Appendix 8: Servicing Report

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Surveying • Planning • Engineering

Gould Developments Limited

&

Four Stars Development Limited

SERVICING REPORT

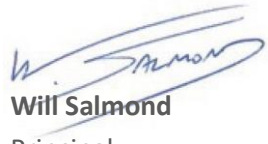
ROLLESTON RESIDENTIAL RE-ZONING

139 Levi Road
294-232 Lincoln Rolleston Road
5-25 Nobeline Drive

PATERSONPITTSGROUP
Surveying • Planning • Engineering

PREPARED BY

Prepared by:



Will Salmond
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Reviewed by:

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Date: 19/10/2020
Reference: CH5653

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LIST OF APPENDICES

1 Introduction

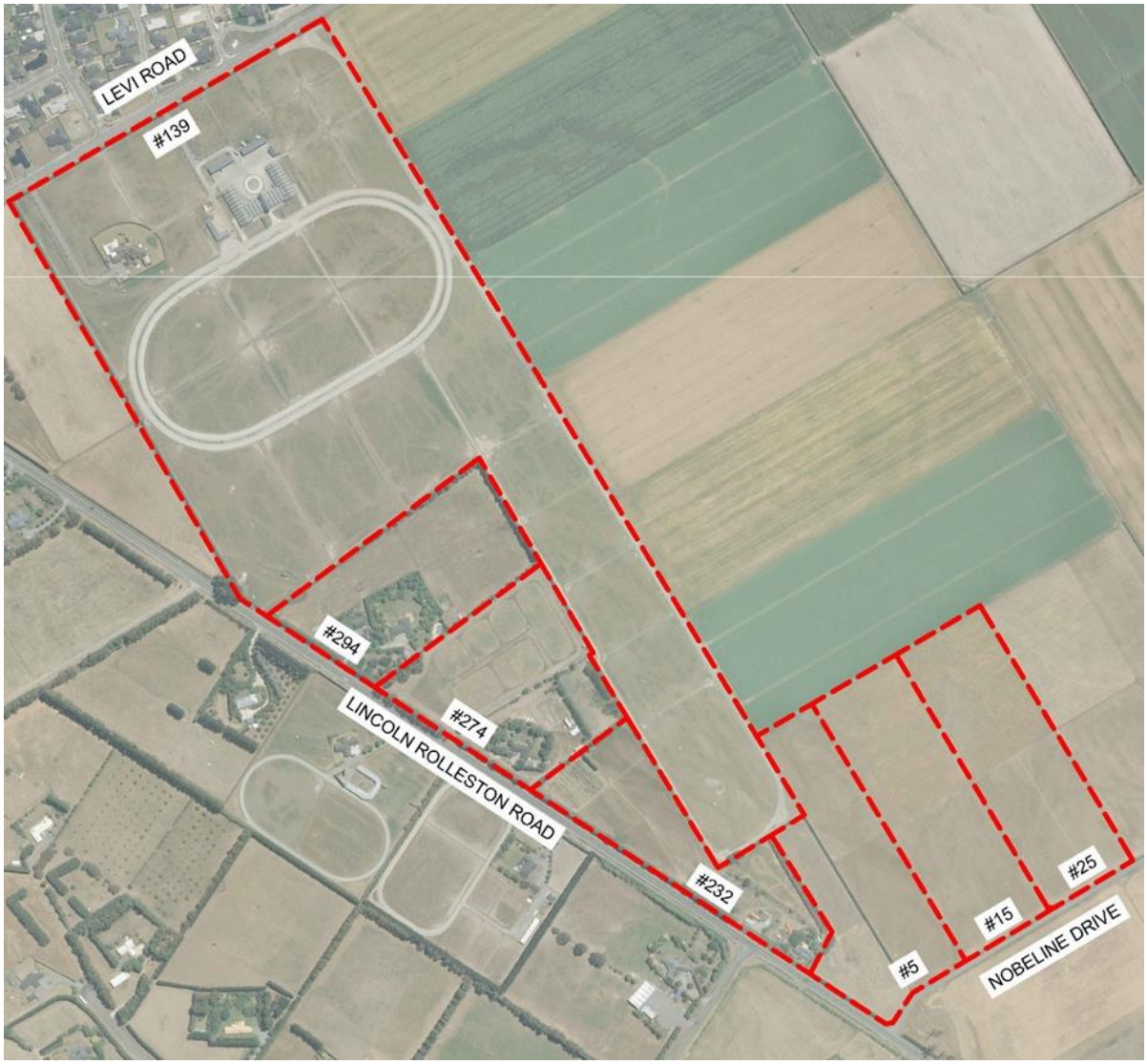
Paterson Pitts Group have been commissioned by Gould Developments Limited & Four Stars Development Limited to provide a services report for an application for residential rezoning of rural land as graphically shown below within Rolleston;

The report covers the following primary servicing:

- Earthworks
- Water supply
- Wastewater
- Stormwater
- Roading
- Utilities
    - Electricity including street lighting
    - Telecommunications

2 Site Location and Description

The site is generally bounded by Levi Road, Lincoln Rolleston Road and Nobeline Drive as illustrated below;



Please note that for the most part, the opposite side of Lincoln Rolleston Road has been developed from rural lifestyle properties to residential use.

