Appendix 4: Geotech Investigation south block

GEOTECHNICAL INVESTIGATION REPORT

FOR PROPOSED LAND USE CHANGE

Lincoln Rolleston Road, Rolleston

Client: Goulds Development Limited

Project Reference:	LTC20265
Revision:	Revision A
Date:	12 October 2020

Documentation Control:

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Document Title:	**Geotechnical Report for Proposed Land Use Change**	
Address:	Lincoln Rolleston Road, Rolleston	
Revision:	Revision A	
Client:	Goulds Development Limited	
Project Reference:	LTC20265	
Author:		Luke Challies, Associate Geotechnical Engineer BEngTech (Civil), MEngNZ
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REPORT DISTRIBUTION:		
Recipient	**Release Date**	**Document Type**
Goulds Development Limited	12 October 2020	Rev A (PDF)
Paterson Pitts Group	12 October 2020	Rev A (PDF)

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1.0 Introduction

1.1 Project Brief

LandTech Consulting Ltd. (LandTech) were engaged by Goulds Development Limited (the Client) to carry out a geotechnical investigation at Lincoln Rolleston Road, Rolleston (the Site). The geotechnical investigation is in relation to the proposal to change the land use within the investigated area.

The geotechnical investigation has been carried out to determine a geological model of the site, qualitatively assess the future land performance (i.e. during seismic events) and provide preliminary recommendations for site development.

This geotechnical report summarises the findings of our investigation and assessment. It includes a preliminary geotechnical assessment of the site, and may be used to support the land use change application to the Selwyn District Council (SDC). This report is not intended to support the subdivision application, individual house design or corresponding Building Consents, and further testing will be needed to address these applications.

1.2 Scope of Works

The geotechnical investigation for the proposed development included the following:

- Review of the New Zealand Geotechnical Database (NZGD) and other relevant geological/ geotechnical data;
- Detailed walkover inspection;
- Intrusive field investigation (i.e. test pits and insitu strength testing);
- Collation of field data and drafting;
- Geotechnical assessment;
- Provision of preliminary recommendations for development; and
- Preparation of this geotechnical report, detailing all of the above.

2.0 Site & Project Description

The investigation site is located on the corner of Lincoln Rolleston Road and Nobeline Drive in Rolleston. The site is indicated in Figure 1 below, an is located approximately 1.7km to the south east of the Rolleston Township. The site comprised four existing lots and the southern end of a property accessed from Levi Road to the North. Legal Descriptions of properties within the investigation site are given below in Table 1.

Figure 1: Aerial photograph of investigation site (source: https://mapviewer.canterburymaps.govt.nz/, accessed 29 September 2020)

The five properties are generally flat and are currently used primarily for grazing and horse training. Some young and mature hedge rows are located along property boundaries. A dwelling and associated sheds are located within 232 Lincoln Rolleston Road. The land is essentially flat with some very minor changes in elevations and undulations indicative of historic river channels located near the northern corner.

Table 1: Summary of legal descriptions for the investigation site

Mapped Street Address	Legal Description	Survey Area (Ha)
232 Lincoln Rolleston Road	LOT 3 DP 67190 BLK III LEESTON SD	3.38
5 Nobeline Drive	Lot 7 DP 483709	4.08
15 Nobeline Drive	Lot 8 DP 483709	4.06
25 Nobeline Drive	Lot 9 DP 483709	4.04
***Portion of* 139 Levi Road**	LOT 2 DP 416195 LOT 5 DP 322710	apx. 2.43 of 30.43
		Total ≈18.00ha

Table Notes: Legal Descriptions and area's sourced from Canterbury Maps Viewer, weblink: https://mapviewer.canterburymaps.govt.nz/, accessed 30 September 2020

3.0 Area Geology

Reference has been made to the *New Zealand Geology Web Map*, GNS Science, http://data.gns.cri.nz/geology/, website accessed 30 September 2020. The reviewed sources indicate that the site is underlain by Holocene Aged River Deposits. These materials generally comprise rounded to subrounded gravel and cobble sized particles within a matrix of silt and sand, deposited via the lateral and vertical migration of the past and present river systems, from the Southern Alps, out toward the east coast. Due to the depositional environment, the geotechnical characteristics of this material can be variable.

The characteristics of the River Deposits can vary widely over small distances. These variances include vertical and horizontal differences in both soil particle size distribution and consolidation. It is discussed above that these materials generally comprise gravel and cobbles; however, interbedded horizons of fine to coarse grained sand, silt and clay can also exist. They can also be capped by loessal soils or finer grained silts and sands.

3.1 Faults in Canterbury

For the purpose of our investigation we have referred to a Selwyn District earthquake fault report compiled by GNS Science and Environment Canterbury (ECan). The referenced report is titled:

- *General distribution and characteristics of active faults and folds in the Selwyn District, North Canterbury*, GNS Science and Environment Canterbury, dated July 2013.

The reference report gives a general outline of the nature of geologically active areas within the Selwyn District. Figure 6 in the referenced report indicates that the investigation site is located within 10km of the mapped Greendale Fault, to the northwest.

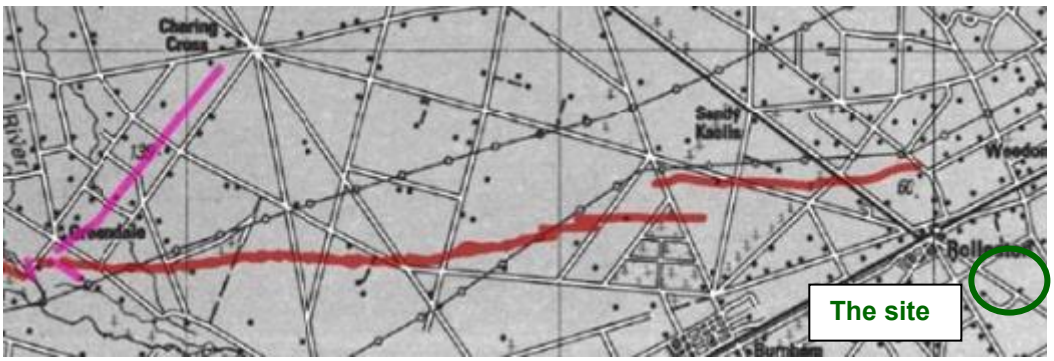


Figure 2: shows excerpt from figure A.1e of the referenced report (red line is a definite or likely fault).

