BASELINEGROUP

Appendix 5: Geotechnical Investigation

Soil&Rock Consultants

For well-grounded solutions

GEOTECHNICAL INVESTIGATION REPORT

PROPOSED LAND USE CHANGE
LEESTON

PREPARED FOR LOUISE AND BRENT HARKERS

C17120
6 OCTOBER 2017

Document Control Record

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Document Control

Document Title	Geotechnical Investigation Report		
Project	Proposed Land Use Change	**Project Number**	C17120
Client	Louise and Brent Harkers	**Revision**	A
Prepared By		Callum Nicholas Engineering Geologist	
Reviewed By		Matthew Naylor Principal Geotechnical Engineer	
Authorised By		Zeljko Viljevac Senior Hydrogeologist/Engineering Geologist (MSc)	

Revision History

Rev	Date	Amendment	Prepared By		Reviewed By		Authorised By	
A	06/10/2017	Issued to Client	CN		MN		ZV	

DISTRIBUTION:

Louise and Brent Harkerss		PDF
Soil & Rock Consultants		PDF

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1 Introduction

1.1 Project Brief

Soil & Rock Consultants have been engaged by Mike Vincent of Baseline Group Ltd on behalf of Louise and Brent Harkers to undertake a geotechnical investigation in connection with a proposed subdivision and development of land north-west of Leeston ('the site'). The purpose of this investigation is to develop a geological model of the site, assess its future land performance providing comment on the suitability to subdivide the land, and address the requirements of Section 106 of the Resource Management Act 1991.

Where relevant, reporting has been conducted in accordance with the Ministry of Business, Innovation and Employment December 2012 'Repairing and Rebuilding Houses Affected by the Canterbury earthquakes' Guidance (MBIE Guidelines) and relevant updates and clarifications.

This report summarises our findings and recommendations and may be used to support a Building Consent application to the Selwyn District Council.

1.2 Scope of Works

The following work has been undertaken for this geotechnical investigation:

- A site walk-over to assess site conditions;
- Review of the New Zealand Geotechnical Database (NZGD) and other available relevant geological or geotechnical information;
- Shallow geotechnical testing comprising 16 hand augerholes (AH) and Scala Penetration Tests (DCP);
- Geotechnical testing comprising one Test Pits (TP) excavated with machine excavator along with Dynamic Cone Penetrometer test (DCP - Scala) carried out beside TP to a target depth of 3.0m;
- Assessment against Section 106 of the RMA and comment on the suitability to subdivide;
- Recommendations for new residential foundations; and
- Preparation of this report detailing all the above.

2 Site Description

The subject site (Figure 1), located in north-west Leeston, and is bounded by High Street to the south, Harmans Road to the west, Leeston Dunsandel Road to the north, Ellesmere College to the north-east and residential sections of Leeston to the east, covering an approximate total area of 77.9ha.

The site consists of the following lots:

- Lot 1 DP 82846 (pastoral and agricultural containing wheat, beans and lucerne).
- Lot 2 DP 82846 (pastoral and agricultural containing wheat, beans and lucerne).
- Lot 2 DP 365379 (pastoral land).
- Lot 3 DP 82846 (pastoral land, small creek approximately 0.5m deep 5.0 meters wide flows north-east through the Lot).

The site and surrounding areas are categorised by the Canterbury Earthquake Recovery Authority (CERA) as N/A Rural & Unmapped.

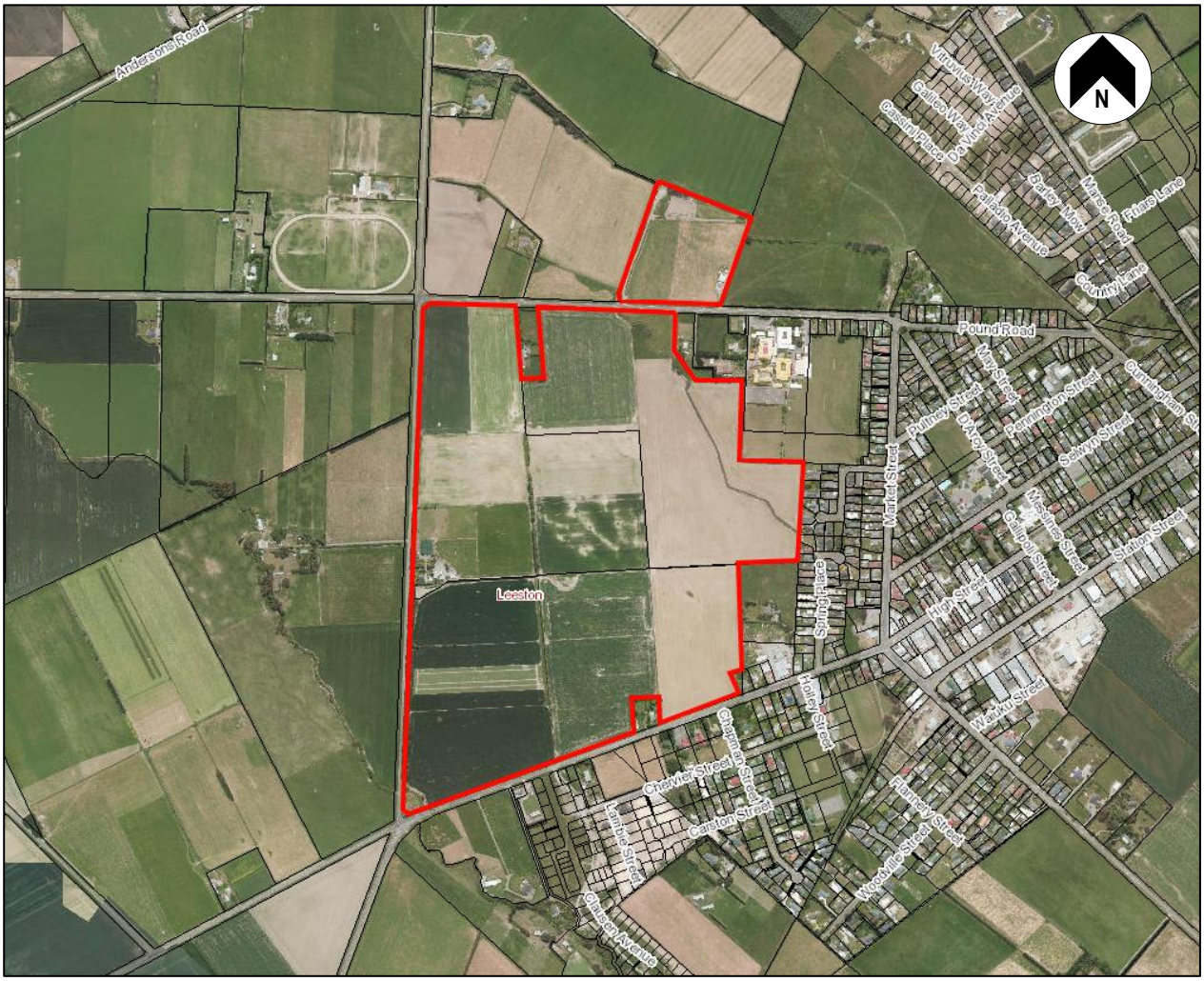

Figure 1. Site location (red) **(Canterbury Maps Imagery, obtained 21/08/17)**

3 Proposed Development

Soil & Rock Consultants were not in receipt of any preliminary drawings showing the proposed development. However, based on the correspondence we understand a residential subdivision with associated roads, drainage, and infrastructure is proposed. No plans have been received showing the number of lots to be divided into.

