Geotechnical Assessment

Cashmere Oaks Drive, Masterton

RILEY

Geotechnical Assessment
Proposed Plan Change
Cashmere Oaks Drive, Masterton

Report prepared for: Welhom Developments Limited

Report prepared by: Rebecca Farrant, Geotechnical Engineer

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Report reviewed by: Chris Gilbert, Senior Geotechnical Engineer

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Report approved for issue by: Brett Black, Project Director, CPEng

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Report reference: 210422-E (Issue 2.0)

Date: 29 April 2022

Copies to: Welhom Developments Limited Electronic copy

Riley Consultants Ltd Electronic copy

Issue	Details	Date
1.0	Final	20 April 2022
2.0	Final (Revision)	29 April 2022

Contents

Appendices

Geotechnical Assessment
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1.0 Introduction

The following report has been prepared by Riley Consultants Ltd (Riley) at the request of Welhom Developments Limited. It presents the findings of a geotechnical investigation at the site, and includes comment on geology, geomorphology, natural hazards and considerations with respect to future development of the site. This report has been prepared to support a private plan change request to be submitted to Masterton District Council (MDC).

2.0 Summary

The site is generally considered suitable for residential development from a geotechnical perspective with the considerations summarised below:

- The site is underlain by alluvial deposits consisting of clayey silts within the near surface (up to approximately 1.0m below ground level (bgl)) layer which is underlain by silty gravels to depths greater than 15m bgl. Regional groundwater is understood to be between 0.9m and 1.2m bgl across the site.
- There is generally a low risk of instability given the flat nature of the site. The liquefaction susceptibility of the site has been assessed to be negligible based on analysis of cone penetrometer test (CPT) data and general characteristics of the soils.
- The underlaying materials generally provide favourable bearing capacity for future development to adopt shallow foundations.
- Earthworks are anticipated to be minor given the site profile, however, design of final levels across the site will need to consider the relatively significant topsoil layer across the site.
- Soakage is considered to be poor within the near surface clayey silt layer across the site, however, on-site soakage is achievable within the underlying gravel layers sing standard drainage design measures.
- Road pavements will require specific design and a preliminary testing considers a California bearing ratio (CBR) value between 3% and 5% is likely available.

3.0 Background

3.1 Site Description

The site is located on the northern outskirts of Masterton and includes the following lots:

- Lot 1 DP 69308
- Lot 3 DP 516269, Lot 36 DP 429991, Part Lot 9 DP 65445

The site has a total approximate area of 14.7ha. It is presently being subdivided into two lots of 10.4ha and 4.3ha, respectively (site). The lots are currently accessed from the end of Roger Renal Avenue. The site is zoned Rural (Primary Production) and consists of greenfield space which also borders the site to the north. The site is bordered by the rail corridor to the west and rural lifestyle properties to the east. The gradients across the site are predominantly flat to very gently sloping and from aerial imagery appears to be used as pastoral land.

It is proposed to change the zoning of the site from the current Rural (Primary Production) to Residential zoning with provision for a retirement village. We understand that the site may yield up to approximately 254 residential houses at current Residential Zone District Plan density standards. The intention of the assessments to support the rezoning is to provide certainty regarding key requirements for any future residential activity on the site.

3.2 Desktop Study

Information available from the infrastructure report prepared for the Cashmere Oaks Subdivision Stage 2, to the south of the site, indicated silty clayey deposits that graded to gravels at approximately 0.8m to 1.2m below the surface. Testing indicated groundwater levels were in the order of 0.9m below the surface and more favourable soakage was apparent within the gravel layers.

Existing information on the single structure to the east of the site shows it was relocated to the site circa 2006 and founded on a shallow foundation system.

Existing information available on the New Zealand Geotechnical Database (NZGD) from nearby investigations, indicated the presence of silty gravels between 0.6m and 1.5m depth. These were typically overlain by cohesive clayey silts. A summary of other geotechnical information is summarised further below.

3.3 Geology

Based on our knowledge of the immediate area and a review of IGNS Geological Map Sheet 11 'Wairarapa', the site is inferred to be underlain by Late Pleistocene-age alluvial deposits comprising of a mix of gravel, sand, and silt horizons. Holocene-age alluvium is noted along the Waipoua River channel approximately 500m to the west of the site.

4.0 Geotechnical Investigation

Riley has undertaken a subsurface investigation and testing on-site between 22 and 24 September 2021 and the 21 and 22 October 2021 which comprised the following:

- Two machine boreholes (BH1 and BH2) were drilled by ProDrill Ltd to depths of 15.2m, with supervision and logging by Riley. Standard penetration testing (SPT) was undertaken at 1.5m intervals within the machine boreholes to determine in-situ strength.
- Ten hand auger boreholes (HA1 to HA10) were drilled by Riley to depths between 0.7m and 1.4m bgl, where refusal was encountered. Where material encountered was primarily non-cohesive, Scala penetrometer (Scala) testing was undertaken to determine in-situ strength. Similarly, where material was cohesive in nature shear vane testing was undertaken.
- Seven Scala testing (SC01 to SC07) was extended from the surface to 1.0m bgl in order to estimate CBR values for pavement design.
- Six CPTs were carried out by ProDrill Ltd to depths between 1.3m and 1.5m bgl where refusal was encountered.
- Nine falling head soakage tests within HA3, HA5, HA9, BH2, and SP1 through SP5.

Results of all in-situ soil tests, together with detailed descriptions and depths of strata encountered during drilling of the boreholes are appended in the investigation logs. Test locations are presented on the site plan, Riley Dwg: 210422-2 (appended).

4.1 Summary of Ground Conditions

The subsoil conditions across the site consisted of a layer of topsoil (200mm to 300mm) generally underlain by a clayey silt layer that is between 0.7m and 1.3m thick. The clayey silts were generally of a stiff to very stiff consistency (65kPa to 126kPa) and were considered to have a low plasticity. Varying amounts of fine to course gravels were encountered within the clayey silt matrix from approximately 0.5m bgl.

Below the clayey silt layer, the material graded to gravels and cobbles that were infilled with silts as well as interbedded bands of finer gravelly silt material. The gravels were generally sub-rounded and graded from medium to course. This layer was generally very dense with Scala tests generally encountering effective refusal (three 10+ counts per 50mm of penetration) and SPTs with the machine holes encountered N-values of 50+. The layer was encountered through to the termination depth of the machine boreholes at 15.2m bgl.

Groundwater was generally encountered across the Site at a depth of approximately 0.8m to 0.9m bgl in the hand augered boreholes. Following completion of the machine boreholes, groundwater was measured at approximately 0.9m bgl, indicating this is likely the approximately level of the regional groundwater. Groundwater was not encountered in the hand augers on the southern portion of the site to a depth of 1.2m although given the ground levels across the site, groundwater is not expected to be significantly deeper than this depth. As previously outlined, similar groundwater levels were encountered in the investigation within the residential subdivision to the south.

5.0 Geotechnical Hazards

5.1 Stability and Settlement

The stiff nature of surficial clayey silt layer and the characteristics of the underlying silty gravel layer derived from in-situ testing, combined with the flat profile of the site, mean instability is unlikely.

The soils have low compressibility and are unlikely to result in significant static settlement under development surcharge loading. Specific considerations for building structures are outlined further in this report in Section 5.1.

5.2 Seismic Design Considerations

The structural design code requires buildings to be designed for two seismic criteria, Serviceability Limit State (SLS) and Ultimate Limit State (ULS). SLS considers a return period less than the structures design life and requires the designed structure to remain fit for its intended use in the event of an earthquake. ULS considers the highest reasonable return period for the structures use where the design is to ensure that life is protected in the event of a major earthquake.

The Ministry of Business, Innovation and employment (MBIE) and the New Zealand Geotechnical Society (NZGS) have recently reissued several modules for the guidelines titled Earthquake Geotechnical Engineering Practice.

The MBIE and NZGS Module 1 Guidelines provide interim recommendations for the derivation of ground motion parameters. The methods presented in this report are interim and the detailed design should account for these guidelines or the revised method.

Method 1 is used to derive the ground motion parameters. These are summarised in Table 1 for an importance Level 3 (IL3) and IL2 type structure.

Table 1: Seismicity Parameters used for Preliminary Liquefaction Analysis

Limit State	Return Period (years)	PGA (g)	M_w
ULS (IL3)	1000	0.91	7.7
SLS	25	0.13	6.5

5.3 Liquefaction

Liquefaction typically occurs in recent (i.e., typically less than 10,000-years old), normally consolidated silt and sand beneath the groundwater table. It is dependent on soil density, grain size, and soil composition. Liquefaction analysis was undertaken using the CPT data collected, seismic parameters in Table 1, and a groundwater level of 0.8m, which is considered to be appropriate for the site.

The method by Boulanger & Idriss 2014 has been used in assessing liquefaction settlement. Liquefaction analysis of the CPTs, using the parameters outlined in Table 1 with CLiq software, indicated that liquefaction induced settlements for both design earthquake scenarios are likely to be less than minor (<15mm) and are consistent with Technical Category 1 (TC1) levels of settlement as outlined in the Ministry of Business, Innovation and Employment Christchurch Earthquake Guidelines.

Note that the liquefaction analysis has only considered the near surface soil layer (up to approximately 1.4m bgl) due to refusal at the gravel layer. The in-situ tests indicate the gravel layer is generally dense to very dense and the infilled silt and clay material indicate there is low potential for liquefaction in this layer. Detailed CPT results and calculations are appended.

5.4 Faults

Based on information provided in the GNS New Zealand Geology Webmap, the Masterton Fault is approximately 1km south of the site with an east-to-west trajectory. The fault is known to be active with dextral movement (northern side of the fault effectively moving laterally to the east). As the fault does not pass in proximity of the site, it is not expected that significant differential ground movement will occur as a result of fault movement.

6.0 Site Development Suitability

6.1 Building Foundations

Shear strengths in the near surface soils indicate that there is suitable bearing capacity for one to two-storey timber structures to be founded on conventional shallow foundations designed in general accordance with NZS 3604:2011. A soil expansivity class of Class M (moderately reactive clays and silts) would be recommended with respect to AS 2870.

Therefore, subsurface material is suitable to facilitate structures consistent with those typically proposed within Residential zoning subject to future resource consent assessments and detailed design. Where structures fall outside the scope of NZS 3604 specific design will be required, however, subsurface conditions are favourable for shallow foundation designs.

6.2 Roading

Surficial Scala testing up to 1m bgl returned CBR values for preliminary pavement design in the order of 3% to 5%. If greater values are required, subgrade improvement via either undercutting and replacement, cement/lime stabilisation or dynamic compaction may be required. Further investigation should be undertaken once road layout and pavement depths have been further developed.

6.3 Soakage Assessment

From review of the soakage tests done within the neighbouring Cashmere Oaks Subdivision to the south of our site, it appears a soakage rate of 334mm/hour was adopted for their design.

The on-site soakage testing conducted by Riley indicates that soakage rates are poor within the near surface clays and silts. However, soakage within the underlying gravel has been tested to be approximately 300mm/hour and onsite soakage can be achieved using standard draining design measures.

6.4 Earthworks

The generally flat nature of the Site indicates only minor cut and fill earthworks would likely be required for any future development of the Site, primarily for roading construction and stormwater flow path purposes. Given fill is likely to be limited and subsurface conditions indicate generally stiff material, consolidation settlement is considered unlikely.

Further assessment should be undertaken at resource consent stage to determine what mitigation measures such as preloading (if any) is required and what appropriate engineering solutions should be incorporated into detail design. It is considered that standard engineering solutions can be applied to manage any site geotechnical matters with future development.

7.0 Limitation

This report has been prepared solely for the benefit of Welhom Developments Limited as our client and Masterton District Council in processing the plan change. The reliance by other parties on the information or opinions contained in the report shall, without our prior review and agreement in writing, be at such parties' sole risk.

Recommendations and opinions in this report are based on data from limited test positions. The nature and continuity of subsoil conditions away from the test positions are inferred, and it must be appreciated that actual conditions could vary considerably from the assumed model.

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Appendix A

Investigation Logs

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GEOTECHNICAL AND GEOLOGICAL INFORMATION

SOIL TYPES AND SYMBOLS


FILL


TOPSOIL


SILT


SAND


GRAVEL


CLAY


PEAT


GROUNDWATER LEVEL


10,11,10

SCALA PENETROMETER
LAST 3 NUMBER OF BLOWS PER 50mm INCREMENT

ROCK TYPES AND SYMBOLS


SANDSTONE


SILTSTONE


MUDSTONE


LIMESTONE


BASALT


TUFF


IGNIMBRITE


GREYWACKE

SOIL STRENGTH CLASSIFICATION

FINE GRAINED COHESIVE SOILS

TERM	FIELD IDENTIFICATION	UNDRAINED SHEAR STRENGTH (KPa)
Very Soft (Vs)	Exudes between fingers when squeezed.	<12
Soft (S)	Easily indented by fingers.	12 – 25
Firm (F)	Indented only by strong finger pressure.	25 – 50
Stiff (St)	Indented by thumb pressure.	50 – 100
Very Stiff (VSt)	Indented by thumbnail.	100 – 200
Hard (H)	Difficult to indent by thumbnail.	200+

SPT & SCALA PENETROMETER RESULTS

TERM	SPT VALUE No. of BLOWS/300mm	SCALA PENETROMETER No. of BLOWS/100mm
very dense	>50	17+
dense	30 – 50	7 – 17
medium dense	10 – 30	3 – 7
loose	4 – 10	1 – 3
very loose	0 – 4	0 – 2

ROCK STRENGTH CLASSIFICATION

TERM		FIELD IDENTIFICATION	UNCONFINED UNIAXIAL COMPRESSIVE STRENGTH (MPa)
Extremely weak	(EW)	Indented by thumbnail.	< 1
Very weak	(VW)	Crumbles under firm blows with point of geological hammer. Can be peeled with pocket knife.	1 – 5
Weak	(W)	Difficult to peel with pocket knife.	5 – 20
Moderately strong	(MS)	Cannot be scraped or peeled with pocket knife.	20 – 50
Strong	(S)	More than one blow of geological hammer to fracture.	50 – 100
Very strong	(VS)	Many blows of geological hammer to break.	100 – 250
Extremely strong	(ES)	Can only be chipped with geological hammer.	250+

MOISTURE CONDITION

Dry (D)	Looks and feels dry; powdery and friable.
Moist (M)	Feels cool; darkened in colour; no free water when remoulded.
Wet (W)	Feels cool; darkened in colour; free water forms on hands.
Saturated (S)	Free water is present on sample.

SAMPLE TYPES


UNDISTURBED


MACHINE AUGER DISTURBED

D
HAND AUGER DISTURBED


STANDARD PENETRATION TEST (solid cone)


STANDARD PENETRATION TEST (hollow cone)

DRILLING METHOD

OB	OPEN BARREL
TT	TRIPLE TUBE
WB	WASH BORE
SH	UNDISTURBED SHELBY TUBE
RC	ROCK CORE
SPT	STANDARD PENETRATION TEST

FIELD TESTS

V	SHEAR VANE (corrected to BS:1377)
R	REMOULDED STRENGTH
P	POCKET PENETROMETER
CH	CLEGG HAMMER

INFORMATION BASED ON THE NZ GEOTECHNICAL SOCIETY INC. GUIDELINES FOR THE CLASSIFICATION AND DESCRIPTION OF SOIL AND ROCK FOR ENGINEERING PURPOSES

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MACHINE HOLE LOG

Project No.:	Project Name:	Project Location:	No.:
210422	Masterton Due Diligence	Roger Rennal Drive, Lansdowne, Masterton	BH01

Client:	Start Date: 20 Sep 2021	Hole Location:
Welhom Development Ltd	End Date: 20 Sep 2021	Refer to site plan

Co-ordinates (NZTM):	Ground Level (NZVD 2016):	Hole Depth:	Inclination:	Azimuth:	Sheet:
E 1824517, N 5465706	123 m	15.20 m	90°	N/A	1 of 2

Elevation (m NZVD 2016)	Depth (m)	Method	Run (Box No.)	Core Loss (%)	Geological Unit	Legend	Geological Description	Groundwater	Field Strength (Soil / Rock)	In-Situ Testing Data / Results	Sample / Laboratory Testing	Backfill / Installation
122.80	0.20	Sonic core drilling	0.00	0	TS	TS	SILT (TS SI), with minor sand, with trace rootlets and clay; brown. Firm; low plasticity; moist; sand, fine to medium; [TOPSOIL].					
122.90	1.10		1.00	0			Clayey SILT (CL SI), with trace sand; light orange brown with grey mottling. Firm to stiff; low plasticity; moist to wet; sand, fine to medium; [Q2A ALLUVIUM].					
124	1		1.50	0			Silty GRAVEL (CL SI), with minor clay and sand and cobbles; bedded. Very dense; low plasticity; wet to saturated; gravel, medium to coarse, subround to rounded, slightly weathered; sand, fine to medium; Predominantly clast supported, greywacke. - INTERBEDDED WITH - Gravelly SILT (GR SI), with minor clay and sand; bedded. Very stiff; low plasticity; wet to saturated; gravel, medium to coarse, subround to rounded, slightly weathered; sand, fine to medium; Lenses.	▼		SPT 1.50 m 8, 18 / 19, 16, 15 Nc=50 for 225mm		
125	2		2.60	0			1.25m: Greyish brown to yellowish brown. 2.00m - 3.00m: Grades to yellowish brown; gravelly SILT.					
126	3		3.00	20						SPT 3.00 m 3, 6 / 11, 19, 21, 10 for 40mm Nc=50 for 265mm		
127	4		4.50	13			4.50m: Grades to orange brown.			SPT 4.50 m 8, 8 / 8, 11, 21, 10 for 35mm Nc=50 for 260mm		
128	5		6.10	0			6.10m: Grades orange brown to yellowish brown.			SPT 6.00 m 5, 11 / 19, 15, 13, 3 for 5mm Nc=50 for 230mm		
129	6		7.60	0						SPT 7.50 m 9, 13 / 13, 14, 13, 10 for 50mm		
130	7											

Explanations: *Refer to "Geological and Geotechnical Information" sheet for further details.*

- Standing Water Level
- Out flow
- In flow
- Standard Penetration Test (SPT) — Filled = Solid cone (C); No Fill = Split spoon (S)
- Vane Shear Strength (kPa) — V=Peak, R=Residual, UTP=Unable to penetrate

Moisture: M = moist; W = wet; S = saturated

Backfill: Topsoil, Peat, Fill, Core Loss, Clay, Silt, Sand, Gravel, Bentonite, Grout/concrete, Drill arisings, Filter sand

Remarks
1. Co-ordinates and elevation are approximate and subject to survey confirmation.
2. Strength terms are based on SPT testing where appropriate, otherwise based on field description

All dimensions in metres NOT TO SCALE	Drilling Contractor:	Drilling Rig ID:	Driller:	Logged By:	Checked By:
	PRO-DRILL	Sonic Dual Head	Keith	AvD	SRO

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MACHINE HOLE LOG

Project No.:	Project Name:	Project Location:	No.:
210422	Masterton Due Diligence	Roger Rennal Drive, Lansdowne, Masterton	BH01

Client:	Start Date: 20 Sep 2021	Hole Location:
Welhom Development Ltd	End Date: 20 Sep 2021	Refer to site plan

Co-ordinates (NZTM):	Ground Level (NZVD 2016):	Hole Depth:	Inclination:	Azimuth:	Sheet:
E 1824517, N 5465706	123 m	15.20 m	90°	N/A	2 of 2

Elevation (m NZVD 2016)	Depth (m)	Method	Run / Box No.	Core Loss (%)	Geological Unit	Legend	Geological Description	Groundwater	Field Strength (Soil | Rock)	In-Situ Testing Data / Results	Sample / Laboratory Testing	Backfill / Installation
132	9	Sonic core drilling	9.10	0			[CONT] 6.10m: Grades orange brown to yellowish brown.			Nc=50 for 275mm		
133	10		10.60	20						SPT 9.00 m 11, 39 Nc=50 for 0mm	9	
134	11		11.40	0						SPT 10.50 m 5, 17 / 20, 20, 10 for 10mm Nc=50 for 160mm	10	
135	12		12.20	0						SPT 12.00 m 15, 9 / 13, 15, 20 for 55mm Nc=50 for 205mm	11	
136	13		13.70	0						SPT 13.50 m 13, 22 / 29, 21 for 55mm Nc=50 for 130mm	12	
137	14			0						SPT 15.00 m 11, 17 / 19, 23, 8 for 15mm Nc=50 for 165mm	13	
138	15						END OF HOLE: 15.20m				14	
107.80	15.20										15	

Explanations: *Refer to "Geological and Geotechnical Information" sheet for further details.*

- Standing Water Level
- Out flow
- In flow

Moisture:
M = moist
W = wet
S = saturated

- Standard Penetration Test (SPT) Filled = Solid cone (C) No Fill = Split spoon (S)
- Vane Shear Strength (kPa) V=Peak, R=Residual UTP=Unable to penetrate
- Core Loss

Topsoil, Peat, Fill, Clay, Silt, Sand, Gravel

Backfill: Bentonite, Grout/concrete, Drill arisings, Filter sand

Remarks
1. Co-ordinates and elevation are approximate and subject to survey confirmation.
2. Strength terms are based on SPT testing where appropriate, otherwise based on field description

All dimensions in metres NOT TO SCALE	Drilling Contractor:	Drilling Rig ID:	Driller:	Logged By:	Checked By:
	PRO-DRILL	Sonic Dual Head	Keith	AvD	SRO