The Greendale Fault and associated blind faults of the Darfield earthquake sequence have been defined by GNS Science via field inspection, aerial photograph interpretation and regional geologic mapping. The reference source indicates that these faults were unknown prior to 2010 and the ages of previous ruptures are also not known. This leave the potential for further unmapped faults to exist within the locality of the investigation site.

4.0 Geotechnical Data Review

Reference has been made to sources including the New Zealand Geotechnical Database (NZGD): http://www.nzgd.org.nz/ and Environment Canterbury (ECan): http://canterburymaps.govt.nz/ (accessed 21 September 2020). The following text summaries the findings of our data review:

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

- According to Canterbury Maps there are a series of Ecan wells within close proximity to the site. The associated bore logs for the following ECan wells have been reviewed and are attached with Appendix B:
  - M36/0328, drilled to 28.6m and located with 232 Lincoln Rolleston Rd site. The borelog for the well shows earth and clay to 1.2m depth underlain by claybound to rough sandy gravel to the drill depth. Water levels from 1989, indicate a groundwater level of between 13.5m and 14.3m below ground level.

  - MX23/0620, drilled to 48.0m and located at the eastern corner of the site. The borelog for the well shows topsoil to 0.3m depth underlain by light brown gravelly clay or sandy gravel to the drill depth. Ground water levels are indicated at 13.0m ground level.

  - M36/4894, drilled to 34.0m and located to the west of the site across Lincoln Rolleston Road. The borelog for the well shows topsoil and clay to 0.6m depth underlain by sandy gravel or claybound gravel to the drill depth. Initial groundwater levels are indicated at 12.0m ground level.

- According to the Environment Canterbury Soil Type map, the site is mapped as either comprising a *Typic Immature Plallic Soils* with a moderately deep silty loam or *Typic Immature Plallic Soils* with a deep silty loam. Both soil types are described as having *moderate over slow* permeability.

- Eastern Canterbury Liquefaction susceptibility (2012), shows the site is located within an area were *Liquefaction damage is unlikely.*

- A review of historical photograph of the site from between 1940 and 2004 has been carried out on Canterbury Maps. Imagery from 1940 to 1944 (shown overleaf in Figure 3), shows evidence of paleo river channels near the northern corner of the site, it is possible additional channels are present within the investigation site. Some historic infilling of these paleo channels could have taken place as part of farming activities. However, our investigation found limited evidence of filling having taken place across the general subdivision site.

Figure 3: Aerial photograph of investigation site (source: https://mapviewer.canterburymaps.govt.nz/, accessed 07 September 2020)

5.0 Field Investigation

Our field investigation took place on 21 September 2020 and comprised the following components:

- Detailed walkover inspection;
- Excavation of Six test pits (TP01 – TP06) and associated Scala penetrometer testing; and
- Soakage testing (ST01) within TP02.

Each test was positioned evenly across the site away from infrastructure and animals, test locations are shown on the LandTech *Site Test Plan*, Drawing No. LTC20265/ 1, (attached in Appendix A). The positions have been located via a hand-held GPS without survey control and are therefore approximate only.

The soil conditions encountered within the hand augerholes and test pits were logged by LandTech field staff in accordance with New Zealand Geotechnical Society *Guideline for the Description of Soil and Rock for Engineering Purposes* (2005). The test pit logs and corresponding photographs are attached in Appendix B, while the hand augerhole logs are within Appendix C.

The undrained shear strength of the fine-grained soils was recorded where applicable using a Geovane hand held shear vane in accordance with the NZGS *Guideline for Hand Held Shear Vane Test*, published August 2001. The peak and remoulded vane shear strength values have been factored in terms of BS1377.

Dynamic Cone (Scala) Penetrometer testing was carried out near the test pit locations to determine a soil density profile. Testing procedures were in accordance with NZS 4402:1988, Test 6.5.2, *Dynamic Cone Penetrometer*. The test results are shown on test pit logs.

Soakage testing was carried out in general accordance with the Auckland City Soakage Design Manual, worksheet W1: Falling-head Percolation Test. That being the change in water depth against time was recorded. A slight modification for the diameter of the holes has been made with a simple area conversion from a rectangle to a circle to give an equivalent diameter.

6.0 Subsurface Conditions

The sites subsurface conditions generally comprised a surficial layer of topsoil underlain by a sequence of Alluvial / Loess deposits followed by River Deposits. This is consistent with the geology described in Section 3.0 (Area Geology). A subsurface summary is given in Table 2 and detailed descriptions are given in the subsequent sections.

Table 2: Subsurface summary

Test pit ID	Test Pit Depth	Topsoil Depth	Soil Depth	Scala Depth
TP01	2.8	0.2	0.6	0.6
TP02	2.8	0.2	1.2	1.3
TP03	2.6	0.3	0.8	0.8
TP04	2.8	0.3	0.9	1.0
TP05	2.7	0.2	0.7	1.2
TP06	2.6	0.3	0.5	0.6

Table notes: Measurements are in metres (m) below present ground level
Scala penetrometer refusal considered when an excess of 20 blows /100mm penetration occurs

6.1 Topsoil

Topsoil was encountered from the surface at all test locations and ranged between the depths of 0.2m and 0.3m below present ground level (bpgl). This mostly comprised dark brown silt with minor fractions of fine to coarse grained sand. The topsoil is not considered suitable for the support of building foundations.

6.2 Alluvial / Loess Deposits

Soil deposits comprising either alluvial soils or loessal soils where present above the river deposits at depth. The depth of these soils ranged from between 0.5m (TP06) and 1.2m (TP02) below ground level, and typically comprised a moist fine sandy silt.

Scala penetrometer testing within the soils ranged from 1 and 20 Blows / 100mm penetration. Higher blow counts may be due to gravels within the soil at the test location. Typically the Scala blow counts ranged from between 1 and 6 Blows / 100mm of penetration indicating a loose to medium dense soil.