4 Site History

Aerial photographs of the site were assessed from Canterbury Maps website (https://mapviewer.canterburymaps.govt.nz/). Photographs showed the site in 1946 was similar to its present day condition and was used as pastoral and agricultural land. Between 1967 and 1975, a shed has been built on Lot 2 DP 365379 otherwise the site was unchanged. Between 1990 and 1994 some residential development of the dwelling on Lot 2 DP 82846 and surrounding area has took place.

5 Geological Model

5.1 Published Regional Geology

The regional geological Maps (GNS – Geology of the Christchurch Area, 2008) indicates the site is underlain by grey river alluvium beneath plains or low-level terraces (Q1a).

5.2 Nearby Geotechnical Data

Geotechnical data was taken from nearby ECan Wells and Boreholes and is summarised in Table 1 below.

Table 1: Nearby Geotechnical Data

Borehole	Distance from Site (m)	Depth to Gravel (m)	Gravel Thickness (m)
M36/7817	Onsite	1.2	> 12.8
M36/5682	42	1.2	> 9.8
M36/2992	61	Unconfirmed	> 28.0
M36/2149	75	0.9	> 10.7
M36/2064	123	0.6	> 52.4
M36/0781	156	0.6	> 51.0

5.3 Site Specific Investigation

Following an initial site walkover and location of services the Soil & Rock site investigation comprised:

- 16 hand augerholes with Scala penetrometer tests undertaken through the augerholes from surface namely;
  - (i) Four across Lot 3 DP 82846;
  - (ii) Four across Lot 2 DP 82846; and
  - (iii) Eight across Lot 1 DP 82846.
- One test pit with Scala penetrometer test located in Lot 2 DP 365379

Originally fieldwork was to consist of 17 test pits but wet weather and soft ground made machine access to test pit locations impractical. After discussions with Selwyn District Council geotechnical engineer Ian McCahon, it was agreed to switch to hand augers for the remainder of the testing with an understanding that later phases will undergo further site investigation deep testing.

A visual-tactile field classification of the subsoils encountered during hand augerhole drilling was carried out in accordance with 'Guidelines for the Field Classification and Description of Soil and Rock for Engineering Purposes' (NZGS, 2005) and Scala Penetrometer testing was carried out in accordance with NZS 4402:1988, Test 6.5.2, 'Dynamic Cone Penetrometer'.

Investigation details are provided in Table 2. The tests were positioned to provide the most effective coverage of the site. Test locations and relative levels (RL) were recorded by handheld GPS and are therefore approximate only.

Table 2: Site Specific Investigation

Test ID.	RL(m)	Termination Depth (m bgl)	Notes
AH01	26	0.7	Gravel Obstruction. Groundwater not encountered.
AH02	26	0.5	Gravel Obstruction. Groundwater not encountered.
AH03	25	0.9	Gravel Obstruction. Groundwater not encountered.
AH04	26	0.6	Gravel Obstruction. Groundwater not encountered.
AH05	26	0.5	Gravel Obstruction. Groundwater not encountered.
AH06	24	0.5	Gravel Obstruction. Groundwater not encountered.
AH07	25	0.6	Gravel Obstruction. Groundwater not encountered.
AH08	26	1.0	Gravel Obstruction. Groundwater not encountered.
AH09	26	0.7	Gravel Obstruction. Groundwater not encountered.
AH10	25	0.6	Gravel Obstruction. Groundwater not encountered.
AH11	25	1.4	Gravel Obstruction. Groundwater at 1.1m
AH12	26	1.5	Gravel Obstruction. Groundwater not encountered.
AH13	25	0.8	Gravel Obstruction. Groundwater not encountered.
AH14	24	1.2	Gravel Obstruction. Groundwater not encountered.
AH15	26	1.7	Gravel Obstruction. Groundwater at 0.7m
AH16	26	1.6	Gravel Obstruction. Groundwater not encountered.
TP01	26	1.6	Gravel Obstruction. Groundwater not encountered.

All test locations are presented on drawing C17120 /1 in Appendix A and hand augerhole and Scala Penetrometer results showing detailed soil descriptions, test pit results and blows per 100mm penetration are presented in Appendix B.

5.4 Site Subsurface Conditions

Subsurface conditions based on those encountered within the hand augerholes and the test pit site are summarised in Table 3.

Table 3: Simplified soil profile

Soil Type	Depth to Top of Layer (m)	Layer Thickness (m)	Relative Density / Consistency
SILT, trace sand, trace gravel (Topsoil/non engineered fill)	0.0	0.3 – 0.7	Very soft to firm
SILT, trace to minor sand, trace to minor gravel	0.3 – 0.7	0.2 – 1.2	Soft to firm
[1] PEAT, minor silt	1.7	1.5	Soft
GRAVEL	0.5 – 1.8	> 10	Dense

[1]PEAT encountered in AH15

1.8 meters to gravel in the south-west corner of the site.

5.5 Groundwater

Groundwater was measured within augerholes AH11 and AH15 on the day of our investigation at 0.7m and 1.1m and 0.6m in TP01. Groundwater is expected to vary seasonally and due to irrigation abstraction. It should be noted that fieldwork was undertaken shortly after heavy rainfall and flooding in the area.

5.6 Site Subsoil Classification

NZS 1170.5:2004 outlines criteria for the assessment of different site subsoil classes. The alluvial soils of the Canterbury plains are generally classified as either 'Class D' or 'Class E' subsoil due to the considerable depth to bedrock (locally from 100m to in excess of 1km). In accordance with the standard Class D applies to this particular site defining it as a 'deep soil site'.

6 Geotechnical Assessment

6.1 Lateral Displacement

6.1.1 Global Lateral Movement & Lateral Spreading

The site is not mapped on the NZGD for global lateral movement and lateral spreading but a creek that runs through Lot 3 DP 82846 which is approximately 0.5m deep and 5m wide. This may potentially cause lateral spread adjacent to its banks.

6.2 Expected Future Land Performance

The site may have a potential for liquefaction based on the deeper natural silts within the south-west corner. Further deep testing with a CPT rig is likely to be required for a subdivision consent application for quantitative liquefaction assessment and to help determine a MBIE Technical Category.