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MACHINE HOLE LOG

Project No.:	Project Name:	Project Location:	No.:
210422	Masterton Due Diligence	Roger Rennal Drive, Lansdowne, Masterton	BH02

Client:	Start Date: 17 Sep 2021	Hole Location:
Welhom Development Ltd	End Date: 17 Sep 2021	Refer to site plan

Co-ordinates (NZTM):	Ground Level (NZVD 2016):	Hole Depth:	Inclination:	Azimuth:	Sheet:
E 1824613, N 5465658	125 m	15.20 m	90°	N/A	1 of 2

Elevation (m NZVD 2016)	Depth (m)	Method	Run / Box No.	Core Loss (%)	Geological Unit	Legend	Geological Description	Groundwater	Field Strength	In-Situ Testing Data / Results	Sample / Laboratory Testing	Backfill / Installation
124.70	0.30	Sonic core drilling	0.00	0	TOPSOIL	TS	SILT, with minor sand, with trace rootlets and clay; brown. Firm; low plasticity; moist; sand, fine to medium; [TOPSOIL].	▼				
					Q2A ALLUVIUM		Clayey SILT, with trace sand; light orange brown with grey mottling. Firm to stiff; low plasticity; moist to wet; sand, fine to medium; [Q2A ALLUVIUM].					
123.75	1.25		1.50	0			Silty GRAVEL (GR SI), with minor clay and sand and cobbles; bedded. Very stiff; low plasticity; wet to saturated; gravel, medium to coarse, subround to rounded, slightly weathered; sand, fine to medium; Predominantly clast supported, greywacke. - INTERBEDDED WITH - Gravelly SILT, with minor clay and sand; bedded. Very stiff; low plasticity; wet to saturated; gravel, medium to coarse, subround to rounded, slightly weathered; sand, fine to medium; Lenses. 1.25m: Greyish brown. 1.50m - 3.90m: "claybound".			SPT 1.50 m 8, 10 / 18, 14, 12, 6 for 50mm N=50 for 275mm	SPT Rec: ~200 mm	
			3.00	0						SPT 3.00 m 3, 10 / 21, 22, 18, 10 for 50mm N=50 for 275mm	SPT Rec: ~250 mm	
			3.90	-			4.50m: Grades to orange brown.			SPT 4.50 m 10, 15 / 21, 20, 9 for 40mm Nc=50 for 190mm		
			4.60	0			5.50m: Grades to yellowish brown; gravelly SILT.					
			6.10	0			6.10m: Grades to bluish grey.			SPT 6.10 m 8, 17 / 20, 20, 10 for 30mm Nc=50 for 180mm		
			7.60	0						SPT 7.60 m 8, 25 / 40, 10 for 25mm		

Explanations: *Refer to "Geological and Geotechnical Information" sheet for further details.*

- Standing Water Level
- Out flow
- In flow

Moisture:
M = moist
W = wet
S = saturated

- Standard Penetration Test (SPT) Filled = Solid cone (C) No Fill = Split spoon (S)
- Vane Shear Strength (kPa) V=Peak, R=Residual UTP=Unable to penetrate

Topsoil, Peat, Fill, Core Loss, Clay, Silt, Sand, Gravel

Backfill: Bentonite, Grout/concrete, Drill arisings, Filter sand

Remarks
1. Co-ordinates and elevation are approximate and subject to survey confirmation.
2. Strength terms are based on SPT testing where appropriate, otherwise based on field description
3. Undertaken during period of persistent rain.

All dimensions in metres NOT TO SCALE	Drilling Contractor:	Drilling Rig ID:	Driller:	Logged By:	Checked By:
	PRO-DRILL	Sonic Dual Head	Keith	AvD	SRO

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MACHINE HOLE LOG

Project No.:	Project Name:	Project Location:	No.:
210422	Masterton Due Diligence	Roger Rennal Drive, Lansdowne, Masterton	BH02

Client:	Start Date: 17 Sep 2021	Hole Location:
Welhom Development Ltd	End Date: 17 Sep 2021	Refer to site plan

Co-ordinates (NZTM):	Ground Level (NZVD 2016):	Hole Depth:	Inclination:	Azimuth:	Sheet:
E 1824613, N 5465658	125 m	15.20 m	90°	N/A	2 of 2

Elevation (m NZVD 2016)	Depth (m)	Method	Run (Box No.)	Core Loss (%)	Geological Unit	Legend	Geological Description	Groundwater	Field Strength	In-Situ Testing Data / Results	Sample / Laboratory Testing	Backfill / Installation
							In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" sheet for explanation of legend and abbreviations		Soil | Rock			
134	9	Sonic core drilling	8.60	0	Q2A ALLUVIUM		8.00m: Grades to yellowish brown.			Nc=50 for 100mm		
135	10		9.10	0			8.90m: Grades to bluish grey.			SPT 9.10 m 4, 10 / 20, 22, 8 for 10mm Nc=50 for 160mm		
136	11		10.60	0						SPT 10.60 m 5, 21 / 30, 20 for 70mm Nc=50 for 145mm		
137	12		11.60	0								
138	13		12.20	0						SPT 12.20 m 13, 30 / 42, 8 for 5mm Nc=50 for 80mm		
139	14		13.70	0						SPT 13.70 m 6, 10 / 12, 15 for 15mm, 5 for 0mm Nc=50 for 90mm		
140	15		14.60	0								
109.80	15.20						END OF HOLE: 15.20m			SPT 15.20 m 9, 23 / 20, 18, 12 for 50mm Nc=50 for 200mm		

Explanations: *Refer to "Geological and Geotechnical Information" sheet for further details.*

- Standing Water Level
- Out flow
- In flow

Moisture:
M = moist
W = wet
S = saturated

- Standard Penetration Test (SPT) Filled = Solid cone (C) No Fill = Split spoon (S)
- Vane Shear Strength (kPa) V=Peak, R=Residual UTP=Unable to penetrate
- Core Loss

Topsoil, Peat, Fill, Clay, Silt, Sand, Gravel

Backfill: Bentonite, Grout/concrete, Drill arisings, Filter sand

Remarks
1. Co-ordinates and elevation are approximate and subject to survey confirmation.
2. Strength terms are based on SPT testing where appropriate, otherwise based on field description
3. Undertaken during period of persistent rain.

All dimensions in metres NOT TO SCALE	Drilling Contractor:	Drilling Rig ID:	Driller:	Logged By:	Checked By:
	PRO-DRILL	Sonic Dual Head	Keith	AvD	SRO

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HAND AUGER LOG

Project No.:	Project:	Project Location:	No.:
210422	Masterton Due Diligence	Roger Rennal Drive, Lansdowne, Masterton	HA01
Date Augered:	**Client:**	**Hole Location:**	
15 Sep 2021	Welhom Development Ltd	Refer to site plan	
Ground Level (m NZVD 2016):	**Co-ordinates (NZTM):**	**Hole Depth:**	**Reason Terminated:**	**Sheet:**
130 m	E 1824440, N 5465847	0.90 m	Refusal	1 of 1

Elevation m NZVD 2016	Depth (m)	Geological Unit	Legend	Geological Description	Water / Moisture	Samples	Soil Shear Strength (kPa)	Scala Penetrometer (blows/50mm)	In Situ Testing Data/Results	Depth (m)	Backfill / Install
				In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" sheet for explanation of legend and abbreviations			△ Residual ● Peak 50 100 150 200	5 10 15			
129.80	0.20	TOPSOIL	TS	SILT, trace clay and organics; brown with white specks. Moist; low plasticity.		0.10m, HA1_0.1			0, 1, 0 1, 1, 1 2, 1, 1 1, 2, 1 1, 2, 2 3, 3, 3 19, 8		
		Q4A ALLUVIUM		SILT, with minor clay; light brown with orange mottles. Stiff; moist, low plasticity.	M						
130.5	0.5					0.50m, HA1_0.5	△ ●		V=65 R=26	0.5	
				0.60m - 0.90m: Grades to clayey.							
				0.80m: Grades to include fine gravel; wet.	W						
129.10	0.90			0.90m: Grades to hard; saturated.					UTP		
				END OF HOLE: 0.90m							
131.0	1.0									1.0	

Explanations: *Refer to "Geological and Geotechnical Information" sheet for further details.*

- Standing Water Level
- Out-flow
- In-flow

Moisture:
M = moist
W = wet
S = saturated

Scala Penetrometer Tests
Raw data in blows per 50mm

Vane Shear Strength (kPa)
V = Peak, R = Residual
UTP = Unable To Penetrate

Topsoil, Peat, Fill, Core Loss, Clay, Silt, Sand, Gravel, Bentonite, Grout/concrete, Drill arisings, Filter sand

Remarks

1. Co-ordinates and elevation are approximate and subject to survey confirmation.
2. Strength terms are based on shear vane tests.
3. Site testing undertaken during period of persistent rain.

All dimensions in metres NOT TO SCALE	Contractor (if applicable):	Instrument Details:	Shear Vane No.:	Logged By:	Checked By:
		Hand Auger 70mm	GEO105	BCF	AvD

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HAND AUGER LOG

Project No.:	Project:	Project Location:	No.:
210422	Masterton Due Diligence	Roger Rennal Drive, Lansdowne, Masterton	HA02
Date Augered: 15 Sep 2021	**Client:** Welhom Development Ltd	**Hole Location:** Refer to site plan	
Ground Level (m NZVD 2016): 130 m	**Co-ordinates (NZTM):** E 1824578, N 5465835	**Hole Depth:** 1.00 m	**Reason Terminated:** Refusal	**Sheet:** 1 of 1

Elevation m NZVD 2016	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" sheet for explanation of legend and abbreviations)	Water / Moisture	Samples	Soil Shear Strength (kPa)	Scala Penetrometer (blows/50mm)	In Situ Testing Data/Results	Depth (m)	Backfill / Install
129.70	0.30	TOPSOIL	TS	SILT, minor to some clay, trace organics; brown. Moist, organics, rootlets.		0.10m, HA2_0.1			0, 1, 1 1, 0, 1 1, 0, 1 0, 0, 1 1, 2, 1 0, 1, 3 3, 9		
130.5	0.5	Q4A ALLUVIUM	×	Clayey SILT; light yellowish brown with orange mottles. Very stiff; moist; low plasticity.	M	0.50m, HA2_0.5	Δ Residual ● Peak 50 100 150 200	5 10 15	V=126 R=40	0.5	
				0.60m: Grades to cream and orange.							
				0.80m: Grades to include trace fine to coarse gravel. Wet.	W						
				0.90m: Grades to minor to some gravel. Saturated.	S	0.90m, HA2_0.9			UTP		
129.00	1.00			END OF HOLE: 1.00m					17	1.0	

Explanations: *Refer to "Geological and Geotechnical Information" sheet for further details.*

- Standing Water Level
- Out-flow
- In-flow

Moisture:
M = moist
W = wet
S = saturated

Scala Penetrometer Tests
Raw data in blows per 50mm

Vane Shear Strength (kPa)
V = Peak, R = Residual
UTP = Unable To Penetrate

Topsoil, Peat, Fill, Core Loss, Clay, Silt, Sand, Gravel, Bentonite, Grout/concrete, Drill arisings, Filter sand

Remarks

1. Co-ordinates and elevation are approximate and subject to survey confirmation.
2. Stength terms are based on shear vane tests.
3. Site testing undertaken during period of persistent rain.

All dimensions in metres NOT TO SCALE	Contractor (if applicable):	Instrument Details:	Shear Vane No.:	Logged By:	Checked By:
		Hand Auger 70mm	GEO105	RJF	AvD

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HAND AUGER LOG

Project No.:	Project:	Project Location:	No.:
210422	Masterton Due Diligence	Roger Rennal Drive, Lansdowne, Masterton	HA03
Date Augered: 15 Sep 2021	**Client:** Welhom Development Ltd	**Hole Location:** Refer to site plan	
Ground Level (m NZVD 2016): 130 m	**Co-ordinates (NZTM):** E 1824531, N 5465771	**Hole Depth:** 1.15 m	**Reason Terminated:** Refusal	**Sheet:** 1 of 1

Elevation m NZVD 2016	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" sheet for explanation of legend and abbreviations)	Water / Moisture	Samples	Soil Shear Strength (kPa)	Scala Penetrometer (blows/50mm)	In Situ Testing Data/Results	Depth (m)	Backfill / Install
129.70	0.30	TOPSOIL	TS	SILT, minor to some clay, trace organics; brown. Moist; low plasticity; organics, rootlets.	M	0.10m, HA3_0.1			0, 1, 0 1, 1, 0 1, 0, 1 1, 2, 1 2, 1, 1 2, 1, 1 1, 1		
130.5	0.5	Q4A ALLUVIUM		Clayey SILT; light brown with orange mottles. Very stiff; moist; low plasticity.		0.50m, HA3_0.5			V=119 R=29	0.5	
				0.60m: Grades to wet.	W						
				0.80m: Grades to saturated.							
				0.90m: Grades to trace fine to medium gravel. Saturated.	S						
131.0	1.0			1.00m: Grades to minor gravel, fine to coarse.		1.00m, HA3_1.0			V=123 R=19	1.0	
128.85	1.15								2, 3, 7 12, 17		
				END OF HOLE: 1.15m							

Soil Shear Strength (kPa): Residual △ Peak ● — 50 100 150 200

Scala Penetrometer (blows/50mm): 5 10 15

Explanations: *Refer to "Geological and Geotechnical Information" sheet for further details.*

- Standing Water Level
- Out-flow
- In-flow

Moisture:
M = moist
W = wet
S = saturated

Scala Penetrometer Tests
Raw data in blows per 50mm

Vane Shear Strength (kPa)
V = Peak, R = Residual
UTP = Unable To Penetrate

Topsoil, Peat, Fill, Core Loss, Clay, Silt, Sand, Gravel, Bentonite, Grout/concrete, Drill arisings, Filter sand

Remarks

1. Co-ordinates and elevation are approximate and subject to survey confirmation.
2. Strength terms are based on shear vane tests.
3. Site testing undertaken during period of persistent rain.
4. Falling head test undertaken in 100mm auger hole 2m from this hole.

All dimensions in metres NOT TO SCALE	Contractor (if applicable):	Instrument Details:	Shear Vane No.:	Logged By:	Checked By:
		Hand Auger 70mm	GEO105	RJF	AvD

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HAND AUGER LOG

Project No.:	Project:	Project Location:	No.:
210422	Masterton Due Diligence	Roger Rennal Drive, Lansdowne, Masterton	HA04
Date Augered: 15 Sep 2021	**Client:** Welhom Development Ltd	**Hole Location:** Refer to site plan	
Ground Level (m NZVD 2016): 130 m	**Co-ordinates (NZTM):** E 1824637, N 5465759	**Hole Depth:** 1.00 m	**Reason Terminated:** Refusal	**Sheet:** 1 of 1

Elevation m NZVD 2016	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005). Refer to "Geotechnical and Geological Information" sheet for explanation of legend and abbreviations)	Water / Moisture	Samples
129.80	0.20	TOPSOIL	TS	SILT, some clay, trace organics; brown. Moist; low plasticity.	M	0.10m, HA4_0.1
		Q4A ALLUVIUM		Silt, some clay, trace organics; brown with orange mottles. Moist; low plasticity; organics, rootlets.		
				0.40m: Grades to no organics; light brown with orange streaks.		0.50m, HA4_0.5
130.5	0.5			0.60m: Grades to clayey; wet.	W	
				0.70m: Grades to saturated.	S	
				0.90m: Grades to include trace fine gravel.		
129.00	1.00			END OF HOLE: 1.00m		1.00m, HA4_1.0

Soil Shear Strength (kPa): △ Residual ● Peak; 50 100 150 200

Scala Penetrometer (blows/50mm): 5 10 15

In Situ Testing Data/Results (Depth (m)):
0, 0, 1
0, 0, 1
1, 1, 0
2, 0, 1
2, 2, 1
3, 4, 3
4, 6
V=110 R=23
UTP
13, 7, 3
4, 3, 12
6, 15, 16

Backfill / Install

Explanations: *Refer to "Geological and Geotechnical Information" sheet for further details.*

- Standing Water Level
- Out-flow
- In-flow

Moisture:
M = moist
W = wet
S = saturated

Scala Penetrometer Tests
Raw data in blows per 50mm

Vane Shear Strength (kPa)
V = Peak, R = Residual
UTP = Unable To Penetrate

Topsoil, Peat, Fill, Core Loss, Clay, Silt, Sand, Gravel, Bentonite, Grout/concrete, Drill arisings, Filter sand

Remarks

1. Co-ordinates and elevation are approximate and subject to survey confirmation.
2. Strength terms are based on shear vane tests.
3. Site testing undertaken during period of persistent rain.

All dimensions in metres NOT TO SCALE	Contractor (if applicable):	Instrument Details:	Shear Vane No.:	Logged By:	Checked By:
		Hand Auger 70mm	GEO105	BCF	AvD

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HAND AUGER LOG

Project No.:	Project:	Project Location:	No.:
210422	Masterton Due Diligence	Roger Rennal Drive, Lansdowne, Masterton	HA05
Date Augered: 15 Sep 2021	**Client:** Welhom Development Ltd	**Hole Location:** Refer to site plan	
Ground Level (m NZVD 2016): 130 m	**Co-ordinates (NZTM):** E 1824442, N 5465657	**Hole Depth:** 1.10 m	**Reason Terminated:** Refusal	**Sheet:** 1 of 1

Elevation m NZVD 2016	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" sheet for explanation of legend and abbreviations)	Water / Moisture	Samples	Soil Shear Strength (kPa) △ Residual ● Peak	Scala Penetrometer (blows/50mm)	In Situ Testing Data/Results	Depth (m)	Backfill / Install
129.75	0.25	TOPSOIL	TS	SILT, minor to some clay, trace organics; brown. Moist; low plasticity.		0.10m, HA5_0.1			0, 1, 0 1, 2, 0 1, 1, 0 1, 1, 1 1, 1, 1 2, 2, 4 5, 6		
		Q4A ALLUVIUM		Clayey SILT, trace organics; yellowish brown. Stiff; moist; low plasticity; organics, rootlets.	M						
				0.40m: Grades to no organics.							
130.5	0.5					0.50m, HA5_0.5	△ ●		V=90 R=24	0.5	
				0.75m: Grades to cream and orange streaks. Wet.							
				0.80m: Grades to minor gravel, fine to coarse.	W						
				0.90m: Grades to white / orange / brown; saturated.							
131.0	1.0				S	1.00m, HA5_1.0				1.0	
128.90	1.10			END OF HOLE: 1.10m					20		

Soil Shear Strength (kPa): 50 100 150 200
Scala Penetrometer (blows/50mm): 5 10 15

Explanations: *Refer to "Geological and Geotechnical Information" sheet for further details.*

- Standing Water Level
- Out-flow
- In-flow

Moisture:
M = moist
W = wet
S = saturated

Scala Penetrometer Tests
Raw data in blows per 50mm

Vane Shear Strength (kPa)
V = Peak, R = Residual
UTP = Unable To Penetrate

Topsoil	Clay	Bentonite
Peat	Silt	Grout/concrete
Fill	Sand	Drill arisings
Core Loss	Gravel	Filter sand

Remarks

1. Co-ordinates and elevation are approximate and subject to survey confirmation.
2. Strength terms are based on shear vane tests.
3. Site testing undertaken during period of persistent rain.

All dimensions in metres NOT TO SCALE	Contractor (if applicable):	Instrument Details:	Shear Vane No.:	Logged By:	Checked By:
		Hand Auger 70mm	GEO105	RJF	AvD

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HAND AUGER LOG

Project No.:	Project:	Project Location:	No.:
210422	Masterton Due Diligence	Roger Rennal Drive, Lansdowne, Masterton	HA06
Date Augered: 16 Sep 2021	**Client:** Welhom Development Ltd	**Hole Location:** Refer to site plan	
Ground Level (m NZVD 2016): 130 m	**Co-ordinates (NZTM):** E 1824615, N 5465582	**Hole Depth:** 0.90 m	**Reason Terminated:** Refusal	**Sheet:** 1 of 1

Elevation m NZVD 2016	Depth (m)	Geological Unit	Legend	Geological Description	Water / Moisture	Samples	Soil Shear Strength (kPa)	Scala Penetrometer (blows/50mm)	In Situ Testing Data/Results	Depth (m)	Backfill / Install
				In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" sheet for explanation of legend and abbreviations			△ Residual ● Peak 50 100 150 200	5 10 15			
129.70	0.30	TOPSOIL	TS	SILT, some clay, trace organics; brown. Moist; low plasticity.		0.10m, HA6_0.1			0, 1, 1 1, 1, 0 1, 0, 1 0, 1, 1 1, 1, 1 1, 1, 3 3, 3		
130.5	0.5	Q4A ALLUVIUM	×	Clayey SILT; tan with orange mottles. Stiff; moist; low plasticity.	M	0.50m, HA6_0.5	△ ●		V=87 R=23	0.5	
				0.75m: Grades to trace to minor fine gravel.							
				0.80m: Grades to wet.	W						
129.10	0.90			0.90m: Grades to hard; saturated.		0.90m, HA6_0.9			UTP		
				END OF HOLE: 0.90m							
131.0	1.0								6, 5, 20	1.0	

Explanations: *Refer to "Geological and Geotechnical Information" sheet for further details.*

- Standing Water Level
- Out-flow
- In-flow

Moisture:
M = moist
W = wet
S = saturated

Scala Penetrometer Tests
Raw data in blows per 50mm

Vane Shear Strength (kPa)
V = Peak, R = Residual
UTP = Unable To Penetrate

Topsoil, Clay, Bentonite, Peat, Silt, Grout/concrete, Fill, Sand, Drill arisings, Core Loss, Gravel, Filter sand

Remarks

1. Co-ordinates and elevation are approximate and subject to survey confirmation.
2. Strength terms are based on shear vane tests.
3. Site testing undertaken during period of persistent rain.