Where possible shear vane testing was carried out, peak shear vane testing ranged from between 107kPa and 187+kPa indicating a very stiff soil.

6.3 River Deposits

River Deposits were encountered below the surficial layer of sandy silts to the termination depth of all test locations (TP01 – TP06). The River Deposits generally comprised fine to coarse sandy, fine to coarse subrounded gravel. The gravel deposits where described as wet near the refusal depths in some of the tests, while larger cobbles were also encountered.

Scala penetrometer testing was unable to penetrate the gravels with refusal typically being achieved in contact with the underlying gravels.

6.4 Soakage

The soakage capacity of the gravel was tested within TP02; the location of the test pits are shown on the LandTech *Site Test Plan*, Drawing No. LTC20265/ 1 (attached in Appendix A). The results of the soakage testing are attached in Appendix C.

The results of the calculated average soakage rates are shown in Table 3 below:

Table 3: Average soakage rates

	SP01 / TP06
Average Soak Rate (mm/hour)	1836
Percolation Rate (L/m^2/min)	13

6.5 Site Seismicity

For the purpose of applying requirements of NZS 1170.5:2004 the site subsoil is Class D – Deep or Soft Soil Site. This classification is based on depths of soil exceeding the limits of Table 3.2 of the reference standard. seismic hazard factor (Z) for the site is 0.3 as per the standard.

7.0 Qualitative Liquefaction Analysis

The MBIE & New Zealand Geotechnical Society Inc. report titled *Earthquake geotechnical engineering practice, Module 3: Identification, assessment and mitigation of liquefaction hazards* (2016) explains that the evaluation of the geologic susceptibility of liquefaction is a key aspect in the evaluation of liquefaction potential at a given site.

Based on our desktop study and field investigation, we have established that the site is generally underlain by Holocene Age horizons of tightly packed gravel (i.e. River Deposits) with groundwater average ground water levels of around 13.0m. In addition to this ECan (2012) liquefaction susceptibility maps has indicated that the site is unlikely to be damaged via earthquake induced liquefaction.

The region comprises a rural/unmapped Residential Foundation Technical Category (based on MBIE); however, is considered an area that is not likely to be susceptible to liquefaction induced damage. This is based on the geology underlying the site (i.e. Holocene Aged River Deposits), the previously referenced reports and maps, and our qualitative liquefaction assessment.

Based on our assessment of the investigation site, we are categorising existing property as Technical Category 1 (TC1) with damaging liquefaction unlikely and consider the site suitable for residential development from a geotechnical perspective.

8.0 Geotechnical Hazard Evaluation

Section 106 of the Resource Management Act 1991 outlines hazards that must be assessed when a territorial authority considers subdivision of land. This section outlines our evaluation of possible geotechnical hazards associated with this site. Based on the results of our investigation and assessment, we consider this site suitable for land use change to residential zoning from a geotechnical perspective.

8.1 Erosion

The surface of the property is near level to undulating with no general contour/runoff direction. During our field investigation, we did not observe any obvious signs of erosion from concentrated surface runoff. Furthermore, we do not consider the proposed site development will increase the erosion potential provided stormwater is disposed of in a controlled manner subject to usual Council Consenting procedures.

8.2 Inundation

Assessment for inundation from flooding is not a part of the scope of this report and therefore has not been fully assessed. A basic review online mapping available from CanterburyMaps has been carried out and no information for the site was evident. If required an assessment should be carried out by suitably experienced consultant.

8.3 Subsidence

It is discussed in previous sections of this report, liquefaction is not likely to occur within the investigation site. This is due to the shallow depth to gravel and gravelly sand layers (between 0.5m and 1.2m below the site) and the ECan well logs indicating that groundwater in the area is at an average of around 13.0m below ground level.

This means that corresponding liquefaction induced subsidence is unlikely, as per the site performance through the CES. Foundation settlements are also considered unlikely due to the dense nature of the subsoils. This is provided in our recommendations given further herein are followed regarding further investigation, foundation design and construction.

8.4 Falling Debris

No tall standing slopes exist in the vicinity of the investigation site, therefore falling debris hazard is non-existent.

8.5 Slippage

Due to the site being near level to gently undulating, it's removed location from any major waterways, and inferred non-liquefiable nature of the underlying subsoils, slippage via liquefaction-induced lateral spreading is not considered to affect the subdivision site. No other geotechnical mechanism of slippage was noted during out field investigation or from our assessment.

8.6 Contamination

Whilst not a requirement of Section 106 of the RMA 1991, soil contamination is a potential geotechnical hazard that should be considered when making Consent applications to territorial authorities where ground disturbance works are proposed (i.e. foundation excavations etc.).

We have made reference to the ECan Listed Land Use Register (LLUR), that a Detailed Site Investigation has taken place with 5 Nobeline Drive. A copy this report is available upon request from https://llur.ecan.govt.nz/ .

The remaining sites have no recorded information registered against them. This indicates no HAIL activities are recorded to have taken place at the site, according to the register. This does not confirm the site has no soil contamination, but only indicates the Regional Council does not have records of potentially hazardous activities taking place the site that could lead to soil contamination.

9.0 Geotechnical Recommendations

It is stated in the previous sections that the site has been classified as TC1; based on our desktop study, the underlying geology and qualitative liquefaction assessment. Following our assessment, we consider the site suitable land use change to residential zoning from a geotechnical perspective. Our recommendations with regard to site development and preliminary foundation design follow subsequently.

9.1 Preliminary Foundation Recommendations

Due to the low risk of liquefaction at the subdivision we have classified the investigation site as TC1, and conclude the River Deposits beneath any surficial soils meet the criteria for “good ground” as defined by NZS3604:2011. Some areas of weak upper surficial soils may require foundations to be subject to specific engineering design due to low bearing capacities. Alternatively, earthworks during subdivision may compact any weak upper layers so standard foundations can be utilised without engineering design input. The extent of any weak upper soils can be determined with further shallow soil testing as part of the subdivision design/consenting stage.