The site consists of 6 x separate titles as tabulated below.

ADDRESS	RT REF	LEGAL DESCRIPTION	LEGAL AREA
139 Levi Road	463353	Lot 2 DP 416195 & Lot 2 DP 322710	30.4300ha
232 Lincoln Rolleston Road	CB39B/871	Lot 3 DP 67190	3.2820ha
274 Lincoln Rolleston Road	CB39B/870	Lot 2 DP 67190	4.010ha
294 Lincoln Rolleston Road	CB39B/869	Lot 1 DP 67190	4.0000ha
5 Nobeline Drive	695247	Lot 7 DP 483709	4.0805ha
15 Nobeline Drive	695248	Lot 8 DP 483709	4.0558ha
25 Nobeline Drive	695249	Lot 9 DP 483709	4.0393ha

Three of the titles contain dwellings with a number of rural accessory buildings including large stables at 139 Levi Road.

The total area of all 7 x titles is 53.89ha. The site forms an irregular shape, it is 1.3km from Levi Road to Nobeline Drive. Each road has the following frontage length.

Levi Road : 428m

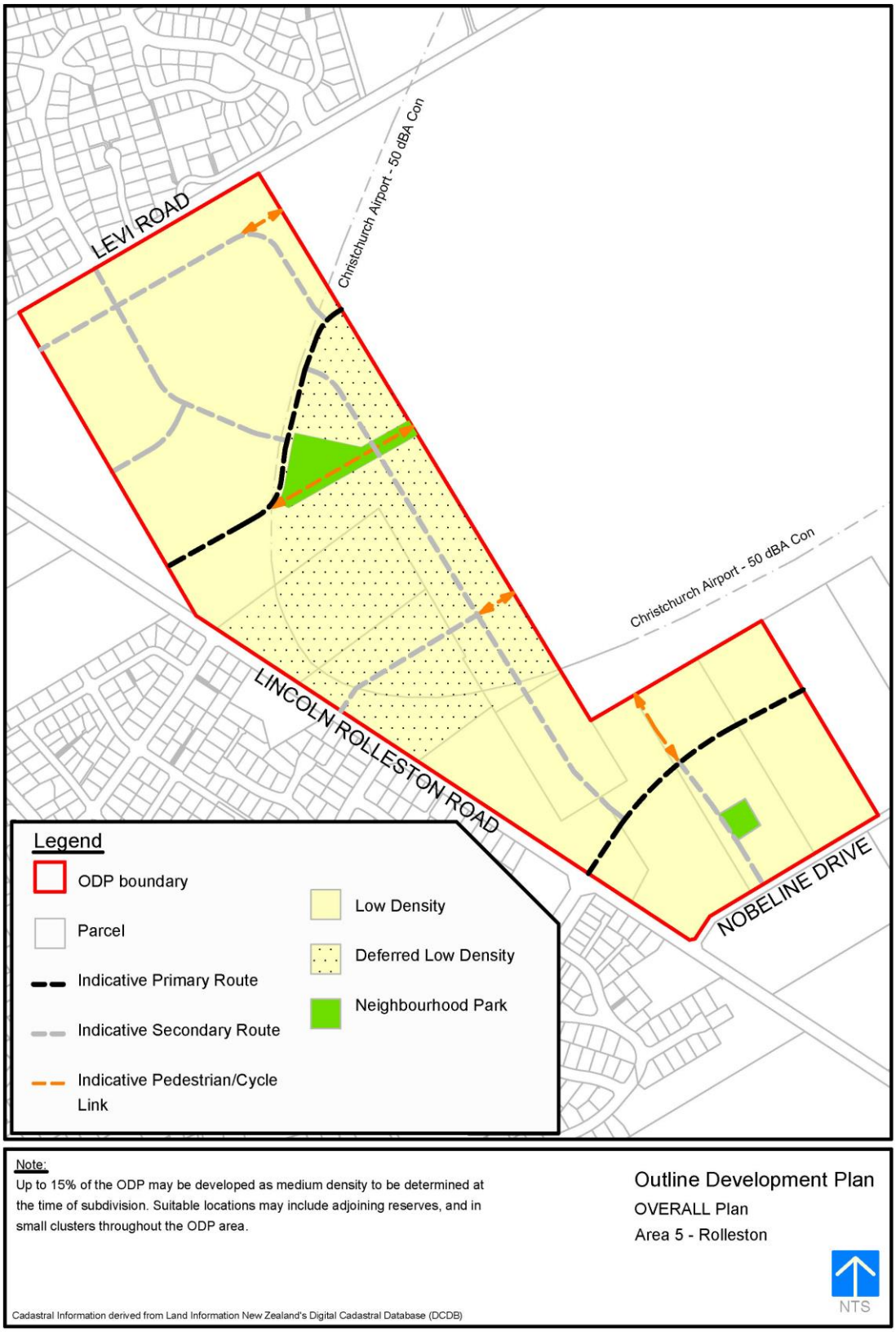
Lincoln Rolleston : 918m

Nobeline Drive : 350m

Topographically the site generally slopes from Levi Road in a SE direction towards the intersection of Lincoln Rolleston Road and Nobeline Drive. Overall, there is a height difference of 9.5m, this equates to a grade of 1:140.

Levi Road and Lincoln Rolleston Road are both classified as Arterial roads and are double lane.

A private plan change is sought for the 53.89ha to be converted from Rural to Residential zoning as per the following Outline Development Plan 5. As a guide, the overall yield will be in the order of 660 residential sites. The area north of the 50db contour will realize approximately 220 sites. The area south, a further 220. The mid area that is predominantly under the 50db contour a further 220 lots.


LEVI ROAD
Christchurch Airport - 50 dBA Con
Christchurch Airport - 50 dBA Con
LINCOLN ROLLESTON ROAD
NOBELINE DRIVE
Legend
ODP boundary
Parcel
Indicative Primary Route
Indicative Secondary Route
Indicative Pedestrian/Cycle Link
Low Density
Deferred Low Density
Neighbourhood Park
Note:
Up to 15% of the ODP may be developed as medium density to be determined at the time of subdivision. Suitable locations may include adjoining reserves, and in small clusters throughout the ODP area.
Outline Development Plan
OVERALL Plan
Area 5 - Rolleston
NTS
Cadastral Information derived from Land Information New Zealand's Digital Cadastral Database (DCDB)

3 Earthworks & Clearing

As described earlier the site has a typical grade of 1:140 from Levi Road to the intersection of Lincoln Rolleston Road and Nobeline Drive with an overall height difference of approximately 9.5m. Refer Appendix **A** for preliminary land contour plan.