All dimensions in metres NOT TO SCALE	Contractor (if applicable):	Instrument Details:	Shear Vane No.:	Logged By:	Checked By:
		Hand Auger 70mm	GEO105	RJF	AvD

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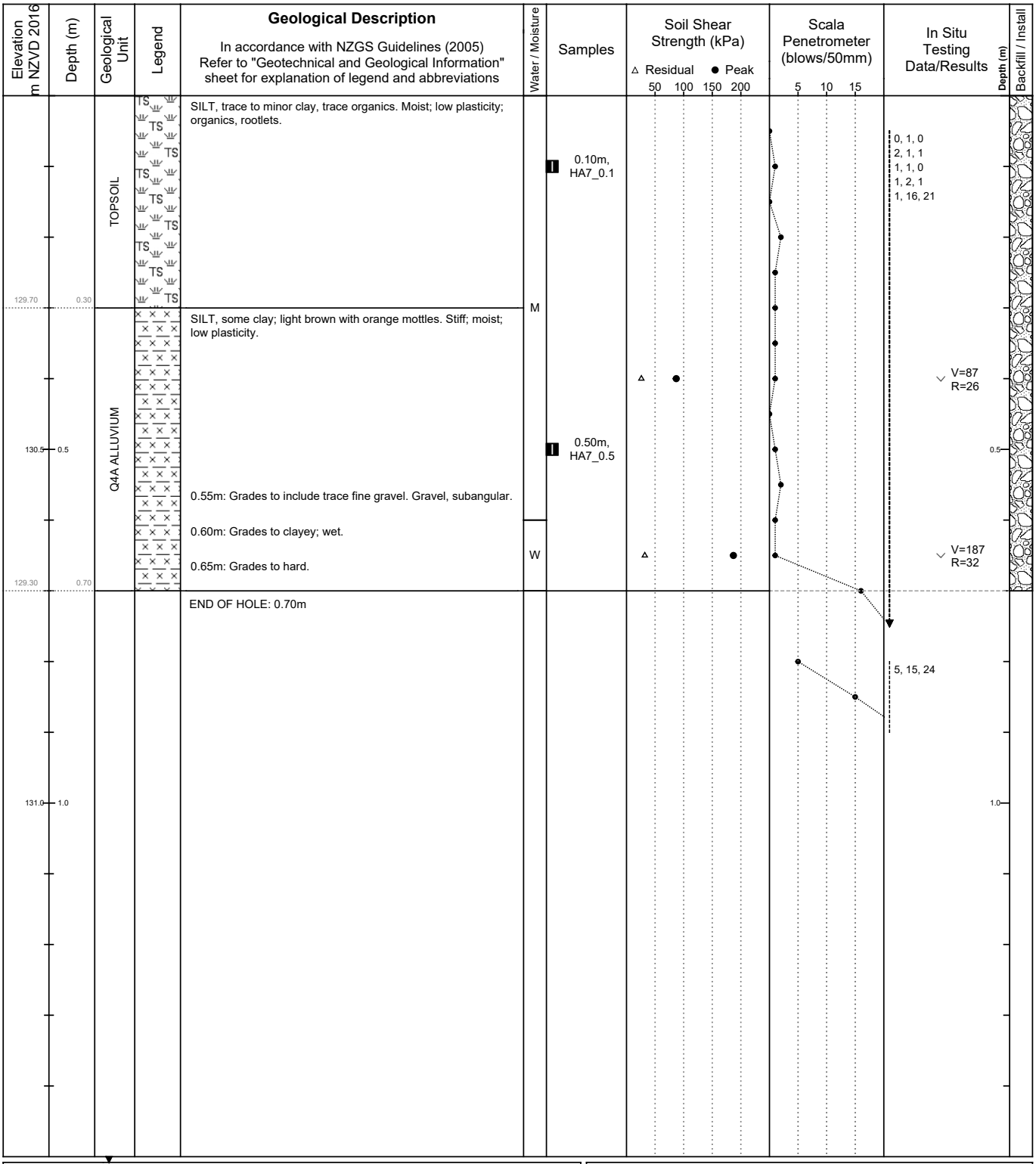
HAND AUGER LOG

Project No.:	Project:	Project Location:	No.:
210422	Masterton Due Diligence	Roger Rennal Drive, Lansdowne, Masterton	HA07
Date Augered:	**Client:**	**Hole Location:**	
16 Sep 2021	Welhom Development Ltd	Refer to site plan	
Ground Level (m NZVD 2016):	**Co-ordinates (NZTM):**	**Hole Depth:**	**Reason Terminated:**	**Sheet:**
130 m	E 1824502, N 5465597	0.70 m	Refusal	1 of 3



Explanations: *Refer to "Geological and Geotechnical Information" sheet for further details.*

- Standing Water Level
- Out-flow
- In-flow

Moisture:
M = moist
W = wet
S = saturated

Scala Penetrometer Tests
Raw data in blows per 50mm

Vane Shear Strength (kPa)
V = Peak, R = Residual
UTP = Unable To Penetrate

Topsoil	Clay	Bentonite
Peat	Silt	Grout/concrete
Fill	Sand	Drill arisings
Core Loss	Gravel	Filter sand

Remarks

1. Co-ordinates and elevation are approximate and subject to survey confirmation.
2. Stength terms are based on shear vane tests.
3. Site testing undertaken during period of persistent rain.

All dimensions in metres NOT TO SCALE	Contractor (if applicable):	Instrument Details:	Shear Vane No.:	Logged By:	Checked By:
		Hand Auger 70mm	GEO105	BCF	AvD

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HAND AUGER LOG

Project No.:	Project:	Project Location:	No.:
210422	Masterton Due Diligence	Roger Rennal Drive, Lansdowne, Masterton	HA08
Date Augered:	**Client:**	**Hole Location:**	
16 Sep 2021	Welhom Development Ltd	Refer to site plan	
Ground Level (m NZVD 2016):	**Co-ordinates (NZTM):**	**Hole Depth:**	**Reason Terminated:**	**Sheet:**
130 m	E 1824475, N 5465502	0.95 m	Refusal	1 of 1

Elevation m NZVD 2016	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" sheet for explanation of legend and abbreviations)	Water / Moisture	Samples	Soil Shear Strength (kPa) (△ Residual ● Peak)	Scala Penetrometer (blows/50mm)	In Situ Testing Data/Results	Depth (m)	Backfill / Install
129.70	0.30	TOPSOIL	TS	SILT, minor to some clay, trace organics; brown. Wet; low plasticity; organics, rootlets.	W	0.10m, HA8_0.1			0, 1, 0 1, 0, 1 1, 1, 0 1, 1, 1 1, 1, 1 1, 4, 7 3, 5		
130.5	0.5	Q4A ALLUVIUM		Clayey SILT; brown and orange streaks. Stiff; moist; low plasticity.	M	0.50m, HA8_0.5			V=75 R=23	0.5	
129.05	0.95			0.80m: Grades to trace to minor gravel. Gravel, fine to medium, subangular to subrounded.					V=129 R=32		
131.0	1.0			END OF HOLE: 0.95m					4, 5, 6 10, 17, 18	1.0	

Soil Shear Strength (kPa): 50 100 150 200
Scala Penetrometer (blows/50mm): 5 10 15

Explanations: *Refer to "Geological and Geotechnical Information" sheet for further details.*

- Standing Water Level
- Out-flow
- In-flow

Moisture:
M = moist
W = wet
S = saturated

Scala Penetrometer Tests
Raw data in blows per 50mm

Vane Shear Strength (kPa)
V = Peak, R = Residual
UTP = Unable To Penetrate

Topsoil, Peat, Fill, Core Loss, Clay, Silt, Sand, Gravel, Bentonite, Grout/concrete, Drill arisings, Filter sand

Remarks

1. Co-ordinates and elevation are approximate and subject to survey confirmation.
2. Stength terms are based on shear vane tests.
3. Site testing undertaken during period of persistent rain.

All dimensions in metres NOT TO SCALE	Contractor (if applicable):	Instrument Details:	Shear Vane No.:	Logged By:	Checked By:
		Hand Auger 70mm	GEO105	RJF	AvD

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HAND AUGER LOG

Project No.:	Project:	Project Location:	No.:
210422	Masterton Due Diligence	Roger Rennal Drive, Lansdowne, Masterton	HA09
Date Augered:	**Client:**	**Hole Location:**	
15 Sep 2021	Welhom Development Ltd	Refer to site plan	
Ground Level (m NZVD 2016):	**Co-ordinates (NZTM):**	**Hole Depth:**	**Reason Terminated:**	**Sheet:**
130 m	E 1824572, N 5465511	1.00 m	Refusal	1 of 1

Elevation m NZVD 2016	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005). Refer to "Geotechnical and Geological Information" sheet for explanation of legend and abbreviations)	Water / Moisture	Samples	Soil Shear Strength (kPa)	Scala Penetrometer (blows/50mm)	In Situ Testing Data/Results	Depth (m)	Backfill / Install
129.70	0.30	TOPSOIL	TS	SILT, trace clay and organics; dark brown. Moist to wet; low plasticity.	M W	0.10m, HA9_0.1			0, 1, 0 1, 1, 0 1, 1, 1 1, 1, 1 2, 2, 2 2, 1, 2 3, 5		
130.5	0.5	Q4A ALLUVIUM	×	Clayey SILT; dark brown with orange mottles. Stiff; moist; low plasticity. 0.40m: Grades to yellowish brown.	M	0.50m, HA9_0.5			V=97 R=24	0.5	
129.00	1.00		×	0.80m: Grades to include trace fine to coarse gravel. 0.90m: Grades to minor gravel.							
131.0	1.0			END OF HOLE: 1.00m		1.00m, HA9_1.0			7, 14, 12 20	1.0	

Soil Shear Strength (kPa): △ Residual ● Peak; 50 100 150 200
Scala Penetrometer (blows/50mm): 5 10 15

Explanations: *Refer to "Geological and Geotechnical Information" sheet for further details.*

- Standing Water Level
- Out-flow
- In-flow

Moisture:
M = moist
W = wet
S = saturated

Scala Penetrometer Tests
Raw data in blows per 50mm

Vane Shear Strength (kPa)
V = Peak, R = Residual
UTP = Unable To Penetrate

Topsoil, Peat, Fill, Core Loss, Clay, Silt, Sand, Gravel, Bentonite, Grout/concrete, Drill arisings, Filter sand

Remarks

1. Co-ordinates and elevation are approximate and subject to survey confirmation.
2. Stength terms are based on shear vane tests.
3. Site testing undertaken during period of persistent rain.

All dimensions in metres NOT TO SCALE	Contractor (if applicable):	Instrument Details:	Shear Vane No.:	Logged By:	Checked By:
		Hand Auger 70mm	GEO105	RJF	AvD

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HAND AUGER LOG

Project No.:	Project:	Project Location:	No.:
210422	Masterton Due Diligence	Roger Rennal Drive, Lansdowne, Masterton	HA10
Date Augered:	**Client:**	**Hole Location:**	
16 Sep 2021	Welhom Development Ltd	Refer to site plan	
Ground Level (m NZVD 2016):	**Co-ordinates (NZTM):**	**Hole Depth:**	**Reason Terminated:**	**Sheet:**
130 m	E 1824643, N 5465474	1.40 m	Refusal	1 of 1

Elevation m NZVD 2016	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" sheet for explanation of legend and abbreviations)	Water / Moisture	Samples	Soil Shear Strength (kPa) Δ Residual ● Peak	Scala Penetrometer (blows/50mm)	In Situ Testing Data/Results	Depth (m)	Backfill / Install
129.75	0.25	TOPSOIL	TS	SILT, minor clay; brown. Moist; low plasticity.	M	0.10m, HA10_0.1			0, 1, 0 1, 1, 1 1, 1, 1 2, 1, 2 2, 1, 2 1, 2, 5 2, 2		
130.5	0.5	Q4A ALLUVIUM		SILT, some clay; light brown with orange mottles. Very stiff; moist; low plasticity.		0.50m, HA10_0.5				0.5	
				0.60m: Grades to clayey. Wet.	W				V=116 R=36		
131.0	1.0			0.90m: Grades to trace fine gravel; saturated.		1.00m, HA10_1.0			V=177 R=36	1.0	
128.90	1.10			Silty CLAY; light brown with orange streaks. Saturated; low plasticity.	S				2, 1, 4 4, 4, 5 8, 9, 12 19		
128.60	1.40			END OF HOLE: 1.40m							

Soil Shear Strength (kPa): 50 100 150 200
Scala Penetrometer (blows/50mm): 5 10 15

Explanations: *Refer to "Geological and Geotechnical Information" sheet for further details.*

- Standing Water Level
- Out-flow
- In-flow

Moisture:
M = moist
W = wet
S = saturated

Scala Penetrometer Tests
Raw data in blows per 50mm

Vane Shear Strength (kPa)
V = Peak, R = Residual
UTP = Unable To Penetrate

Topsoil, Peat, Fill, Core Loss, Clay, Silt, Sand, Gravel, Bentonite, Grout/concrete, Drill arisings, Filter sand

Remarks

1. Co-ordinates and elevation are approximate and subject to survey confirmation.
2. Stength terms are based on shear vane tests.
3. Site testing undertaken during period of persistent rain.

All dimensions in metres NOT TO SCALE	Contractor (if applicable):	Instrument Details:	Shear Vane No.:	Logged By:	Checked By:
		Hand Auger 70mm	GEO105	BCF	AvD

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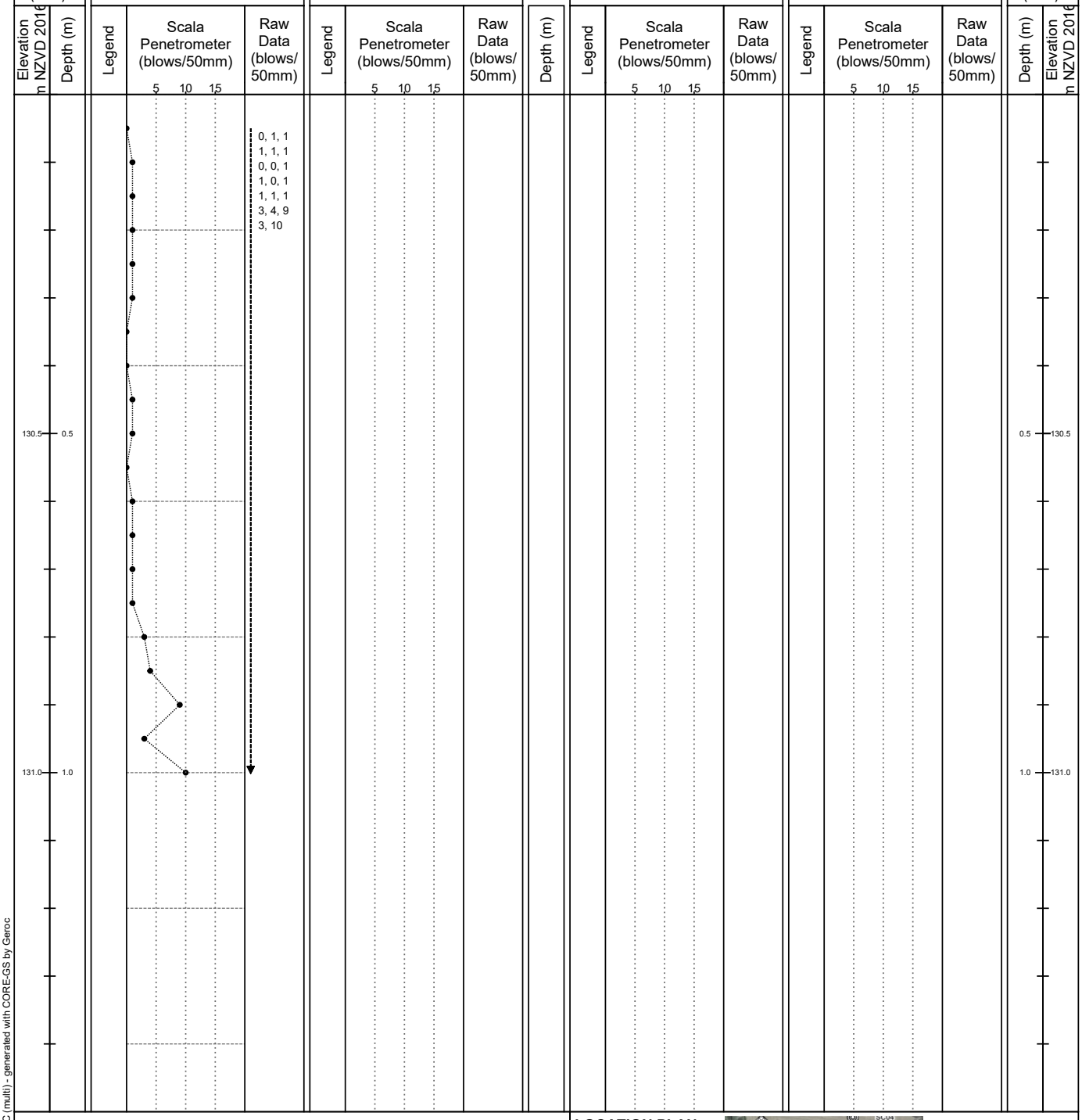
SCALA PENETROMETER TESTS

Project No.:	Project Name:	Project Location:	Sheet:
210422	Masterton Due Diligence	Roger Rennal Drive, Lansdowne, Masterton	1 of 1

Client:	Co-ordinate System:	Elevation (m NZVD 2016):
Welhom Development Ltd	NZTM	130m (SC01)

Test ID:	SC01				Test ID:
Date:	16 Sep 2021				Date
Logged By: / Checked By:	BCF	AvD			Logged By:
Co-ordinates (NZTM):	E 1824552, N 5465458	,	,	,	Co-ordinates (NZTM):



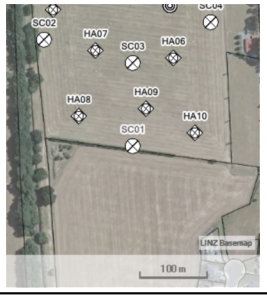
Explanations:

▼ Scala Penetrometer Tests
Raw data in blows per 50mm

Remarks

1. Co-ordinates and elevation are approximate and subject to survey confirmation.
2. Stength terms are based on shear vane tests.
3. Site testing undertaken during period of persistent rain.

LOCATION PLAN



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SCALA PENETROMETER TESTS

Project No.:	Project Name:	Project Location:	Sheet:
210422	Masterton Due Diligence	Roger Rennal Drive, Lansdowne, Masterton	1 of 1

Client:	Co-ordinate System:	Elevation (m NZVD 2016):
Welhom Development Ltd	NZTM	130m (SC02)

Test ID:	SC02				Test ID:
Date:	16 Sep 2021				Date
Logged By: / Checked By:	BCF	AvD			Logged By:
Co-ordinates (NZTM):	E 1824428, N 5465615	,	,	,	Co-ordinates (NZTM):

Elevation m NZVD 2016	Depth (m)	Legend	Scala Penetrometer (blows/50mm) 5 10 15	Raw Data (blows/50mm)	Depth (m)	Elevation m NZVD 2016
130.5	0.5			0, 1, 1 1, 1, 1 0, 1, 2 1, 0, 1 0, 1, 0 1, 0, 3 2, 3	0.5	130.5
131.0	1.0				1.0	131.0

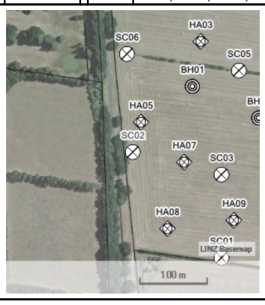
Explanations:

▼ Scala Penetrometer Tests
Raw data in blows per 50mm

Remarks

1. Co-ordinates and elevation are approximate and subject to survey confirmation.
2. Stength terms are based on shear vane tests.
3. Site testing undertaken during period of persistent rain. tests.

LOCATION PLAN



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SCALA PENETROMETER TESTS

Project No.:	Project Name:	Project Location:	Sheet:
210422	Masterton Due Diligence	Roger Rennal Drive, Lansdowne, Masterton	1 of 1

Client:	Co-ordinate System:	Elevation (m NZVD 2016):
Welhom Development Ltd	NZTM	130m (SC03)

Test ID:	SC03			Test ID:
Date:	16 Sep 2021			Date
Logged By: / Checked By:	BCF	AvD		Logged By:
Co-ordinates (NZTM):	E 1824555, N 5465578	,	,	,	Co-ordinates (NZTM):

Elevation m NZVD 2016	Depth (m)	Legend	Scala Penetrometer (blows/50mm) 5 10 15	Raw Data (blows/ 50mm)
130.5	0.5			0, 1, 1 1, 0, 1 0, 0, 1 2, 0, 1 2, 1, 3 6, 3, 5 5, 4
131.0	1.0			

Depth (m)	Legend	Scala Penetrometer (blows/50mm) 5 10 15	Raw Data (blows/ 50mm)
0.5			
1.0			

Depth (m)	Elevation m NZVD 2016
0.5	130.5
1.0	131.0

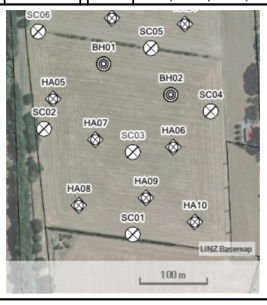
Explanations:

▼ Scala Penetrometer Tests
Raw data in blows per 50mm

Remarks

1. Co-ordinates and elevation are approximate and subject to survey confirmation.
2. Stength terms are based on shear vane tests.
3. Site testing undertaken during period of persistent rain.