9.2 Preliminary Earthwork Recommendations

All proposed earthworks will need to be carried out to the requirements of NZS 4431:1989, ‘Code of Practice for Earthfilling for Residential Development’. All unsuitable materials (vegetation, organic or detritus material, and organic rich topsoil etc.) should be stripped from any areas of earthworks and stockpiled well clear of operations or carted from the site.

10.0 Future Geotechnical Involvement

Should the land use change be approved and a subdivision plan be made, a more detailed geotechnical investigation will be required to more accurately identify areas of deep alluvial soils and provided further geotechnical recommendations for the subdivision development.

Dependent on the extent of earthworks during the subdivision stage and involvement from a geo-professional to observe areas of stripped ground and fill compaction, additional lot specific shallow soil testing may be required. The results of which may supersede our preliminary foundation recommendations if the test results differ to our area wide investigation. However, the risk of differing ground conditions is considered to be low, due to the relatively uniform presence of dense river gravels throughout the general Rolleston area. Potential variations could be from deeper areas of surficial alluvial soils or localised uncontrolled filling in the past.

11.0 Limitations

This geotechnical report has been prepared for our Client, Goulds Investment Limited, for the purposes of supporting a Land Use Change application to the Selwyn District Council. This report shall not be extrapolated for other nearby sites or used for any other purposes without the express approval of LandTech and their Client.

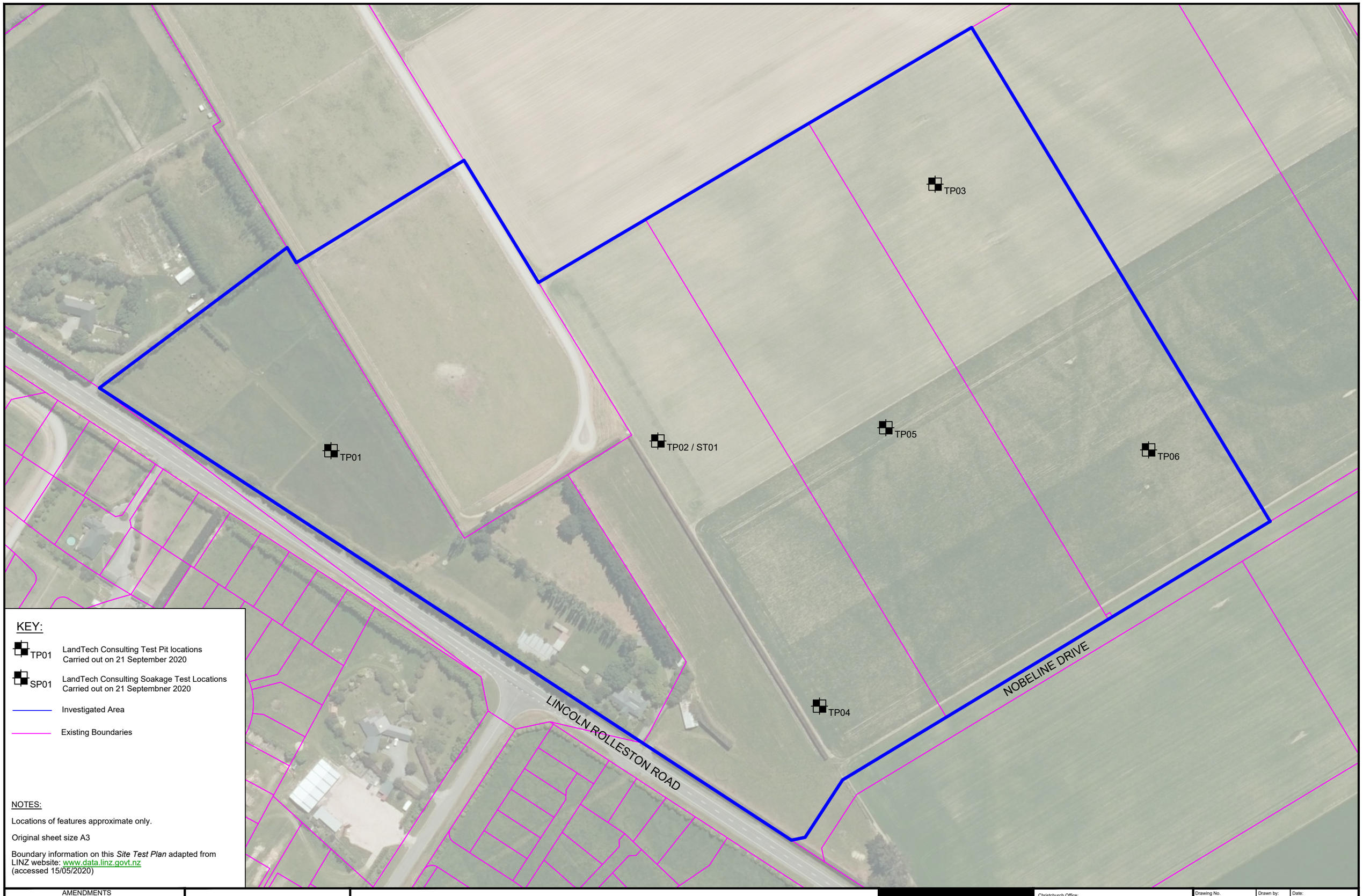
This report has been based on the results of tests at point locations; therefore, subsurface conditions could vary away from the assumed geotechnical model. Should exposed soil conditions vary from those described herein we request to be informed to determine the continued applicability of our recommendations.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

The geotechnical investigation was confined to geotechnical aspects of the site only and did not involve the assessment for environmental contaminants. In addition, our investigation and analyses have also not taken into account possible fault rupture that may cause deformations and displacements of the ground directly below the site. This type of assessment is outside of the scope of our geotechnical engagement.

END OF REPORT

APPENDIX A

LandTech Site Test Plan



KEY:

- TP01 — LandTech Consulting Test Pit locations Carried out on 21 September 2020
- SP01 — LandTech Consulting Soakage Test Locations Carried out on 21 Septembner 2020
- Investigated Area
- Existing Boundaries

NOTES:

Locations of features approximate only.