7 Resource Management Act Requirements

Section 106 of the Resource Management Act 1991 states a consent authority may refuse to grant a subdivision consent, or may grant a consent subject to specific consent conditions if the land is likely to be subject to erosion, falling debris, subsidence, slippage or inundation.

- The site is not located near any major water ways but a creek flows north-east through Lot 3. As a result some lower lying areas may be susceptible to erosion adjacent to the creek.
- Falling debris from upslope land slippage or rock fall is unlikely at this site in the absence of any elevated land in proximity to the site.
- Slope stability is not considered to be a significant hazard. Earthquake-induced lateral movement is considered to be minor to moderate, in accordance with the MBIE criteria (December 2012). Lateral ground movement is most likely to occur within the land immediately surrounding the creek and inside bends. The rest of the site is well removed from the areas of land highlighted as susceptible to lateral spreading and the risk is considered minimal.
- Limited subsidence and inundation by ejected matter (i.e. sand, silt and water) could occur from future liquefaction of the site soils from a future large earthquake. Subsidence is expected to be within the limits of Technical Category 1 across most of the site. In south-west corner subsidence might be within TC2 limits in accordance with the most recent MBIE criteria (December 2012).
- Peat long term differential settlement due to consolidation of the peat in south-west corner.
- Assessment of inundation from flooding is not part of our current brief and has therefore not been assessed. If according to Selwyn District Council held records the site has the potential to be flooded we recommend a flood assessment be carried out by a suitably experienced Engineer.

8 Geotechnical Ultimate Bearing Capacity

With reference to Scala Penetrometer results an Ultimate Bearing Capacity (UBC) of 150kPa is available within the natural soil at 0.3m – 0.6m and 300kPa is available at a depth of 0.45m to 1.7m bgl in accordance with (Stockwell 1977). A Strength Reduction Factor of $\Phi = 0.5$ should be applied to the Ultimate Bearing Capacity, which should then equal or exceed the factored Ultimate Limit State design actions. Foundations should be founded below topsoil, fill or peat within good ground as defined by NZS3604.

9 Recommendations

9.1 Site Zoning and Preliminary Foundation Options

The current scope of field investigations and assessments were primarily intended to support the currently proposed Plan Change and Subdivision Consent application. Based on the results of the desk study and field work, we consider the ground across the site to be suitable for construction of typical residential building in accordance with NZS3604:2011. Across most of the site, these may be supported on TC1 foundations. In the south-west corner of the site the deeper foundations and /or TC2 foundations will be required in accordance with the MBIE December 2012 guidelines.

At this initial stage, the following residential foundation preliminary options are considered appropriate:

9.1.1 TC1 foundation options as per NZS3604:2001

For the majority of land founded on shallow gravel above 1m, and above the groundwater table:

- Type A, timber floor suspended on shallow piles;
- Type B, timber floor suspended on shallow piles with concrete perimeter foundation; and
- Type C, Concrete slab.

9.1.2 TC2 type foundations as given within Part A of the MBIE December 2012 guidelines.

These foundation options may be suitable for the south-west corner where the gravel is deeper. These consist of various slab-on-grade reinforced concrete foundations:

- Option 1 comprising 800mm granular fill supporting NZS3604:2011 reinforced concrete slabs or Construction Considerations
- Options 2, 3 and 4 comprising robust stiffened slab and beam foundations) or typical NZS3604:2011 suspended timber floor sub-floor and foundation systems with stiffened perimeter footings.
- Deep posthole foundations or short piles in areas of peat, founded on natural gravel to support suspended floors.

9.2 Pavement Areas

Vegetation, any organic or deleterious material, topsoil and non-engineered fill should be removed from the site under pavement areas prior to aggregate placement. Based on our observations during testing we consider the natural ground at the site should provide an adequate subgrade for the proposed pavement areas. We recommend for preliminary design a CBR value of 2% or a modulus of subgrade reaction of 20kPa/mm, for flexible or rigid pavements respectively with adequate subgrade drainage.

The thickness of the basecourse would depend on the final CBR/modulus of subgrade reaction used for the subgrade and the traffic loads anticipated. The compaction of the basecourse should be carried out with a static roller of appropriate static weight and energy.

10 Further Geotechnical Involvement

Following development of subdivision plan, the site should be subject to further geotechnical investigation to better define the TC1 and TC2 zones. This investigation would support the subdivision consent application, as well as the preparation of an earthworks specification. During the earthworks and civil engineering works, geotechnical observations will lead to the issue of an earthworks completion report, back by a Statement of Professional Opinion. Following completion of the earthworks, Lot specific geotechnical assessment can be carried to the TC of each lot and recommend an appropriate foundation design. We recommend geotechnical, civil and structural engineers liaise closely during the detailed design stage for building foundations.

11 Conclusions

We consider the site is geotechnically suitable to subdivide for a residential development. Based on our investigation we consider that the ground performance can be considered equivalent to residential Technical Category 1 (TC1) for most of the site and TC2 in the south-west corner, while the site is considered to have minor to moderate global lateral movement and lateral stretch potential for ULS events. Future dwelling foundations should comprise TC1 and TC2 foundation options provided within Part A of the MBIE December 2012 guidelines.

12 Limitations

This report has been prepared for the sole benefit of our Client, Louise and Brent Harkers, with respect to the particular brief given to us. The reliance by other parties on the information or opinions contained within this report shall, without our prior review and agreement in writing, be at such parties' sole risk.

The recommendations given in this report are based on site data from discrete locations. Inferences about the subsoil conditions away from the test locations have been made, but cannot be guaranteed. We have inferred a geotechnical model that can be applied for our analyses, however, variations in ground conditions from those described in this report could exist across the site. Should conditions differ to those outlined in this report we ask that we be given the opportunity to review the continued applicability of our recommendations.

Investigation and analysis of seismic events has resulted in modifications to building codes including MBIE Guidelines, and further changes are expected with time. The findings and recommendations of this report may require modification to accommodate any changes before building works are implemented. It is recommended that the findings of this report be reviewed if there is any delay in the implementation of building works beyond the immediate future.

The investigation was confined to geotechnical aspects of the site and did not involve assessment or testing for environmental contaminants or flooding potential. Our investigation and assessments have also not taken into account possible fault rupture that may cause deformations and displacements of the ground directly below the site. This is outside of the scope of our engagement and beyond the realms of geotechnical investigation and assessment, and from recent accounts nearly impossible to predict.

13 References

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15. Tonkin & Taylor Limited, 2013. Liquefaction vulnerability study, Prepared for Earthquake Commission.