Landtech Consulting Limited (Landtech), have completed investigations for both north and south areas as contained in Appendix **B**. On average the average topsoil nominal depth is 200-300mm. Their reports concluded that the sites meet Technical Category 1 (TC1) with damaging liquefaction unlikely and consider the site suitable for residential development from a geotechnical perspective. This being the case no remediation is likely to be required to improve land from a geotechnical perspective.

Preliminary Site Investigations (PSI) have been completed by Malloch Environmental Ltd (MEL). Areas on 232 Lincoln Rolleston Road and 5 Nobeline Drive have been identified requiring a Detailed Site Investigation (DSI), the areas are listed as

- Old buildings and a railway carriage potentially painted with lead-based paints
- Storage of treated timber
- An above ground diesel tank
- A waste/burn pile

Pending a DSI and remediation plan it is likely that material from these areas will have to be removed from site to meet National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health Regulations 2011 (NESCS).

Detailed engineering design will attempt to minimise earthworks and maintain a balance of cut and fill across the site. Engineered fill will be compacted in layers not exceeding 230mm thick when uncompacted. All bulk fill will be specified to be in accordance with the Code of Practice for Earthfill for Residential Purposes NZS4431:1989.

Earthworks across the site primarily consists of cutting in roads to the existing ground and shaping lots to slope towards the road. Residential sites will be designed with a minimum grade of 1:500. Turf stripping of the top 50mm will be undertaken across the site where earthworks will be done. All existing topsoil will be stripped prior to placing of fill on Lots and road pavement construction. The roads and ROW's are likely to be cut to subgrade to allow for a nominal 300mm pavement depth which will be determined at the time of detailed engineering. The sites peripheral boundaries will interface with existing ground levels. Shaping and grading will be used to direct overland flow away from adjacent neighbours. Where the site is receiving overland flow from adjacent sites, these flows will be accommodated to

ensure no nuisance flooding occurs for neighbours that is not pre-existing. Additionally, there will also be earthworks associated with trenching and reinstatement of services, and some minor temporary earthworks as part of the construction Erosion and Sediment Control Plan.

All earthworks will be undertaken in accordance with Environment Canterbury (Ecan) guidelines. It is likely that a resource consent from ECan will be required for construction and operational phase stormwater management.