Original sheet size A3

Boundary information on this *Site Test Plan* adapted from LINZ website: www.data.linz.govt.nz (accessed 15/05/2020)

AMENDMENTS

DATE	REV	DESCRIPTION
30/09/2020	A	Test Plan

Lincoln Rolleston Road

ROLLESTON

LandTech CONSULTING

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PO Box 119, Christchurch 8013

Website: www.landtech.nz Email: info@landtech.nz

Drawing No.	Drawn by:	Date:
LTC20265/1	L C	30 September 2020
Scale: 1: 2000 (A3)	Checked by: D W	Revision: A

Filename: LTC20264 - Drawings.dwg

APPENDIX B

Environment Canterbury Well Logs

canterbury maps

Canterbury Maps

Information has been derived from various organisations, including Environment Canterbury and the Canterbury Maps partners. Boundary information is derived under licence from LINZ Digital Cadastral Database (Crown Copyright Reserved). Environment Canterbury and the Canterbury Maps partners do not give and expressly disclaim any warranty as to the accuracy or completeness of the information or its fitness for any purpose.

Information from this map may not be used for the purposes of any legal disputes. The user should independently verify the accuracy of any information before taking any action in reliance upon it.

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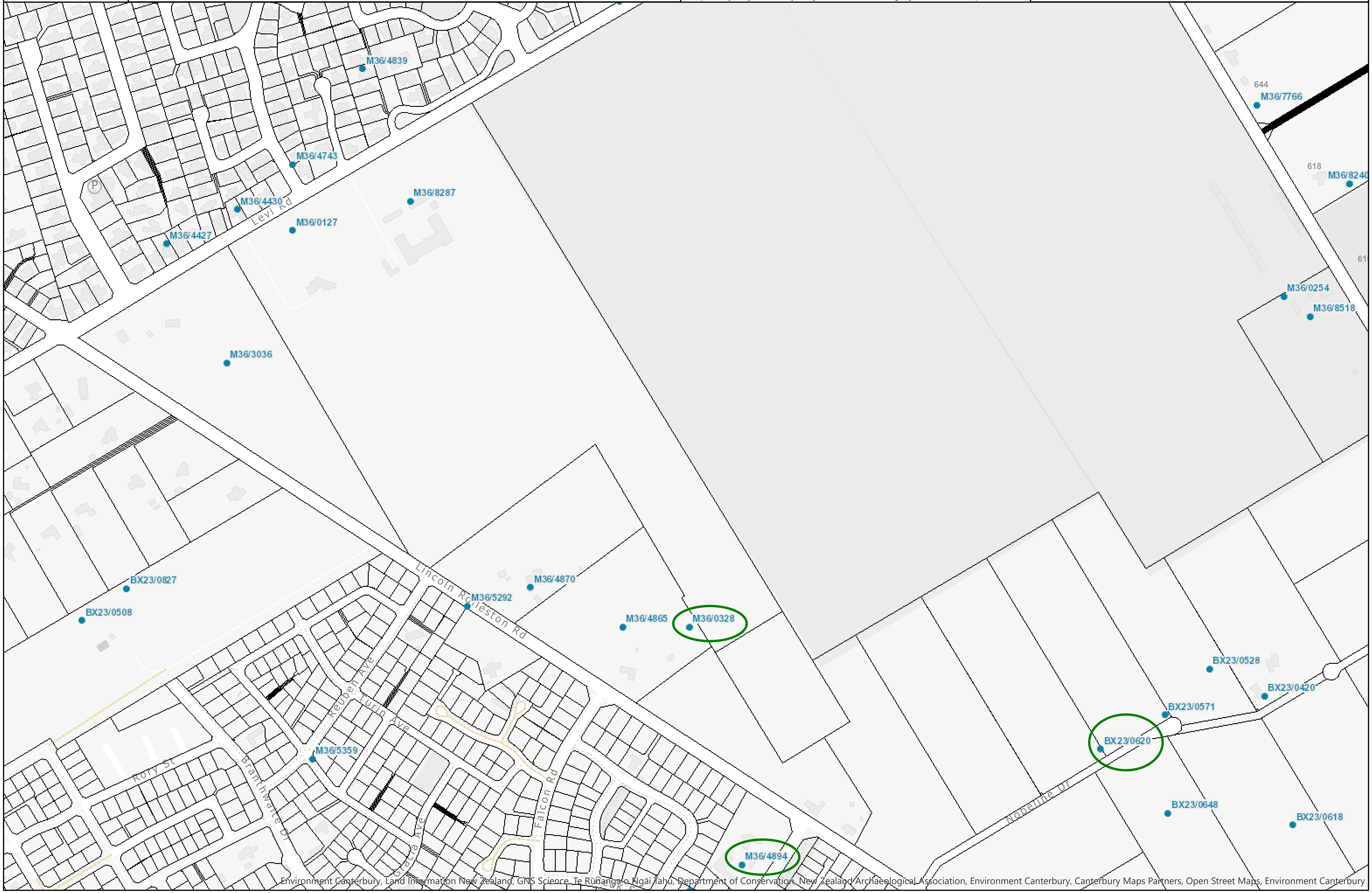
0 0.07 0.14 0.21 0.28 Kilometres

Scale: 1:5,000 @A3

Map Created by Canterbury Maps on 12/10/2020 at 12:49 PM



Environment Canterbury, Land Information New Zealand, GNS Science, Te Rūnanga o Ngāi Tahu, Department of Conservation, New Zealand Archaeological Association, Environment Canterbury, Canterbury Maps Partners, Open Street Maps, Environment Canterbury

APPENDIX C

Test Pit Logs

LandTech CONSULTING	Client: Gould Developments Limited Project: Geotechnical Investigation for Proposed Land Use Change Address: Lincoln Rolleston Road, Rolleston	Test Pit No.	TP01
		Sheet No.	1 of 1