16. Zhang, G, Robertson, PK & Brachman, RW 2002. Estimating Liquefaction-Induced Ground Settlements from CPT for Level Ground, Canadian Geotechnical Journal, vol. 39, pp. 1168-1180

APPENDIX A
TEST LOCATION PLAN

N

Approximate True North Direction

Legend:

Approx. Location of Hand Augerholes completed by Soil & Rock Consultants

Approx. Property Boundaries

Approx. Location of Test Pit completed by Soil & Rock Consultants

Notes:

1. Soil & Rock Consultants Test Location Plan adapted from Google Maps
2. Locations of features are approximate only
3. Original sheet size A4
4. Buried services to be located prior to construction

Soil&Rock Consultants
For well-grounded solutions

DATE:	August 2017
DRAWN:	CN
SCALE:	SCALE BAR
CAD REF:	C17120/TLP

SITE PLAN
GEOTECHNICAL INVESTIGATION
LEESTON PLAN CHANGE
CHRISTCHURCH

DRAWING NO:
C17120/TLP

SHEET 1 OF 1

APPENDIX B
HAND AUGERHOLE, TEST PIT
&
SCALA PENETROMETER LOGS

Soil&Rock Consultants
For well-grounded solutions

CLIENT: Louise and Brent Harkerss

PROJECT: Geotechnical Investigation, Leeston

Auger Hole No: AH01

Sheet 1 of 1

Drill Type:	50mm Hand Auger	Project No:	C17120	Logged By:	CN
Drilled By:	MG	Coordinates:	1542345 E, 5154731 N	Reviewed By:	MN
Date Started:	8/8/17	Ground Elevation:	26m	Surface Conditions:	Near Level, Pasture
Date Finished:	8/8/17	Water Level:	Groundwater not encountered	Shear Vane Number:	N/A

STRATIGRAPHY	DEPTH (m)	GRAPHIC LOG	Soil description in accordance with the NZ Geotechnical Society Inc 2005 "Guidelines for Field Description of Soil and Rock in Engineering Use"
TOPSOIL	0.0		SILT, trace fine sand, dark brown. Very soft, wet, non-plastic, trace rootlets.(TOPSOIL)
ALLUVIAL DEPOSITS	0.5		SILT, trace to minor fine sand, light brownish grey. Soft, moist, wet, non-plastic. (ALLUVIAL DEPOSITS)
			Trace fine to medium rounded gravel, wet.
	1.0		END OF BORE. 0.70 METRES. GRAVEL OBSTRUCTION
	1.5		
	2.0		

WATER LEVEL (m)

SCALA PENETROMETER TEST METHOD NZS4402: 1986 test 6.5.2

(Blows per 100mm Increment)

DEPTH (m)	5	10	15	20
0.0	0			
	0			
	2			
	3			
	4			
0.5	4			
		17		
		10		
		17		
			25	
1.0				
1.5				
2.0				

Comments

HAND AUGER WITH SCALA CHCH LOG C17120_AH02-AH17_08-08-17_11-08-17_DRAFT.GPJ S+R_2012-AGS - REVISED.GDT 5/10/17

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CLIENT: Louise and Brent Harkerss

PROJECT: Geotechnical Investigation, Leeston

Auger Hole No: AH02

Sheet 1 of 1

Drill Type:	50mm Hand Auger	Project No:	C17120	Logged By:	MG
Drilled By:	CN	Coordinates:	1542595 E, 5154760 N	Reviewed By:	MN
Date Started:	8/8/17	Ground Elevation:	26m	Surface Conditions:	Near Level, Soil
Date Finished:	8/8/17	Water Level:	Groundwater not encountered	Shear Vane Number:	N/A

STRATIGRAPHY	DEPTH (m)	GRAPHIC LOG	Soil description in accordance with the NZ Geotechnical Society Inc 2005 "Guidelines for Field Description of Soil and Rock in Engineering Use"
TOPSOIL	0.0		SILT, trace fine sand, dark brown. Very soft to soft, moist wet, non-plastic. (TOPSOIL)
A. DEPOSITS	0.5		SILT, trace to minor fine sand, greyish light brown, mottled brownish orange. Soft to firm, moist to wet, non-plastic. (ALLUVIAL DEPOSITS) Trace to minor fine to medium sub-rounded to rounded gravel.
	1.0		END OF BORE. 0.50 METRES. GRAVEL OBSTRUCTION
	1.5		
	2.0		

WATER LEVEL (m)

SCALA PENETROMETER TEST METHOD NZS4402: 1986 test 6.5.2

(Blows per 100mm Increment)

DEPTH (m)	5	10	15	20
0.0	0			
	0.5			
	0.5			
	1			
	1			
0.5	3			
		8		
		10		
			17	
				25
1.0				
1.5				
2.0				

Comments

HAND AUGER WITH SCALA CHCH LOG C17120_AH02-AH17_08-08-17_11-08-17_DRAFT.GPJ S+R_2012-AGS - REVISED.GDT 5/10/17

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CLIENT: Louise and Brent Harkerss

PROJECT: Geotechnical Investigation, Leeston

Auger Hole No: AH03

Sheet 1 of 1

Drill Type:	50mm Hand Auger	Project No:	C17120	Logged By:	MG
Drilled By:	CN	Coordinates:	1542850 E, 5154542 N	Reviewed By:	MN
Date Started:	8/8/17	Ground Elevation:	25m	Surface Conditions:	Near Level, Grass
Date Finished:	8/8/17	Water Level:	Groundwater not encountered	Shear Vane Number:	N/A

STRATIGRAPHY	DEPTH (m)	GRAPHIC LOG	Soil description in accordance with the NZ Geotechnical Society Inc 2005 "Guidelines for Field Description of Soil and Rock in Engineering Use"	WATER LEVEL (m)
TOPSOIL	0.0		SILT, trace fine sand, dark brown. Very soft to soft, moist to wet, non-plastic. (TOPSOIL)	
ALLUVIAL DEPOSITS	0.5		SILT, trace to minor fine sand, light brown, mottled brownish orange. Soft to firm, moist to wet, non-plastic. (ALLUVIAL DEPOSITS)	
			Minor fine to medium sand.	
			Trace fine to medium sub-rounded to rounded gravel.	
			Minor fine to medium sub-rounded to rounded gravel.	
	1.0		END OF BORE. 0.90 METRES. GRAVEL OBSTRUCTION	
	1.5			
	2.0			

SCALA PENETROMETER TEST METHOD NZS4402: 1986 test 6.5.2

(Blows per 100mm Increment)

DEPTH (m)	0	5	10	15	20
0.0	0				
	0				
	1				
	2				
	3				
0.5	3				
	4				
	5				
	8				
	16				
1.0	25				
1.5					
2.0					

Comments

HAND AUGER WITH SCALA CHCH LOG C17120_AH02-AH17_08-08-17_11-08-17_DRAFT.GPJ S+R_2012-AGS - REVISED.GDT 5/10/17

Soil&Rock Consultants
For well-grounded solutions

CLIENT: Louise and Brent Harkerss

PROJECT: Geotechnical Investigation, Leeston

Auger Hole No: AH04

Sheet 1 of 1

Drill Type:	50mm Hand Auger	Project No:	C17120	Logged By:	MG
Drilled By:	CN	Coordinates:	1542343 E, 5154525 N	Reviewed By:	MN
Date Started:	8/8/17	Ground Elevation:	26m	Surface Conditions:	Near Level, Soil
Date Finished:	8/8/17	Water Level:	Groundwater not encountered	Shear Vane Number:	N/A

