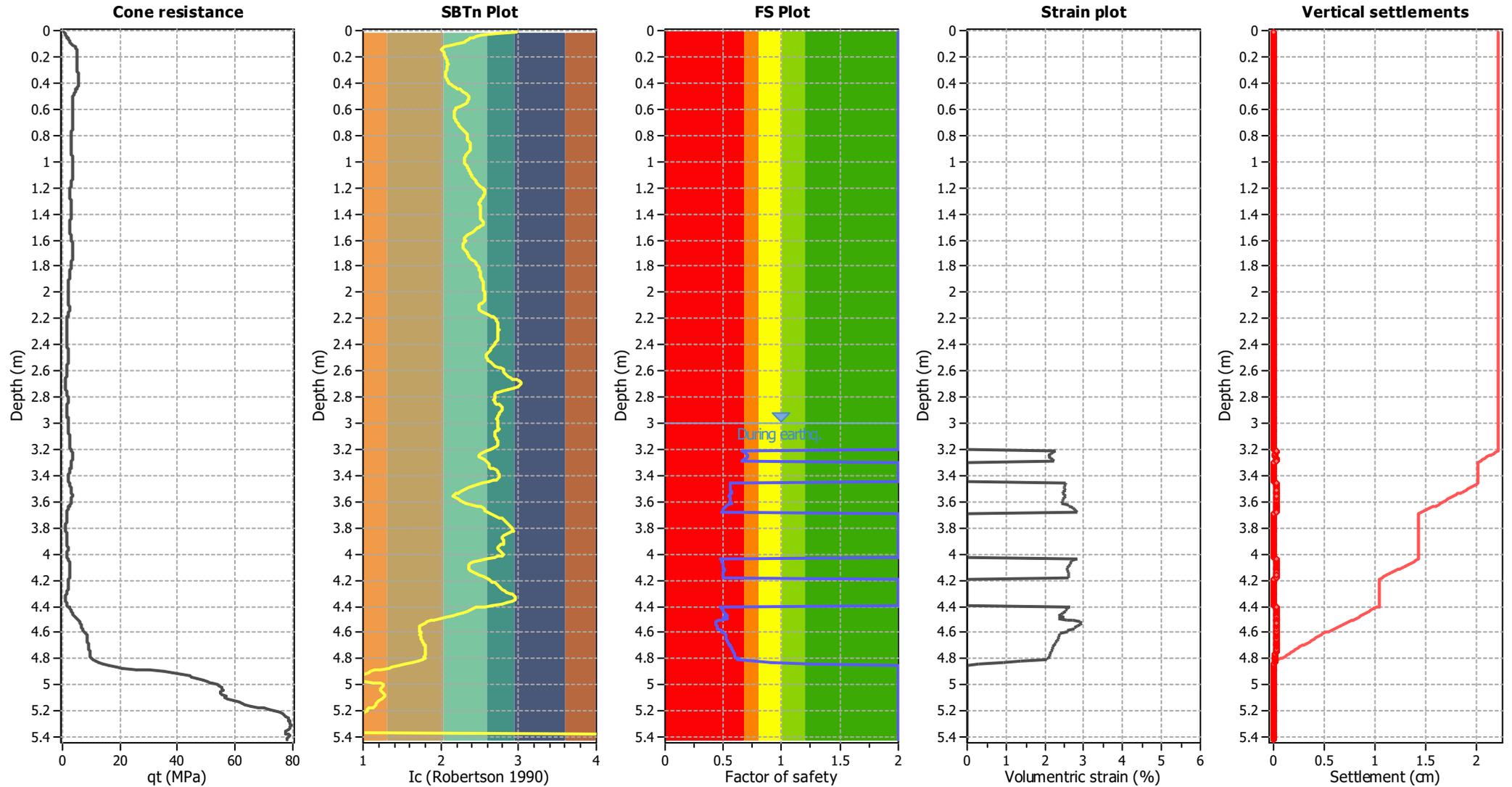
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Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	$K_0$ applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

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

**LIQUEFACTION ANALYSIS REPORT**

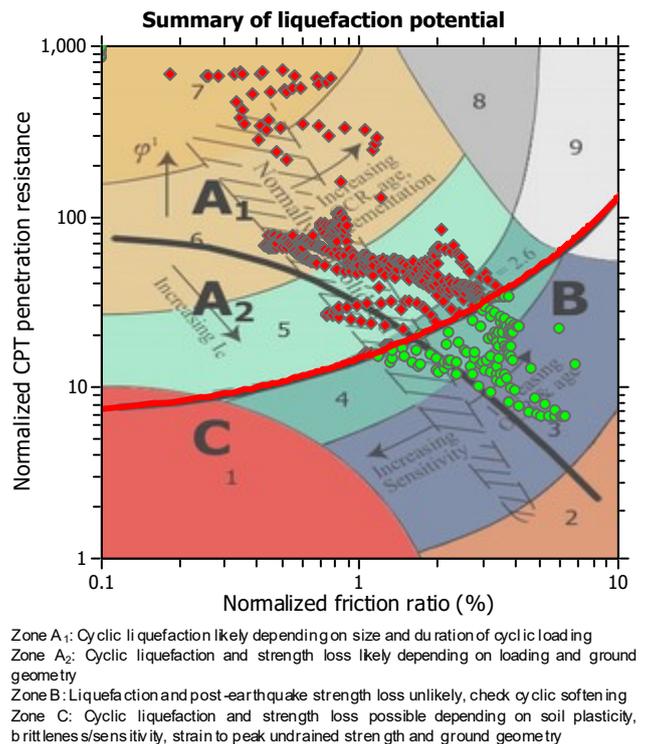
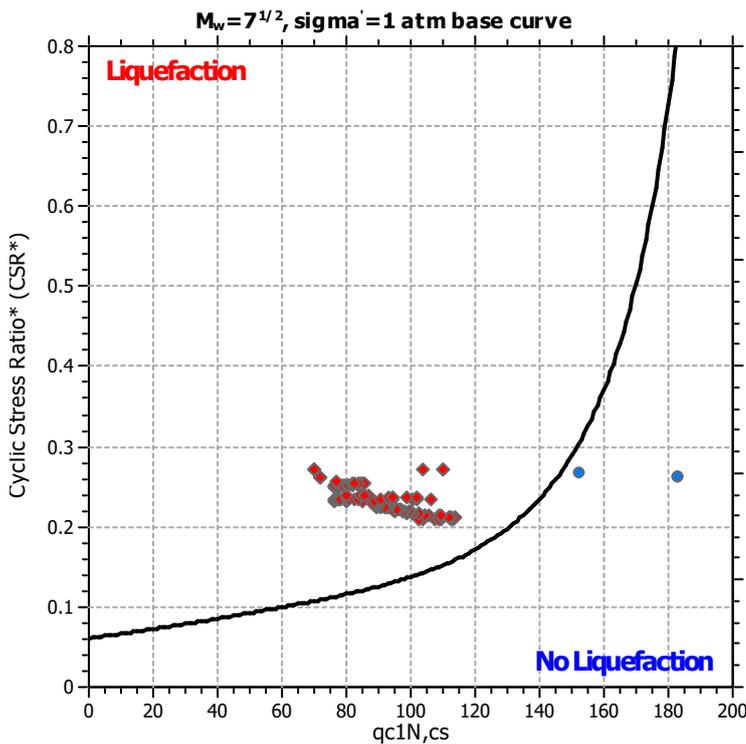
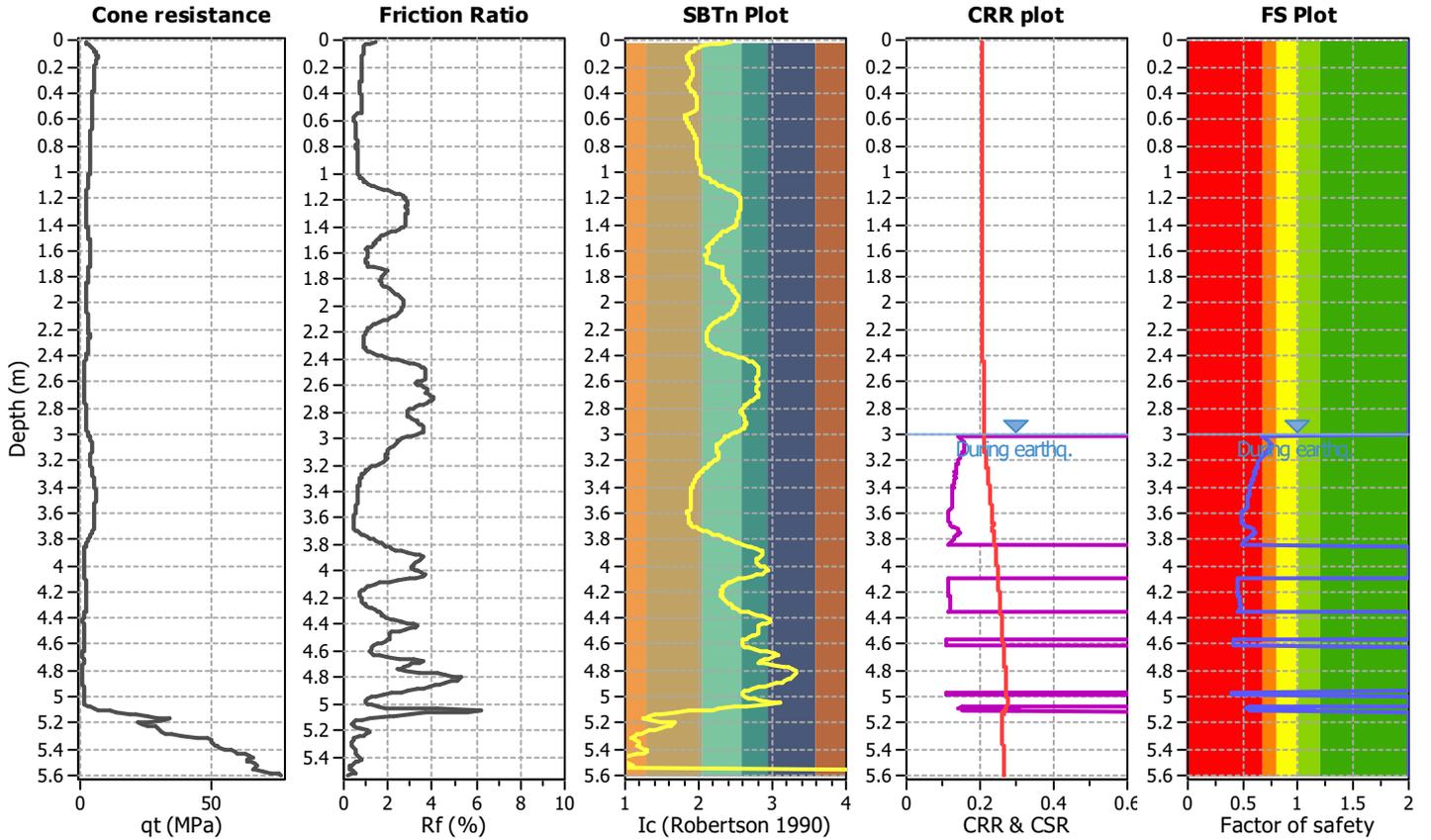
**Project title : K210318**

**Location : 232 Styx Mill Road, Casebrook, Christchurch**

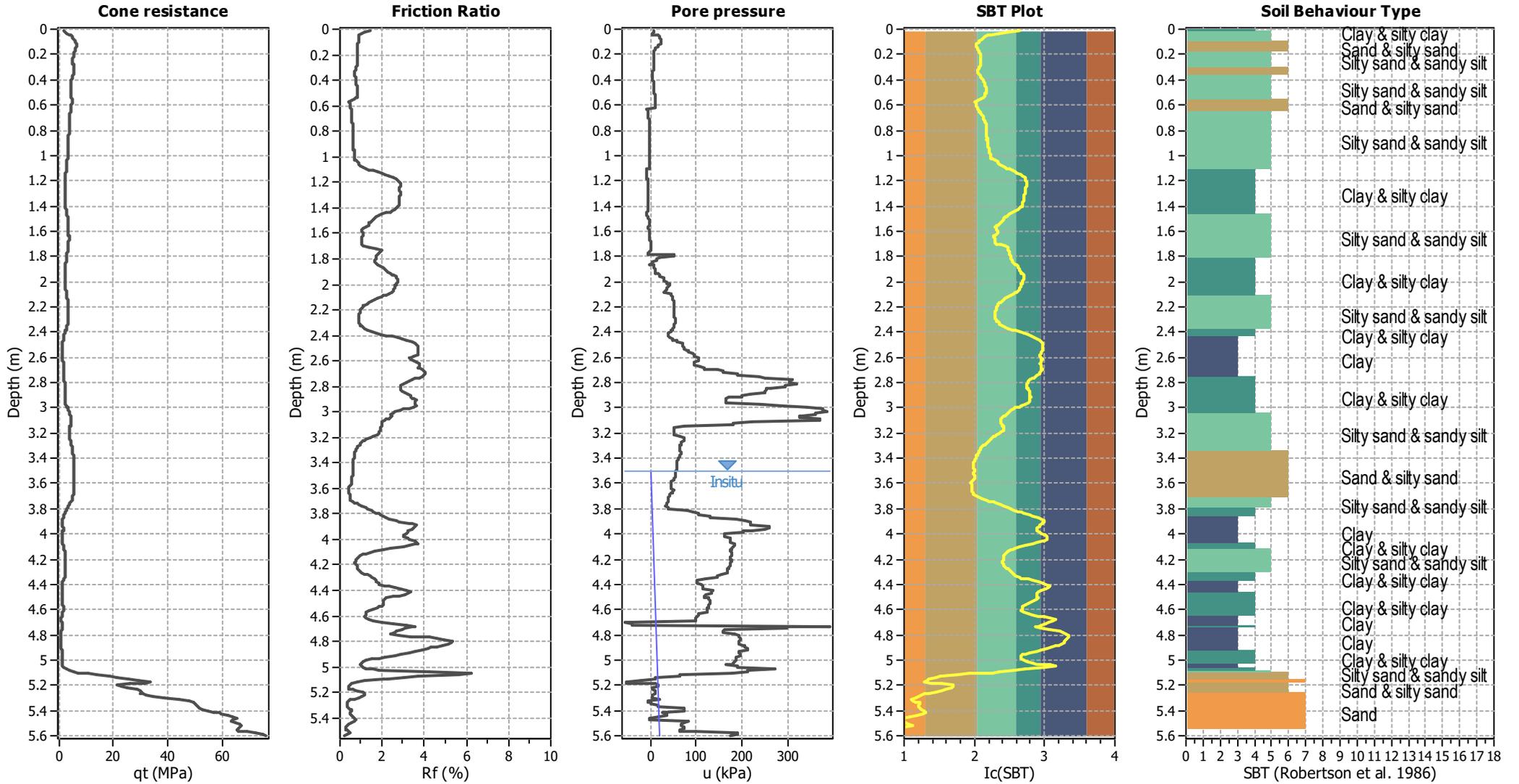
**CPT file : CPT-06 ULS**

**Input parameters and analysis data**

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Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
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### CPT basic interpretation plots



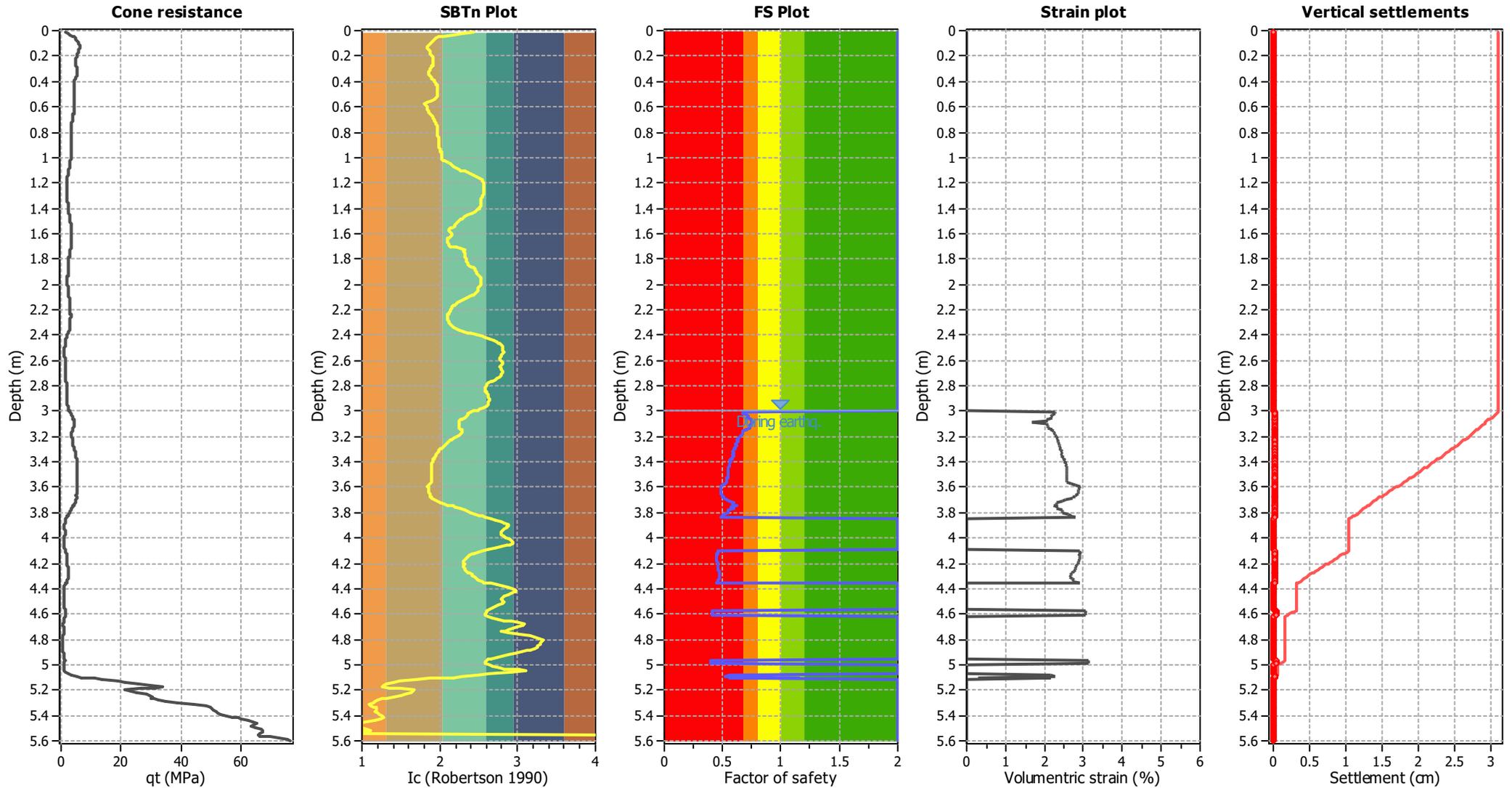
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Points to test:	Based on Ic value	Ic cut-off value:	2.60	$K_v$ applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