Drill Type:	6T Hydraulic Excavator	Project No:	LTC20265	Logged By:	L Challies
Drilled By:	BM Contracting	Coordinates:	NZTM2000 E1552067 N5172037	Shear Vane No:	2255
Date Started:	21-Sep-20	Ground Conditions:	Near level, grass	Calibration Factor:	1.333
Date Finished:	21-Sep-20	Groundwater Level (m):	Not Encountered (03-Sep-30)	Calibration Date:	16-Mar-20

Stratigraphy	Depth (m)	Graphic Log	Soil description in accordance with *Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes*, NZ Geotechnical Society Inc., 2005
T.SOIL	0.0		SILT, some fine sand, dark brown, stiff, moist, non-plastic, trace organics and rootlets [TOPSOIL]
ALLUVIAL DEPOSITS	0.5		Fine sandy SILT, yellowish light brown, very stiff, moist, non-plastic [ALLUVIAL DEPOSITS / LOESS]
	1.0		Fine to coarse sandy, sub rounded GRAVEL, minor silt, brown, dense, moist [RIVER DEPOSITS]
	1.5		trace cobbles, very dense
	2.0		
	2.5		
	3.0		End of Test Pit 2.8m [TARGET DEPTH]
	3.5		
	4.0		
	4.5		
	5.0		

Groundwater Level (m): Not Encountered (21-Sep-20)

In-situ Field Testing

Shear Strength (kPa) — Peak: / Remoulded: — 0

Dynamic Cone Penetrometer Depth (m)	Blow Count	Scala Blow Count / 100mm
-0.1	2	
-0.2	2	
-0.3	2	
-0.4	3	
-0.5	5	
-0.6	13	
-0.7	18	
-0.8	18	
-0.9	7	
-1.0	8	
-1.1	15	
-1.2	20 +	
-1.3		
-1.4		
-1.5		
-1.6		
-1.7		
-1.8		
-1.9		
-2.0		
-2.1		
-2.2		
-2.3		
-2.4		
-2.5		
-2.6		
-2.7		
-2.8		
-2.9		
-3.0		
-3.1		
-3.2		
-3.3		
-3.4		
-3.5		
-3.6		
-3.7		
-3.8		
-3.9		
-4.0		
-4.1		
-4.2		
-4.3		
-4.4		
-4.5		
-4.6		
-4.7		
-4.8		
-4.9		
-5.0		

In-situ field testing in accordance with the following Standards:

Scala Penetrometer Testing: NZS 4402:1988, Test 6.5.2, Dynamic Cone Penetrometer

Shear Vane Testing: Guideline for Hand Held Shear Vane Test, NZGS, August 2001

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Phone: (03) 390 1371
Phone: (09) 930 9334
Email: info@landtech.nz
Website: www.landtech.nz

LandTech CONSULTING

Client:	Gould Developments Limited	Test Pit No.	TP02
Project:	Geotechnical Investigation for Proposed Land Use Change		
Address:	Lincoln Rolleston Road, Rolleston	Sheet No.	1 of 1

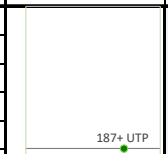
Drill Type:	6T Hydraulic Excavator	Project No:	LTC20265	Logged By:	L Challies
Drilled By:	BM Contracting	Coordinates:	NZTM2000 E1552266 N5172044	Shear Vane No:	2255
Date Started:	21-Sep-20	Ground Conditions:	Near level, grass	Calibration Factor:	1.333
Date Finished:	21-Sep-20	Groundwater Level (m):	Not Encountered (03-Sep-30)	Calibration Date:	16-Mar-20

Stratigraphy	Depth (m)	Graphic Log	Soil description in accordance with *Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes*, NZ Geotechnical Society Inc., 2005
T.SOIL	0.0		SILT, some fine sand, dark brown, stiff, moist, non-plastic, trace organics and rootlets [TOPSOIL]
ALLUVIAL DEPOSITS	0.5		Fine sandy SILT, yellowish light brown, very stiff, moist, non-plastic [ALLUVIAL DEPOSITS / LOESS]
	1.0		
	1.5		Fine to coarse sandy, sub rounded GRAVEL, minor silt, brown, dense, moist [RIVER DEPOSITS]
	2.0		trace subrounded to round boulders, wet
	2.5		
	3.0		End of Test Pit 2.8m [TARGET DEPTH]
	3.5		
	4.0		
	4.5		
	5.0		

Groundwater Level (m): Not Encountered (21-Sep-20)

In-situ Field Testing

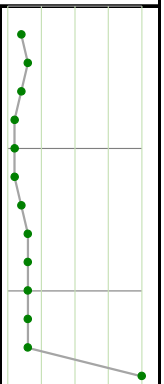
Shear Strength (kPa) — Peak: / Remoulded: — 150 200



Dynamic Cone Penetrometer

Depth (m)	Blow Count
-0.1	2
-0.2	3
-0.3	2
-0.4	1
-0.5	1
-0.6	1
-0.7	2
-0.8	3
-0.9	3
-1.0	3
-1.1	3
-1.2	3
-1.3	20 +

Scala Blow Count / 100mm — 0 5 10 15 20



In-situ field testing in accordance with the following Standards:

Scala Penetrometer Testing: NZS 4402:1988, Test 6.5.2, Dynamic Cone Penetrometer

Shear Vane Testing: Guideline for Hand Held Shear Vane Test, NZGS, August 2001

LandTech Consulting Ltd. (Christchurch): Unit 6, 31 Carlyle Street, Sydenham — Phone: (03) 390 1371 — Email: info@landtech.nz

LandTech Consulting Ltd. (Auckland): 17 Nils Andersen Road, Whenuapai — Phone: (09) 930 9334 — Website: www.landtech.nz

LandTech CONSULTING	Client: Gould Developments Limited Project: Geotechnical Investigation for Proposed Land Use Change Address: Lincoln Rolleston Road, Rolleston	Test Pit No.	TP03
		Sheet No.	1 of 1

Drill Type:	6T Hydraulic Excavator	Project No:	LTC20265	Logged By:	L Challies
Drilled By:	BM Contracting	Coordinates:	NZTM2000 E1552434 N5172199	Shear Vane No:	2255
Date Started:	21-Sep-20	Ground Conditions:	Near level, grass	Calibration Factor:	1.333
Date Finished:	21-Sep-20	Groundwater Level (m):	Not Encountered (21-Sep-30)	Calibration Date:	16-Mar-20