STRATIGRAPHY	DEPTH (m)	GRAPHIC LOG	Soil description in accordance with the NZ Geotechnical Society Inc 2005 "Guidelines for Field Description of Soil and Rock in Engineering Use"	WATER LEVEL (m)	DEPTH (m)	SCALA PENETROMETER TEST METHOD NZS4402: 1986 test 6.5.2 (Blows per 100mm Increment)	Comments
TOPSOIL	0.0		SILT, trace fine sand, dark brown. Very soft to soft, moist to wet, non-plastic. (TOPSOIL)		0.0	0	
ALLUVIAL DEPOSITS	0.5		SILT, trace to minor fine sand, light brown, mottled orange. Soft to firm, moist to wet, non-plastic. (ALLUVIAL DEPOSITS) Wet. Grey, mottled orange, wet to saturated.		0.5	3	
	1.0		END OF BORE. 0.60 METRES. GRAVEL OBSTRUCTION		1.0	25	
	1.5				1.5		
	2.0				2.0		

HAND AUGER WITH SCALA CHCH LOG C17120_AH02-AH17_08-08-17_11-08-17_DRAFT.GPJ S+R_2012-AGS - REVISED.GDT 5/10/17

Soil&Rock Consultants
For well-grounded solutions

CLIENT: Louise and Brent Harkerss

PROJECT: Geotechnical Investigation, Leeston

Auger Hole No: AH05

Sheet 1 of 1

Drill Type:	50mm Hand Auger	Project No:	C17120	Logged By:	CN
Drilled By:	MG	Coordinates:	1542593 E, 5154544 N	Reviewed By:	MN
Date Started:	8/8/17	Ground Elevation:	26m	Surface Conditions:	Near Level, Soil
Date Finished:	8/8/17	Water Level:	Groundwater not encountered	Shear Vane Number:	N/A

STRATIGRAPHY	DEPTH (m)	GRAPHIC LOG	Soil description in accordance with the NZ Geotechnical Society Inc 2005 "Guidelines for Field Description of Soil and Rock in Engineering Use"	WATER LEVEL (m)	DEPTH (m)	SCALA PENETROMETER TEST METHOD NZS4402: 1986 test 6.5.2 (Blows per 100mm Increment)	Comments
TOPSOIL	0.0		SILT, trace fine sand, dark brown. Very soft to soft, moist, non-plastic. (TOPSOIL)		0.0	0 1 3 2 3	
A. DEPOSITS	0.5		SILT, trace to minor fine sand, light brownish grey. Soft, moist, non-plastic. (ALLUVIAL DEPOSITS) Trace fine sub-rounded gravel.		0.5	8 4 5 2 8	
	1.0		END OF BORE. 0.50 METRES. GRAVEL OBSTRUCTION		1.0	12 10 13 20 25	
	1.5				1.5		
	2.0				2.0		

HAND AUGER WITH SCALA CHCH LOG C17120_AH02-AH17_08-08-17_11-08-17_DRAFT.GPJ S+R_2012-AGS - REVISED.GDT 5/10/17

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For well-grounded solutions

CLIENT: Louise and Brent Harkerss

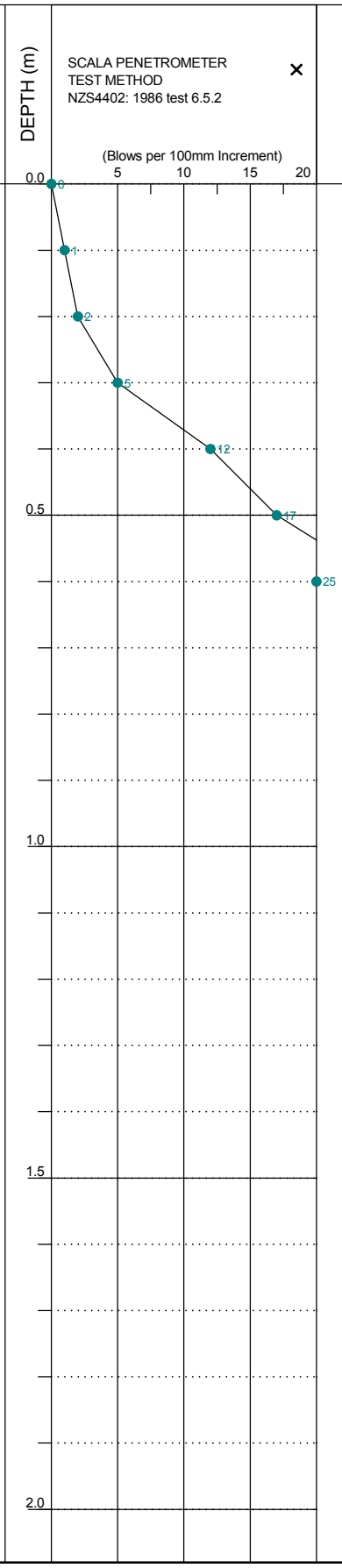
PROJECT: Geotechnical Investigation, Leeston

Auger Hole No: AH06

Sheet 1 of 1

Drill Type:	50mm Hand Auger	Project No:	C17120	Logged By:	CN
Drilled By:	MG	Coordinates:	1542948 E, 5154408 N	Reviewed By:	MN
Date Started:	8/8/17	Ground Elevation:	24m	Surface Conditions:	Near Level, Grass
Date Finished:	8/8/17	Water Level:	Groundwater not encountered	Shear Vane Number:	N/A

STRATIGRAPHY	DEPTH (m)	GRAPHIC LOG	Soil description in accordance with the NZ Geotechnical Society Inc 2005 "Guidelines for Field Description of Soil and Rock in Engineering Use"	WATER LEVEL (m)
TOPSOIL	0.0		SILT, trace fine sand, dark brown. Soft, moist, non-plastic. (TOPSOIL)	
A. DEPOSITS	0.5		SILT, trace to minor fine sand, greyish light brown, mottled orange. Soft, moist to wet, non-plastic. (ALLUVIAL DEPOSITS) Trace to minor fine sub-rounded to rounded gravel.	
			END OF BORE. 0.50 METRES. GRAVEL OBSTRUCTION	



Comments

HAND AUGER WITH SCALA CHCH LOG C17120_AH02-AH17_08-08-17_11-08-17_DRAFT.GPJ S+R_2012-AGS - REVISED.GDT 5/10/17

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CLIENT: Louise and Brent Harkerss