4 Water Supply

Rolleston Master Planning 2017-2048 Figure 19-5 (see Appendix **C**, of SDC's 5Waters Activity Management Plan) shows proposed trunk watermain upgrades along the frontage of Levi Road and Lincoln Rolleston Road. The upgrades are planned for 2021-2028. Additional wells are proposed at Helpet facility and the NE end of Levi Road near the intersection with Weedons. SDC engineering staff have confirmed that there is or will be sufficient capacity to supply the proposed site.

Further mains and submains will be designed in accordance with SDC's Engineering Code of Practise to service the plan change area at the time of subdivision. Mains are likely to be in the order of 100-150mm to maintain the required pressure.

The reticulation will also be designed to comply with the New Zealand Fire Service Firefighting Water Supplies Code of Practise being SNZ PAS 4509:2008. As minimum any one dwelling will be within 135m of a single fire hydrant and within 270m of two hydrants. Hydrants will be modelled to ensure they provide a minimum flow of 12.5L/s while maintaining pressure of 100kPa being the minimum allowable residual pressure.

5 Wastewater

There are several opportunities to service the site with sewer as there are existing services located in both Levi Road and Lincoln Rolleston Road. Ultimately the capacity of the lines, their respective depths and costs are the determining factors. SDC Asset Manager - Water Services, Mr Murray England, has confirmed that the details of which will be able to worked through at the time of detailed engineering as it is likely that the site can be accommodated once factors are methodically evaluated . A summary of the options and considerations are;

- If all existing adjacent lines in Levi and Lincoln Rolleston Roads have sufficient capacity to accept flows, it will simply be a case convenience.

- If there is capacity for all Lots in the southern-most line to Flight Close PS, it may be the easiest option to install a central line effectively from Levi Road through the site and out Nobeline Drive then onto the Pump Station (PS).
- As the land falls north-south at approximately 1:140, to the southernmost point of the development. This southernmost point can readily access the existing sewer in Lincoln Rolleston Road draining to Flight Close with the installation of additional manholes in Lincoln Rolleston Road. The whole development could gravitate to this one outfall if capacity allows, with some Lots accessing other existing nearby mains where adjacent/appropriate.
- Flush tanks/pump station may be required to allow for larger diameter pipes/lesser gradients to service the whole development. This is based on existing invert levels in sewer mains and cover over the proposed mains throughout the development. The number & location of these is dependent on capacity of existing lines which will determine the overall sewer layout.
- For Lots adjacent to Levi Road, approximately 40-50 of these could be serviced by the existing sewer line along Levi Road if capacity allows. This could service more of the site, if the existing pump chamber in Goldrush Lane can be broken into to provide deeper mains. However, it would be running against the fall of the land, so may be very deep for only gaining a few additional Lots. The remainder of the "North Block" could be serviced either by running mains through the middle block into the south block to the southernmost end, or by gravitating to the southern point of the north block, near Reuben Ave. This would then outfall into existing sewer lines, capacity permitting.
- A further consideration is to install a new line along the future Broadlands Drive Road to SDC Helpet facility. This could possibly service the northern half of the site.

6 Stormwater

Presently there is no existing reticulated stormwater network servicing the site. Landtech's report for the northern area concluded an average ground water depth of 13.0m below existing ground based on desktop analysis. The same again for southern portion. Their indicative percolation rates of 10 and 13 L/m²/min supports stormwater discharge to ground which is typical within Rolleston. Furthermore, due to the depth of ground water it is likely that no additional treatment than sumps and the soakage itself through gravel media will be necessary. This is consistent with the 2011 SDC commissioned stormwater report

undertaken by Pattle Delamore Partners (PDP) that outlines the quality of stormwater discharged throughout the Rolleston area. A copy of this report is contained in Appendix **D**.

The site sits outside SDC's global stormwater consent. As a result, an Ecan consent will be required for stormwater discharge to ground during construction and operational phases. These consents will be confirmed by SDC engineers to ensure their suitability as many of the stormwater assets will transfer to Council.

The future roading network will be designed to provide secondary flow paths. As the site has a typical grade of 1:140 from Levi Road to the intersection of Lincoln Rolleston Road and Nobeline Drive, the majority of overland water will ultimately be directed towards Lincoln Rolleston Road/Noeline Drive.

Stormwater from the roads will be reticulated to soakpits at the time of contruction. Ecan conditions are likely to require for all stormwater runoff from up to and including a 2%, 24-hour event must enter the soakpits.

All individual lot roof stormwater is to be drained to individual soakpits installed on each lot under building consent at dwellings time of construction. A subdivision wide consent will be sought from ECan to allow future sites to establish pits in accordance with the New Zealand Building Code clause E1.