Stratigraphy	Depth (m)	Graphic Log	Soil description in accordance with *Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes*, NZ Geotechnical Society Inc., 2005
T. SOIL	0.0		SILT, some fine sand, dark brown, stiff, moist, non-plastic, trace organics and rootlets [TOPSOIL]
ALLUVIAL DEPOSITS	0.5		Fine sandy SILT, yellowish light brown, very stiff, moist, non-plastic [ALLUVIAL DEPOSITS / LOESS]
	1.0		Fine to coarse sandy, sub rounded GRAVEL, minor silt, brown, dense, moist [RIVER DEPOSITS]
	1.5		trace subrounded to round boulders, wet
	2.0		
	2.5		
	3.0		End of Test Pit 2.6m [TARGET DEPTH]
	3.5		
	4.0		
	4.5		
	5.0		

Groundwater Level (m): Not Encountered (21-Sep-20)

In-situ Field Testing

Shear Strength (kPa)

Peak:

Remoulded:

150 200

187+ UTP

Dynamic Cone Penetrometer

Depth (m)	Blow Count
-0.1	2
-0.2	2
-0.3	3
-0.4	3
-0.5	3
-0.6	8
-0.7	21
-0.8	25+
-0.9	
-1.0	
-1.1	
-1.2	
-1.3	
-1.4	
-1.5	
-1.6	
-1.7	
-1.8	
-1.9	
-2.0	
-2.1	
-2.2	
-2.3	
-2.4	
-2.5	
-2.6	
-2.7	
-2.8	
-2.9	
-3.0	
-3.1	
-3.2	
-3.3	
-3.4	
-3.5	
-3.6	
-3.7	
-3.8	
-3.9	
-4.0	
-4.1	
-4.2	
-4.3	
-4.4	
-4.5	
-4.6	
-4.7	
-4.8	
-4.9	
-5.0	

Scala Blow Count / 100mm

0 5 10 15 20

In-situ field testing in accordance with the following Standards:

Scala Penetrometer Testing: NZS 4402:1988, Test 6.5.2, Dynamic Cone Penetrometer

Shear Vane Testing: Guideline for Hand Held Shear Vane Test, NZGS, August 2001

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Email: info@landtech.nz
Website: www.landtech.nz

LandTech CONSULTING

Client: Gould Developments Limited
Project: Geotechnical Investigation for Proposed Land Use Change
Address: Lincoln Rolleston Road, Rolleston

Test Pit No. TP04
Sheet No. 1 of 1

Drill Type:	6T Hydraulic Excavator	Project No:	LTC20265	Logged By:	L Challies
Drilled By:	BM Contracting	Coordinates:	NZTM2000 E1552364 N5171882	Shear Vane No:	2255
Date Started:	21-Sep-20	Ground Conditions:	Near level, grass	Calibration Factor:	1.333
Date Finished:	21-Sep-20	Groundwater Level (m):	Not Encountered (21-Sep-30)	Calibration Date:	16-Mar-20

Stratigraphy	Depth (m)	Graphic Log	Soil description in accordance with *Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes*, NZ Geotechnical Society Inc., 2005
T. SOIL	0.0		SILT, some fine sand, dark brown, stiff, moist, non-plastic, trace organics and rootlets [TOPSOIL]
ALLUVIAL DEPOSITS	0.5		Fine sandy SILT, yellowish light brown, stiff, moist, non-plastic [ALLUVIAL DEPOSITS / LOESS]
	1.0		Fine to coarse sandy, sub rounded GRAVEL, minor silt, brown, dense, moist [RIVER DEPOSITS]
	1.5		trace subrounded to round boulders, wet
	2.0		
	2.5		
	3.0		End of Test Pit 2.8m [TARGET DEPTH]
	3.5		
	4.0		
	4.5		
	5.0		

Groundwater Level (m): Not Encountered (21-Sep-20)

In-situ Field Testing

Shear Strength (kPa) — Peak: — Remoulded: ·

Dynamic Cone Penetrometer

Depth (m)	Blow Count
-0.1	2
-0.2	2
-0.3	4
-0.4	2
-0.5	4
-0.6	12
-0.7	20
-0.8	14
-0.9	14
-1.0	20+

Scala Blow Count / 100mm (0 5 10 15 20)

In-situ field testing in accordance with the following Standards:
Scala Penetrometer Testing: NZS 4402:1988, Test 6.5.2, Dynamic Cone Penetrometer
Shear Vane Testing: Guideline for Hand Held Shear Vane Test, NZGS, August 2001

LandTech Consulting Ltd. (Christchurch): Unit 6, 31 Carlyle Street, Sydenham
LandTech Consulting Ltd. (Auckland): 17 Nils Andersen Road, Whenuapai
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Website: www.landtech.nz

LandTech CONSULTING	Client: Gould Developments Limited Project: Geotechnical Investigation for Proposed Land Use Change Address: Lincoln Rolleston Road, Rolleston	Test Pit No.	TP05
		Sheet No.	1 of 1

Drill Type:	6T Hydraulic Excavator	Project No:	LTC20265	Logged By:	L Challies
Drilled By:	BM Contracting	Coordinates:	NZTM2000 E1552405 N5172052	Shear Vane No:	2255
Date Started:	21-Sep-20	Ground Conditions:	Near level, grass	Calibration Factor:	1.333
Date Finished:	21-Sep-20	Groundwater Level (m):	Not Encountered (21-Sep-30)	Calibration Date:	16-Mar-20

Stratigraphy	Depth (m)	Graphic Log	Soil description in accordance with *Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes*, NZ Geotechnical Society Inc., 2005
T. SOIL	0.0		SILT, some fine sand, dark brown, stiff, moist, non-plastic, trace organics and rootlets [TOPSOIL]
ALLUVIAL DEPOSITS	0.5		Fine sandy SILT, yellowish light brown, stiff, moist, non-plastic [ALLUVIAL DEPOSITS / LOESS]
	1.0		Fine to coarse sandy, sub rounded GRAVEL, minor silt, brown, dense, moist [RIVER DEPOSITS]
	1.5		trace subrounded to round boulders
	2.0		
	2.5		wet
	3.0		End of Test Pit 2.7m [TARGET DEPTH]
	3.5		
	4.0		
	4.5		
	5.0		