LOCATION PLAN



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SCALA PENETROMETER TESTS

Project No.:	Project Name:	Project Location:	Sheet:
210422	Masterton Due Diligence	Roger Rennal Drive, Lansdowne, Masterton	1 of 1

Client:	Co-ordinate System:	Elevation (m NZVD 2016):
Welhom Development Ltd	NZTM	130m (SC04)

Test ID:	SC04			Test ID:
Date:	16 Sep 2021			Date
Logged By: / Checked By:	RJF	AvD		Logged By:
Co-ordinates (NZTM):	E 1824671, N 5465633	,	,	,	Co-ordinates (NZTM):

Elevation m NZVD 2016	Depth (m)	Legend	Scala Penetrometer (blows/50mm) 5 10 15	Raw Data (blows/ 50mm)
130.5	0.5			0, 1, 0 1, 1, 1 1, 0, 1 0, 1, 1 1, 1, 2 2, 2, 2 5, 20
131.0	1.0			

Depth (m)	Legend	Scala Penetrometer (blows/50mm) 5 10 15	Raw Data (blows/ 50mm)
0.5	130.5		
1.0	131.0		

Explanations:

▼ Scala Penetrometer Tests
Raw data in blows per 50mm

Remarks

1. Co-ordinates and elevation are approximate and subject to survey confirmation.
2. Stength terms are based on shear vane tests.
3. Site testing undertaken during period of persistent rain.

LOCATION PLAN

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SCALA PENETROMETER TESTS

Project No.:	Project Name:	Project Location:	Sheet:
210422	Masterton Due Diligence	Roger Rennal Drive, Lansdowne, Masterton	1 of 1

Client:	Co-ordinate System:	Elevation (m NZVD 2016):
Welhom Development Ltd	NZTM	130m (SC05)

Test ID:	SC05			Test ID:
Date:	16 Sep 2021			Date
Logged By: / Checked By:	RJF	AvD		Logged By:
Co-ordinates (NZTM):	E 1824586, N 5465727	,	,	,	Co-ordinates (NZTM):

Elevation m NZVD 2016	Depth (m)	Legend	Scala Penetrometer (blows/50mm) 5 10 15	Raw Data (blows/ 50mm)
130.5	0.5			1, 0, 1 2, 1, 0 1, 1, 2 1, 2, 1 2, 1, 2 4, 7, 5 2, 3
131.0	1.0			

Depth (m)	Legend	Scala Penetrometer (blows/50mm) 5 10 15	Raw Data (blows/ 50mm)
0.5			
1.0			

Depth (m)	Elevation m NZVD 2016
0.5	130.5
1.0	131.0

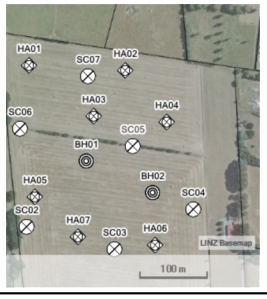
Explanations:

▼ Scala Penetrometer Tests
Raw data in blows per 50mm

Remarks

1. Co-ordinates and elevation are approximate and subject to survey confirmation.
2. Stength terms are based on shear vane tests.
3. Site testing undertaken during period of persistent rain. tests.

LOCATION PLAN



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SCALA PENETROMETER TESTS

Project No.:	Project Name:	Project Location:	Sheet:
210422	Masterton Due Diligence	Roger Rennal Drive, Lansdowne, Masterton	1 of 1

Client:	Co-ordinate System:	Elevation (m NZVD 2016):
Welhom Development Ltd	NZTM	130m (SC06)

Test ID:	SC06			Test ID:
Date:	16 Sep 2021			Date
Logged By: / Checked By:	RJF	AvD		Logged By:
Co-ordinates (NZTM):	E 1824423, N 5465756	,	,	,	Co-ordinates (NZTM):

Elevation m NZVD 2016	Depth (m)	Legend	Scala Penetrometer (blows/50mm) 5 10 15	Raw Data (blows/ 50mm)
130.5	0.5			0, 1, 0 1, 0, 1 1, 2, 1 1, 1, 1 2, 0, 2 1, 1, 2 3, 4
131.0	1.0			

Depth (m)	Legend	Scala Penetrometer (blows/50mm) 5 10 15	Raw Data (blows/ 50mm)
0.5			
1.0			

Depth (m)	Legend	Scala Penetrometer (blows/50mm) 5 10 15	Raw Data (blows/ 50mm)
0.5			
1.0			

Depth (m)	Legend	Scala Penetrometer (blows/50mm) 5 10 15	Raw Data (blows/ 50mm)	Elevation m NZVD 2016
0.5				130.5
1.0				131.0

Explanations:

▼ Scala Penetrometer Tests
Raw data in blows per 50mm

Remarks

1. Co-ordinates and elevation are approximate and subject to survey confirmation.
2. Stength terms are based on shear vane tests.
3. Site testing undertaken during period of persistent rain.

LOCATION PLAN

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SCALA PENETROMETER TESTS

Project No.:	Project Name:	Project Location:	Sheet:
210422	Masterton Due Diligence	Roger Rennal Drive, Lansdowne, Masterton	1 of 1

Client:	Co-ordinate System:	Elevation (m NZVD 2016):
Welhom Development Ltd	NZTM	130m (SC07)

Test ID:	SC07			Test ID:
Date:	16 Sep 2021			Date
Logged By: / Checked By:	RJF	AvD		Logged By:
Co-ordinates (NZTM):	E 1824524, N 5465829	,	,	,	Co-ordinates (NZTM):

Elevation m NZVD 2016	Depth (m)	Legend	Scala Penetrometer (blows/50mm) 5 10 15	Raw Data (blows/50mm)
130.5	0.5			0, 1, 0 1, 0, 1 1, 0, 1 1, 0, 1 1, 1, 1 1, 1, 2 3, 2
131.0	1.0			

Depth (m)	Legend	Scala Penetrometer (blows/50mm) 5 10 15	Raw Data (blows/50mm)
0.5			
1.0			

Depth (m)	Elevation m NZVD 2016
0.5	130.5
1.0	131.0

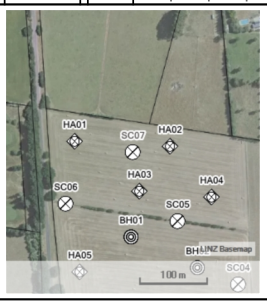
Explanations:

▼ Scala Penetrometer Tests
Raw data in blows per 50mm

Remarks

1. Co-ordinates and elevation are approximate and subject to survey confirmation.
2. Stength terms are based on shear vane tests.
3. Site testing undertaken during period of persistent rain.

LOCATION PLAN



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Appendix B

Core Photographs

Client / Project:	WELHOM DEVELOPMENTS LTD GEOTECHNICAL ASSESSMENT DUE DILIGENCE BOREHOLE CORE PHOTOS	**Hole ID:**	**BH01**	RILEY CONSULTANTS
		Date:	Sep 2021	
Notes:	1. Drill sampling method: Rotary Sonic (approx. 78mm sample diameter). 2. Markers: start/end of run in metres; "CL" indicates core loss in metres; brackets indicate run split between boxes	**Box No(s).**	1 and 2 of 7	
		Depth from (m):	0.00m	
		Depth To (m):	4.70m	
Project No.	210422	**Interval (m):**	4.70m	

Date printed 6 October 2021

Client / Project:	WELHOM DEVELOPMENTS LTD GEOTECHNICAL ASSESSMENT DUE DILIGENCE BOREHOLE CORE PHOTOS	**Hole ID:**	**BH01**	RILEY CONSULTANTS
		Date:	Sep 2021	
Notes:	1. Drill sampling method: Rotary Sonic (approx. 78mm sample diameter). 2. Markers: start/end of run in metres; "CL" indicates core loss in metres; brackets indicate run split between boxes	**Box No(s).**	3 and 4 of 7	
		Depth from (m):	4.70m	
		Depth To (m):	9.90m	
Project No.	210422	**Interval (m):**	5.20m	

Date printed 6 October 2021

Client / Project:	WELHOM DEVELOPMENTS LTD GEOTECHNICAL ASSESSMENT DUE DILIGENCE BOREHOLE CORE PHOTOS	**Hole ID:**	**BH01**	RILEY CONSULTANTS
Notes:	1. Drill sampling method: Rotary Sonic (approx. 78mm sample diameter). 2. Markers: start/end of run in metres; "CL" indicates core loss in metres; brackets indicate run split between boxes	**Date:**	Sep 2021	
		Box No(s).	5 and 6 of 7	
		Depth from (m):	9.90m	
		Depth To (m):	14.60m	
Project No.	210422	**Interval (m):**	4.70m	

Date printed 6 October 2021

Client / Project:	WELHOM DEVELOPMENTS LTD GEOTECHNICAL ASSESSMENT DUE DILIGENCE BOREHOLE CORE PHOTOS	**Hole ID:**	**BH01**	RILEY CONSULTANTS
		Date:	Sep 2021	
Notes:	1. Drill sampling method: Rotary Sonic (approx. 78mm sample diameter). 2. Markers: start/end of run in metres; "CL" indicates core loss in metres; brackets indicate run split between boxes	**Box No(s).**	7 of 7	
		Depth from (m):	14.60m	
		Depth To (m):	15.20m	
Project No.	210422	**Interval (m):**	0.80m	

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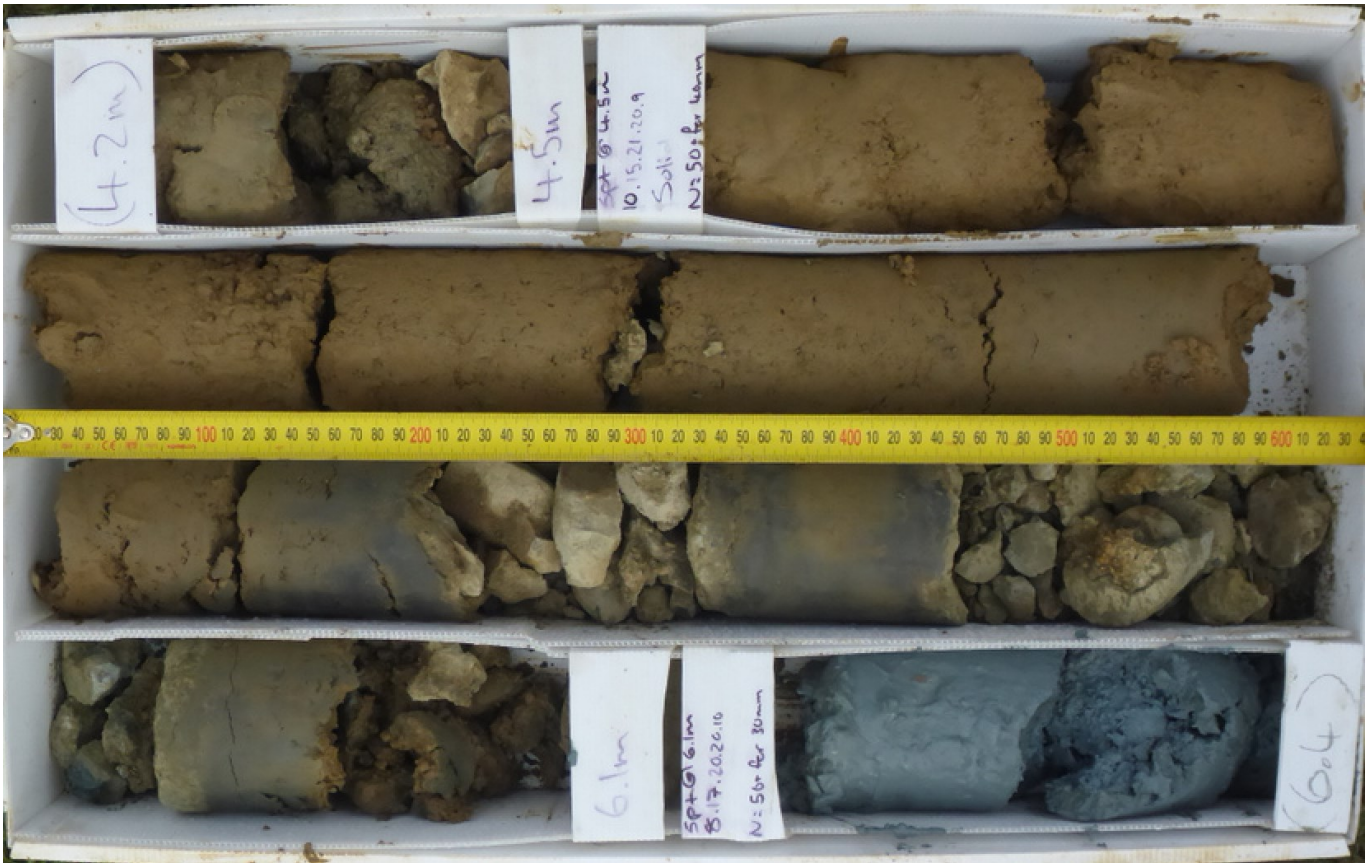
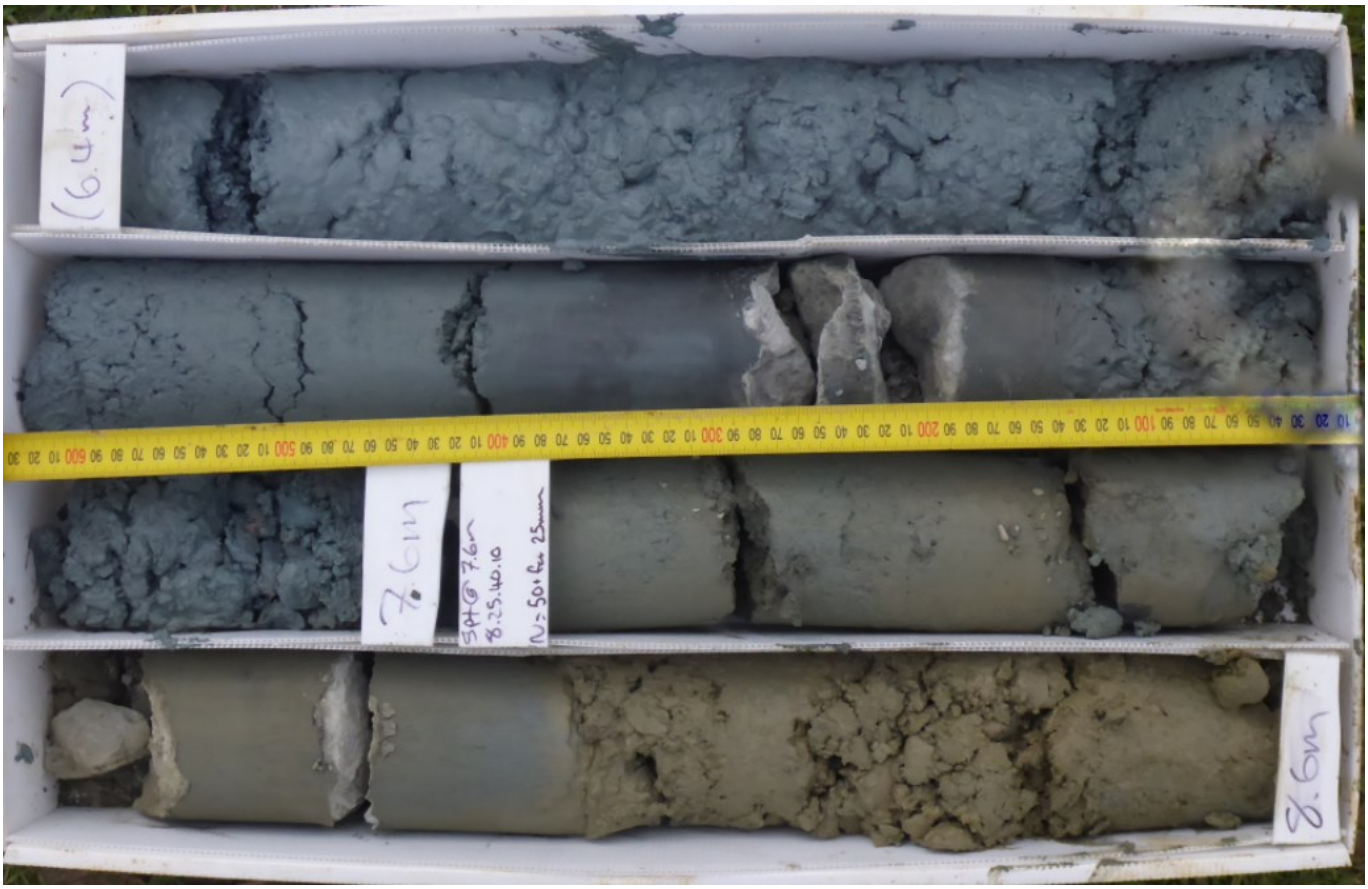
Client / Project:	WELHOM DEVELOPMENTS LTD GEOTECHNICAL ASSESSMENT DUE DILIGENCE BOREHOLE CORE PHOTOS	**Hole ID:**	**BH02**	RILEY CONSULTANTS
		Date:	Sep 2021	
Notes:	1. Drill sampling method: Rotary Sonic (approx. 78mm sample diameter). 2. Markers: start/end of run in metres; "CL" indicates core loss in metres; brackets indicate run split between boxes	**Box No(s).**	1 and 2 of 7	
		Depth from (m):	0.00m	
		Depth To (m):	4.20m	
Project No.	210422	**Interval (m):**	4.20m	

Date printed 6 October 2021





Client / Project:	WELHOM DEVELOPMENTS LTD GEOTECHNICAL ASSESSMENT DUE DILIGENCE BOREHOLE CORE PHOTOS	**Hole ID:**	**BH02**
		Date:	Sep 2021
Notes:	1. Drill sampling method: Rotary Sonic (approx. 78mm sample diameter). 2. Markers: start/end of run in metres; "CL" indicates core loss in metres; brackets indicate run split between boxes	**Box No(s).**	3 and 4 of 7
		Depth from (m):	4.44m
		Depth To (m):	8.60m
Project No.	210422	**Interval (m):**	4.36m