- qt: Total cone resistance (cone resistance q corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

**LIQUEFACTION ANALYSIS REPORT**

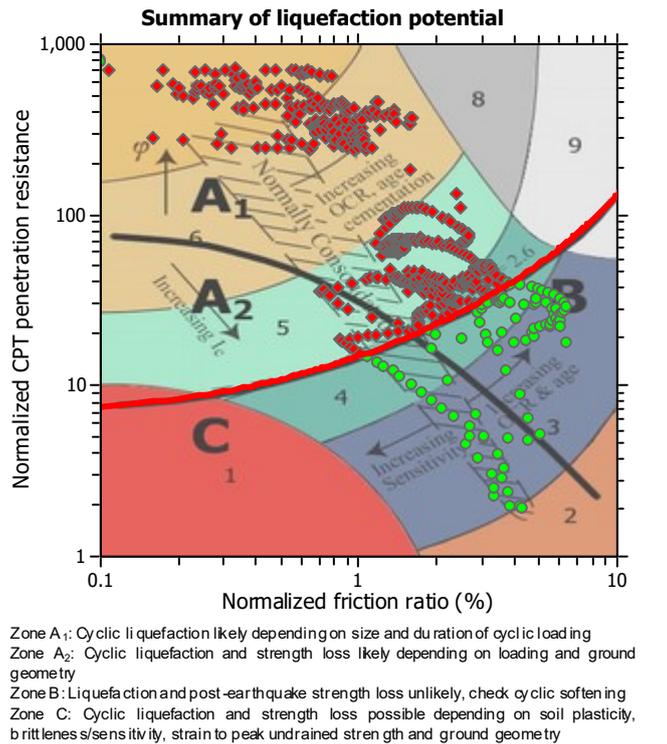
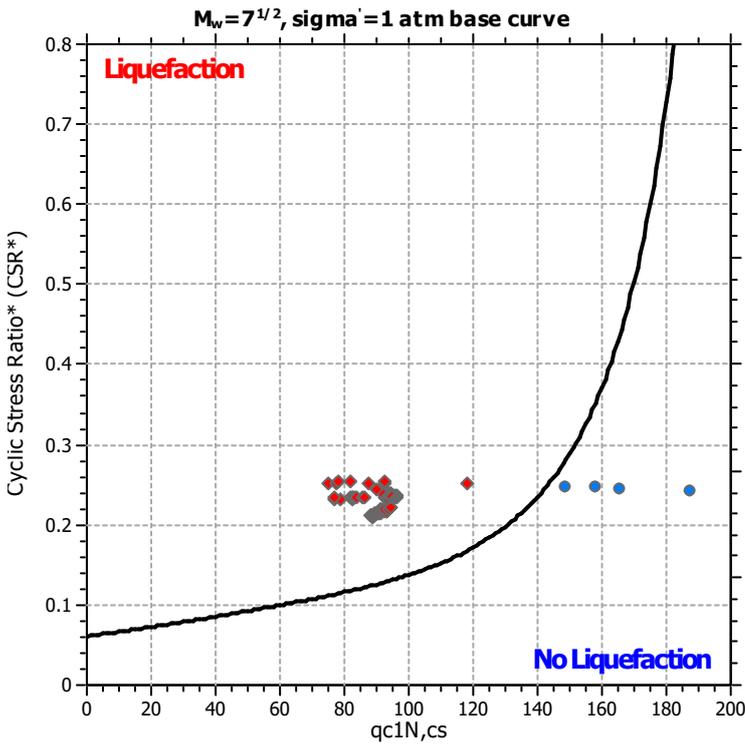
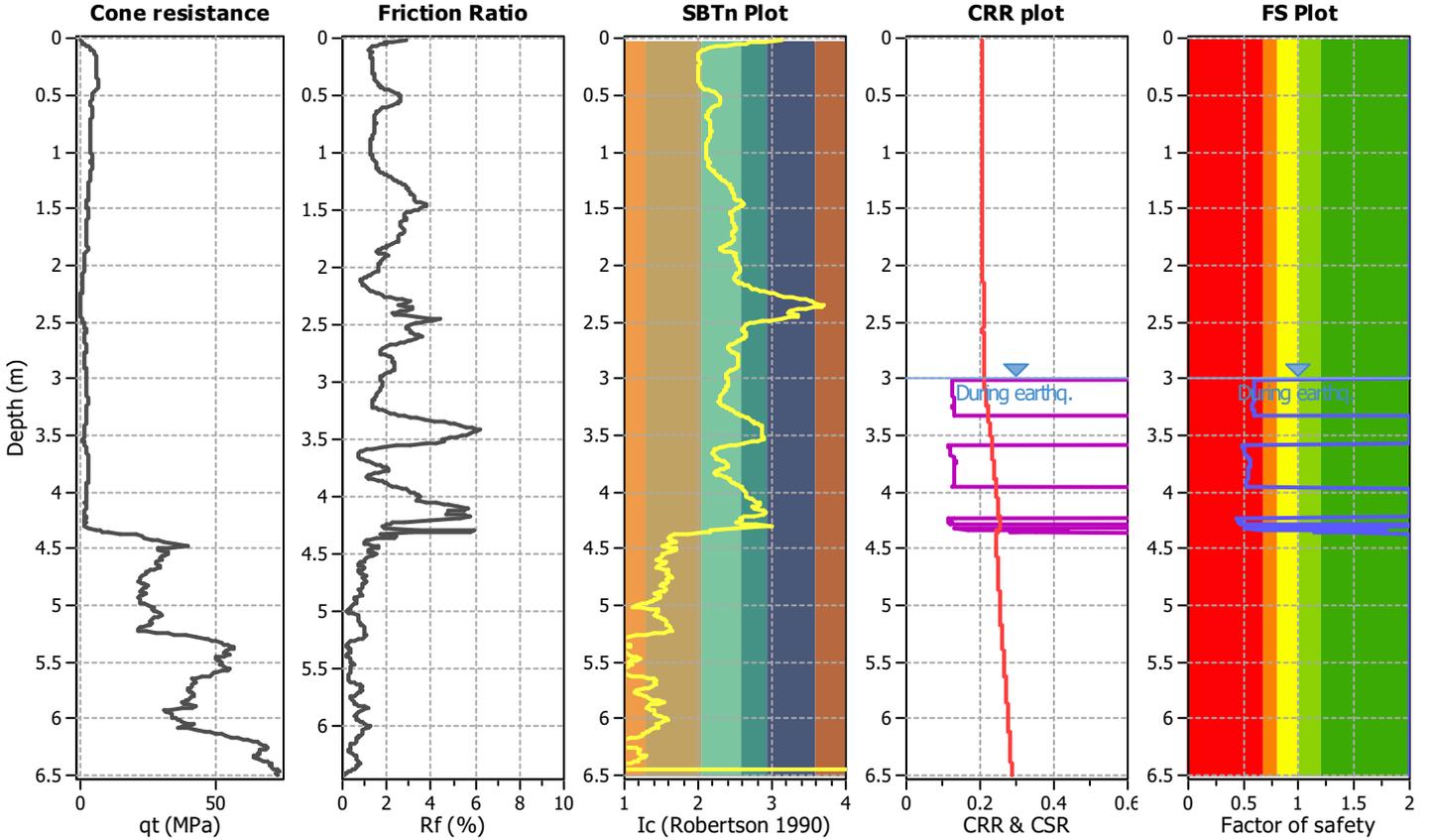
**Project title : K210318**

**Location : 232 Styx Mill Road, Casebrook, Christchurch**

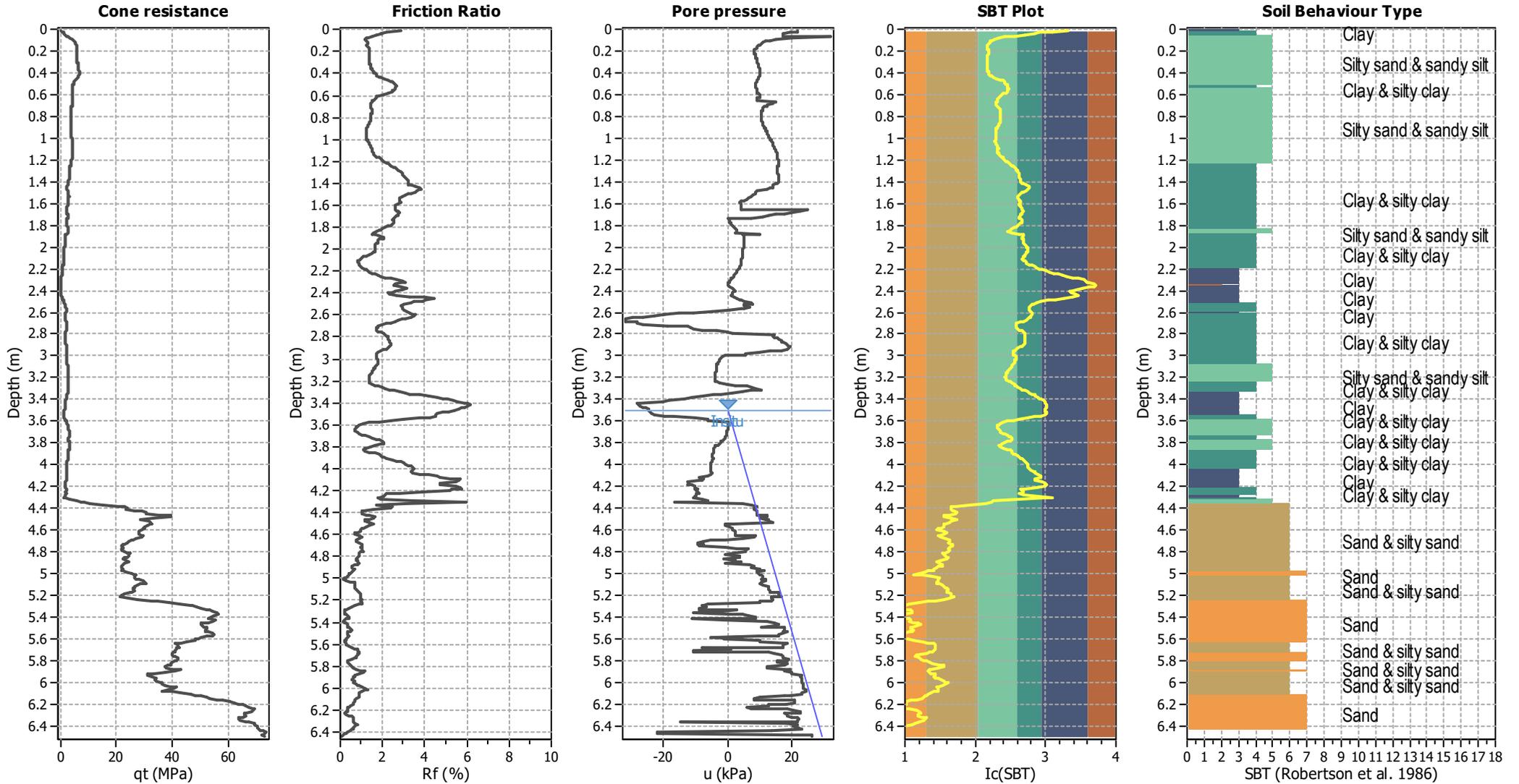
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**Input parameters and analysis data**

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



### CPT basic interpretation plots



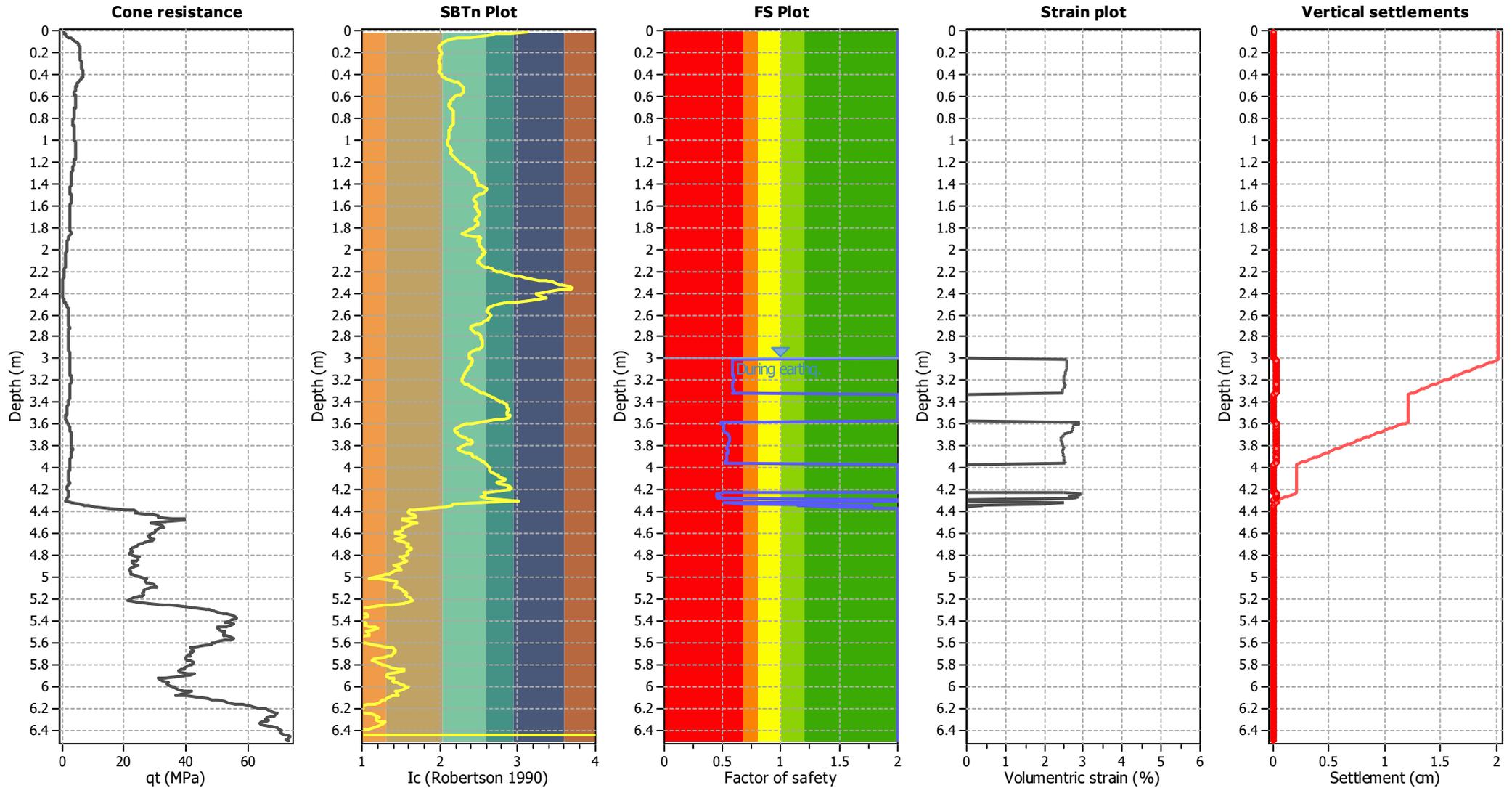
#### Input parameters and analysis data

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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	$K_v$ applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

- qt: Total cone resistance (cone resistance q<sub>c</sub> corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