7 Roading

The roading layout will be developed from the proposed ODP with additional local roads to compliment. The hierarchy and function of ODP roads and upgrades of Levi and Lincoln Rolleston Road has been addressed by Novo Group Limited who prepared the traffic report.

Legal road widths will vary from 20m to 15m for through roads down to 13m for other roads. Right of way legal widths will vary from 4.5m to 7m depending on number of users and length.

All forms of roading and footpaths will be designed to comply with SDC standards. Frontages to Levi, Lincoln Rolleston and Nobeline will be upgraded as required by the developer to meet these standards. This involves kerbing and widening but not extending to the opposite side of the roads. All new internal roads and footpaths will be similar to modern Rolleston residential roads with the use of mountable kerbing, asphalt or concrete footpaths, asphalt road surfaces, with the introduction of other feature surfaces where appropriate.

In general, roads will be crowned in the centre with a 3% cross fall to SDC low-profile kerb and channel. These will direct stormwater to sumps with trapped/submerged outlets and reticulated to nearby soakpits. As mentioned earlier the roads will be designed to provide the secondary flow paths.

8 Utilities

All lots will be provided with the ability to connect to a telecommunications and electrical supply network.

Orion New Zealand Limited have confirmed that their electrical network has capacity to provide future residential subdivision of the site with electricity, refer Appendix **E.**

Enable Networks Limited have confirmed that their network has capacity to feed any future residential subdivision of the site with fibre providing telecommunications, refer Appendix **F**.

Street lighting will be designed and provided in accordance with SDC standards to any future roading networks and reserves for the site.

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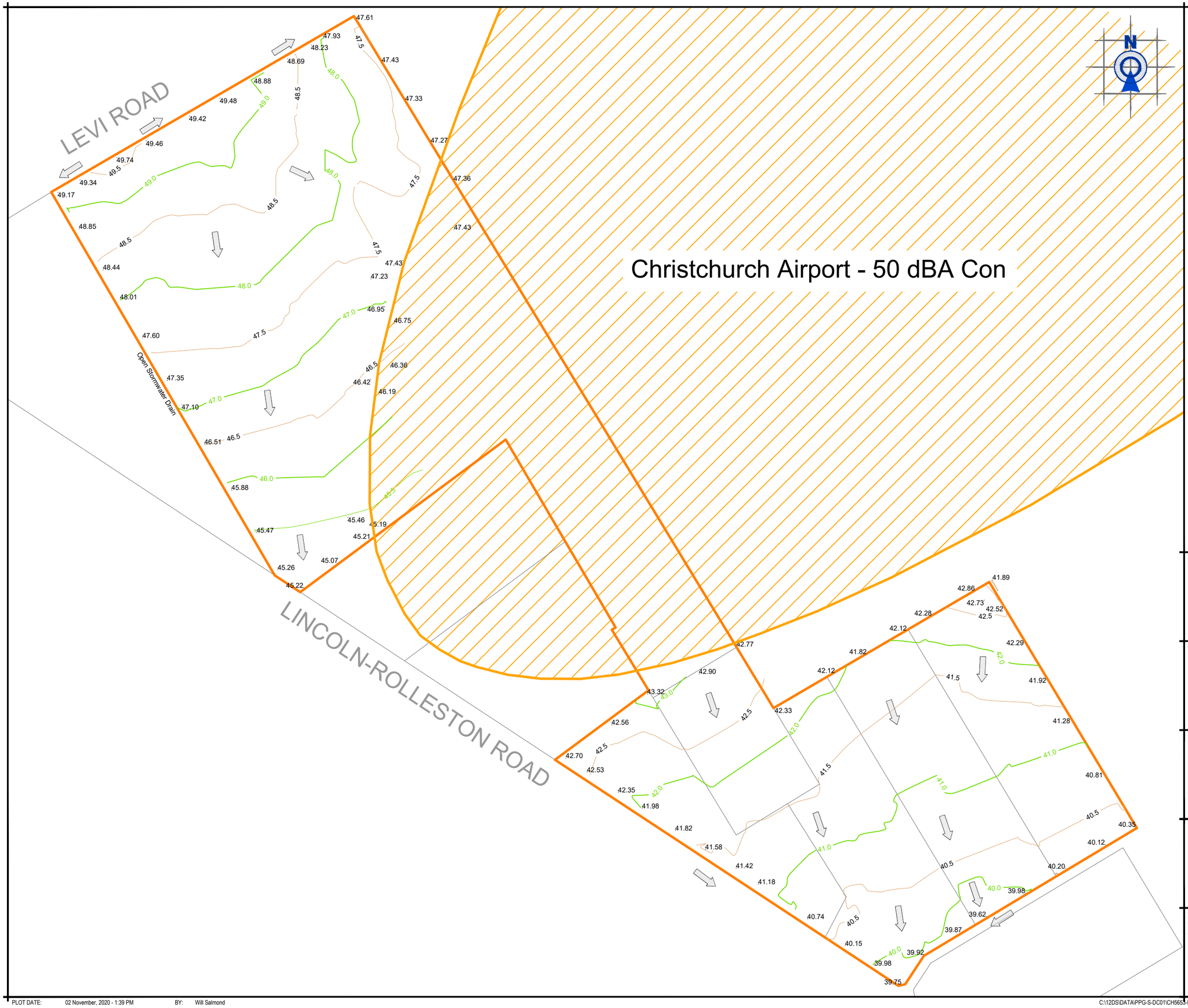
Appendix A