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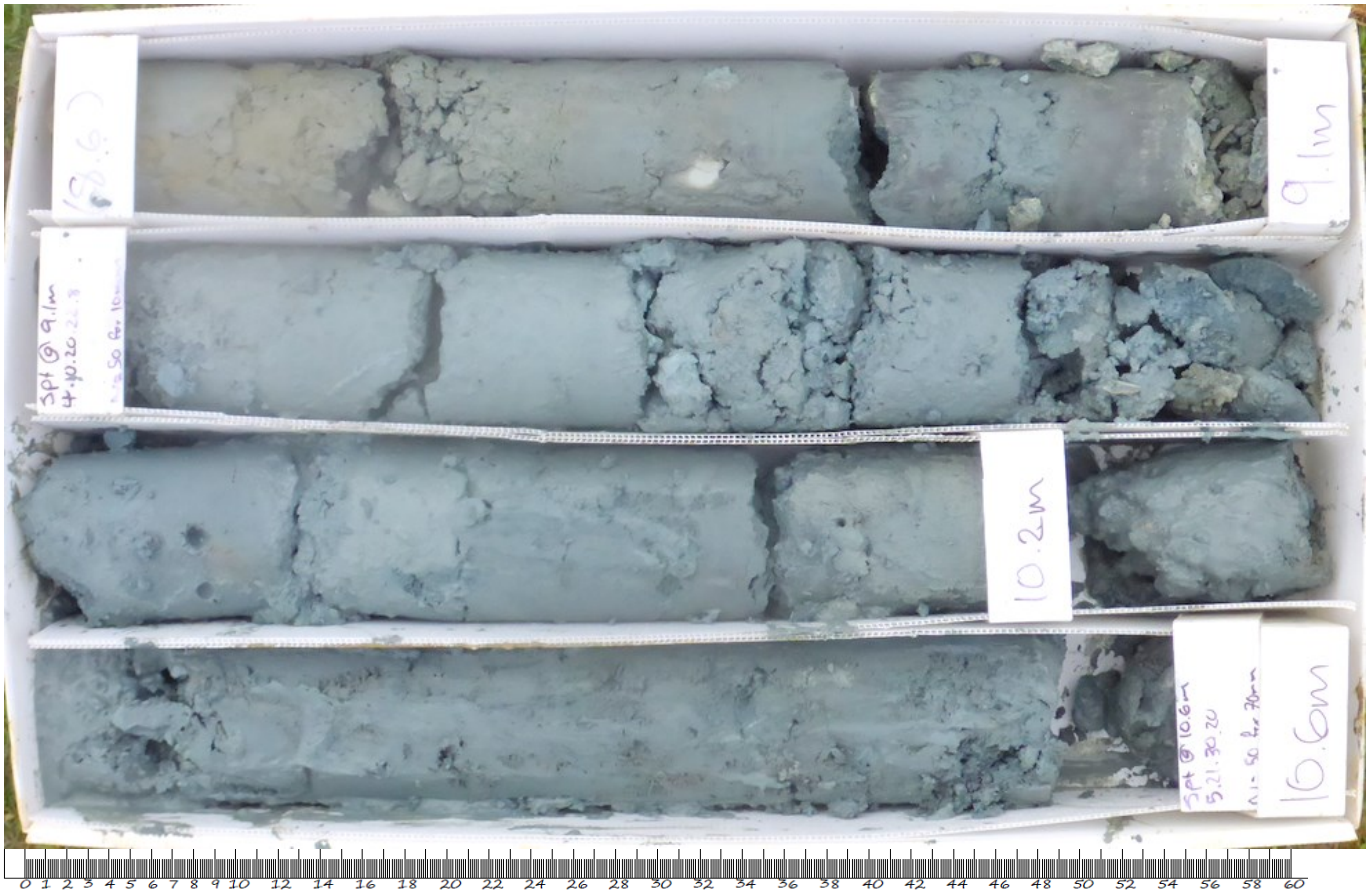
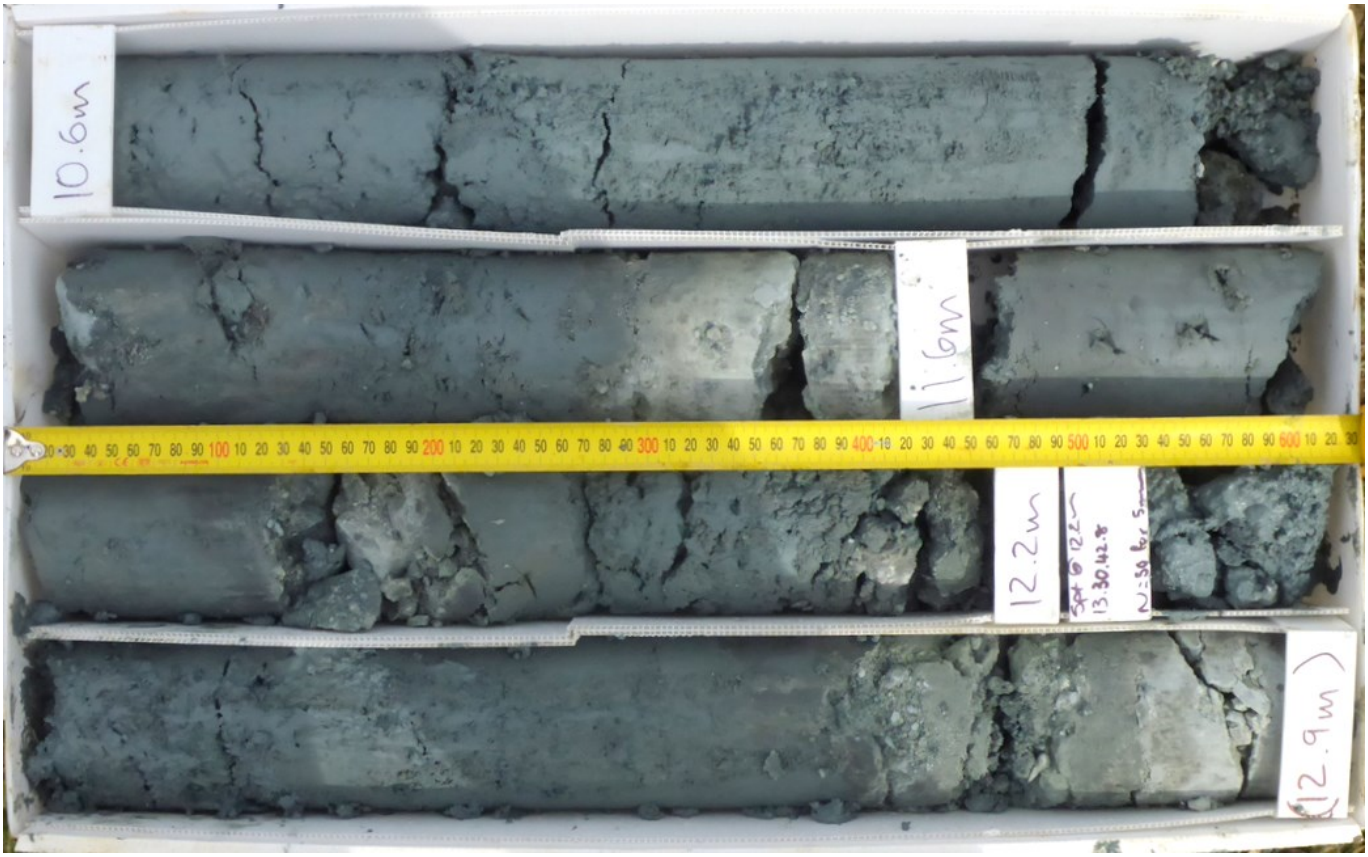




Client / Project:	WELHOM DEVELOPMENTS LTD GEOTECHNICAL ASSESSMENT DUE DILIGENCE BOREHOLE CORE PHOTOS	**Hole ID:**	**BH02**	RILEY CONSULTANTS
Notes:	1. Drill sampling method: Rotary Sonic (approx. 78mm sample diameter). 2. Markers: start/end of run in metres; "CL" indicates core loss in metres; brackets indicate run split between boxes	**Date:**	Sep 2021	
		Box No(s).	5 and 6 of 7	
		Depth from (m):	8.60m	
		Depth To (m):	12.90m	
Project No.	210422	**Interval (m):**	4.30m	

Date printed 6 October 2021

Client / Project:	WELHOM DEVELOPMENTS LTD GEOTECHNICAL ASSESSMENT DUE DILIGENCE BOREHOLE CORE PHOTOS	**Hole ID:**	**BH02**	RILEY CONSULTANTS
		Date:	Sep 2021	
Notes:	1. Drill sampling method: Rotary Sonic (approx. 78mm sample diameter). 2. Markers: start/end of run in metres; "CL" indicates core loss in metres; brackets indicate run split between boxes	**Box No(s).**	7 of 7	
		Depth from (m):	12.90m	
		Depth To (m):	15.20m	
Project No.	210422	**Interval (m):**	2.30m	

Date printed 6 October 2021

Appendix C

Liquefaction Analysis and Soakage Results

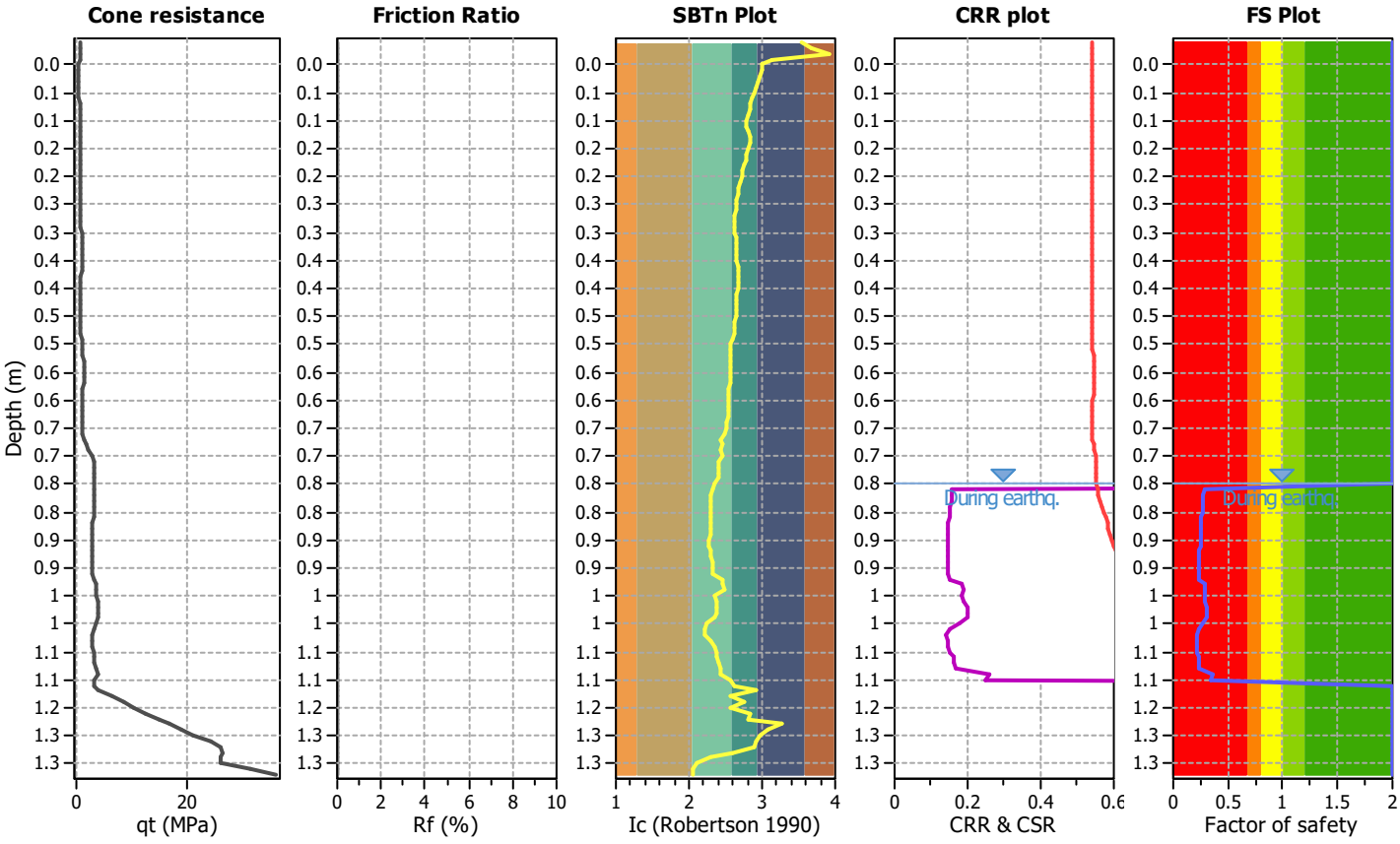
LIQUEFACTION ANALYSIS REPORT

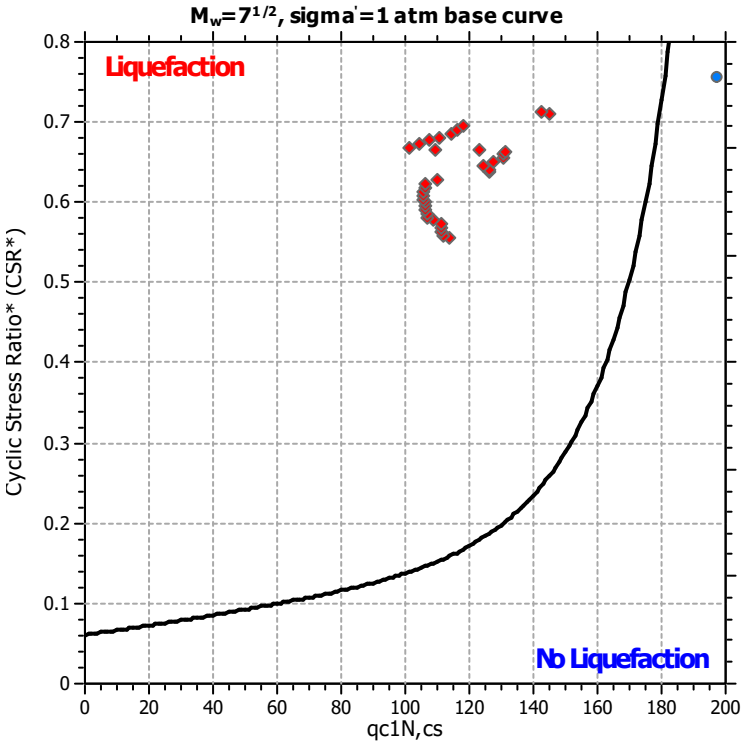
Project title : 210422 Masterton Plan Change **Location : Cashmere Oaks Drive, Masterton**

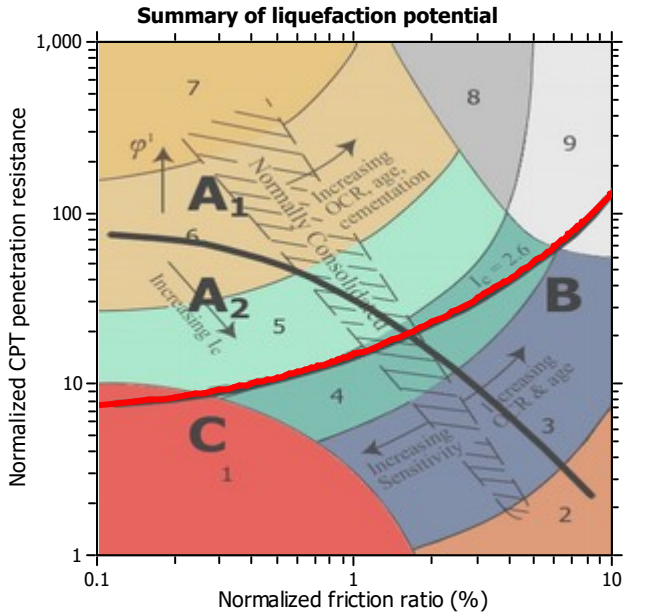
CPT file : 16-CPT01

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	0.80 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	0.80 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	10.00 m
Earthquake magnitude M_w:	7.70	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.91	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

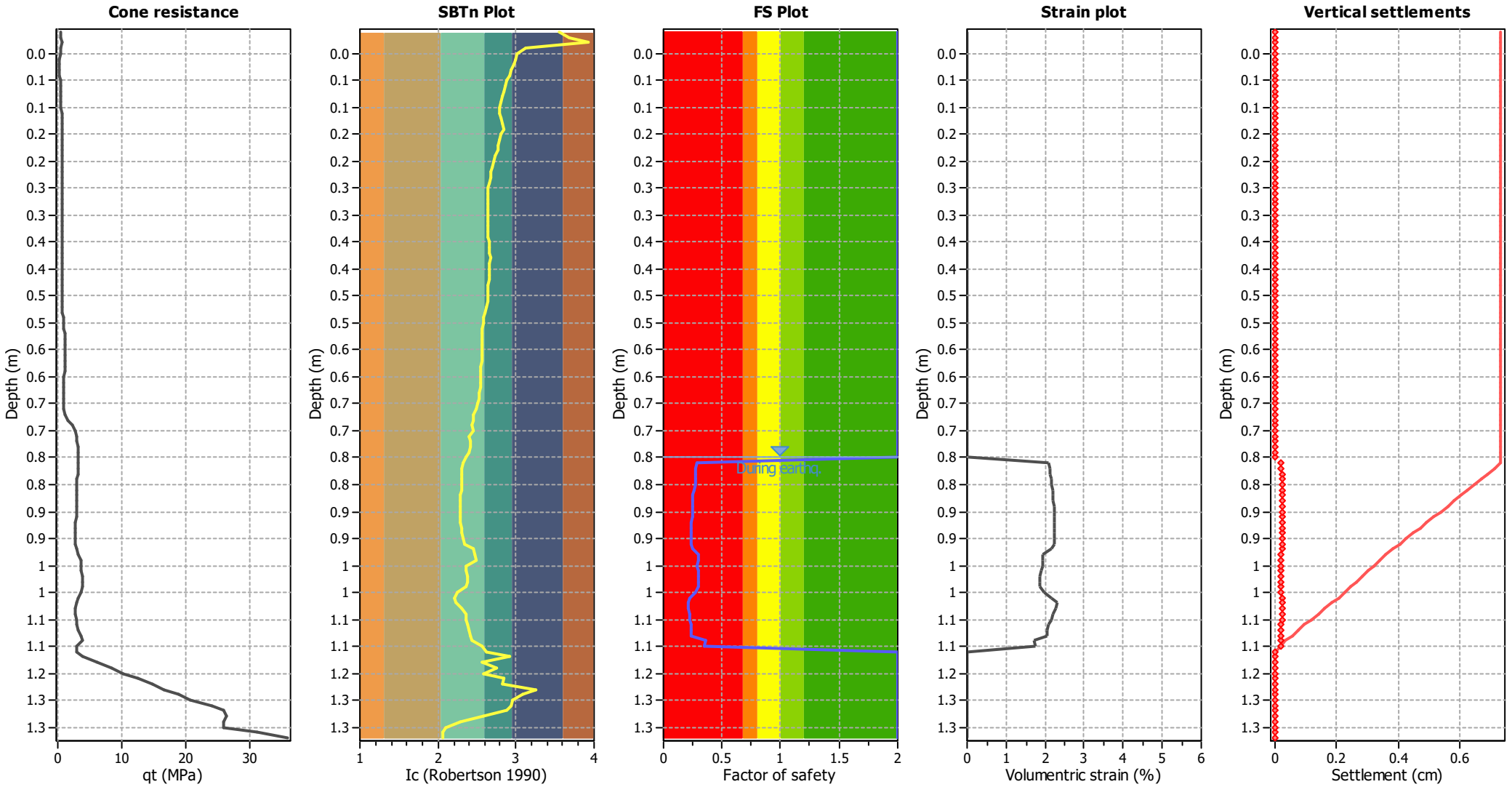






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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
Volumentric strain:	Post-liquefaction volumentric strain

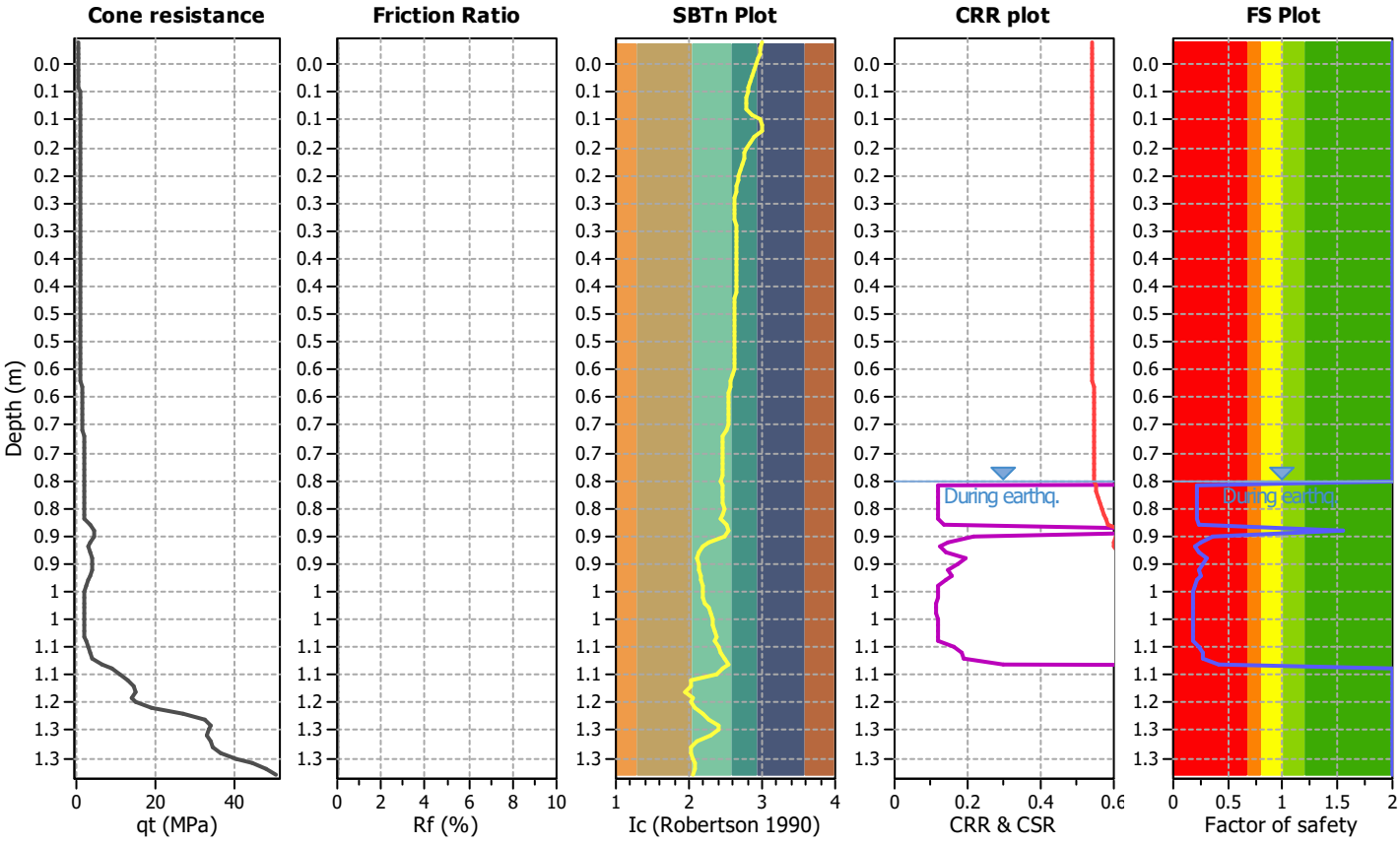
LIQUEFACTION ANALYSIS REPORT

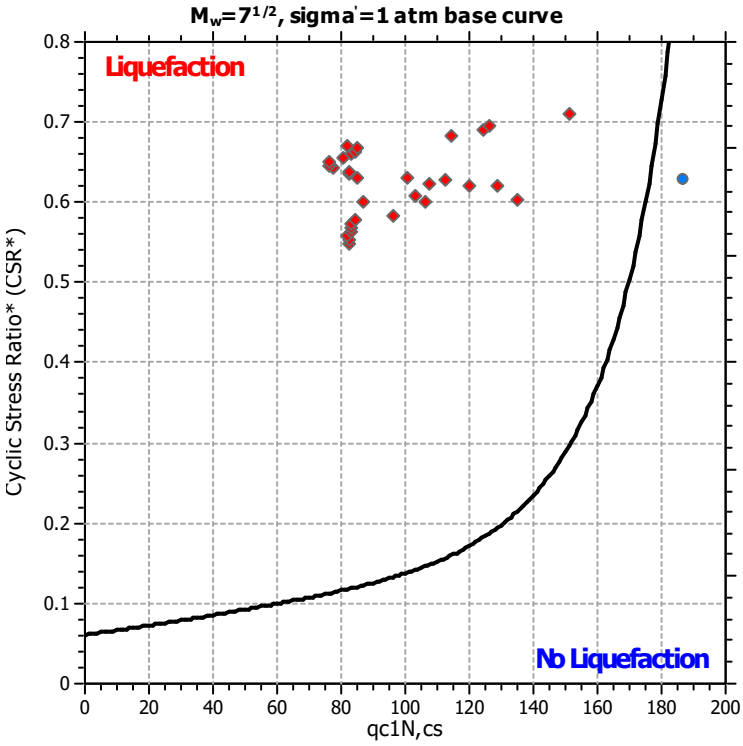
Project title : 210422 Masterton Plan Change **Location : Cashmere Oaks Drive, Masterton**