**LIQUEFACTION ANALYSIS REPORT**

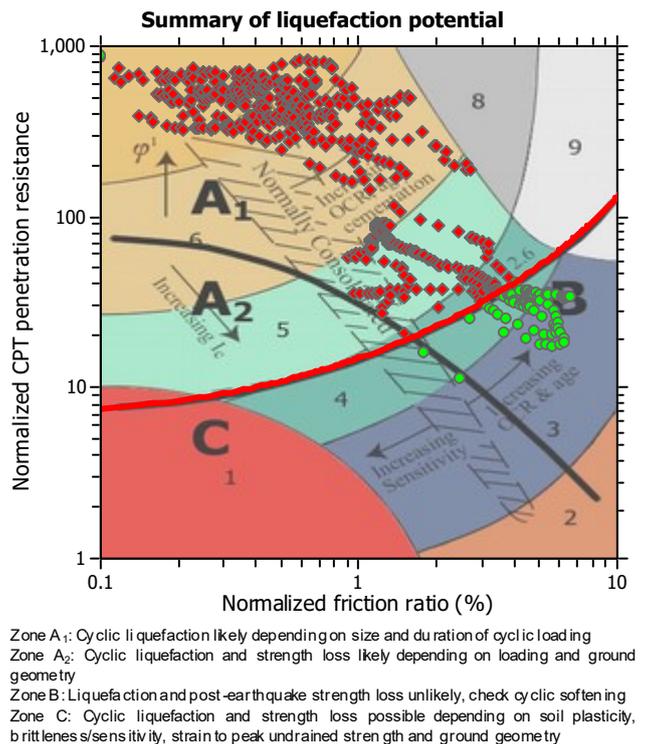
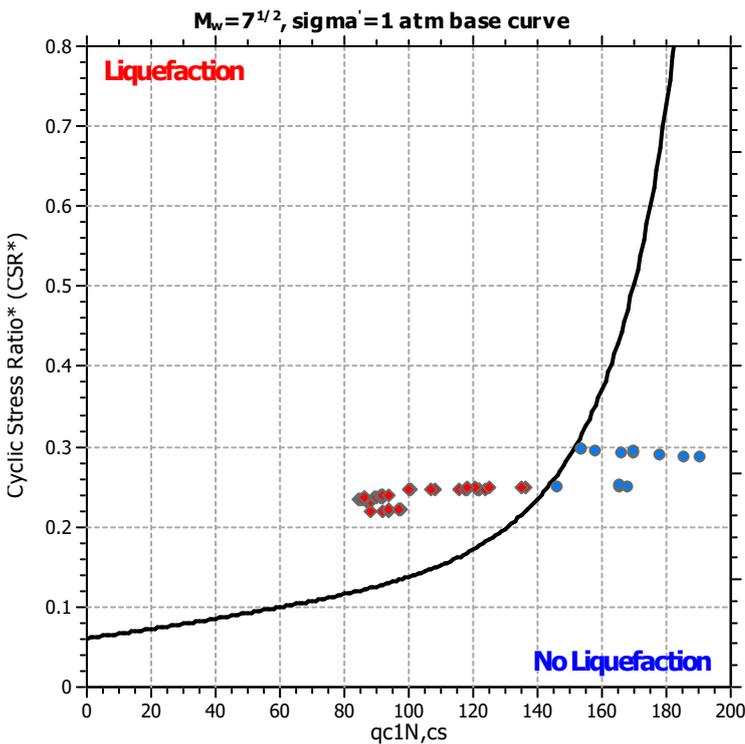
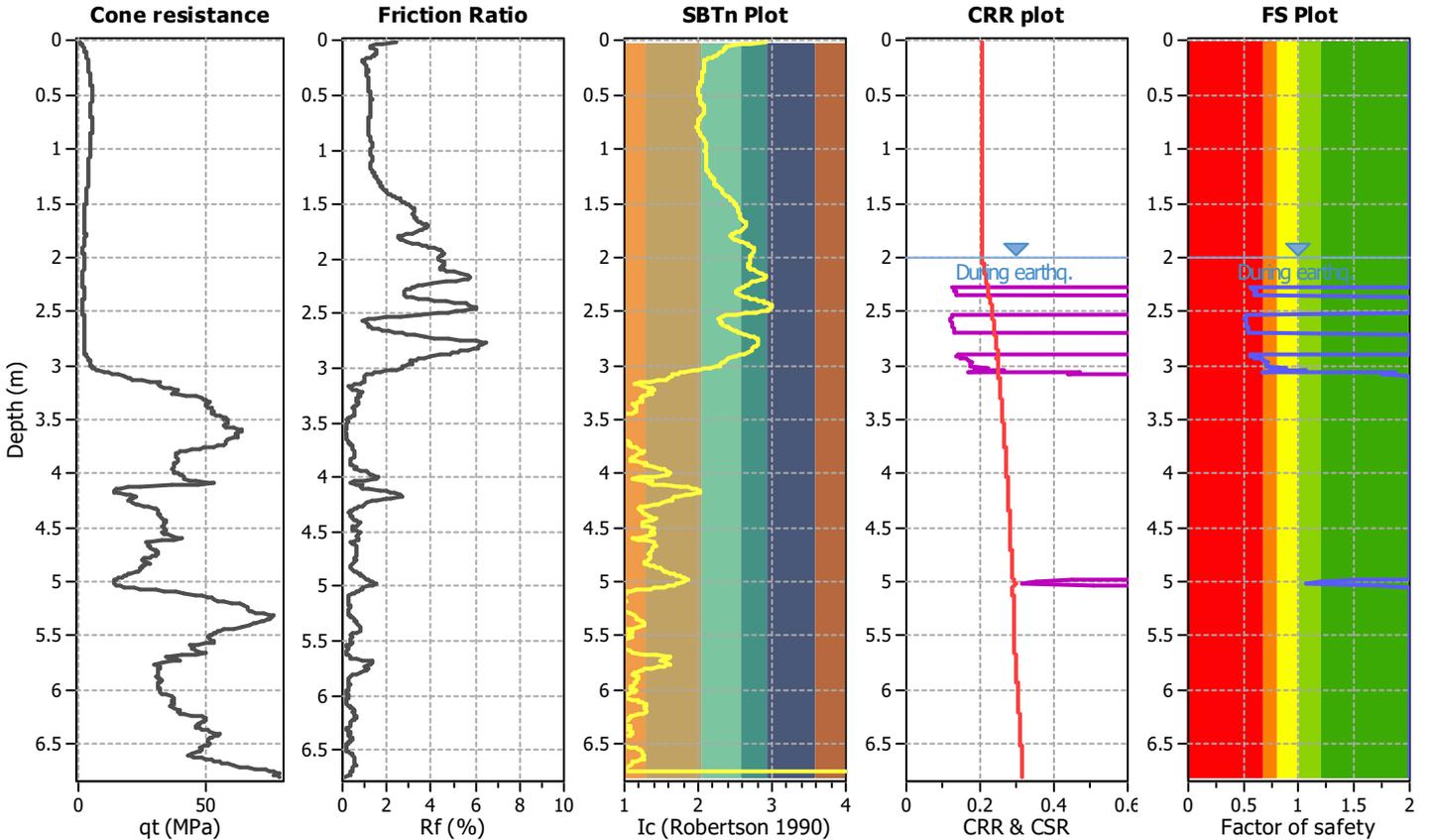
**Project title : K210318**

**Location : 232 Styx Mill Road, Casebrook, Christchurch**

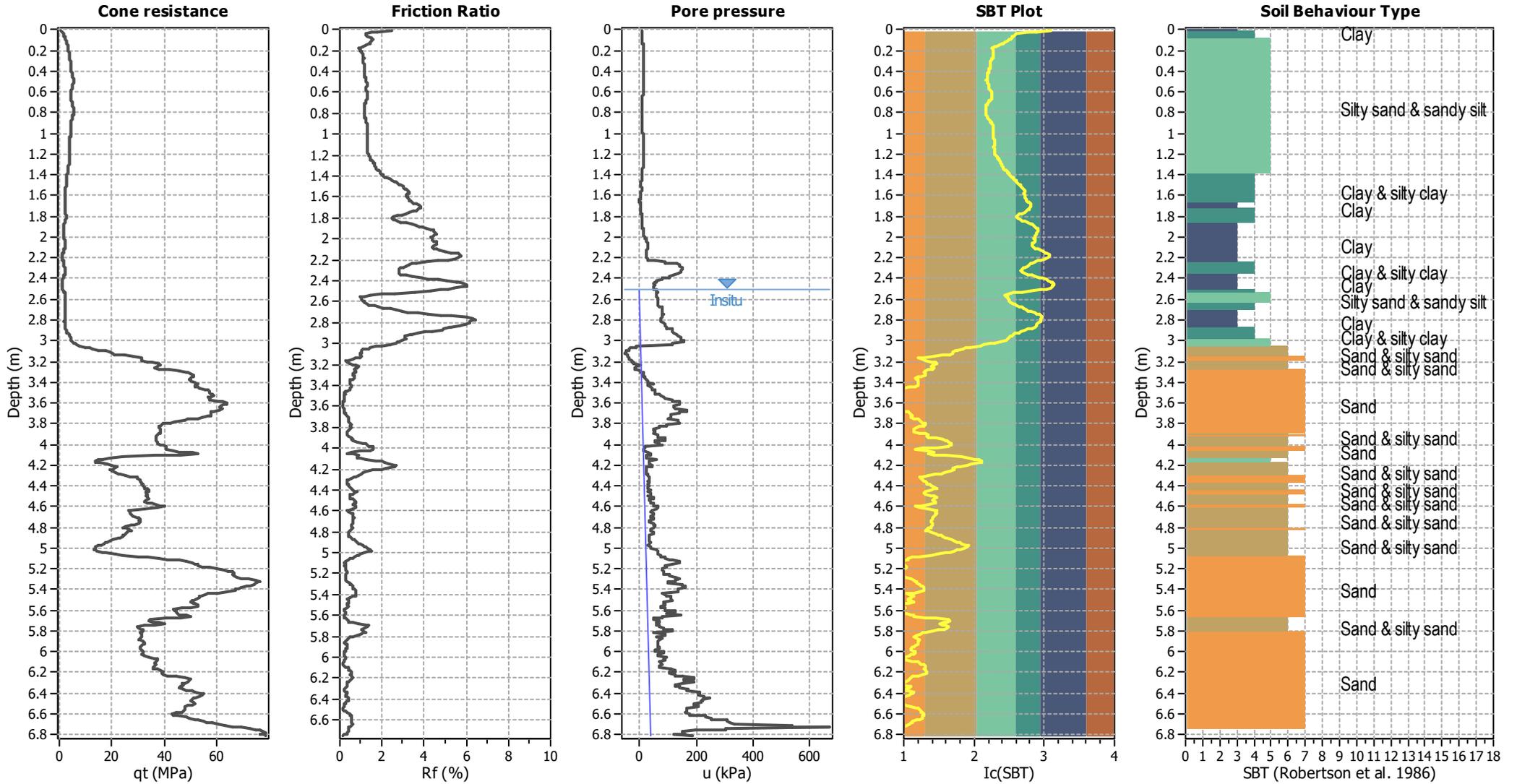
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**Input parameters and analysis data**

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



### CPT basic interpretation plots



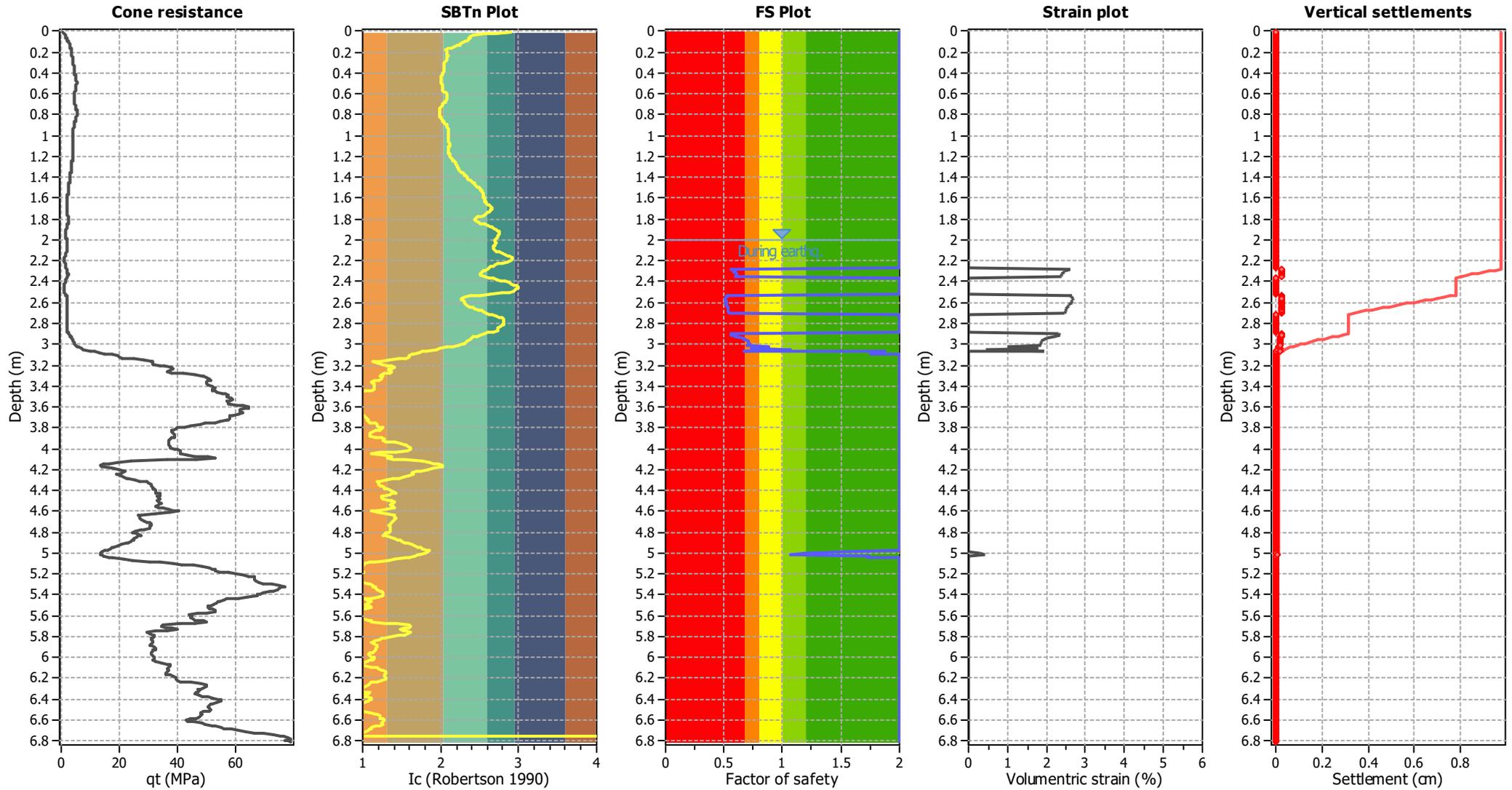
#### Input parameters and analysis data

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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	$K_v$ applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

- qt: Total cone resistance (cone resistance  $q_c$  corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

**LIQUEFACTION ANALYSIS REPORT**

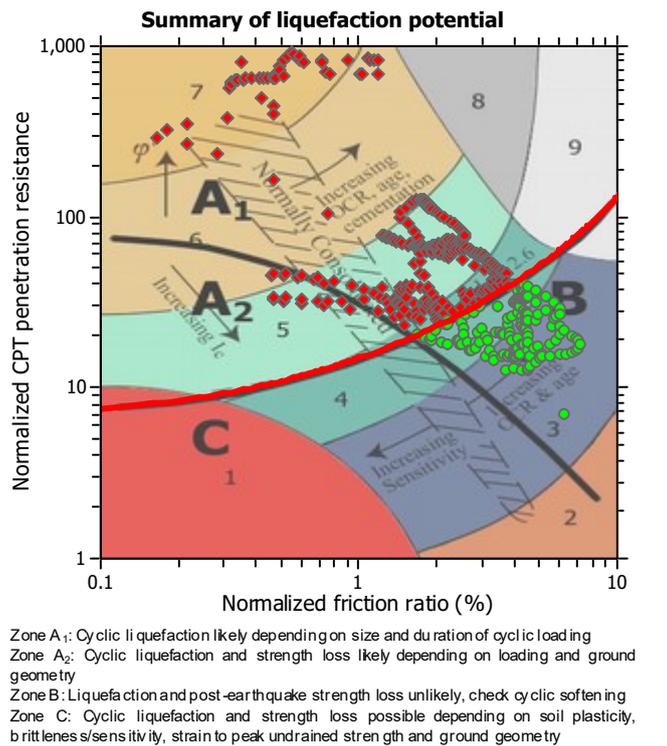
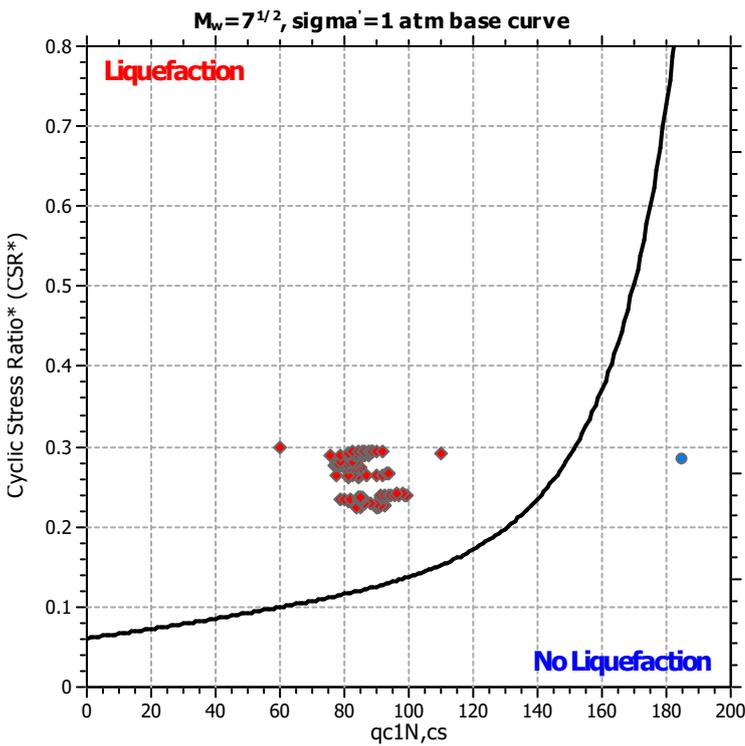
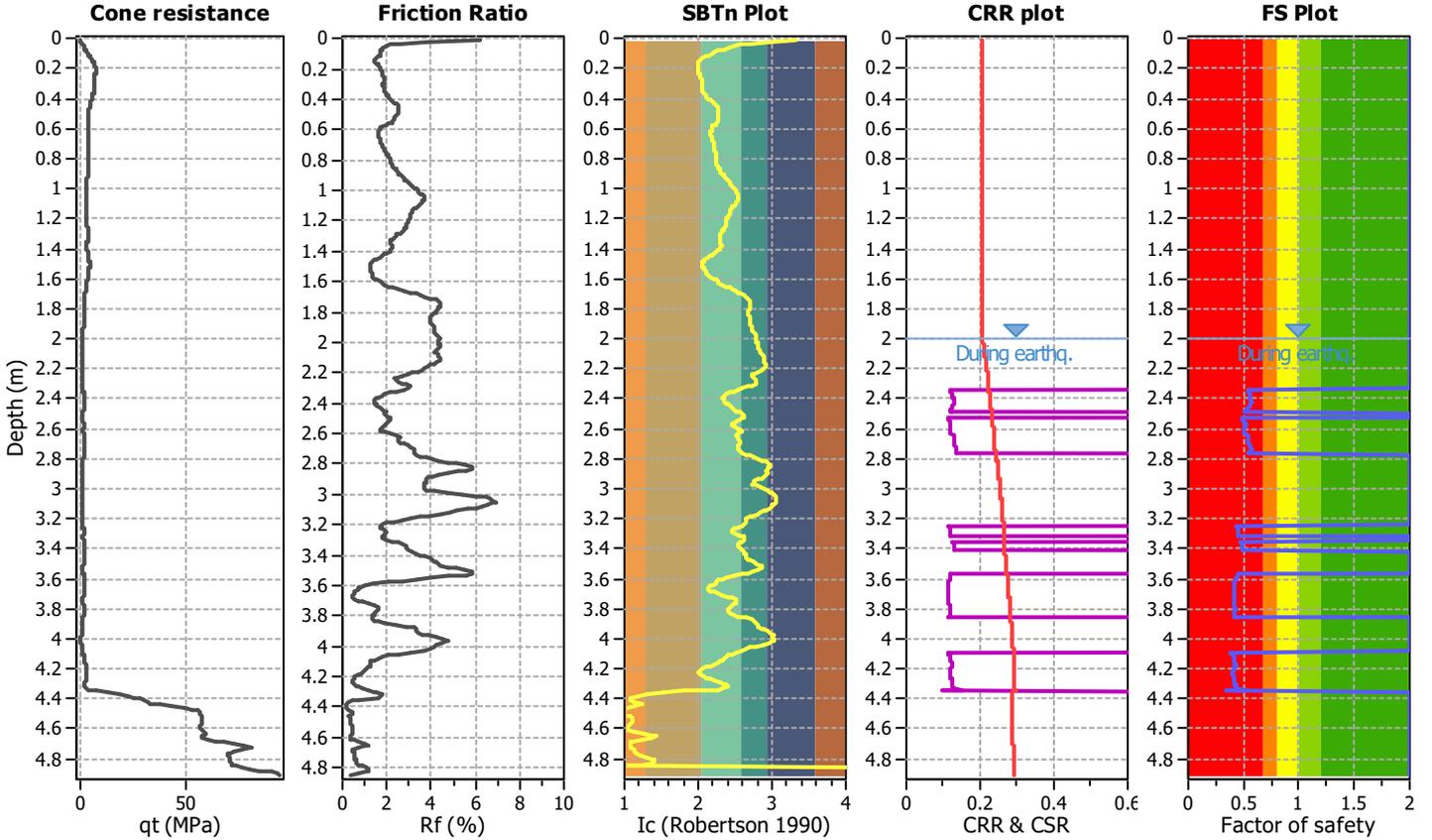
**Project title : K210318**