PROJECT: Geotechnical Investigation, Leeston

Auger Hole No: AH07

Sheet 1 of 1

Drill Type:	50mm Hand Auger	Project No:	C17120	Logged By:	CN
Drilled By:	MG	Coordinates:	1542747 E, 5154395 N	Reviewed By:	MN
Date Started:	8/8/17	Ground Elevation:	25m	Surface Conditions:	Near Level, Grass
Date Finished:	8/8/17	Water Level:	Groundwater not encountered	Shear Vane Number:	N/A

STRATIGRAPHY	DEPTH (m)	GRAPHIC LOG	Soil description in accordance with the NZ Geotechnical Society Inc 2005 "Guidelines for Field Description of Soil and Rock in Engineering Use"	WATER LEVEL (m)	DEPTH (m)	SCALA PENETROMETER TEST METHOD NZS4402: 1986 test 6.5.2 (Blows per 100mm Increment)	Comments
TOPSOIL	0.0		SILT, trace fine sand, dark brown. Soft, moist to wet, non-plastic. (TOPSOIL)		0.0	0, 1, 2, 2, 4, 3, 7, 10, 20, 25	
ALLUVIAL DEPOSITS	0.5		SILT, trace to minor fine sand, light brownish grey, mottled orange. Soft to firm, moist, non-plastic. (ALLUVIAL DEPOSITS)		0.5		
			Trace to minor sub-rounded to rounded gravel.				
	1.0		END OF BORE. 0.60 METRES. GRAVEL OBSTRUCTION		1.0		
	1.5				1.5		
	2.0				2.0		

HAND AUGER WITH SCALA CHCH LOG C17120_AH02-AH17_08-08-17_11-08-17_DRAFT.GPJ S+R_2012-AGS - REVISED.GDT 5/10/17

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CLIENT: Louise and Brent Harkerss

PROJECT: Geotechnical Investigation, Leeston

Auger Hole No: AH08

Sheet 1 of 1

Drill Type:	50mm Hand Auger	Project No:	C17120	Logged By:	MG
Drilled By:	MG	Coordinates:	1542271 E, 5154356 N	Reviewed By:	MN
Date Started:	10/8/17	Ground Elevation:	26m	Surface Conditions:	Near Level, Grass
Date Finished:	10/8/17	Water Level:	Groundwater not encountered	Shear Vane Number:	N/A

STRATIGRAPHY	DEPTH (m)	GRAPHIC LOG	Soil description in accordance with the NZ Geotechnical Society Inc 2005 "Guidelines for Field Description of Soil and Rock in Engineering Use"
TOPSOIL	0.0		SILT, trace fine sand, dark brown. Very soft to soft, wet, non-plastic. (TOPSOIL)
ALLUVIAL DEPOSITS	0.5		SILT, trace to minor fine sand, light brown, mottled brownish orange. Soft to firm, wet, non-plastic. (ALLUVIAL DEPOSITS)
	1.0		Trace fine to medium sub-rounded to rounded gravel.
	1.5		END OF BORE. 1.00 METRES. GRAVEL OBSTRUCTION
	2.0		

WATER LEVEL (m)

SCALA PENETROMETER TEST METHOD NZS4402: 1986 test 6.5.2

(Blows per 100mm Increment)

DEPTH (m)	5	10	15	20
0.0	0			
	1			
	1			
	2			
0.5	2			
	3			
	3			
	3			
	4			
	5			
1.0	6			
	6			
	7			
	8			
	10			
1.5	11			
	16			
	25			
2.0				

Comments

HAND AUGER WITH SCALA CHCH LOG C17120_AH02-AH17_08-08-17_11-08-17_DRAFT.GPJ S+R_2012-AGS - REVISED.GDT 5/10/17

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CLIENT: Louise and Brent Harkerss

PROJECT: Geotechnical Investigation, Leeston

Auger Hole No: AH09

Sheet 1 of 1

Drill Type:	50mm Hand Auger	Project No:	C17120	Logged By:	MG
Drilled By:	CN	Coordinates:	1542555 E, 5154262 N	Reviewed By:	MN
Date Started:	8/8/17	Ground Elevation:	26m	Surface Conditions:	Near Level, Grass
Date Finished:	8/8/17	Water Level:	Groundwater not encountered	Shear Vane Number:	N/A

STRATIGRAPHY	DEPTH (m)	GRAPHIC LOG	Soil description in accordance with the NZ Geotechnical Society Inc 2005 "Guidelines for Field Description of Soil and Rock in Engineering Use"	WATER LEVEL (m)	DEPTH (m)	SCALA PENETROMETER TEST METHOD NZS4402: 1986 test 6.5.2 (Blows per 100mm Increment)	Comments
TOPSOIL/FILL	0.0		SILT, trace fine sand trace fine to medium sub-rounded to rounded gravel, dark brown. Soft to firm, moist, non-plastic. (TOPSOIL/FILL)		0.0	0 5 10 15 20	
			Mixed light brown, mottled brownish orange.				
	0.5		Dark brown.		0.5		
			Minor fine to medium sub-rounded to rounded gravel.				
			END OF BORE. 0.70 METRES. GRAVEL OBSTRUCTION				
	1.0				1.0		
	1.5				1.5		
	2.0				2.0		

HAND AUGER WITH SCALA CHCH LOG C17120_AH02-AH17_08-08-17_11-08-17_DRAFT.GPJ S+R_2012-AGS - REVISED.GDT 5/10/17

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CLIENT: Louise and Brent Harkerss

PROJECT: Geotechnical Investigation, Leeston

Auger Hole No: AH10

Sheet 1 of 1

Drill Type:	50mm Hand Auger	Project No:	C17120	Logged By:	MG
Drilled By:	CN	Coordinates:	1542837 E, 5154266 N	Reviewed By:	MN
Date Started:	8/8/17	Ground Elevation:	25m	Surface Conditions:	Near Level, Grass
Date Finished:	8/8/17	Water Level:	Groundwater not encountered	Shear Vane Number:	N/A

STRATIGRAPHY	DEPTH (m)	GRAPHIC LOG	Soil description in accordance with the NZ Geotechnical Society Inc 2005 "Guidelines for Field Description of Soil and Rock in Engineering Use"	WATER LEVEL (m)	DEPTH (m)	SCALA PENETROMETER TEST METHOD NZS4402: 1986 test 6.5.2 (Blows per 100mm Increment)	Comments
TOPSOIL	0.0		SILT, trace fine sand, dark brown. Very soft to soft, wet, non-plastic. (TOPSOIL)		0.0	0	
ALLUVIAL DEPOSITS	0.5		SILT, trace to minor fine sand, light brown, mottled brownish orange, Soft to stiff, wet, non-plastic. (ALLUVIAL DEPOSITS)		0.5	12	
			Trace fine to medium sub-rounded to rounded gravel.			14	
						14	
						10	
						9	
	1.0		END OF BORE. 0.60 METRES. GRAVEL OBSTRUCTION		1.0	8	
						10	
						11	
						25	
	1.5				1.5		
	2.0				2.0		