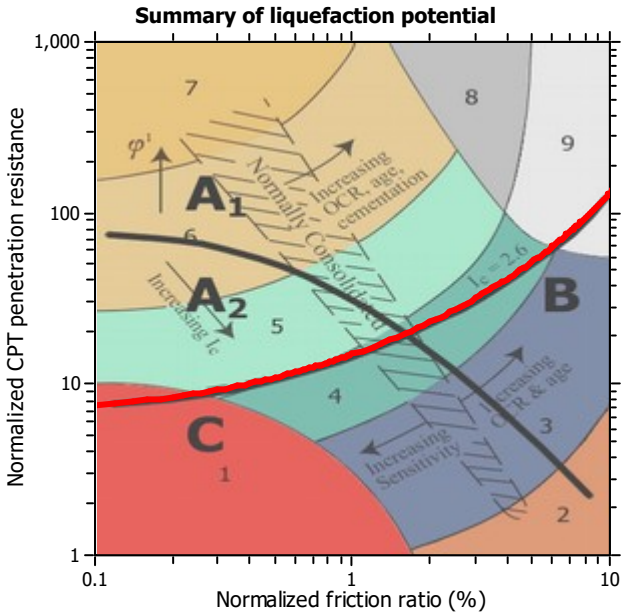
CPT file : 16-CPT02

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	0.80 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	0.80 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	10.00 m
Earthquake magnitude M_w:	7.70	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.91	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

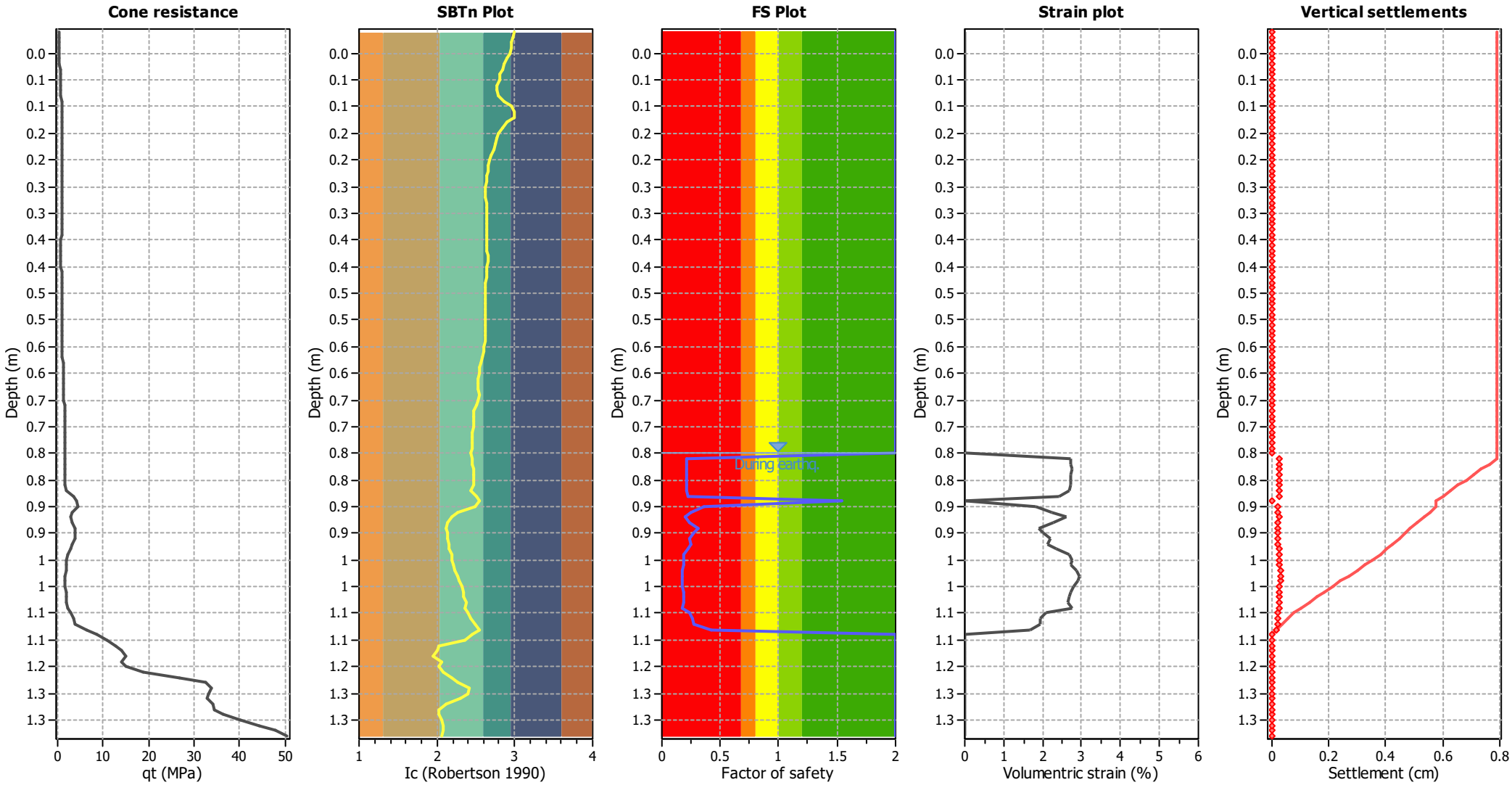






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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
Volumentric strain:	Post-liquefaction volumentric strain

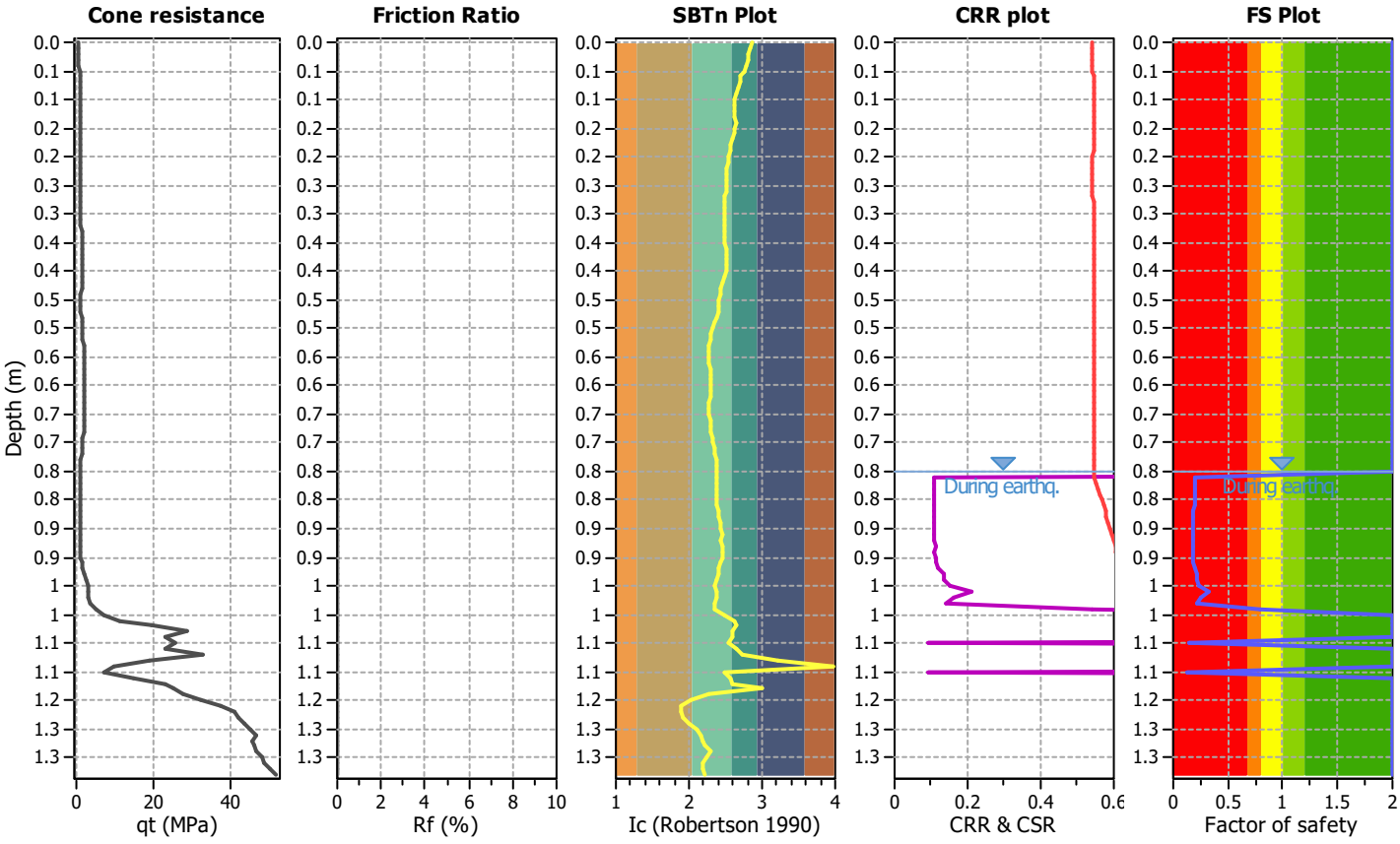
LIQUEFACTION ANALYSIS REPORT

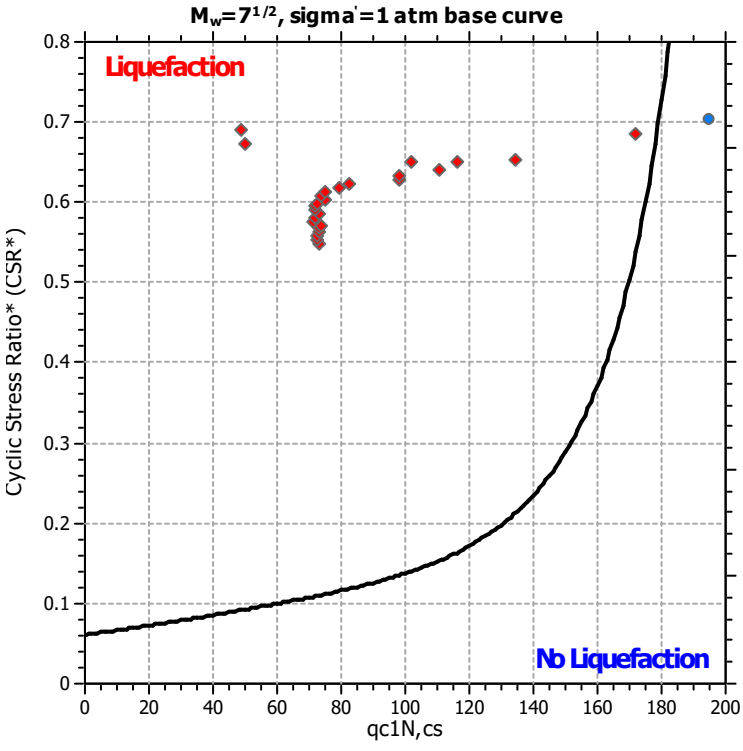
Project title : 210422 Masterton Plan Change **Location : Cashmere Oaks Drive, Masterton**

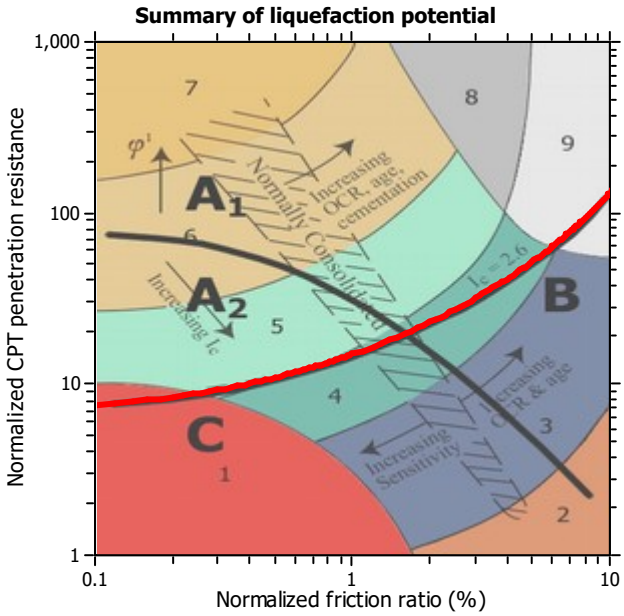
CPT file : 16-CPT03

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	0.80 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	0.80 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	10.00 m
Earthquake magnitude M_w:	7.70	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.91	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

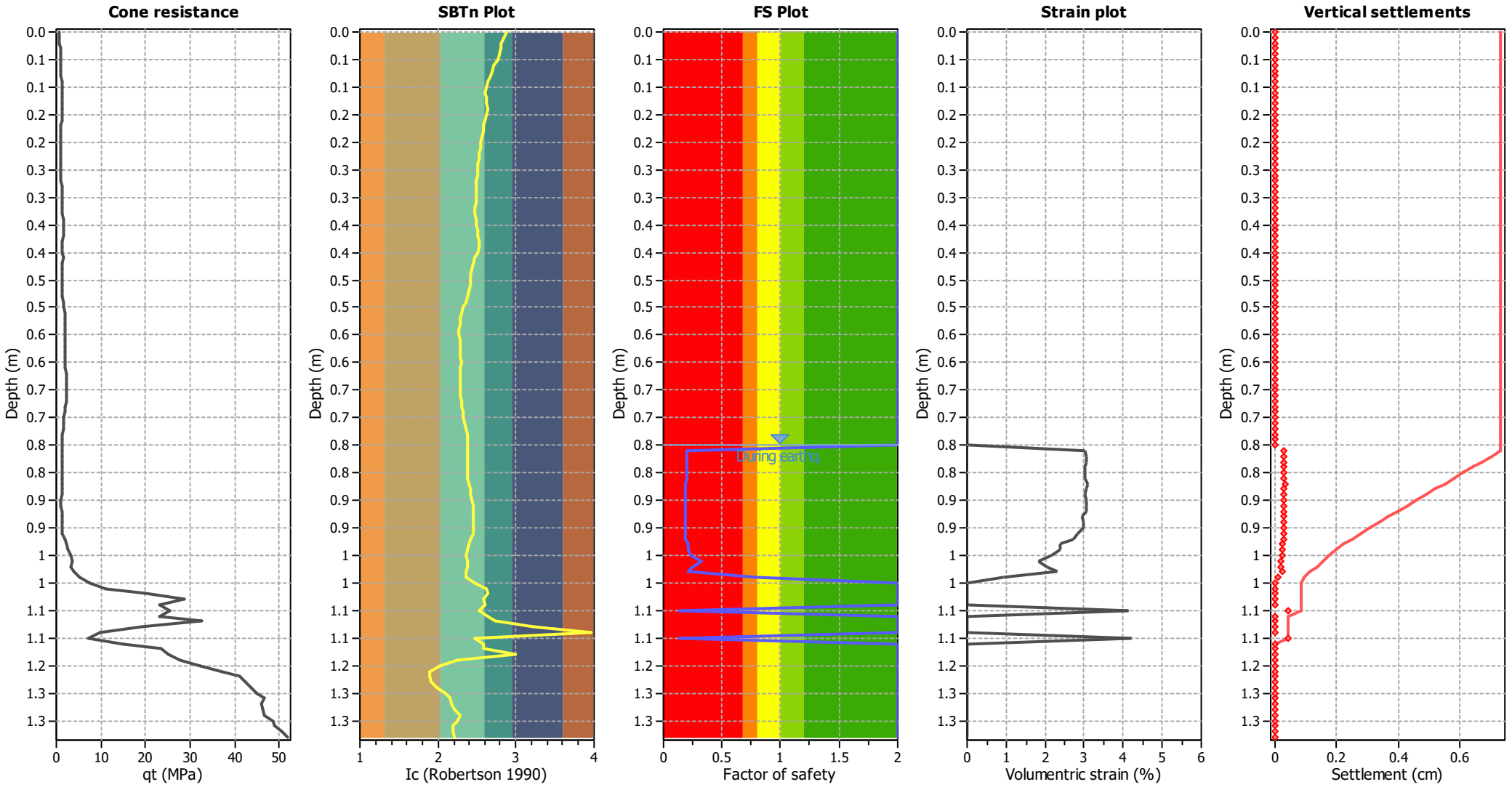






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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
Volumentric strain:	Post-liquefaction volumentric strain

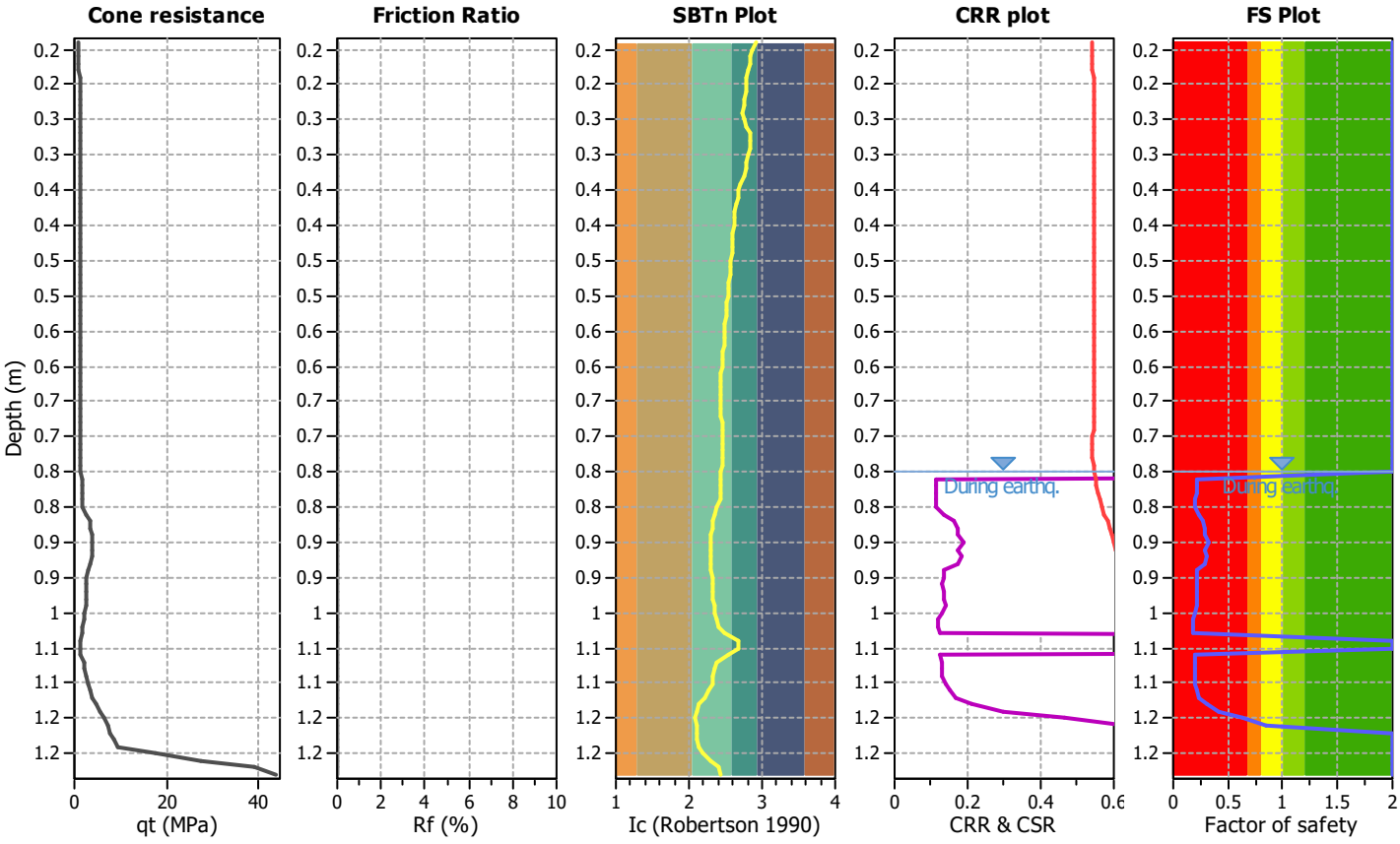
LIQUEFACTION ANALYSIS REPORT

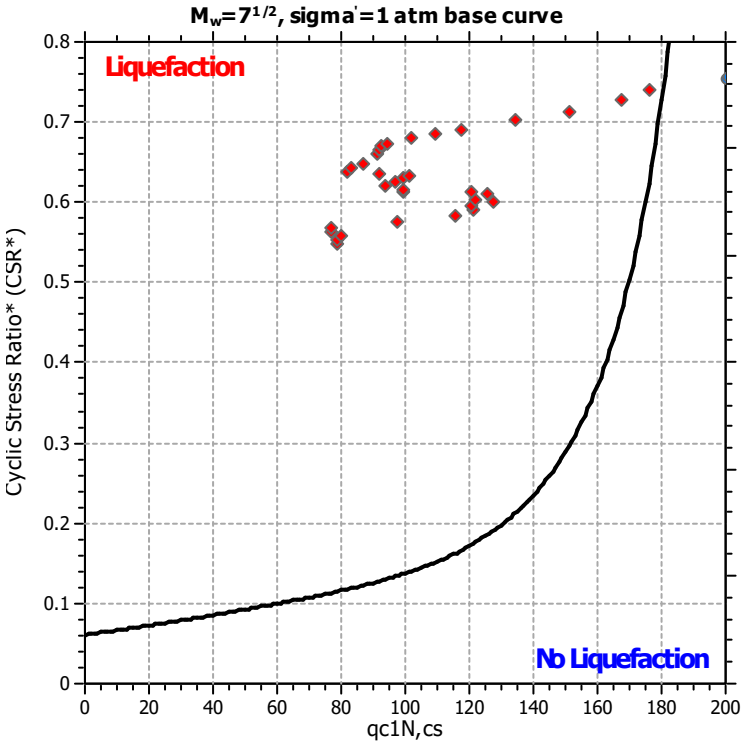
Project title : 210422 Masterton Plan Change **Location : Cashmere Oaks Drive, Masterton**