**Location : 232 Styx Mill Road, Casebrook, Christchurch**

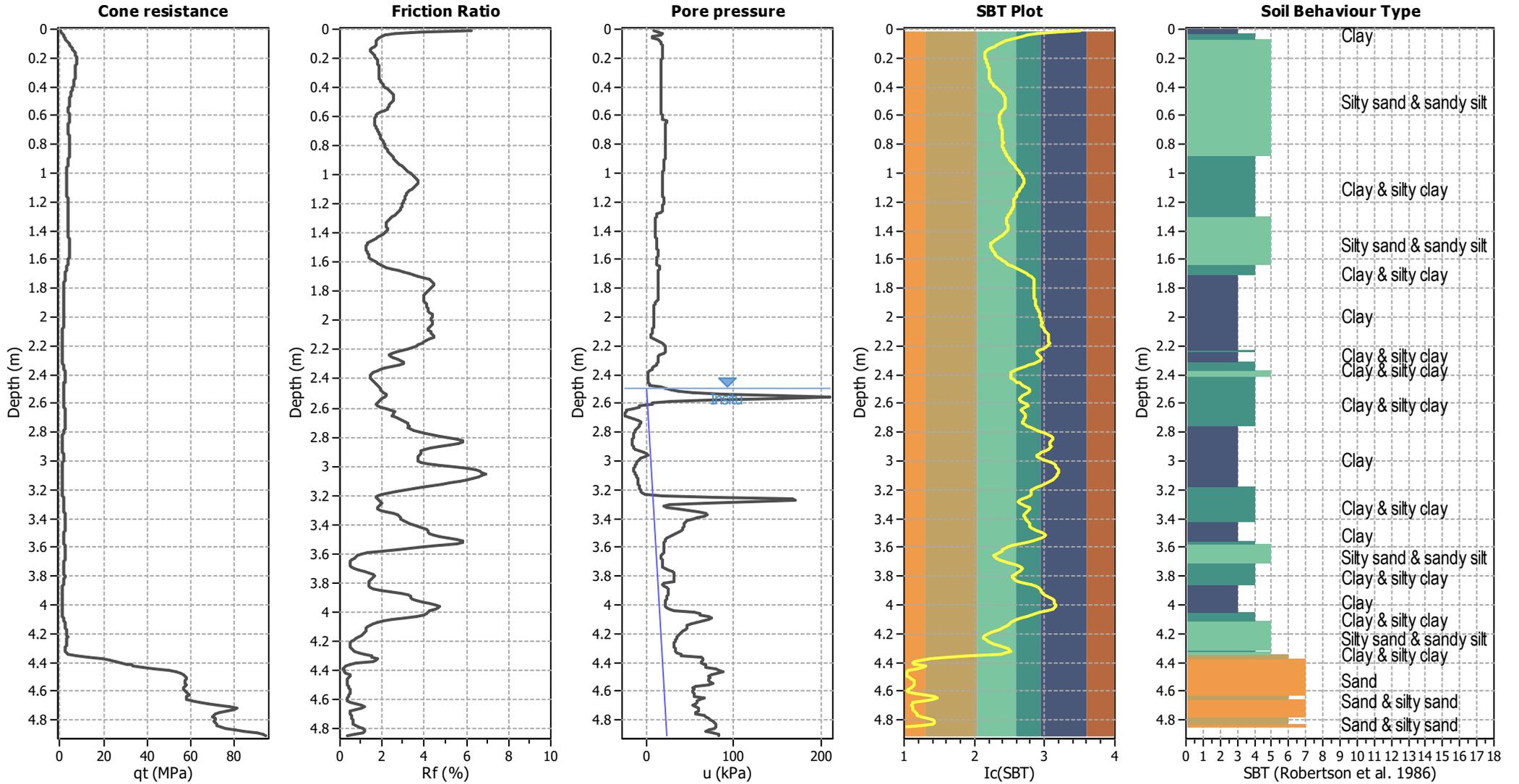
**CPT file : CPT-09 ULS**

**Input parameters and analysis data**

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Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.00 m	Fill height:	N/A	applied:	Sands only
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.35	Unit weight calculation:	Based on SBT	$K_0$ applied:	Yes	MSF method:	Method based



### CPT basic interpretation plots



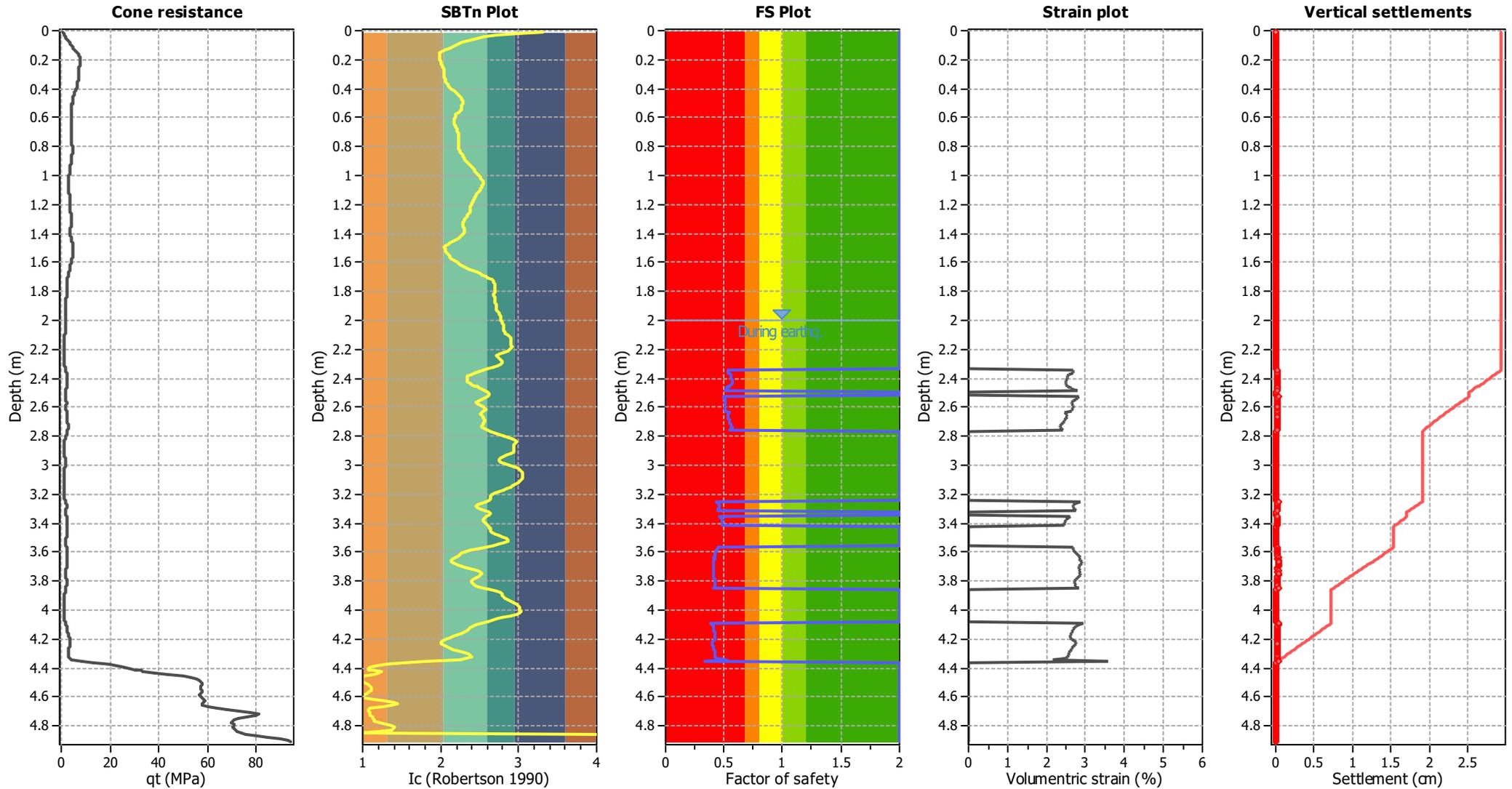
#### Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.00 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>v</sub> applied:	Yes
Earthquake magnitude M <sub>w</sub> :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

- qt: Total cone resistance (cone resistance q<sub>c</sub> corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

**LIQUEFACTION ANALYSIS REPORT**

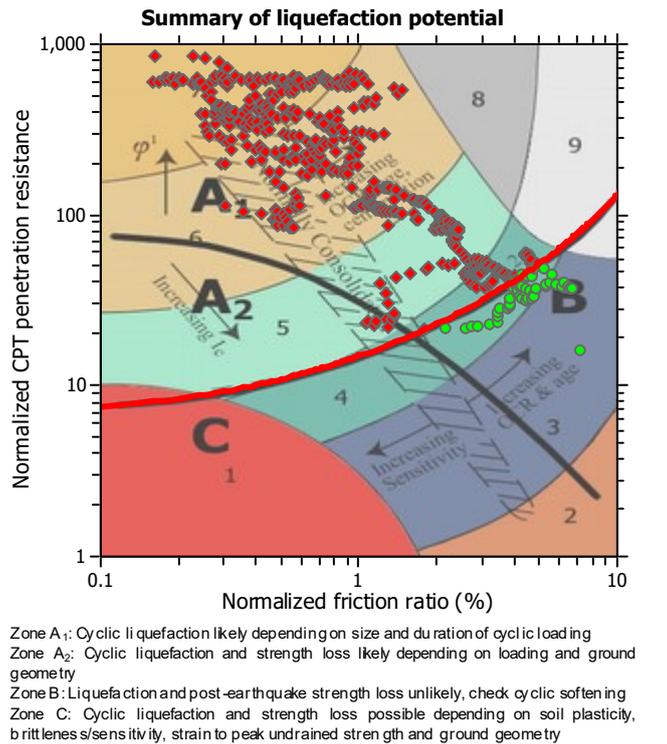
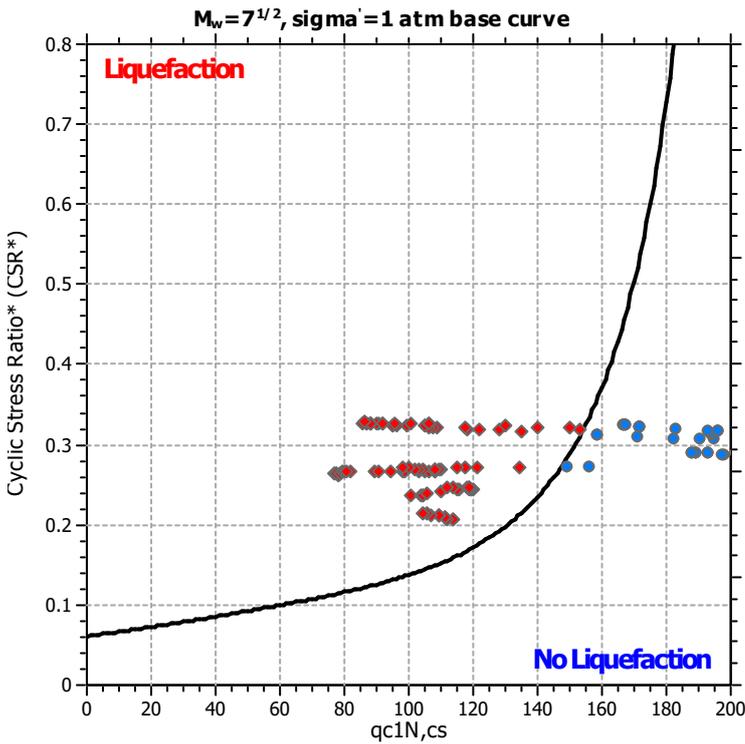
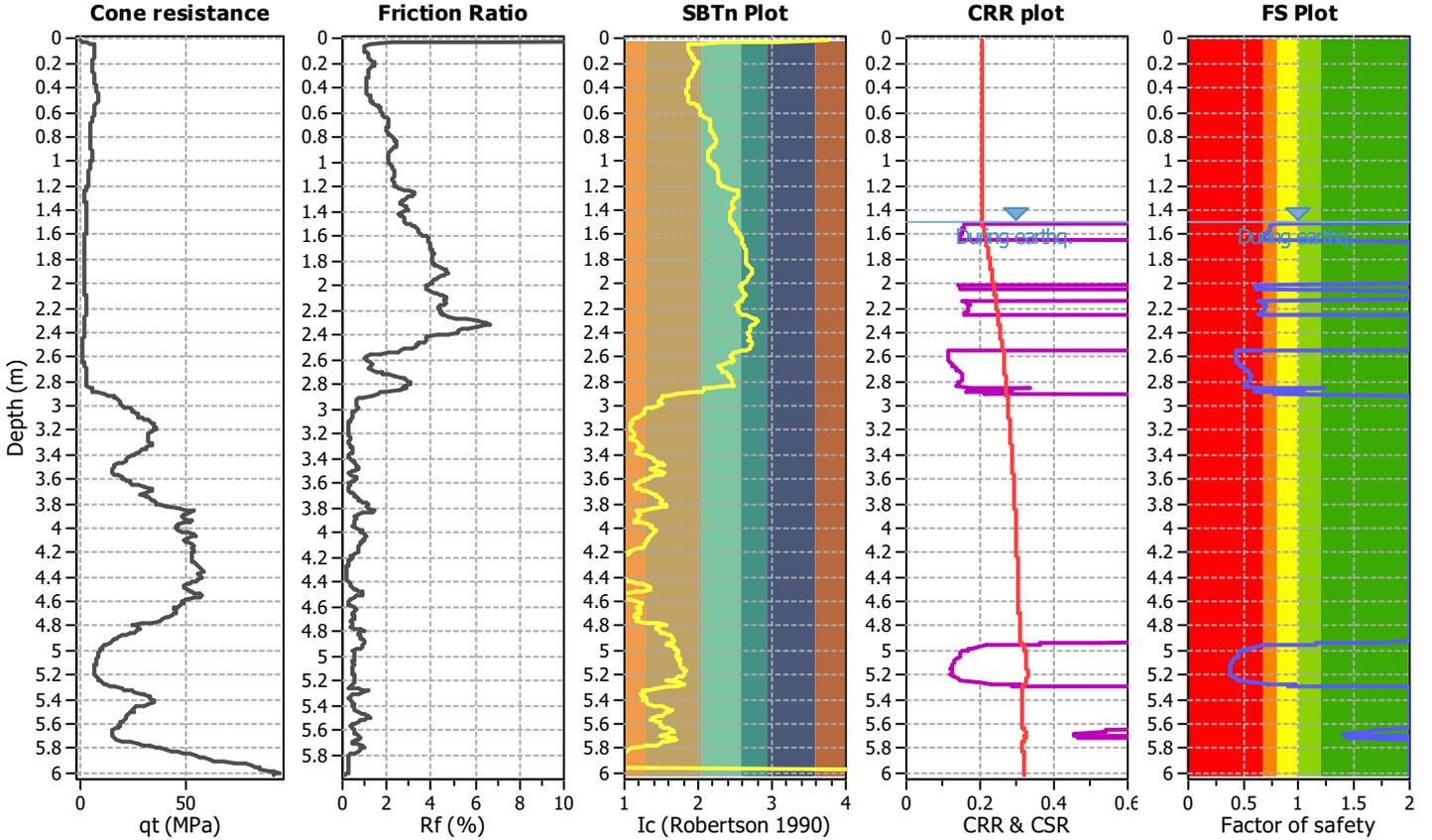
**Project title : K210318**