Preliminary Contour Plan



LEGEND:

- OVERLAND FLOW DIRECTION
- SITE BOUNDARY
- 10.00 SPOT LEVELS

NOTE:
1. FIELD WORK COMPLETED 08/09/2020
2. EQUIPMENT: TRIMBLE GPS RTK
3. ORIGIN OF LEVELS:
   LYTTELON VERTICAL DATUM 1937
   B882 (UG 32) - RL 55.908m
4. AREAS AND MEASUREMENTS ARE SUBJECT TO TITLE SURVEY
5. BOUNDARIES SHOWN ARE INDICATIVE ONLY

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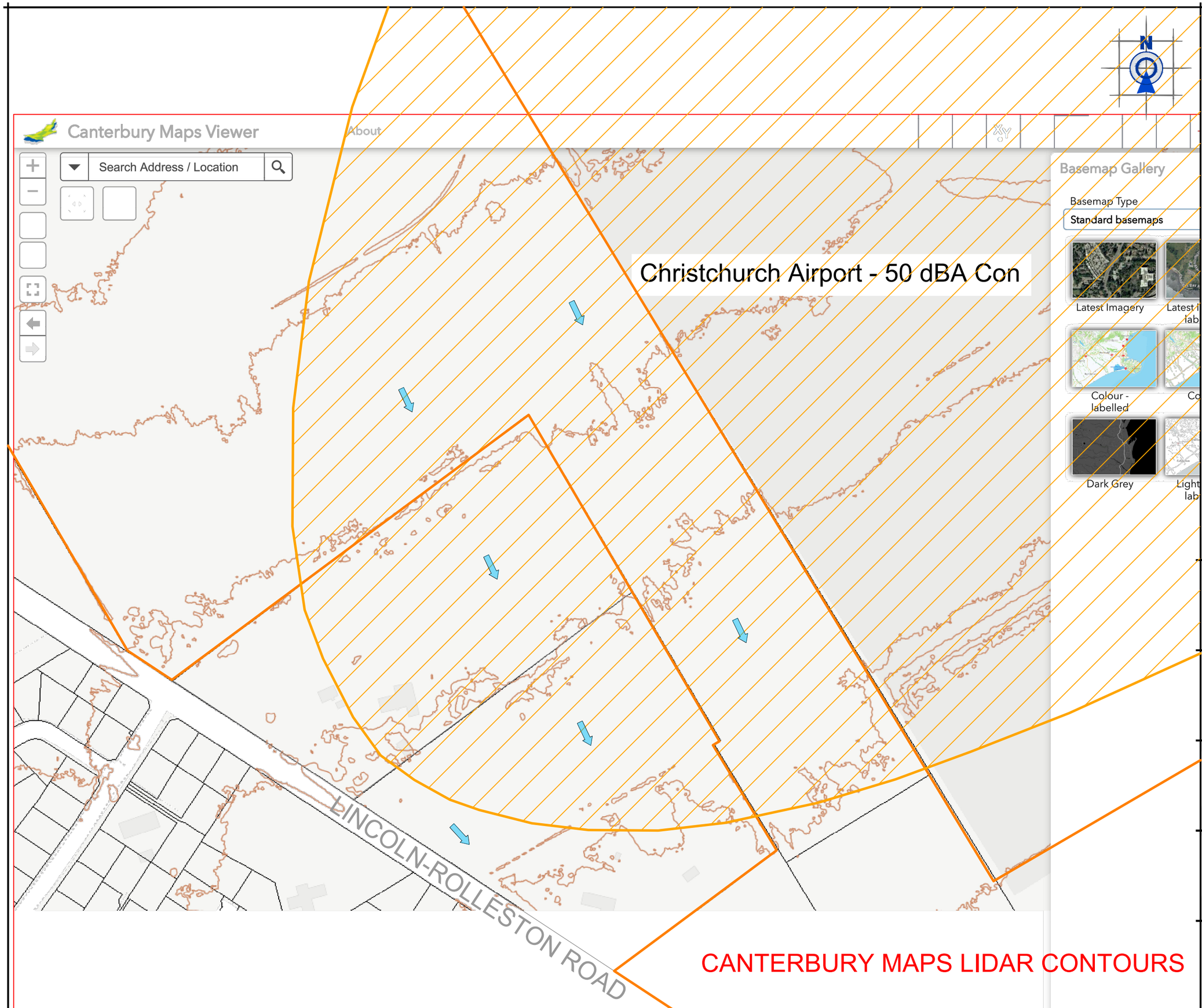
Client/Location:

Gould Developments Limited
&
Four Stars Development Limited

Purpose/Drawing Title:

Preliminary Contour Plan Levi Road / Lincoln-Rolleston Road

Surveyed by:	SS	Original Size:	Scale:		
Designed by:		A3	N.T.S		
Drawn by:	SS		DO NOT SCALE		
Checked by:					
Approved by:					
Job Ref: CH5653		Sheet No: 100	Revision No: A	Date Created: 24/09/2020	



LEGEND:

OVERLAND FLOW DIRECTION

SITE BOUNDARY

NOTE:
1. AREAS AND MEASUREMENTS ARE SUBJECT TO TITLE SURVEY
2. BOUNDARIES SHOWN ARE INDICATIVE ONLY

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Client/Location:

Gould Developments Limited
&
Four Stars Development Limited

Purpose/Drawing Title:

Preliminary Contour Plan Levi Road / Lincoln-Rolleston Road

Surveyed by:	SS	Original Size:	Scale:		
Designed by:		A3	N.T.S		
Drawn by:	SS		DO NOT SCALE		
Checked by:					
Approved by:					
Job Ref: CH5653		Sheet No: 101	Revision No: A	Date Created: 24/09/2020	

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Appendix B

Geotechnical Reports

GEOTECHNICAL INVESTIGATION REPORT

FOR PROPOSED LAND USE CHANGE

139 Levi Road, Rolleston

Client: Four Stars Development Limited

Project Reference:	LTC20264
Revision:	Revision A
Date:	13 October 2020

Documentation Control:

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Document Title:	**Geotechnical Report for Proposed Land Use Change**	
Address:	139 Levi Road, Rolleston	
Revision:	Revision A	
Client:	Four Stars Development Limited	
Project Reference:	LTC20264	
Author:		Luke Challies, Associate Geotechnical Engineer BEngTech (Civil), MEngNZ
Authorised:		Dwayne Wilson, Senior Geotechnical Engineer BEngTech (Civil), MEngSt (Geotechnical), CMEngNZ, CPEng, IntPE (NZ), Director

REPORT DISTRIBUTION:		
Recipient	**Release Date**	**Document Type**
Four Stars Development Limited	13 October 2020	Rev A (PDF)
Paterson Pitts Group	13 October 2020	Rev A (PDF)

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Appendices:

1.0 Introduction

1.1 Project Brief

LandTech Consulting Limited. (LandTech) were engaged by Four Stars Development Limited (the Client) to carry out a geotechnical investigation at 139 Levi 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 near the corner of Levi Road and Lincoln Rolleston Road in Rolleston. The site is indicated in Figure 1 below, and is located approximately 1.1km to the south east of the Rolleston Township. The site comprises part of 139 Levi Road, legally described as Lot 2 DP416195 and Lot 2 DP 322710, and covers a total area of 30.43ha (sourced from https://mapviewer.canterburymaps.govt.nz/ on 11 October 2020).

Due the zoning of a decibel restriction associated with the Christchurch Airport extending into the eastern portion of the property, only the northern and western portion of the property has been investigated for the Land Use Change Application. The location of the investigated area and approximate location of the decibel restrictions is shown on the attached drawings LTC20264/1.

Figure 1: Aerial photograph of investigation site (source: https://mapviewer.canterburymaps.govt.nz/, accessed 11 September 2020)

The property is generally flat and is currently used for horse training, and a stables and associate building are located in the northern portion of the site near Levi Road, along with a dwelling in the western corner. A training oval occupies the centre of the property, along with several tracks providing accesses to the paddocks. The land is essentially flat with no obvious changes in elevations and undulations.

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 11 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.