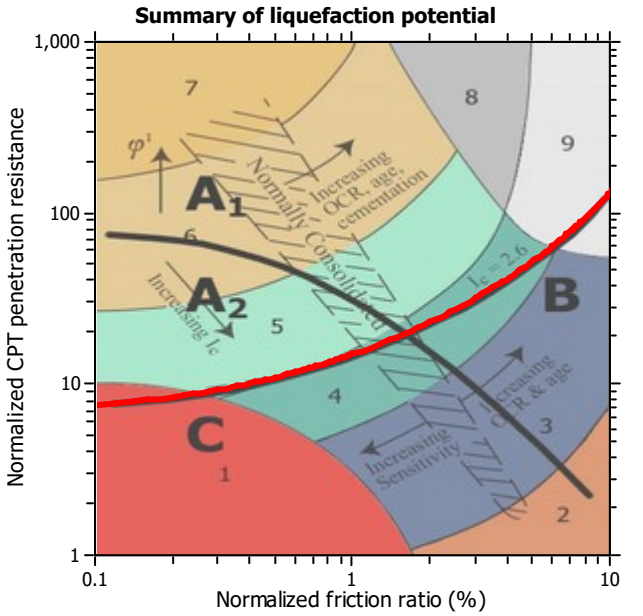
CPT file : 16-CPT04

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	0.80 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	0.80 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	10.00 m
Earthquake magnitude M_w:	7.70	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.91	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

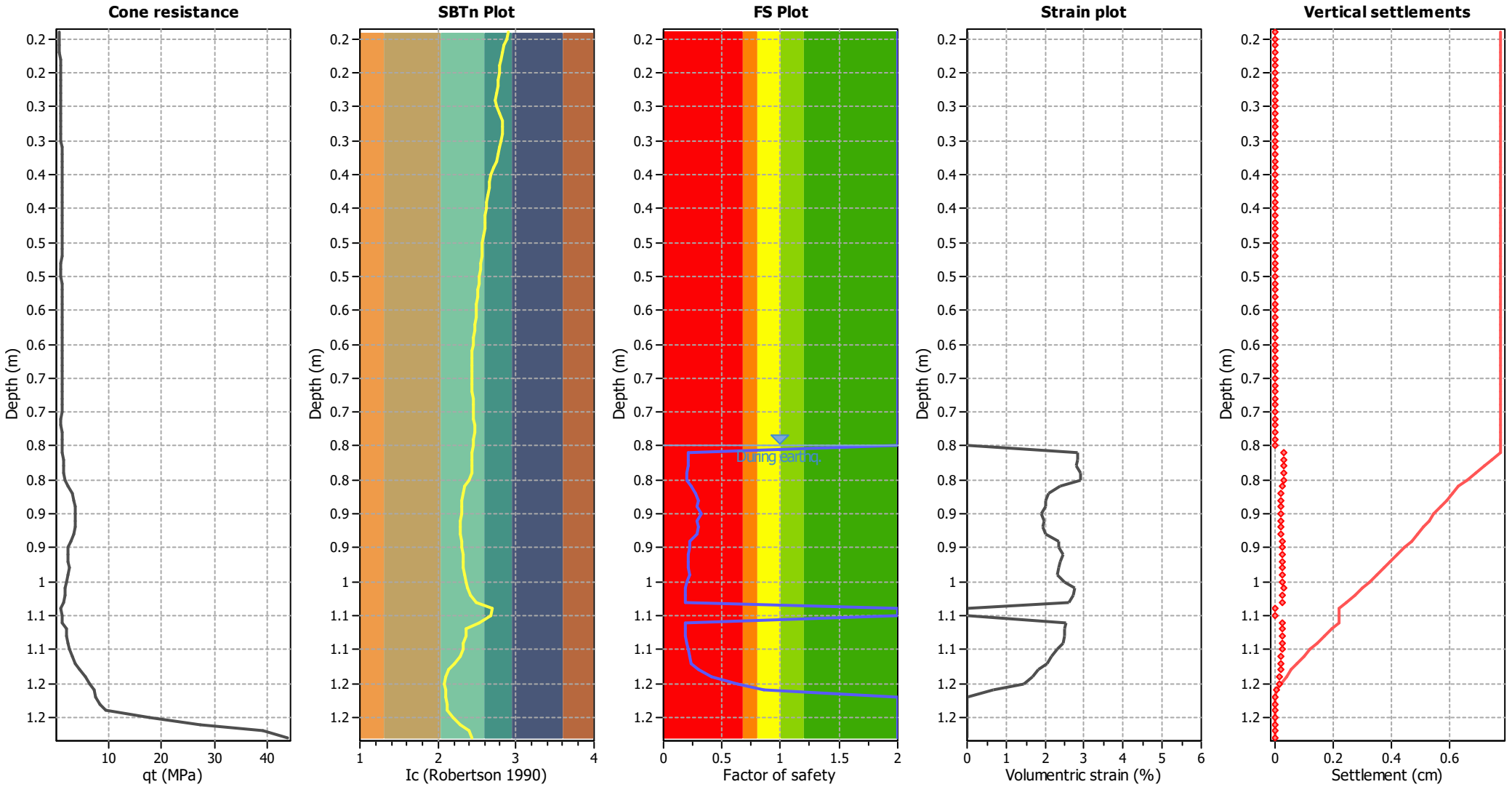






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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
Volumentric strain:	Post-liquefaction volumentric strain

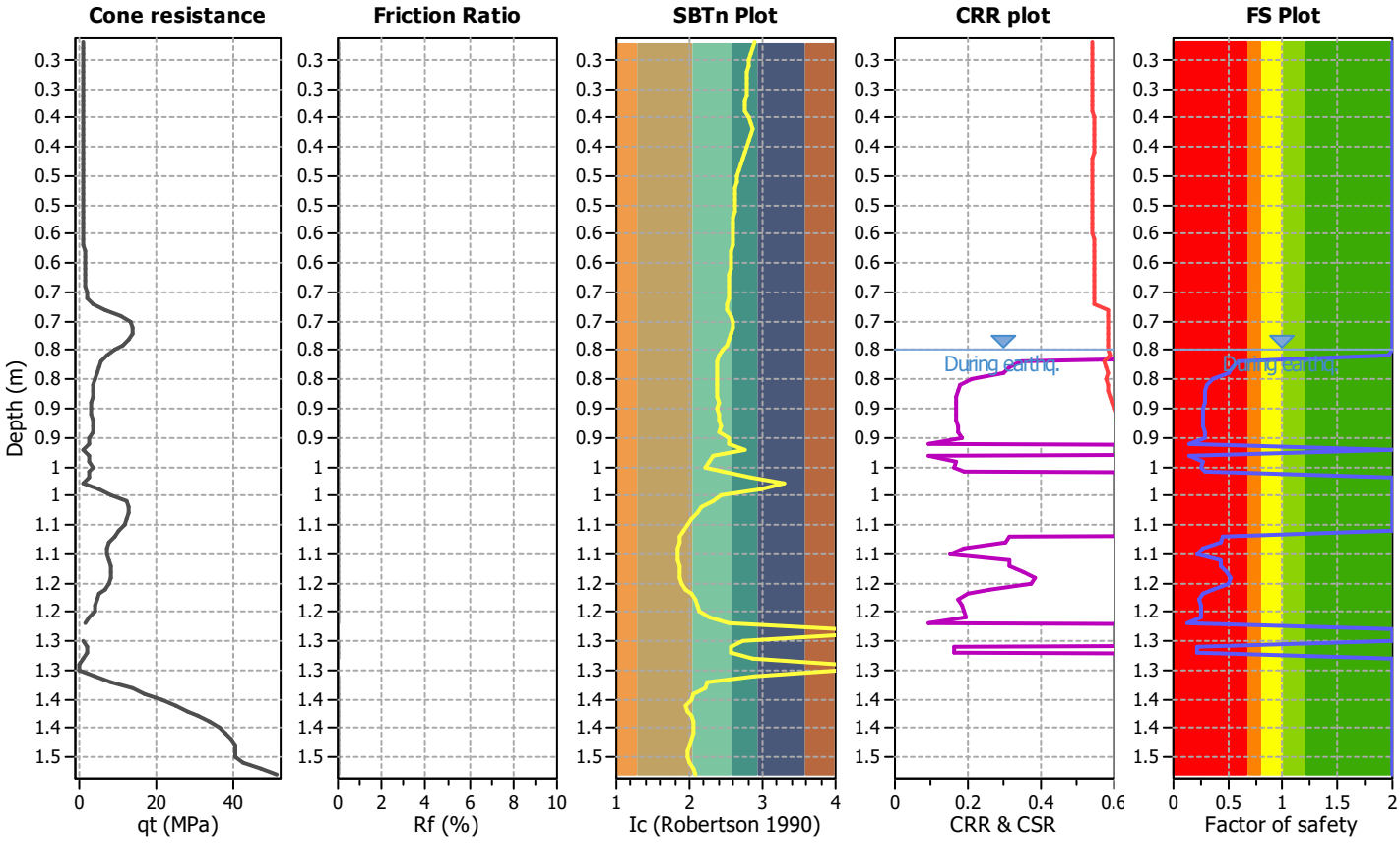
LIQUEFACTION ANALYSIS REPORT

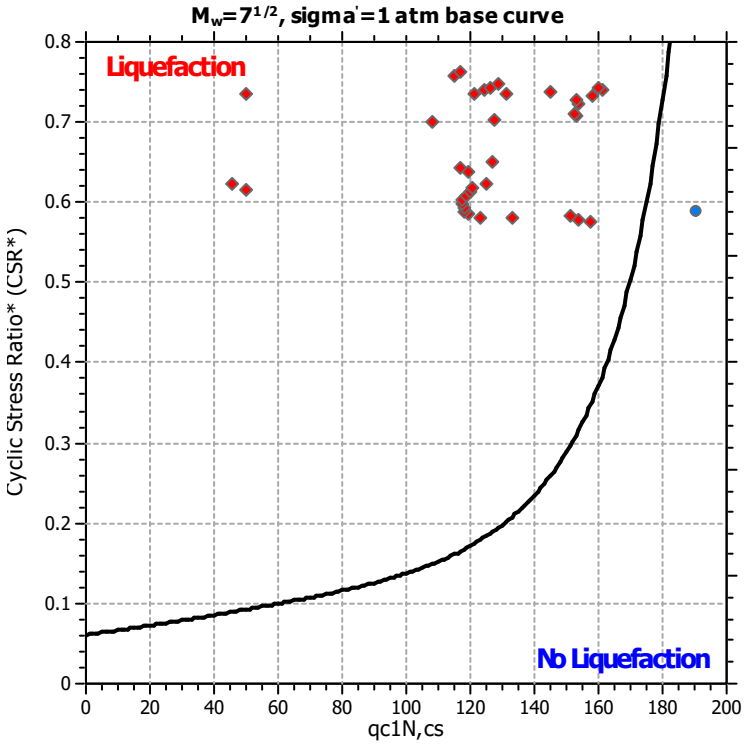
Project title : 210422 Masterton Plan Change **Location : Cashmere Oaks Drive, Masterton**

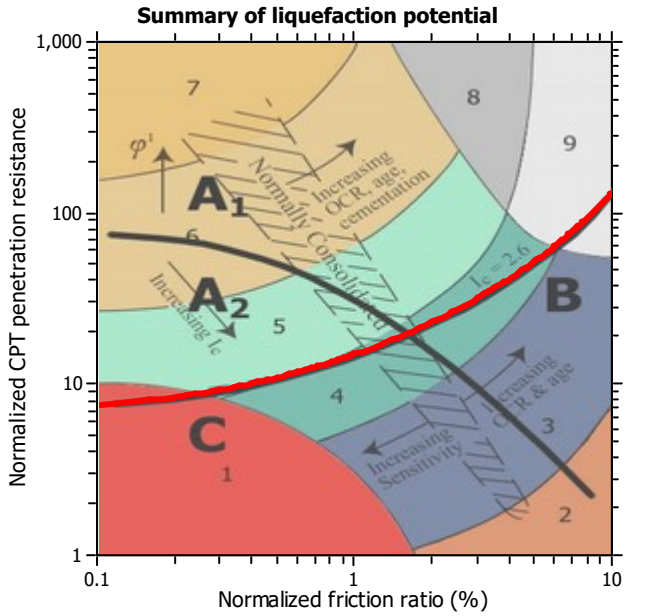
CPT file : 16-CPT05

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	0.80 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	0.80 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	10.00 m
Earthquake magnitude M_w:	7.70	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.91	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

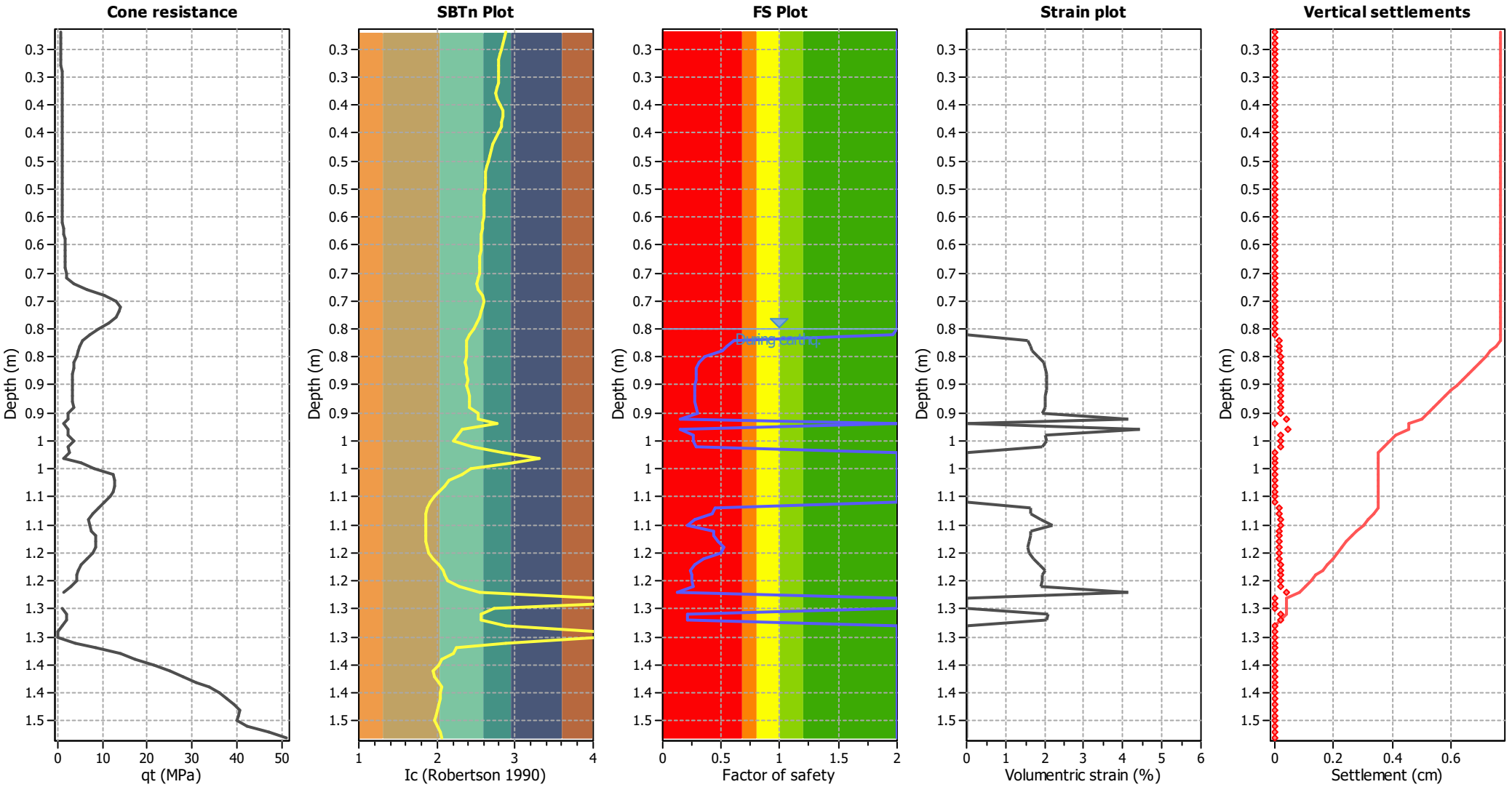






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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
Volumentric strain:	Post-liquefaction volumentric strain

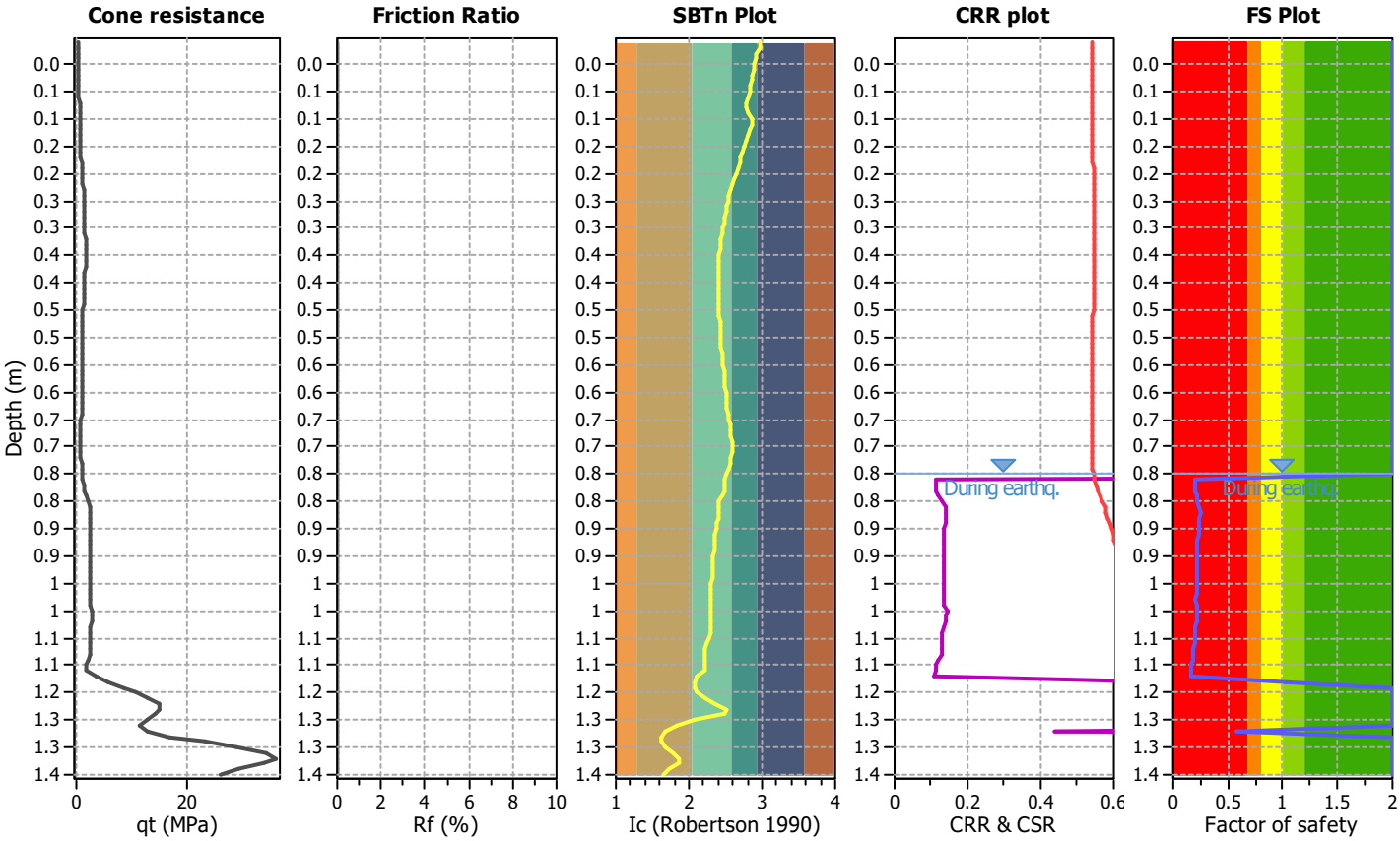
LIQUEFACTION ANALYSIS REPORT

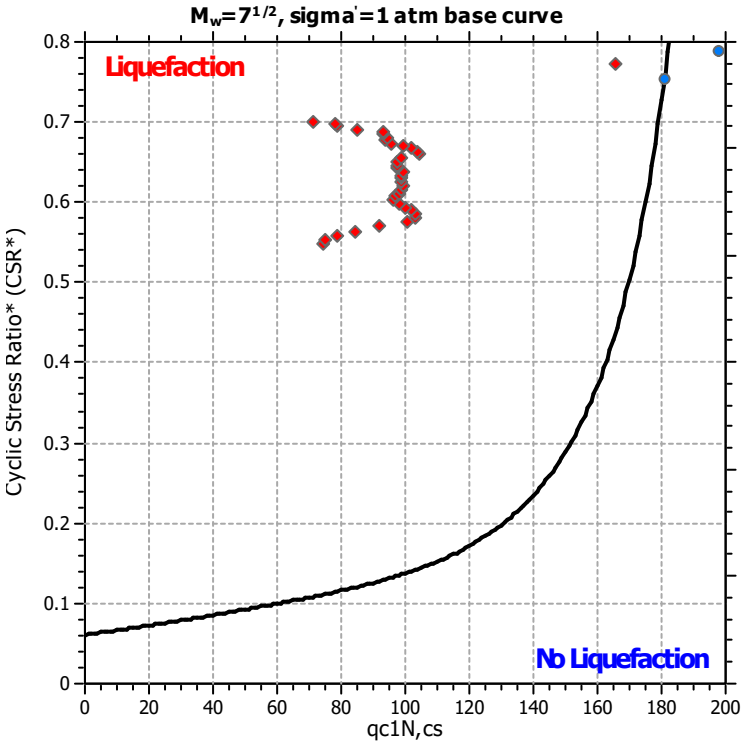
Project title : 210422 Masterton Plan Change **Location : Cashmere Oaks Drive, Masterton**