**Location : 232 Styx Mill Road, Casebrook, Christchurch**

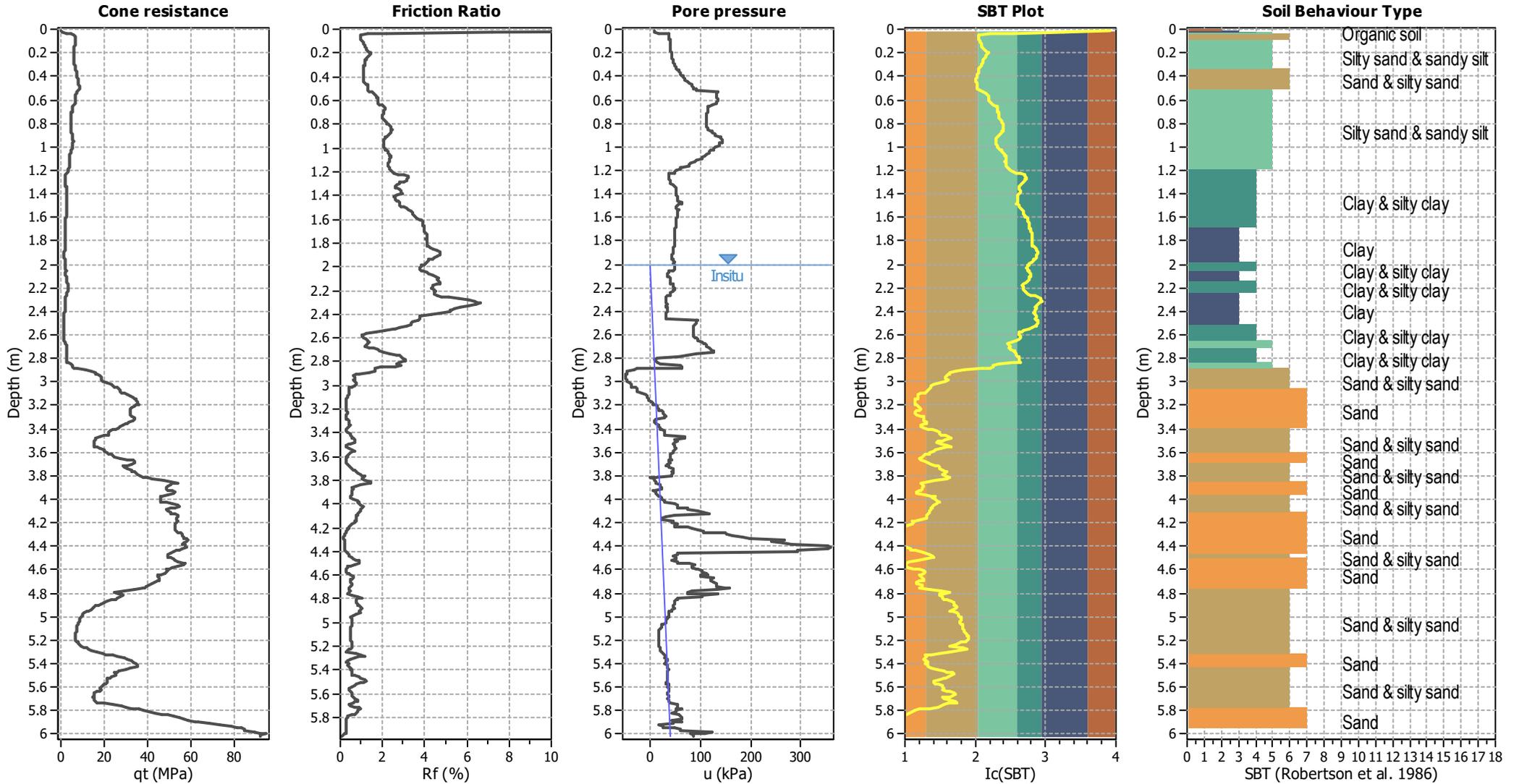
**CPT file : CPT-10 ULS**

**Input parameters and analysis data**

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Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.50 m	Fill height:	N/A	applied:	Sands only
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.35	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes	MSF method:	Method based



### CPT basic interpretation plots



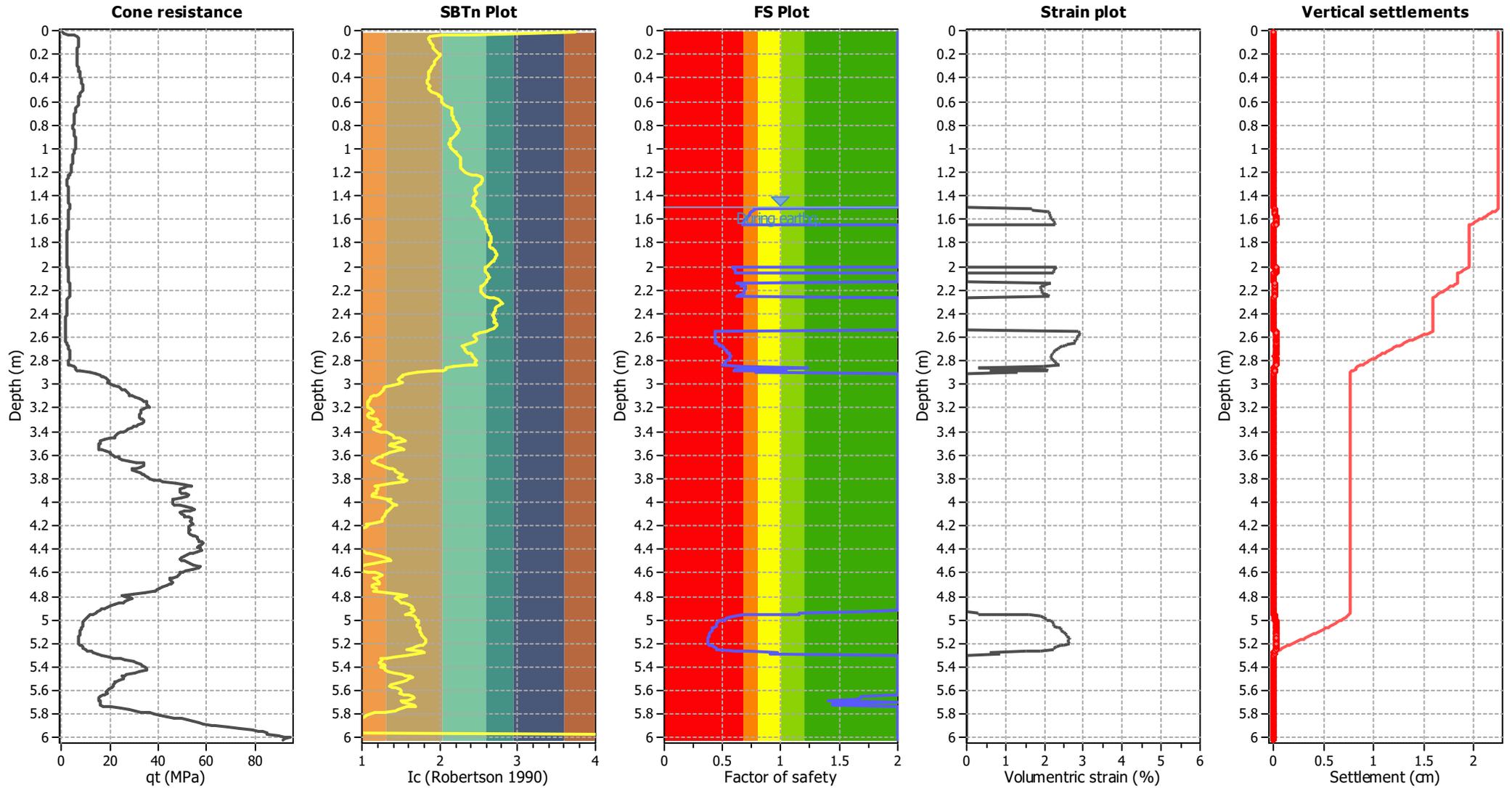
#### Input parameters and analysis data

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Points to test:	Based on Ic value	Ic cut-off value:	2.60	$K_v$ applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

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

**LIQUEFACTION ANALYSIS REPORT**

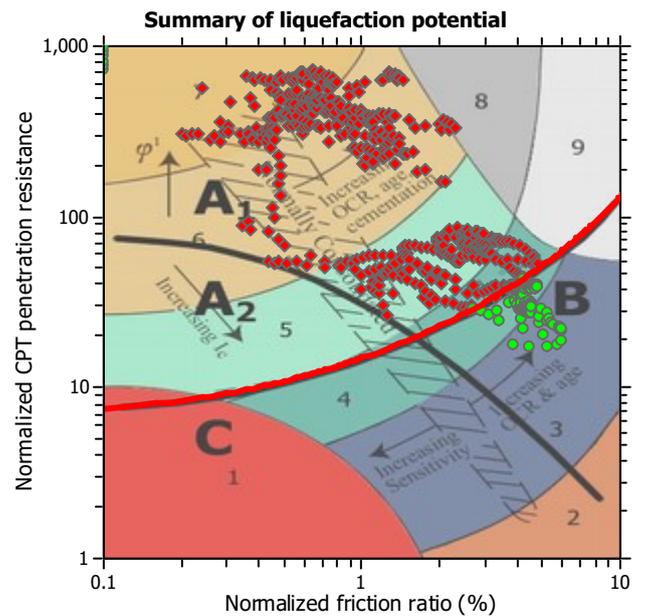
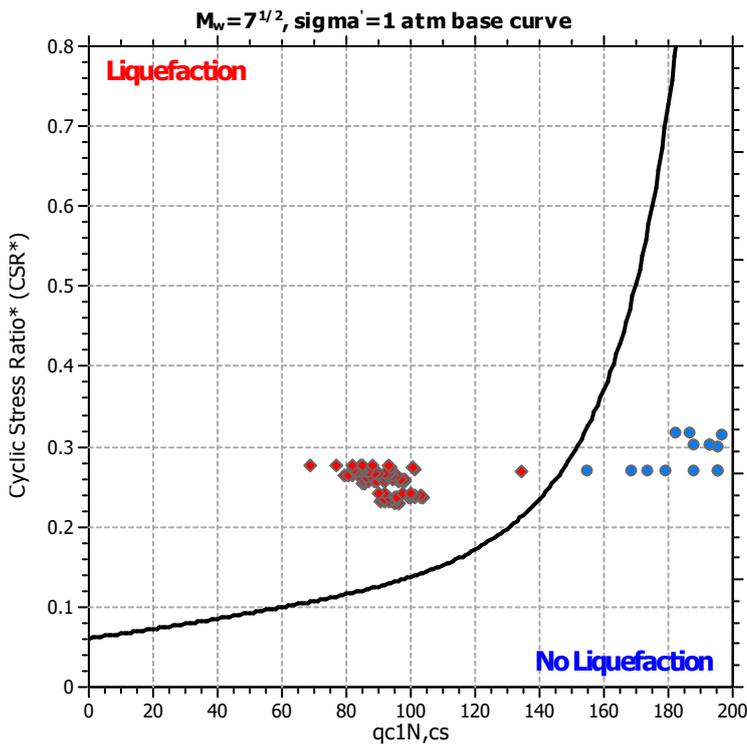
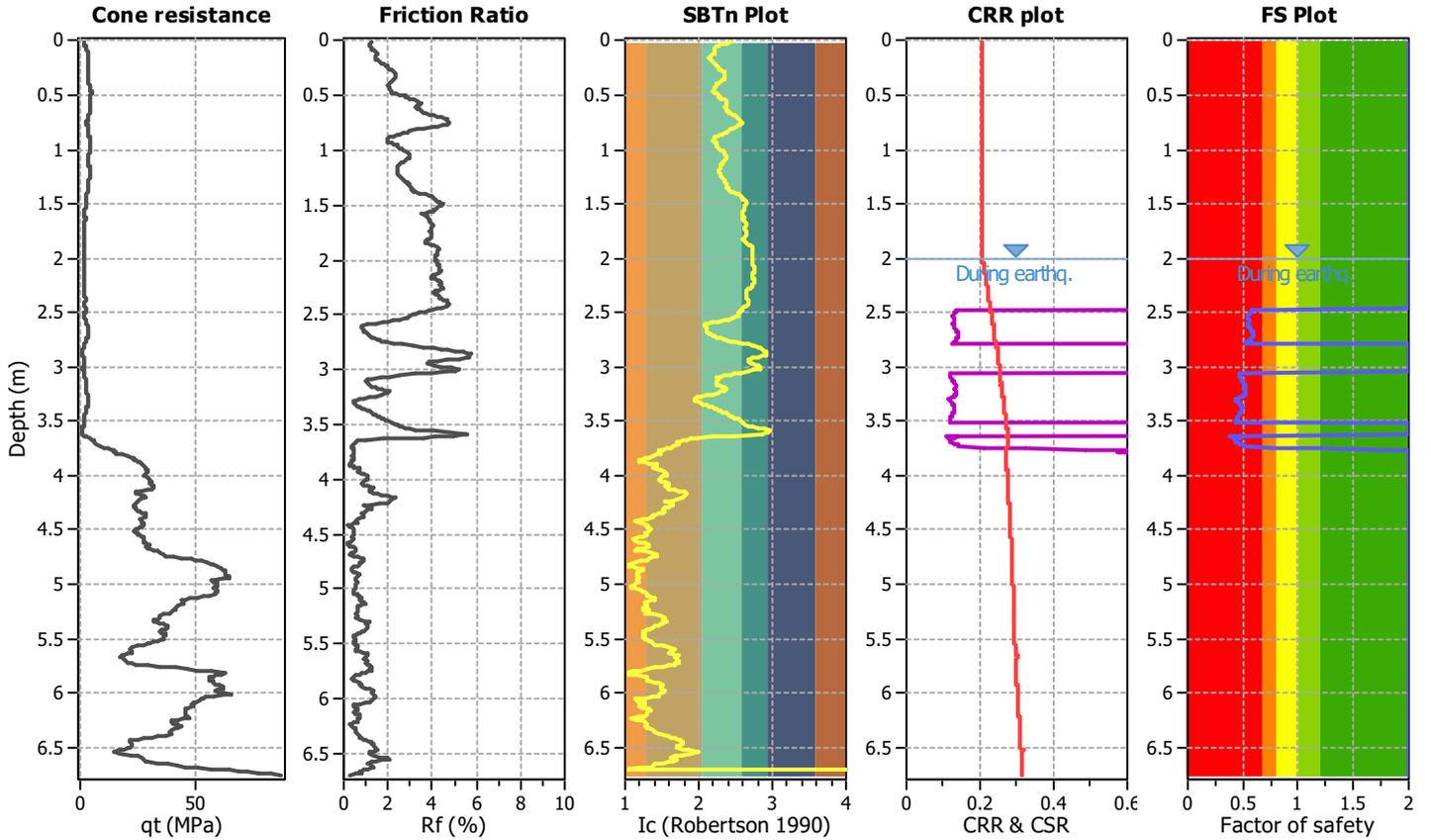
**Project title : K210318**

**Location : 232 Styx Mill Road, Casebrook, Christchurch**

**CPT file : CPT-11 ULS**

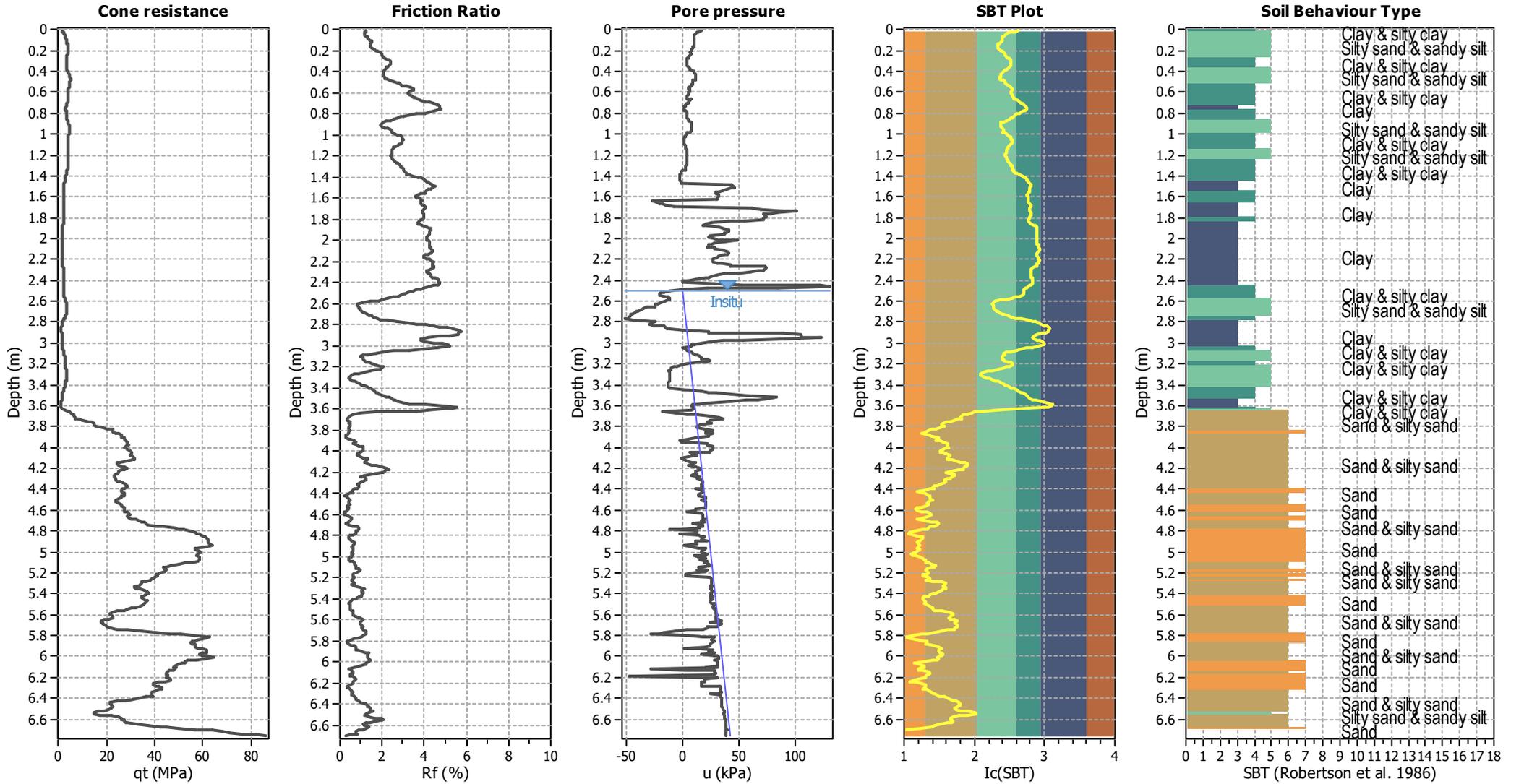
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Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.35	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes		



Zone A<sub>1</sub>: Cyclic liquefaction likely depending on size and duration of cyclic loading  
 Zone A<sub>2</sub>: Cyclic liquefaction and strength loss likely depending on loading and ground geometry  
 Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening  
 Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