HAND AUGER WITH SCALA CHCH LOG C17120_AH02-AH17_08-08-17_11-08-17_DRAFT.GPJ S+R_2012-AGS - REVISED.GDT 5/10/17

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CLIENT: Louise and Brent Harkerss

PROJECT: Geotechnical Investigation, Leeston

Auger Hole No: AH11

Sheet 1 of 1

Drill Type:	50mm Hand Auger	Project No:	C17120	Logged By:	MG
Drilled By:	MG	Coordinates:	1542352 E, 5154126 N	Reviewed By:	MN
Date Started:	10/8/17	Ground Elevation:	26m	Surface Conditions:	Near Level, Pasture
Date Finished:	10/8/17	Water Level:	1.1m	Shear Vane Number:	N/A

STRATIGRAPHY	DEPTH (m)	Soil description in accordance with the NZ Geotechnical Society Inc 2005 "Guidelines for Field Description of Soil and Rock in Engineering Use"
TOPSOIL	0.0	SILT, trace fine sand, dark brown. Very soft to soft, wet, non-plastic. (TOPSOIL)
ALLUVIAL DEPOSITS	0.5	SILT, minor fine sand, light brown. Soft to firm, wet, non-plastic. (ALLUVIAL DEPOSITS)
		Minor to some fine sand.
	1.0	Trace to minor fine sand, light grey, mottled brownish orange,
		Dark grey, saturated.
	1.5	END OF BORE. 1.40 METRES. GRAVEL OBSTRUCTION
	2.0	

WATER LEVEL (m)

SCALA PENETROMETER TEST METHOD NZS4402: 1986 test 6.5.2

(Blows per 100mm Increment)

DEPTH (m)	5	10	15	20
0.0	0			
	1			
	1			
	2			
	1			
0.5	2			
	3			
	4			
	5			
	5			
1.0	3			
	3			
	4			
	5			
	5			
1.5	7			
	8			
				25
2.0				

Comments

HAND AUGER WITH SCALA CHCH LOG C17120_AH02-AH17_08-08-17_11-08-17_DRAFT.GPJ S+R_2012-AGS - REVISED.GDT 5/10/17

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CLIENT: Louise and Brent Harkerss

PROJECT: Geotechnical Investigation, Leeston

Auger Hole No: AH12

Sheet 1 of 1

Drill Type:	50mm Hand Auger	Project No:	C17120	Logged By:	MG
Drilled By:	CN	Coordinates:	1542619 E, 5154126 N	Reviewed By:	MN
Date Started:	8/8/17	Ground Elevation:	26m	Surface Conditions:	Near Level, Pasture
Date Finished:	8/8/17	Water Level:	Groundwater not encountered	Shear Vane Number:	N/A

STRATIGRAPHY	DEPTH (m)	GRAPHIC LOG	Soil description in accordance with the NZ Geotechnical Society Inc 2005 "Guidelines for Field Description of Soil and Rock in Engineering Use"
TOPSOIL	0.0		SILT, trace fine sand, dark brown. Very soft, moist to wet, non-plastic. (TOPSOIL)
ALLUVIAL DEPOSITS	0.5		SILT, trace to minor fine sand, greyish light brown. Soft to firm, moist, non-plastic. (ALLUVIAL DEPOSITS)
			Mottled brownish orange.
			Light brown, moist to wet.
			Wet.
			Minor fine sand.
	1.0		Dark grey streaks, moist.
			No dark grey streaks, trace fine to medium sub-rounded gravel.
	1.5		END OF BORE. 1.50 METRES. GRAVEL OBSTRUCTION
	2.0		

WATER LEVEL (m)

SCALA PENETROMETER TEST METHOD NZS4402: 1986 test 6.5.2

(Blows per 100mm Increment)

DEPTH (m)	5	10	15	20
0.0	0			
	0			
	0.5			
	0.5			
	1			
0.5	1			
	2			
	2			
	2			
	6			
1.0	6			
	6			
	9			
	16			
	15			
1.5	12			
	25			
2.0				

Comments

HAND AUGER WITH SCALA CHCH LOG C17120_AH02-AH17_08-08-17_11-08-17_DRAFT.GPJ S+R_2012-AGS - REVISED.GDT 5/10/17

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CLIENT: Louise and Brent Harkerss

PROJECT: Geotechnical Investigation, Leeston

Auger Hole No: AH13

Sheet 1 of 1

Drill Type:	50mm Hand Auger	Project No:	C17120	Logged By:	CN
Drilled By:	MG	Coordinates:	1542846 E, 5154103 N	Reviewed By:	MN
Date Started:	8/8/17	Ground Elevation:	25m	Surface Conditions:	Near Level, Grass
Date Finished:	8/8/17	Water Level:	Groundwater not encountered	Shear Vane Number:	N/A

STRATIGRAPHY	DEPTH (m)	GRAPHIC LOG	Soil description in accordance with the NZ Geotechnical Society Inc 2005 "Guidelines for Field Description of Soil and Rock in Engineering Use"	WATER LEVEL (m)
TOPSOIL	0.0		SILT, trace fine sand, dark brown. Soft, wet, non-plastic. (TOPSOIL)	
ALLUVIAL DEPOSITS	0.5		SILT, trace fine sand, light brown, mottled orange. Soft, moist to wet, non-plastic. (ALLUVIAL DEPOSITS)	
			Light brownish grey with heavy orange mottling.	
			Minor fine sand, trace fine subrounded gravel.	
	1.0		END OF BORE. 0.80 METRES. GRAVEL OBSTRUCTION	
	1.5			
	2.0			

SCALA PENETROMETER TEST METHOD NZS4402: 1986 test 6.5.2

(Blows per 100mm Increment)

DEPTH (m)	5	10	15	20
0.0	0			
	0			
	1			
	2			
	2			
0.5	3			
	5			
	7			
	12			
	15			
1.0	17			
	25			
1.5				
2.0				

Comments

HAND AUGER WITH SCALA CHCH LOG C17120_AH02-AH17_08-08-17_11-08-17_DRAFT.GPJ S+R_2012-AGS - REVISED.GDT 5/10/17

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CLIENT: Louise and Brent Harkerss

PROJECT: Geotechnical Investigation, Leeston

Auger Hole No: AH14

Sheet 1 of 1

Drill Type:	50mm Hand Auger	Project No:	C17120	Logged By:	CN
Drilled By:	MG	Coordinates:	1542632 E, 5153991 N	Reviewed By:	MN
Date Started:	8/8/17	Ground Elevation:	24m	Surface Conditions:	Near Level, Pasture
Date Finished:	8/8/17	Water Level:	Groundwater not encountered	Shear Vane Number:	N/A