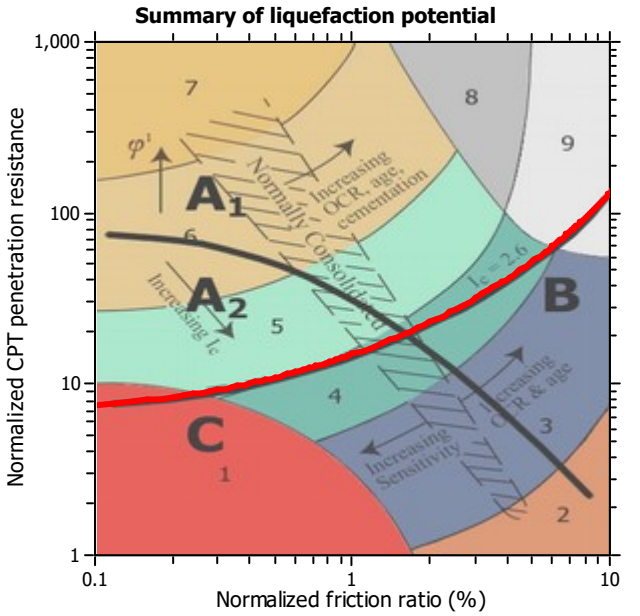
CPT file : 16-CPT06

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	0.80 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	0.80 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	10.00 m
Earthquake magnitude M_w:	7.70	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.91	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

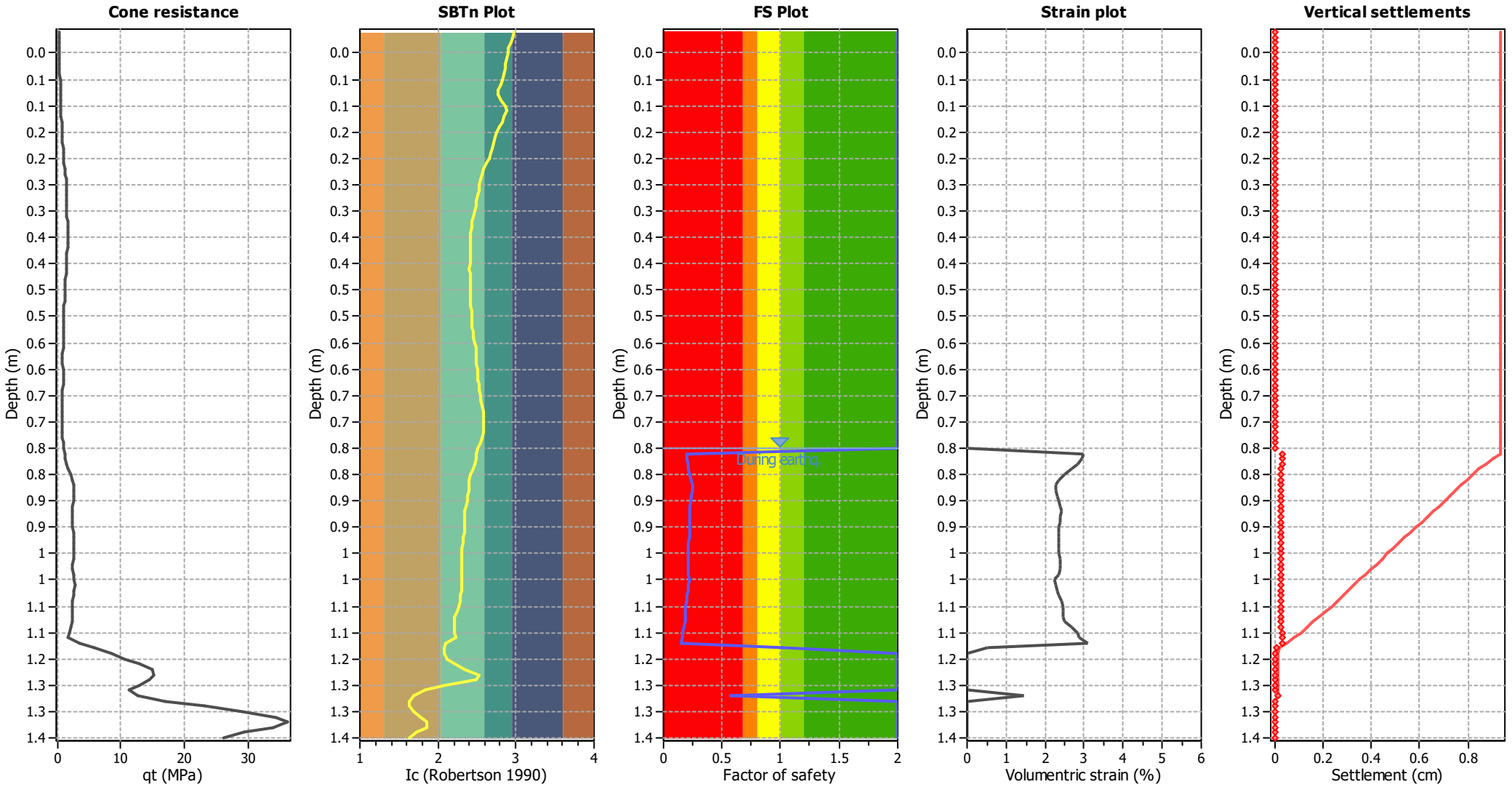






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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
Volumentric strain:	Post-liquefaction volumentric strain

Figure 1: Falling head soakage test results within hand auger boreholes

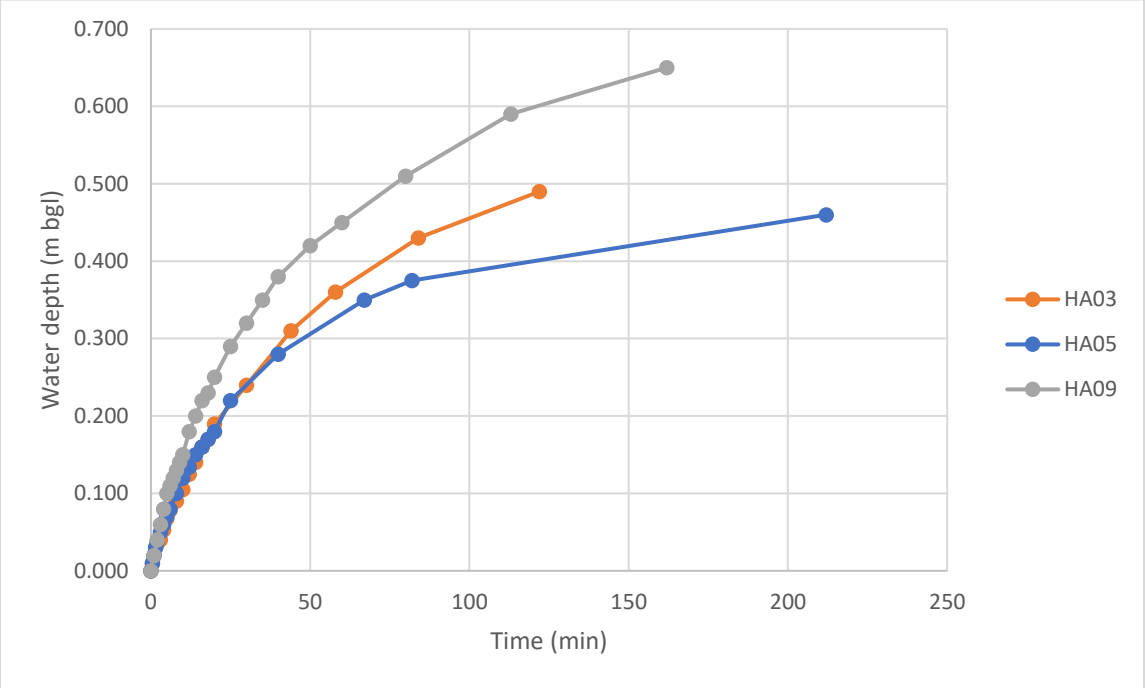


Figure 2: Falling head soakage test results with machine hole (BH02)

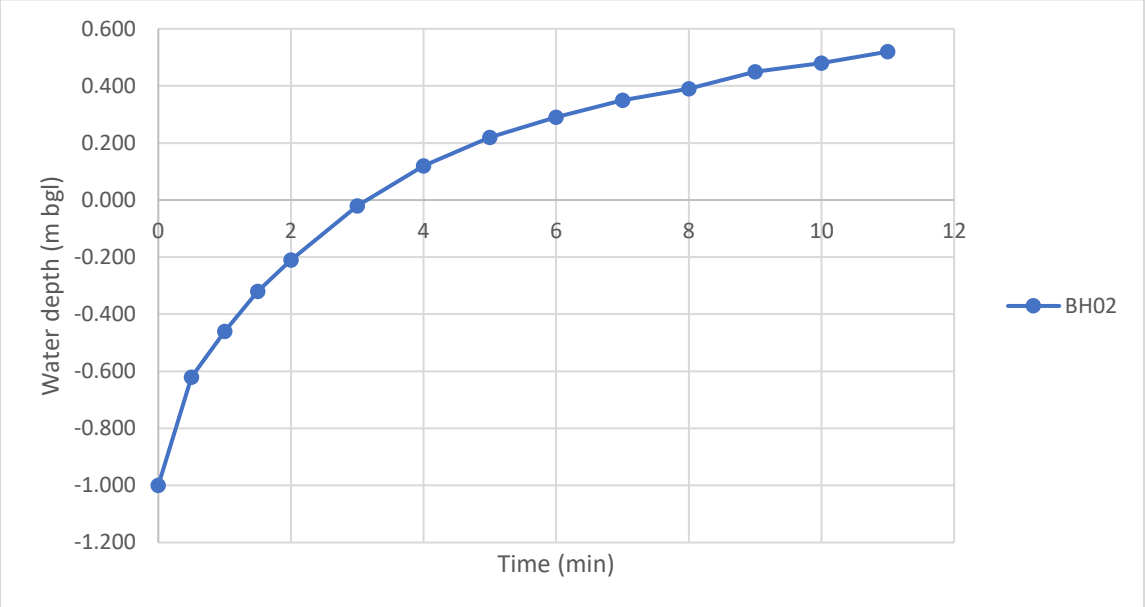
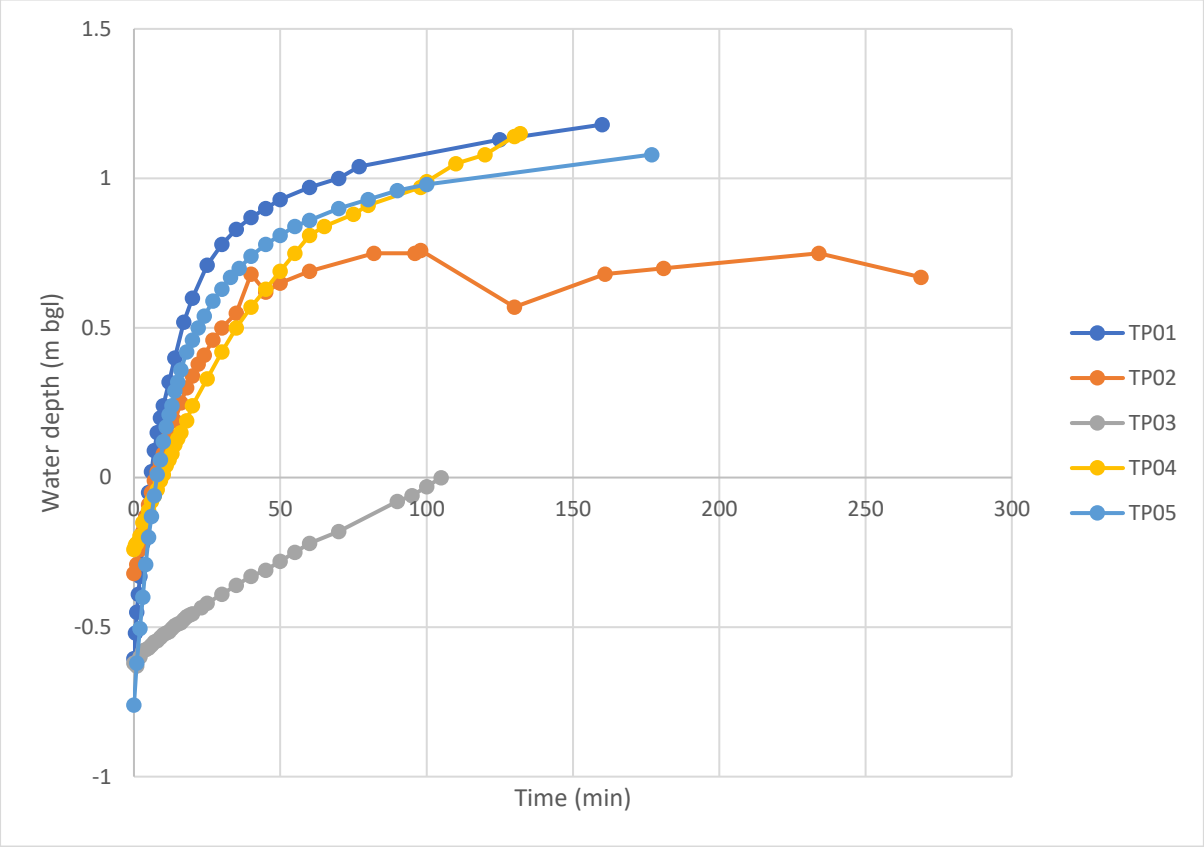
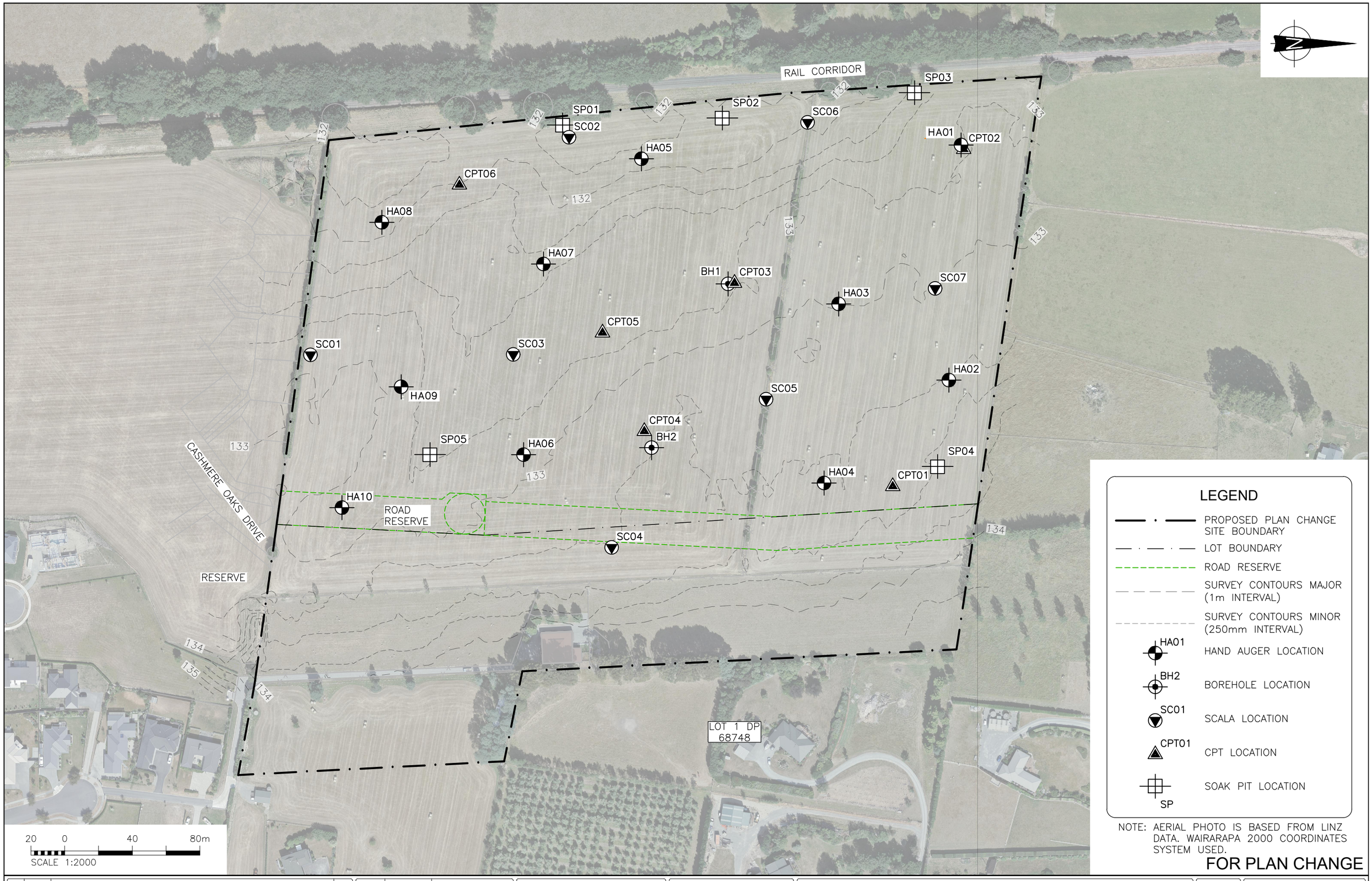


Figure 3: Falling head soakage test results within test pits



Appendix D

Riley Dwg: 210422-2



LEGEND

- PROPOSED PLAN CHANGE SITE BOUNDARY
- LOT BOUNDARY
- ROAD RESERVE
- SURVEY CONTOURS MAJOR (1m INTERVAL)
- SURVEY CONTOURS MINOR (250mm INTERVAL)
- HA01 — HAND AUGER LOCATION
- BH2 — BOREHOLE LOCATION
- SC01 — SCALA LOCATION
- CPT01 — CPT LOCATION
- SP — SOAK PIT LOCATION

NOTE: AERIAL PHOTO IS BASED FROM LINZ DATA. WAIRARAPA 2000 COORDINATES SYSTEM USED.

FOR PLAN CHANGE

REV	DATE	ISSUE	BY
1	20.04.22	FOR PLAN CHANGE	ATI

DESIGN	DES CHECK	APPROVED FOR ISSUE
CG	RF	B. BLACK
DRAWN	CAD CHECK	
ATI	RBT	
DATE DRAWN		ISSUE DATE
APL 2021		20 / 04 / 22

RILEY CONSULTANTS
www.riley.co.nz

CLIENT	WELHOM DEVELOPMENTS LTD
ADDRESS	CASHMERE OAKS DRIVE, LANSDOWNE
PROJECT	PROPOSED PLAN CHANGE
SHEET TITLE	GEOTECHNICAL INVESTIGATION SITE PLAN

ACENZ
ISO 9001 CERTIFIED GCS

CADFILE	210422-2.dwg
SCALE (A3)	1:2000
ORIG. SHEET SIZE	A3
DRAWING No.	210422-2
REV.	1

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