### CPT basic interpretation plots



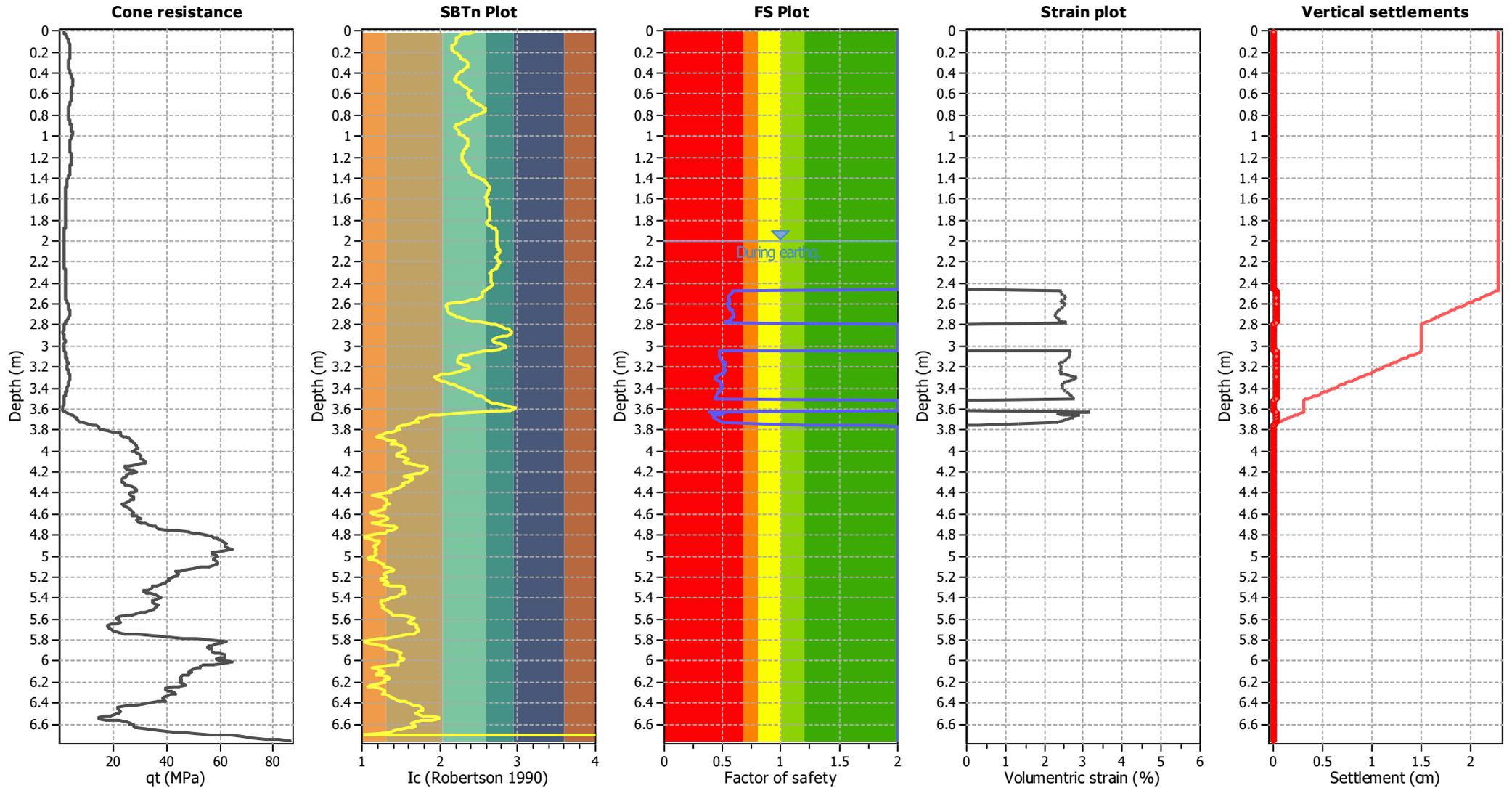
#### Input parameters and analysis data

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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	$K_v$ applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements



**Abbreviations**

- qt: Total cone resistance (cone resistance q<sub>c</sub> corrected for pore water effects)
- I<sub>c</sub>: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

**LIQUEFACTION ANALYSIS REPORT**

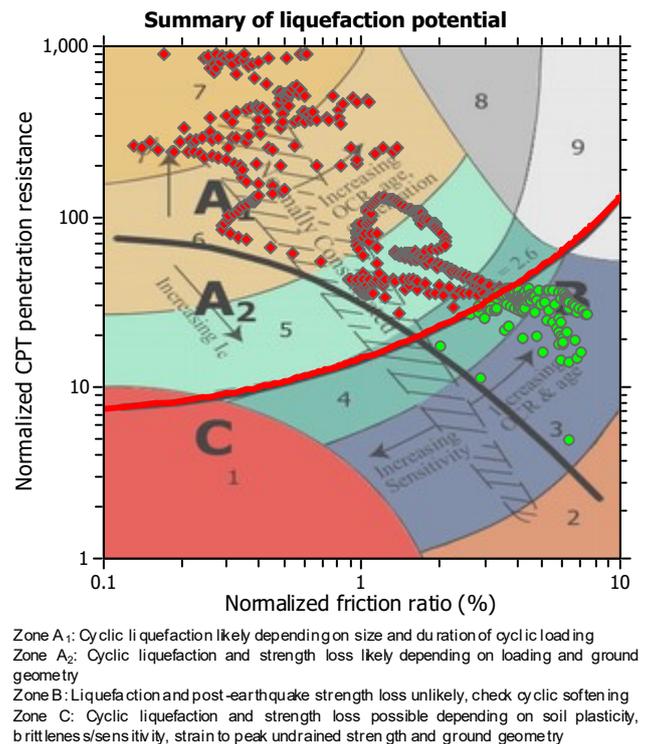
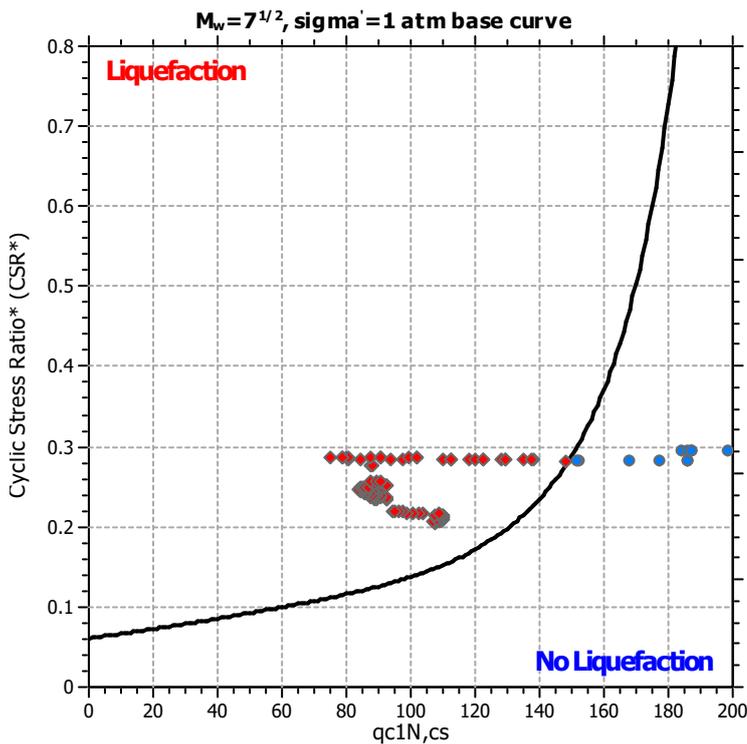
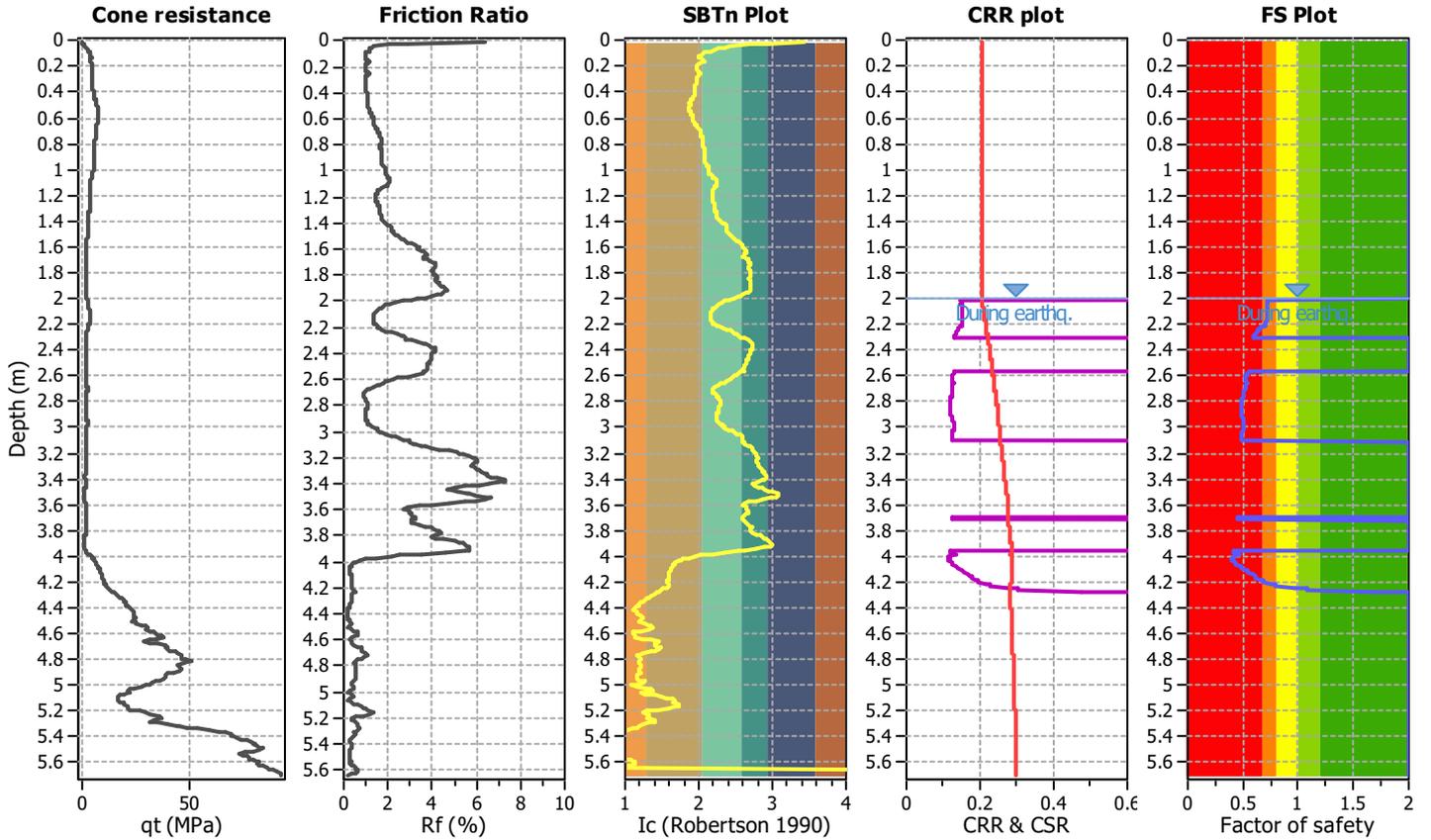
**Project title : K210318**

**Location : 232 Styx Mill Road, Casebrook, Christchurch**

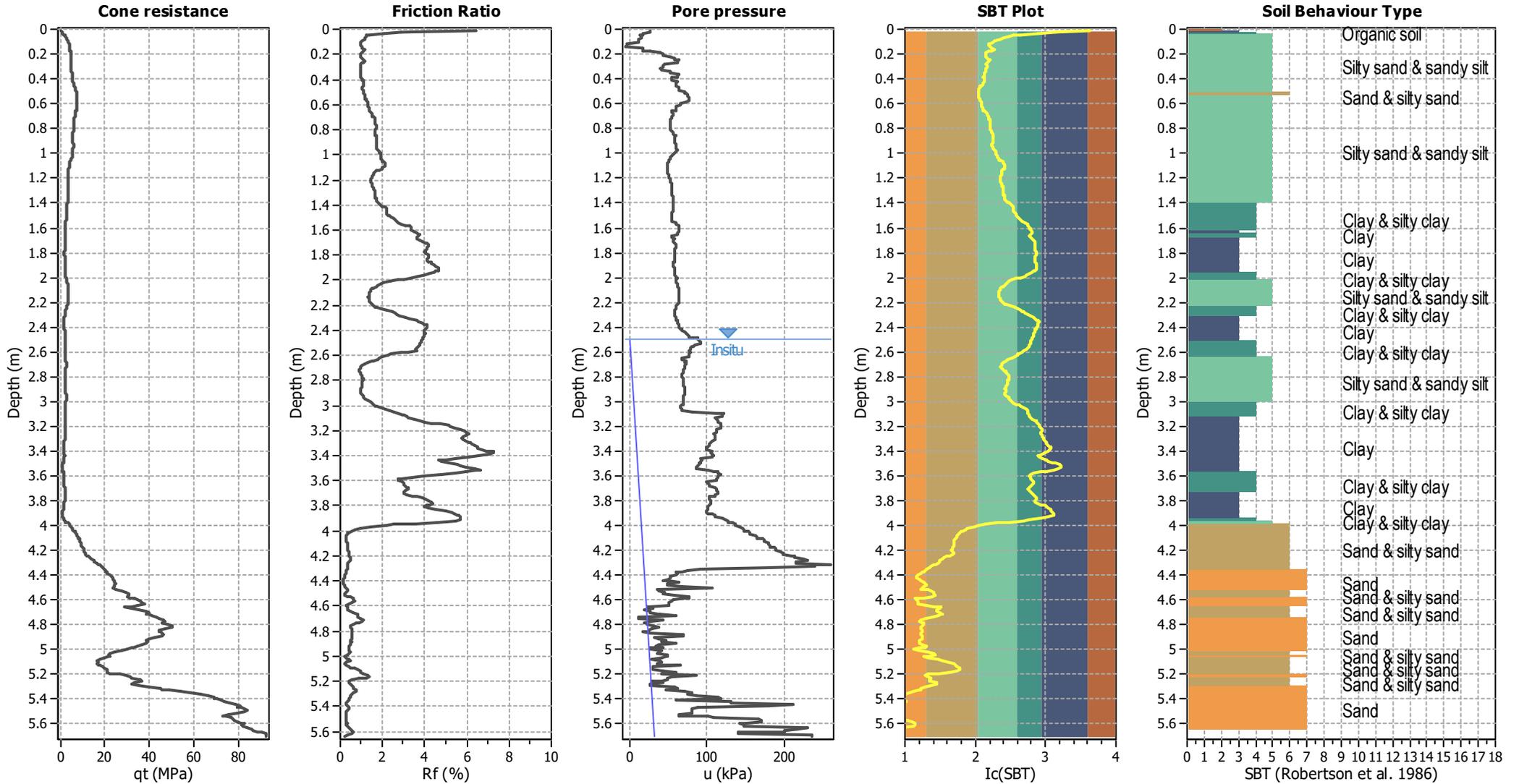
**CPT file : CPT-12 ULS**

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Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.00 m	Fill height:	N/A	applied:	Sands only
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.35	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes	MSF method:	Method based



### CPT basic interpretation plots



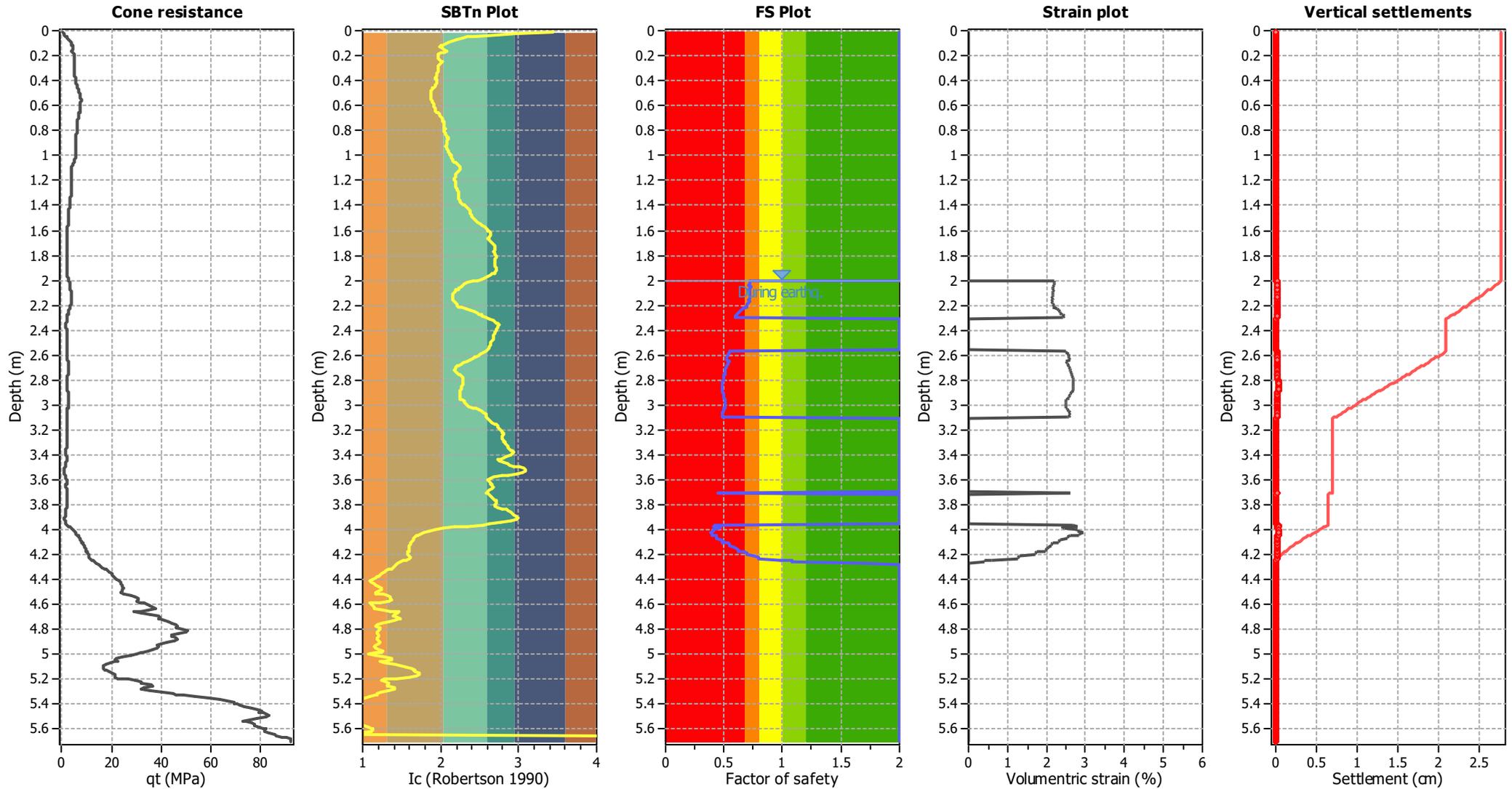
#### Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.00 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	$K_v$ applied:	Yes
Earthquake magnitude $M_w$ :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.50 m	Fill height:	N/A	Limit depth:	N/A