STRATIGRAPHY	DEPTH (m)	GRAPHIC LOG	Soil description in accordance with the NZ Geotechnical Society Inc 2005 "Guidelines for Field Description of Soil and Rock in Engineering Use"
TOPSOIL	0.0		SILT, trace fine sand, dark brown. Very soft, moist to wet, non-plastic, trace rootlets. (TOPSOIL)
ALLUVIAL DEPOSITS	0.5		SILT, trace to minor fine sand, light brown, heavy orange mottling. Soft, moist, non-plastic. (ALLUVIAL DEPOSITS)
			Streaked grey, Firm.
	1.0		Dark grey, mottled orange.
			END OF BORE. 1.20 METRES. GRAVEL OBSTRUCTION
	1.5		
	2.0		

WATER LEVEL (m)

SCALA PENETROMETER TEST METHOD NZS4402: 1986 test 6.5.2

(Blows per 100mm Increment)

DEPTH (m)	5	10	15	20
0.0	0			
	0.5			
	0.5			
	1			
	2			
0.5	3			
	3			
	3			
	3			
	4			
1.0	7			
		14		
			17	
				20
				25
1.5				
2.0				

Comments

HAND AUGER WITH SCALA CHCH LOG C17120_AH02-AH17_08-08-17_11-08-17_DRAFT.GPJ S+R_2012-AGS - REVISED.GDT 5/10/17

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CLIENT: Louise and Brent Harkerss

PROJECT: Geotechnical Investigation, Leeston

Auger Hole No: AH15

Sheet 1 of 1

Drill Type:	50mm Hand Auger	Project No:	C17120	Logged By:	MG
Drilled By:	MG	Coordinates:	1542333 E, 5153916 N	Reviewed By:	MN
Date Started:	10/8/17	Ground Elevation:	26m	Surface Conditions:	Near Level, Pasture
Date Finished:	10/8/17	Water Level:	0.7m	Shear Vane Number:	N/A

STRATIGRAPHY	DEPTH (m)	Soil description in accordance with the NZ Geotechnical Society Inc 2005 "Guidelines for Field Description of Soil and Rock in Engineering Use"
TOPSOIL	0.0	SILT, trace fine sand, dark brown.Very soft to soft, wet, non-plastic. (TOPSOIL)
ALLUVIAL DEPOSITS	0.5	SILT, minor fine sand, light brown, mottled brownish orange. Soft to firm, wet, non-plastic. (ALLUVIAL DEPOSITS)
		Moist to wet.
		Minor to some fine sand.
	1.0	Wet to saturated.
		PEAT, minor silt, dark brown to black. Soft, saturated.
	1.5	
		END OF BORE. 1.70 METRES. GRAVEL OBSTRUCTION
	2.0	

WATER LEVEL (m)

SCALA PENETROMETER TEST METHOD NZS4402: 1986 test 6.5.2

(Blows per 100mm Increment)

DEPTH (m)	5	10	15	20
0.0	0			
	0			
	1			
	2			
	3			
0.5	2			
	2			
	3			
	3			
	4			
1.0	5			
	6			
	3			
	3			
	3			
1.5	4			
	7			
	10			
	25			
2.0				

Comments

HAND AUGER WITH SCALA CHCH LOG C17120_AH02-AH17_08-08-17_11-08-17_DRAFT.GPJ S+R_2012-AGS - REVISED.GDT 5/10/17

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CLIENT: Louise and Brent Harkerss

PROJECT: Geotechnical Investigation, Leeston

Auger Hole No: AH16

Sheet 1 of 1

Drill Type:	50mm Hand Auger	Project No:	C17120	Logged By:	MG
Drilled By:	MG	Coordinates:	1542215 E, 5153782 N	Reviewed By:	MN
Date Started:	10/8/17	Ground Elevation:	26m	Surface Conditions:	Near Level, Grass
Date Finished:	10/8/17	Water Level:	Groundwater not encountered	Shear Vane Number:	N/A

STRATIGRAPHY	DEPTH (m)	GRAPHIC LOG	Soil description in accordance with the NZ Geotechnical Society Inc 2005 "Guidelines for Field Description of Soil and Rock in Engineering Use"	WATER LEVEL (m)	DEPTH (m)	SCALA PENETROMETER TEST METHOD NZS4402: 1986 test 6.5.2 (Blows per 100mm Increment)	Comments
TOPSOIL	0.0		SILT, trace fine sand, dark brown. Soft, moist to wet, non-plastic. (TOPSOIL)		0.0	0, 2, 3, 3, 2	
ALLUVIAL DEPOSITS	0.5		SILT, minor fine sand, light brown, mottled brownish orange. Soft to firm, moist to wet, non-plastic. (ALLUVIAL DEPOSITS)		0.5	2, 3, 4, 4, 4	
			Moist.				
	1.0		Light grey, heavy orange mottling.		1.0	4, 4, 5, 5, 5	
			Trace to minor fine sand.				
	1.5		Dark grey, no orange mottling.		1.5	8, 21, 25	
			Wet to saturated.				
	2.0		END OF BORE. 1.60 METRES. GRAVEL OBSTRUCTION		2.0		

HAND AUGER WITH SCALA CHCH LOG C17120_AH02-AH17_08-08-17_11-08-17_DRAFT.GPJ S+R_2012-AGS - REVISED.GDT 5/10/17

Soil&Rock Consultants
For well-grounded solutions

CLIENT: Louise and Brent Harkerss

PROJECT: Geotechnical Investigation, Leeston

Test Pit No: TP01

Sheet 1 of 1

Drill Type:	16 Tonne Wheeled Excavator	Project No:	C17120	Logged By:	CN
Drilled By:	Densem Contractors Ltd	Coordinates:	1542833 E, 5154999 N	Reviewed By:	
Date Started:	8/8/17	Ground Elevation:	26m	Surface Conditions:	Near Level, Grass
Date Finished:	8/8/17	Water Level:	0.6m	Shear Vane Number:	N/A

STRATIGRAPHY	DEPTH (m)	GRAPHIC LOG	Soil description in accordance with the NZ Geotechnical Society Inc 2005 "Guidelines for Field Description of Soil and Rock in Engineering Use"	WATER LEVEL (m)	DEPTH (m)	SCALA PENETROMETER TEST METHOD NZS4402: 1986 test 6.5.2 (Blows/100mm)	LABORATORY TESTS
TOPSOIL	0.0		SILT, trace fine sand, dark brown. Soft, moist, non-plastic, trace rootlets. (TOPSOIL)		0.0	5 10 15	
ALLUVIAL DEPOSITS	0.5		SILT, trace fine sand, light brownish grey, mottled orange, Soft to firm, moist, non-plastic. (ALLUVIAL DEPOSITS)		0.5		
	1.0		Fine to coarse sandy fine to coarse sub-rounded to rounded GRAVEL, trace silt, grey, Dense, saturated.	▽	1.0		
	1.5				1.5		
	2.0		END OF TEST PIT. 1.6 METRES. HOLE COLLAPSE		2.0		
	2.5				2.5		
	3.0				3.0		

COMMENTS:

TEST PIT LOG C17120_TP01_08-08-17_DRAFT.GPJ S+R_2012-AGS - REVISED.GDT 5/10/17