Groundwater Level (m): Not Encountered (21-Sep-20)

In-situ Field Testing

Shear Strength (kPa)

Peak:

Remoulded:

150 200

187+ UTP

Depth (m)	Blow Count
-0.1	2
-0.2	2
-0.3	3
-0.4	5
-0.5	6
-0.6	6
-0.7	6
-0.8	7
-0.9	7
-1.0	10
-1.1	18
-1.2	20+
-1.3	
-1.4	
-1.5	
-1.6	
-1.7	
-1.8	
-1.9	
-2.0	
-2.1	
-2.2	
-2.3	
-2.4	
-2.5	
-2.6	
-2.7	
-2.8	
-2.9	
-3.0	
-3.1	
-3.2	
-3.3	
-3.4	
-3.5	
-3.6	
-3.7	
-3.8	
-3.9	
-4.0	
-4.1	
-4.2	
-4.3	
-4.4	
-4.5	
-4.6	
-4.7	
-4.8	
-4.9	
-5.0	

Dynamic Cone Penetrometer

Scala Blow Count / 100mm

0 5 10 15 20

In-situ field testing in accordance with the following Standards:

Scala Penetrometer Testing: NZS 4402:1988, Test 6.5.2, Dynamic Cone Penetrometer

Shear Vane Testing: Guideline for Hand Held Shear Vane Test, NZGS, August 2001

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Website: www.landtech.nz

LandTech CONSULTING	Client: Gould Developments Limited Project: Geotechnical Investigation for Proposed Land Use Change Address: Lincoln Rolleston Road, Rolleston	Test Pit No.	TP06
		Sheet No.	1 of 1

Drill Type:	6T Hydraulic Excavator	Project No:	LTC20265	Logged By:	L Challies
Drilled By:	BM Contracting	Coordinates:	NZTM2000 E1552565 N5172038	Shear Vane No:	2255
Date Started:	21-Sep-20	Ground Conditions:	Near level, grass	Calibration Factor:	1.333
Date Finished:	21-Sep-20	Groundwater Level (m):	Not Encountered (21-Sep-30)	Calibration Date:	16-Mar-20

Stratigraphy	Depth (m)	Graphic Log	Soil description in accordance with *Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes*, NZ Geotechnical Society Inc., 2005
T. SOIL	0.0		SILT, some fine sand, dark brown, stiff, moist, non-plastic, trace organics and rootlets [TOPSOIL]
ALLUVIAL DEPOSITS	0.5		Fine sandy SILT, yellowish light brown, stiff, moist, non-plastic [ALLUVIAL DEPOSITS / LOESS]
	1.0		Fine to coarse sandy, sub rounded GRAVEL, minor silt, brown, dense, moist [RIVER DEPOSITS]
	1.5		trace subrounded to round boulders
	2.0		
	2.5		
	3.0		End of Test Pit 2.6m [TARGET DEPTH]
	3.5		
	4.0		
	4.5		
	5.0		

Groundwater Level (m): Not Encountered (21-Sep-20)

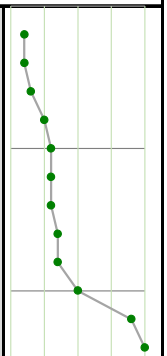
In-situ Field Testing

Shear Strength (kPa)

Dynamic Cone Penetrometer

Depth (m)	Blow Count
-0.1	2
-0.2	2
-0.3	3
-0.4	5
-0.5	6
-0.6	6
-0.7	6
-0.8	7
-0.9	7
-1.0	10
-1.1	18
-1.2	20+
-1.3	
-1.4	
-1.5	
-1.6	
-1.7	
-1.8	
-1.9	
-2.0	
-2.1	
-2.2	
-2.3	
-2.4	
-2.5	
-2.6	
-2.7	
-2.8	
-2.9	
-3.0	
-3.1	
-3.2	
-3.3	
-3.4	
-3.5	
-3.6	
-3.7	
-3.8	
-3.9	
-4.0	
-4.1	
-4.2	
-4.3	
-4.4	
-4.5	
-4.6	
-4.7	
-4.8	
-4.9	
-5.0	

Scala Blow Count / 100mm



In-situ field testing in accordance with the following Standards:

Scala Penetrometer Testing: NZS 4402:1988, Test 6.5.2, Dynamic Cone Penetrometer

Shear Vane Testing: Guideline for Hand Held Shear Vane Test, NZGS, August 2001

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APPENDIX C

Soakage Test Results

	Client:	Goulds Development Limited	
	Project:	Proposed Land Use Change	
	Address:	Lincoln Rolleston Road, Rolleston	
Test Type:	On-site soakage test	Project No:	LTC20265
Tested By:	L Challies	Test Date:	21-Sep-20

Test ID:	TP02/SP01	Test ID:	
Coordinates:	NZTM2000 E1552266 N5172044	Coordinates:	
Groundwater level:	Not Encountered	Groundwater level:	
Method:	In accorandance with W1: Falling-head percolation Test of the Auckland soakage design manual	Method:	

Test Pit Dimensions

2	m	length
1	m	wide
1.60	m	equivalent diameter

1) Test Details

Time (Sec)	Time (min)	Depth (m)	Soak Rate (m/min)
0	0.00	1.6	-
160	2.67	1.5	0.038
330	5.50	1.4	0.035
460	7.67	1.3	0.046
620	10.33	1.2	0.038
810	13.50	1.1	0.032
1010	16.83	1.0	0.030
1220	20.33	0.9	0.029
1430	23.83	0.8	0.029
1620	27.00	0.7	0.032
1800	30.00	0.6	0.033

2) Calculate Minimum Gradient

0.03	m/min	1836	mm/h

3) Calculate percolation rate

13	L/m2/min
771	L/m2/hr