#### SBT legend

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

### Estimation of post-earthquake settlements

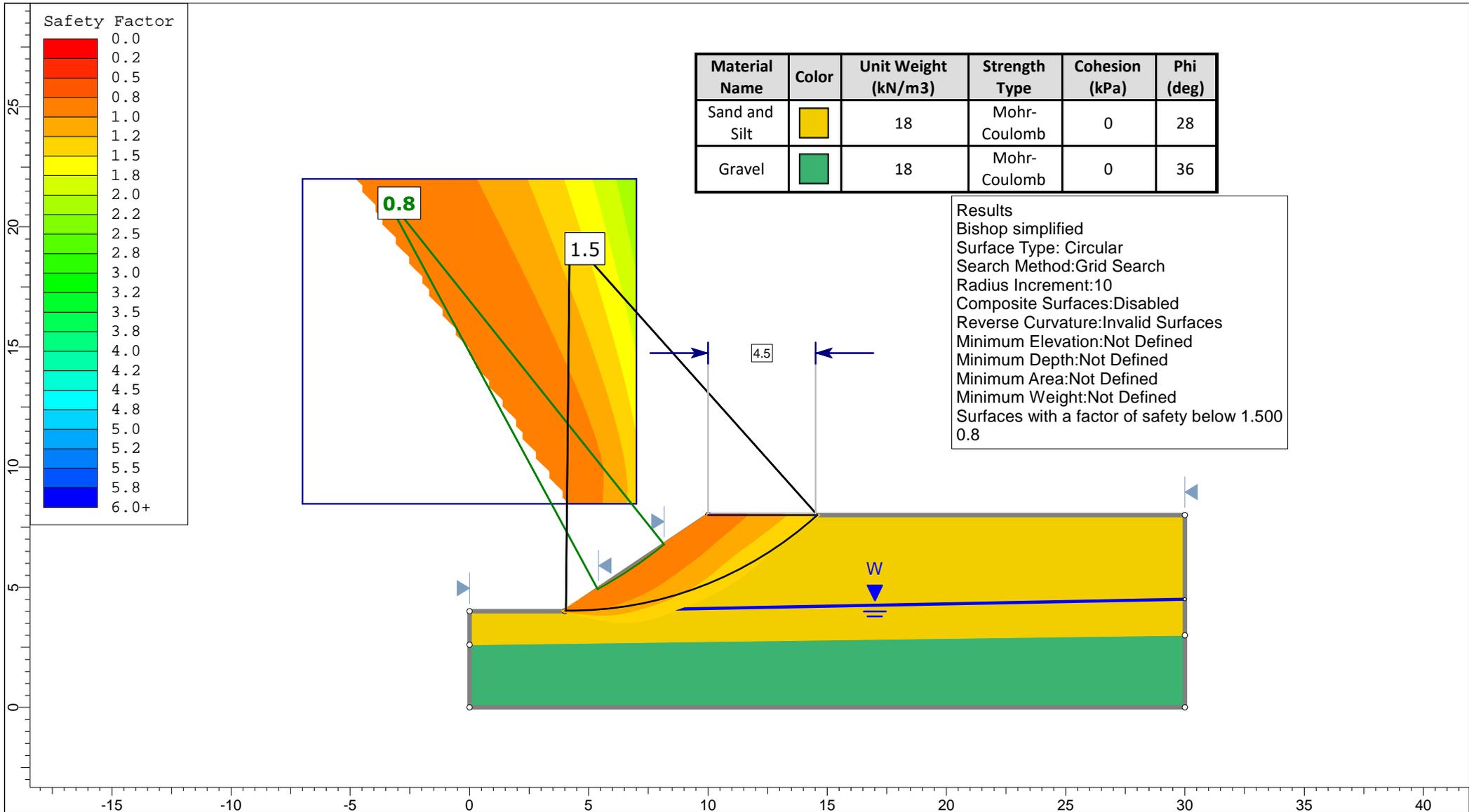


**Abbreviations**

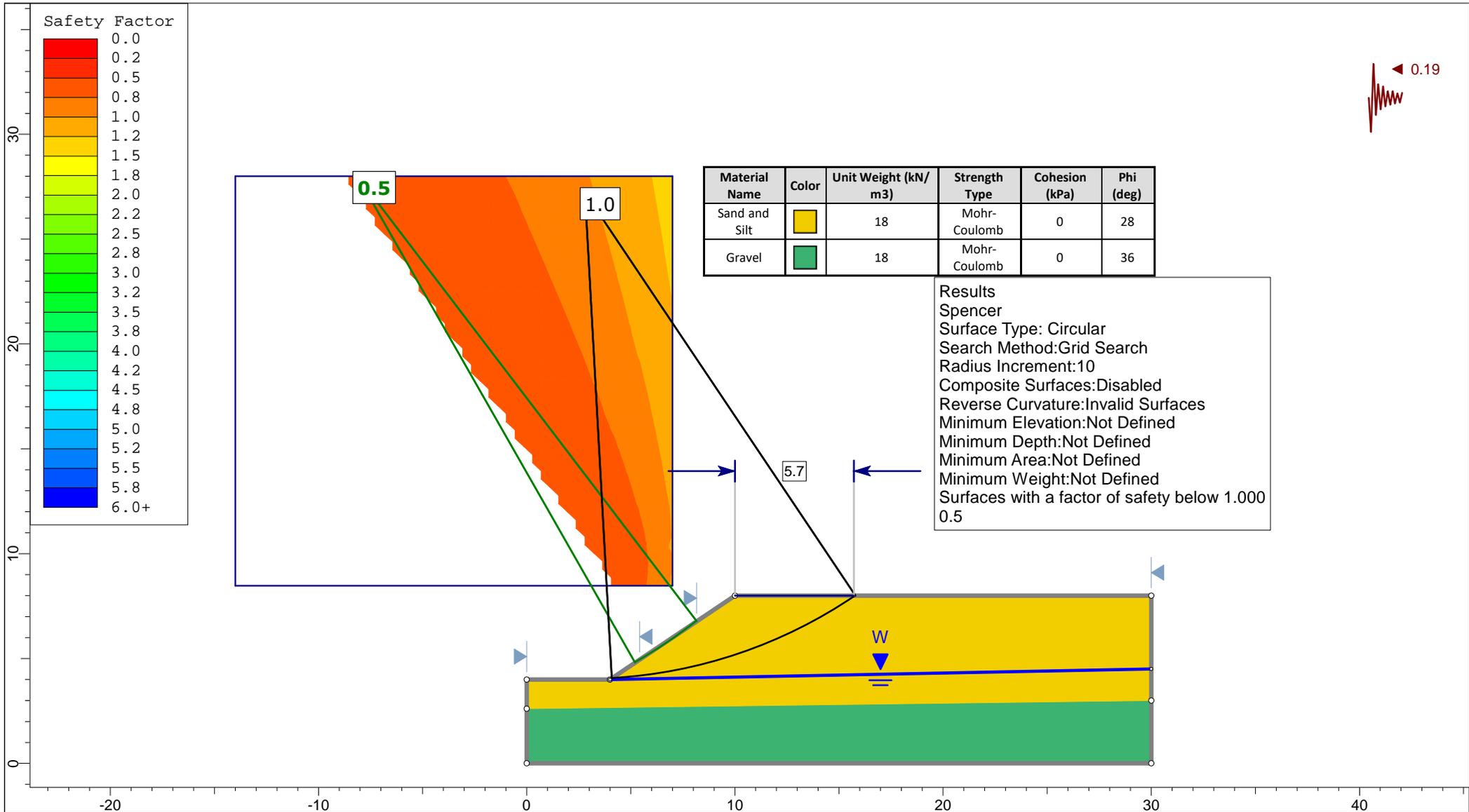
- $q_t$ : Total cone resistance (cone resistance  $q_c$  corrected for pore water effects)
- $I_c$ : Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

## **APPENDIX E**

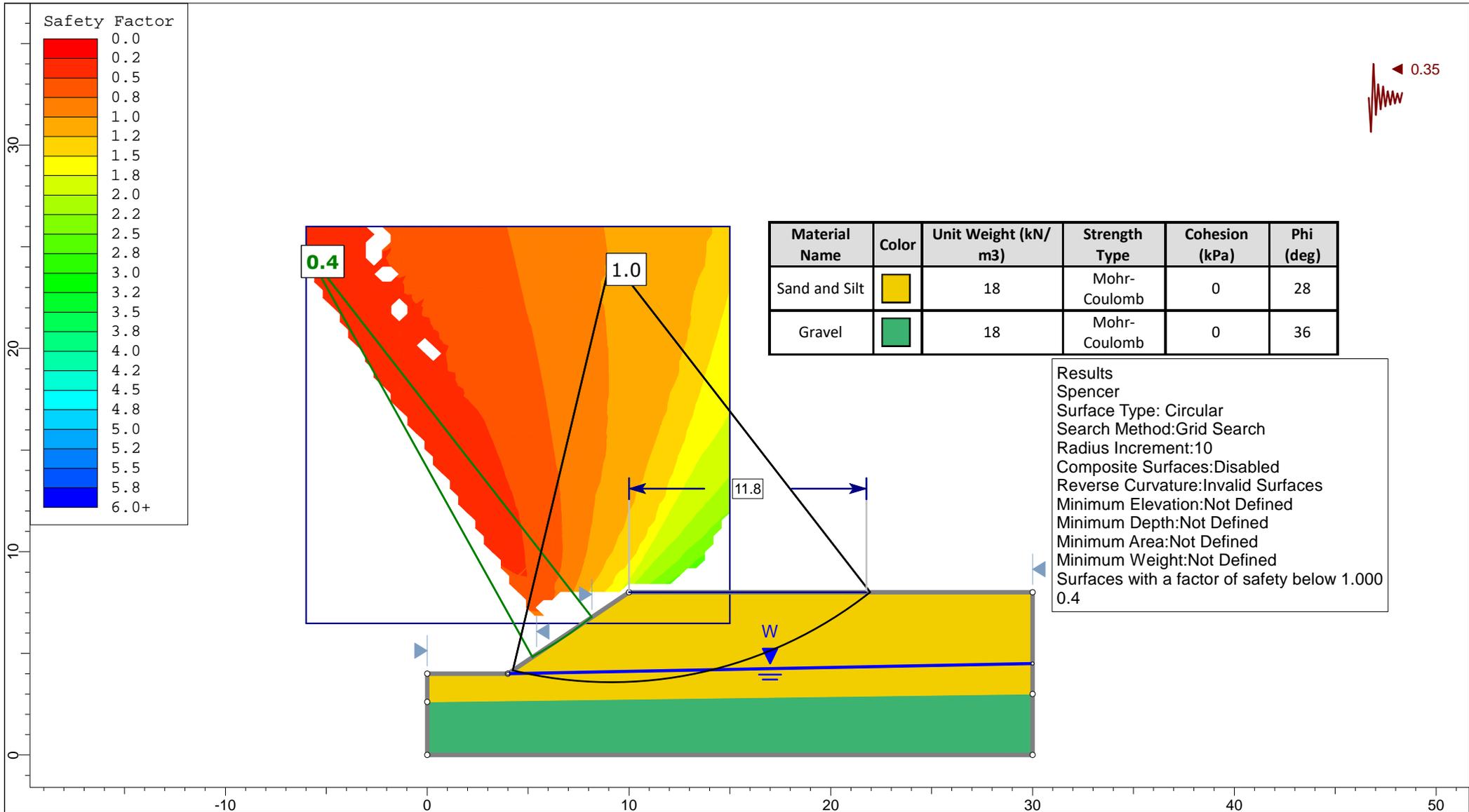
### **Slope Stability and Lateral Spreading Potential Assessment**



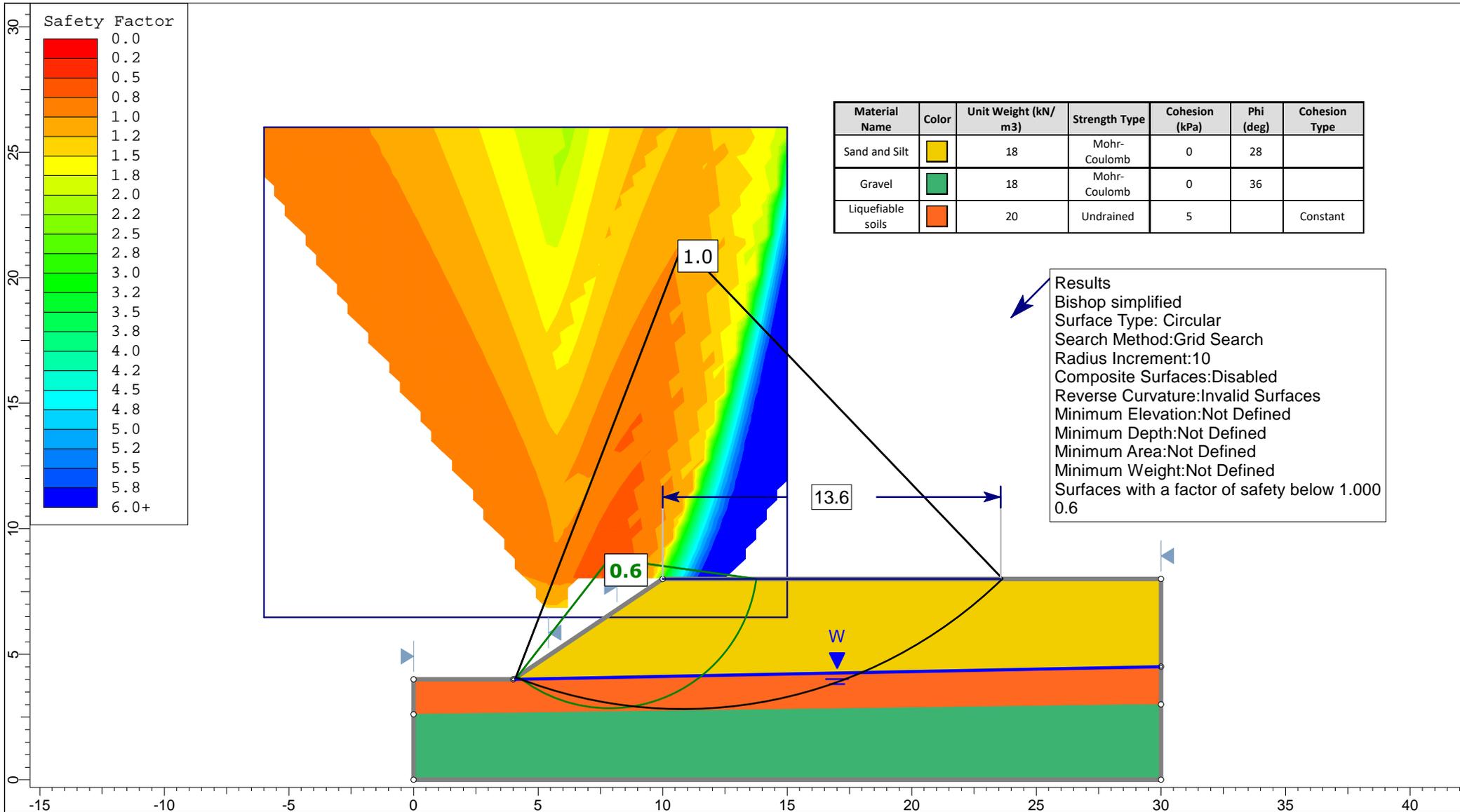
 <p>Auckland   Christchurch 09 478 6655   03 343 5302 www.kga.co.nz</p>	Project			K210318 - 232 Styx Mill Road, Casebrook			
	Analysis Description			Static - Circular - Measured Groundwater			
	Drawn By			TV		Company	KGA Geotechnical
	Date			27/05/2021		File Name	Actual Static.slmd



<p>Auckland   Christchurch 09 478 6655   03 343 5302 www.kga.co.nz</p>	<i>Project</i>		K210318 - 232 Styx Mill Road, Casebrook	
	<i>Analysis Description</i>		Seismic SLS - Circular - Measured Groundwater	
	<i>Drawn By</i>	TV	<i>Company</i>	KGA Geotechnical
	<i>Date</i>	27/05/2021	<i>File Name</i>	Seismic SLS.slmd



<p>Auckland   Christchurch 09 478 6655   03 343 5302 www.kga.co.nz</p>	Project		K210318 - 232 Styx Mill Road, Casebrook	
	Analysis Description		Seismic ULS - Circular - Measured Groundwater	
	Drawn By	TV	Company	KGA Geotechnical
	Date	27/05/2021	File Name	Seismic ULS.slmd

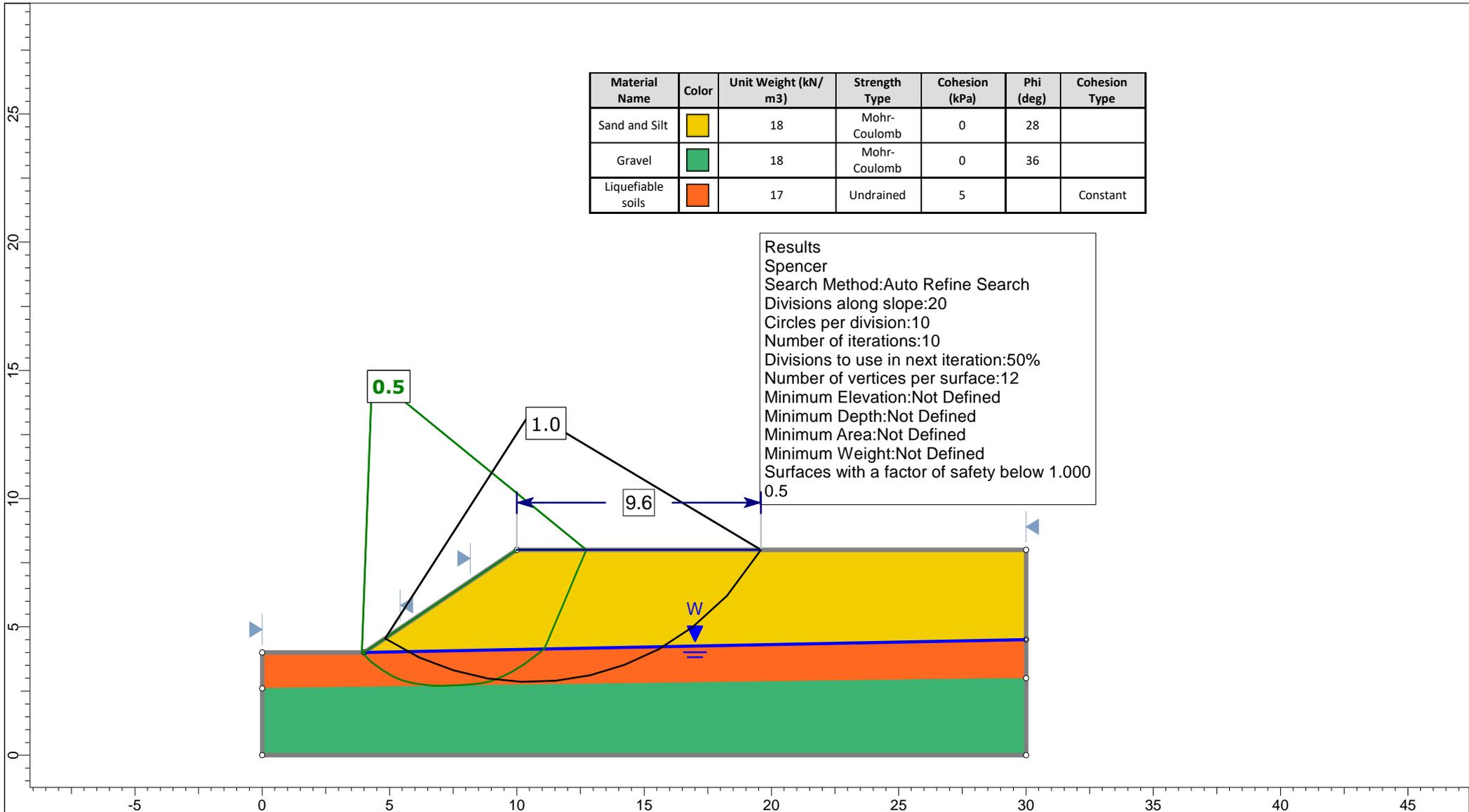


Material Name	Color	Unit Weight (kN/m <sup>3</sup> )	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type
Sand and Silt	Yellow	18	Mohr-Coulomb	0	28	
Gravel	Green	18	Mohr-Coulomb	0	36	
Liquefiable soils	Orange	20	Undrained	5		Constant

Results  
 Bishop simplified  
 Surface Type: Circular  
 Search Method: Grid Search  
 Radius Increment: 10  
 Composite Surfaces: Disabled  
 Reverse Curvature: Invalid Surfaces  
 Minimum Elevation: Not Defined  
 Minimum Depth: Not Defined  
 Minimum Area: Not Defined  
 Minimum Weight: Not Defined  
 Surfaces with a factor of safety below 1.000  
 0.6

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 09 478 6655 | 03 343 5302  
 www.kga.co.nz

Project	K210318 - 232 Styx Mill Road, Casebrook		
Analysis Description	Post Seismic - Circular - Measured Groundwater		
Drawn By	TV	Company	KGA Geotechnical
Date	28/05/2021	File Name	Post Seismic.slmd



Material Name	Color	Unit Weight (kN/m <sup>3</sup> )	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type
Sand and Silt	Yellow	18	Mohr-Coulomb	0	28	
Gravel	Green	18	Mohr-Coulomb	0	36	
Liquefiable soils	Orange	17	Undrained	5		Constant

Results  
 Spencer  
 Search Method:Auto Refine Search  
 Divisions along slope:20  
 Circles per division:10  
 Number of iterations:10  
 Divisions to use in next iteration:50%  
 Number of vertices per surface:12  
 Minimum Elevation:Not Defined  
 Minimum Depth:Not Defined  
 Minimum Area:Not Defined  
 Minimum Weight:Not Defined  
 Surfaces with a factor of safety below 1.000  
 0.5

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 www.kga.co.nz

Project	K210318 - 232 Styx Mill Road, Casebrook		
Analysis Description	Post Seismic - Non-Circular - Measured Groundwater		
Drawn By	TV	Company	KGA Geotechnical
Date	28/05/2021	File Name	Post Seismic Non-circular.slmd



## **APPENDIX D**

### Statement of Professional Opinion (SOPO)

# Statement of Professional Opinion on the Suitability of Land for Subdivision

(Appendix I to the Infrastructure Design Standard)

---

Issued by: *KGA Geotechnical Group Limited*  
(*Geotechnical engineering firm or suitably qualified engineer*)

To: *Davie Lovell-Smith*  
(*Owner/Developer*)

To be supplied to: *Christchurch City Council*  
(*Territorial authority*)

In respect of: *Land Subdivision*  
(*Description of proposed infrastructure/land development*)

At: *232 Styx Mill Road, Casebrook, Christchurch*  
(*Address*)

---

I (*Geotechnical engineer*) *R. Kamuhangire* on behalf of (*Geotechnical engineering firm*) *KGA Geotechnical Group Limited*

hereby confirm:

1. I am a suitably qualified and experienced geotechnical engineer and was retained by the owner/developer as the geotechnical engineer on the above proposed development.
2. My/the geotechnical assessment report, dated *2 June 2021* has been carried out in accordance with the Department of Building and Housing *Guidelines for geotechnical investigation and assessment of subdivisions* and includes:
  - (i) Details of and the results of my/the site investigations.
  - (ii) A liquefaction assessment.
  - (iii) An assessment of rockfall and slippage, including hazards resulting from seismic activity.
  - (iv) An assessment of the slope stability and ground bearing capacity confirming the location and appropriateness of building sites.
  - (v) Recommendations proposing measures to avoid, remedy or mitigate any potential hazards on the land subject to the application, in accordance with the provisions of Section 106 of the Resource Management Act 1991.

3. In my professional opinion, I consider that Council is justified in granting consent incorporating the following conditions:

*Following recommendations described in Section 11 and Table 8 of the KGA Geotechnical Report K210318-1, dated 2 June 2021.*

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

5. This certificate shall be read in conjunction with my/the geotechnical report referred to in Clause 2 above, and shall not be copied or reproduced except in conjunction with the full geotechnical completion report.
6. The geotechnical engineering firm issuing this statement holds a current policy of professional indemnity insurance of no less than \$ 2M  
(Minimum amount of insurance shall be commensurate with the current amounts recommended by IPENZ, ACENZ, TNZ, INGENIUM.)



*(Signature of Engineer)*

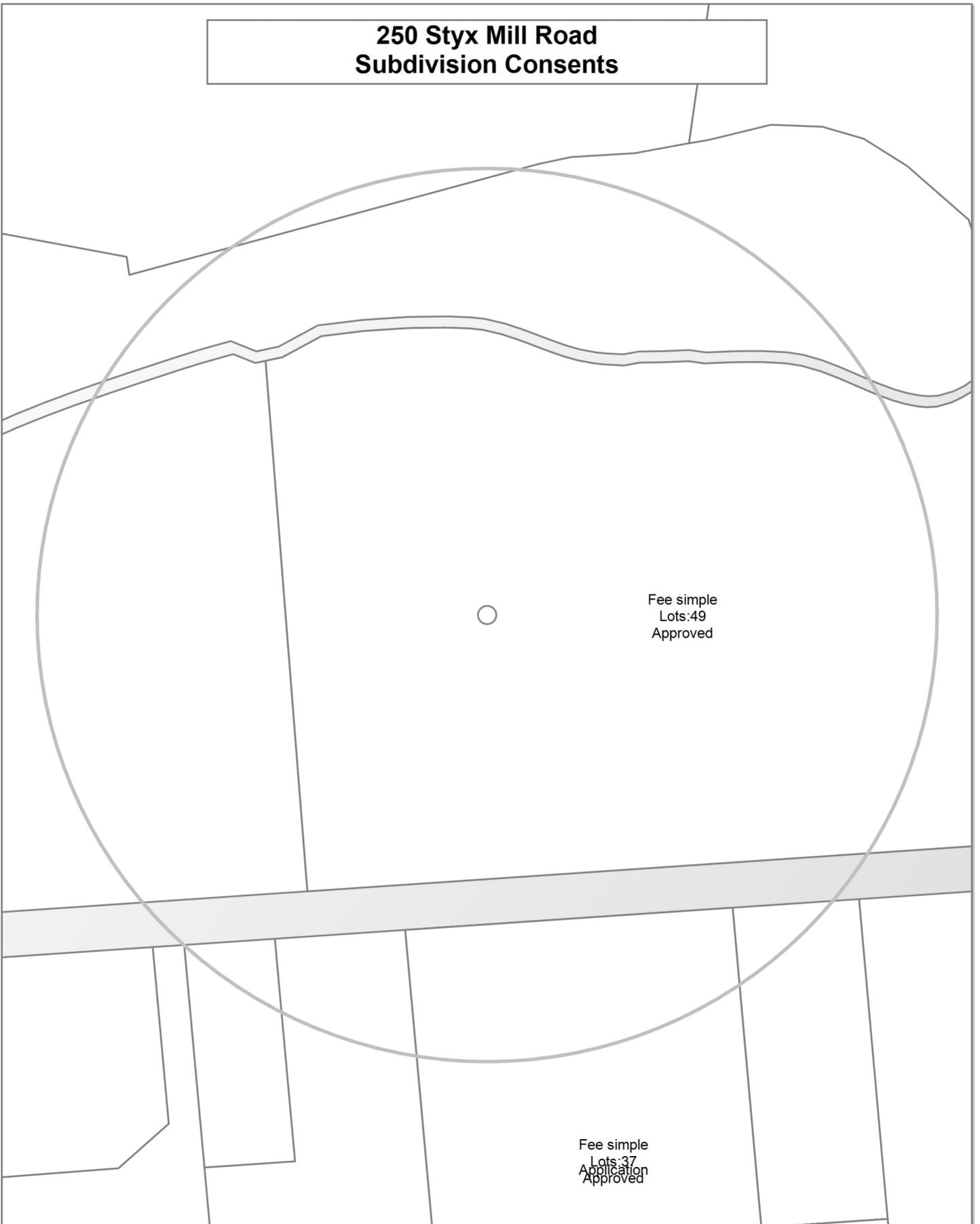
Date: 2 June 2021

Qualifications and experience: *BSc (Civil Hons), MSc, CEng, MICE, CMEngNZ, CPEng*

**250 Styx Mill Road  
Land Use Consents**



**250 Styx Mill Road  
Subdivision Consents**



## Land Use Resource Consents within 200 metres of 250 Styx Mill Road

Note: This list does not include subdivision Consents and Certificates of Compliance issued under the Resource Management Act.

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### 232 Styx Mill Road

RMA/2002/1080

To erect future dwellings on Lots 1, 2, 5 & 6 and to maintain the existing dwelling on Lot 4 under the rules of Rural H of the Waimairi Transitional Plan. - Historical Reference RMA20010071

Processing complete

Applied 13/05/2002

Decision issued 22/05/2002

Granted 22/05/2002

RMA/2021/3027

Subdivision - Fee simple - 49 lots with land use Also see Global Consent RMA/2021/3028

Consent issued

Applied 10/09/2021

Decision issued 13/01/2022

Granted 13/01/2022

RMA/2021/3028

Global Consent - to excavate within 5 metres of a street tree Also see SUB application RMA/2021/3027

Processing complete

Applied 10/09/2021

Decision issued 13/01/2022

Granted 12/01/2022

### 249 Styx Mill Road

RMA/1999/1921

Keeping of pigs to recycle by-products - Historical Reference RES990506

Withdrawn

Applied 19/02/1999

### 251 Styx Mill Road

RMA/1986/107

Conditional use and works contrary consent sought to erect a dwelling and use shed for a home occupation in the rural H zone. - cyanide manufacture. - Historical Reference RES9202324

Processing complete

Applied 24/11/1986

Decision issued 05/03/1987

Declined 05/03/1987

RMA/1986/108

Conditional use and works contrary consents sought to erect a dwelling in a rural H zone. - Historical Reference RES9202327

Processing complete

Applied 18/11/1986

Decision issued 05/02/1987

Granted 05/02/1987

RMA/1987/102

Specified departure and works contrary consents sought to use an existing shed for the mixing of cyanide Jelly as a home occupation in the rural H zone. 4 objection. - Historical Reference RES9202301

Processing complete

Applied 16/12/1987

Decision issued 05/05/1988

Granted 05/05/1988

RMA/1987/103

Dispensation sought to build dwelling with the roof line over the first floor area being one metre over the required height of eight metres. - Historical Reference RES9202311

Processing complete

Applied 27/10/1987

Decision issued 03/11/1987

Granted 03/11/1987

RMA/1987/104

Conditional use and works contrary consents sought to erect a dwelling in conjunction with deer farming. - Historical Reference RES9202314

Processing complete

Applied 15/06/1987

Decision issued 06/08/1987

Granted 06/08/1987

RMA/2021/1571

Global consent for earthworks within 5 metres of a street tree

Consent issued

Applied 28/05/2021

Decision issued 03/08/2021

Granted 03/08/2021

RMA/2021/4004

Proposed removal of three street trees to enable Styx Mill Road to be widened

Processing complete

Applied 29/11/2021

Decision issued 11/02/2022

Granted 11/02/2022

RMA/2021/708

Subdivision - Fee simple - 37 lots with land use

Consent issued

Applied 22/03/2021

Decision issued 03/08/2021

Granted 03/08/2021

## **281 Styx Mill Road**

RMA/1981/85

Conditional use consent sought to erect a dwelling in a rural H zone. 1 objection. - Historical Reference RES9202330

Processing complete

Applied 16/02/1981

Decision issued 20/05/1981

Granted 20/05/1981

## **303 Styx Mill Road**

RMA/2018/1280

Minimum Floor Level Certificate

Processing complete

Applied 29/05/2018

Certificate issued 29/05/2018

RMA/2019/2999

To construct a single storey residential dwelling with attached double garage

Processing complete

Applied 20/12/2019

Decision issued 21/02/2020

Granted 20/02/2020

## **330 Styx Mill Road**

RMA/1999/3589

To erect a sign advertising on site refer to RC992555, RC992622 RC992623 - Historical Reference RES992624

Withdrawn

Applied 13/09/1999

RMA/2002/1080

To erect future dwellings on Lots 1, 2, 5 & 6 and to maintain the existing dwelling on Lot 4 under the rules of Rural H of the Waimairi Transitional Plan. - Historical Reference RMA20010071

Processing complete

Applied 13/05/2002

Decision issued 22/05/2002

Granted 22/05/2002

## 60 Hussey Road

RMA/1975/184

Dispensation to resite a classroom to this address for use as bedrooms attached to existing dwelling - Historical Reference RES9211714

Processing complete

Applied 01/05/1975

Decision issued 01/05/1975

Granted 01/05/1975

RMA/1978/270

Specified departure to subdivide rural land for extensions to wildlife reserve including Zoological Garden, the provision of off-street parking, staff dwellings and other ancillary uses. 1 Objection. - Historical Reference RES9211709

Processing complete

Applied 06/07/1978

Decision issued 09/10/1978

Granted 09/10/1978

RMA/1987/562

Dispensation to erect two remote signs as on accompanying site plans. - Historical Reference RES9211713

Processing complete

Applied 15/12/1987

Decision issued 10/05/1988

Granted 10/05/1988

RMA/2006/2670

site coverage non compliance - Historical Reference RMA92006772

Processing complete

Applied 06/11/2006

Decision issued 30/11/2006

Granted 29/11/2006

RMA/2009/1533

Additions to existing dwelling - Historical Reference RMA92015009

Processing complete

Applied 14/10/2009

Decision issued 03/11/2009

Granted 03/11/2009

RMA/2011/1436

NEW BARN AT WILLOWBANK WILDLIFE RESERVE - Historical Reference RMA92019005

Processing complete

Applied 26/10/2011

Decision issued 23/11/2011

Granted 23/11/2011

RMA/2013/300

Construct a new toilet block for the Willowbank Wildlife Reserve - Historical Reference RMA92021890

Processing complete

Applied 25/02/2013

Decision issued 06/03/2013

Granted 06/03/2013

RMA/2018/2623

To use an existing barn on site for conferences and functions

Processing complete

Applied 29/10/2018

Decision issued 13/05/2019

Granted 13/05/2019

## Data Quality Statement

### Land Use Consents

All resource consents are shown for sites that have been labelled with an address. For sites that have been labelled with a cross (+) no resource consents have been found. Sites that have no label have not been checked for resource consents. This will be particularly noticeable on the margins of the search radius. If there are such sites and you would like them included in the check, please ask for the LIM spatial query to be rerun accordingly. This will be done free of charge although there may be a short delay. Resource consents which are on land occupied by roads, railways or rivers are not, and currently cannot be displayed, either on the map or in the list. Resource consents that relate to land that has since been subdivided, will be shown in the list, but not on the map. They will be under the address of the land as it was at the time the resource consent was applied for. Resource consents that are listed as Non-notified and are current, may in fact be notified resource consents that have not yet been through the notification process. If in doubt. Please phone (03)941 8999.

The term "resource consents" in this context means land use consents. Subdivision consents and certificates of compliance are excluded.

### Subdivision Consents

All subdivision consents are shown for the sites that have been labelled with consent details. For Sites that have been labelled with a cross (+) no records have been found. Sites that have no label have not been checked for subdivision consents. This will be particularly noticeable on the margins of the search radius. If there are such sites and you would like them included in the check, please ask for the LIM spatial query to be rerun accordingly. This will be done free of charge although there may be a short delay.

The term "subdivision consents" in this context means a resource consent application to subdivide land. Non subdivision land use resource consents and certificates of compliance are excluded.

This report will only record those subdivision applications which have not been completed i.e once a subdivision has been given effect to and the new lots/properties have been established the application which created those lots will not be shown

All subdivision consent information is contained on the map and no separate list is supplied