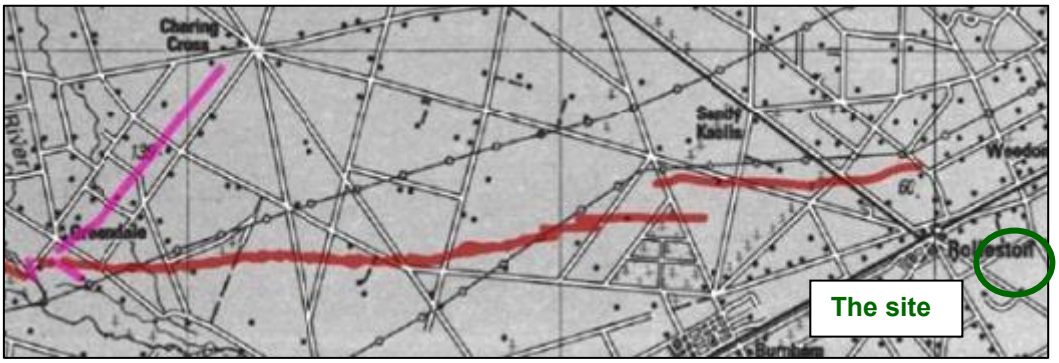


Figure 2: shows excerpt from figure A.1e of the referenced report (red line is a definite or likely fault).

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 11 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 within Appendix B:

    - M36/0328, drilled to 28.6m and located with the neighbouring property to the south of the site at 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.

    - M36/8287, drilled to 46.1m and located at the northeastern corner of the site. The borelog for the well shows topsoil to 0.3m depth underlain by gravels to the drill depth. Ground water levels are indicated at 15.3m below ground level at the time of drilling.

    - M36/5292, drilled to 52.0m and located 80m to the south of the site near 294 Lincoln Rolleston Road. The borelog for the well shows topsoil and clay to 0.3m depth underlain by sandy gravel or claybound gravel to the drill depth. Initial groundwater levels are indicated at 12.2m below ground level at the time of drilling.

- According to the Environment Canterbury Soil Type map, the site is mapped as primarily *Typic Immature Plallic Soils* with a deep silty loam, while the northern corner of the site is mapped as a *Typic Immature Plallic Soils* having a moderately 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 information available from 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 therefore 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 11 September 2020)

5.0 Field Investigation

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

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

Each test was positioned evenly across the site away from infrastructure and animals, and test locations are shown on the LandTech *Site Test Plan*, Drawing No. LTC20264/ 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 1: Subsurface summary

Test pit ID	Test Pit Depth	Topsoil Depth	Soil Depth	Scala Depth
TP01	3.2	0.3	2.8	2.4
TP02	3.2	0.3	2.9	2.5
TP03	2.8	0.3	1.2	1.3
TP04	2.6	0.3	1.5	1.6
TP05	3.0	0.3	1.4	1.4
TP06	2.8	0.2	1.4	1.4

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 1.2m (TP03) and 2.9m (TP02) below ground level, and typically comprised a moist fine sandy silt. Typically, the deeper deposits of soil where encountered along the northern boundary towards the northwestern corner.

Scala penetrometer testing within the soils generally ranged from 2 and 5 Blows / 100mm penetration. Higher blow counts at depth are due to contact with the underlying gravels.

Where possible shear vane testing was carried out in the silt materials, 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 from between 1.2m (TP03) and 2.9m (TP02) 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 moist, 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, indicative of dense packing.

6.4 Soakage

The soakage capacity of the gravel was tested within TP05; the location of the test pits are shown on the LandTech *Site Test Plan*, Drawing No. LTC20264/ 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 2: Average soakage rates

	SP01 / TP06
Average Soak Rate (mm/hour)	368
Percolation Rate (L/m^2/min)	10

Following the testing silt was loaded in the base to a thickness of around 0.2m thick which likely impeded the flow. While the Test pit was being filled the maximum height the above the base the water level rose to was 0.5m, at a flow rate of 833L/min or 520L/m^2/min. This shows that infiltration from the side walls contributes a considerable amount to the drainage.

Based on the variable subsurface conditions throughout this site (i.e. depth of soil), we recommend additional soakage testing be carried out in the location of proposed soakage basins to determine more representative percolation rates to design from.

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 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 of 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 1.2m and 2.9m 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.). 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, Four Stars 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
- 50 dBA contour

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 04 September 2020)

AMENDMENTS

DATE	REV	DESCRIPTION
12/10/2020	A	Test Plan

139 Levi Road

ROLLESTON

Christchurch Office:
Unit 6, 31 Carlyle Street, Sydenham, Christchurch 8023

Auckland Office:
17 Nils Andersen Road, Whenuapai, Auckland 0618

Postal Address:
PO Box 119, Christchurch 8013

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

Drawing No.	Drawn by:	Date:
LTC20264/1	L C	12 October 2020

Scale:	Checked by:	Revision:
1: 2000 (A3)	D W	A

Filename: LTC20264 - Drawings.dwg

APPENDIX B

Environment Canterbury Well logs

canterbury maps

Canterbury Maps

N

0 0.07 0.14 0.21 0.28 Kilometres

Scale: 1:5,000 @A3

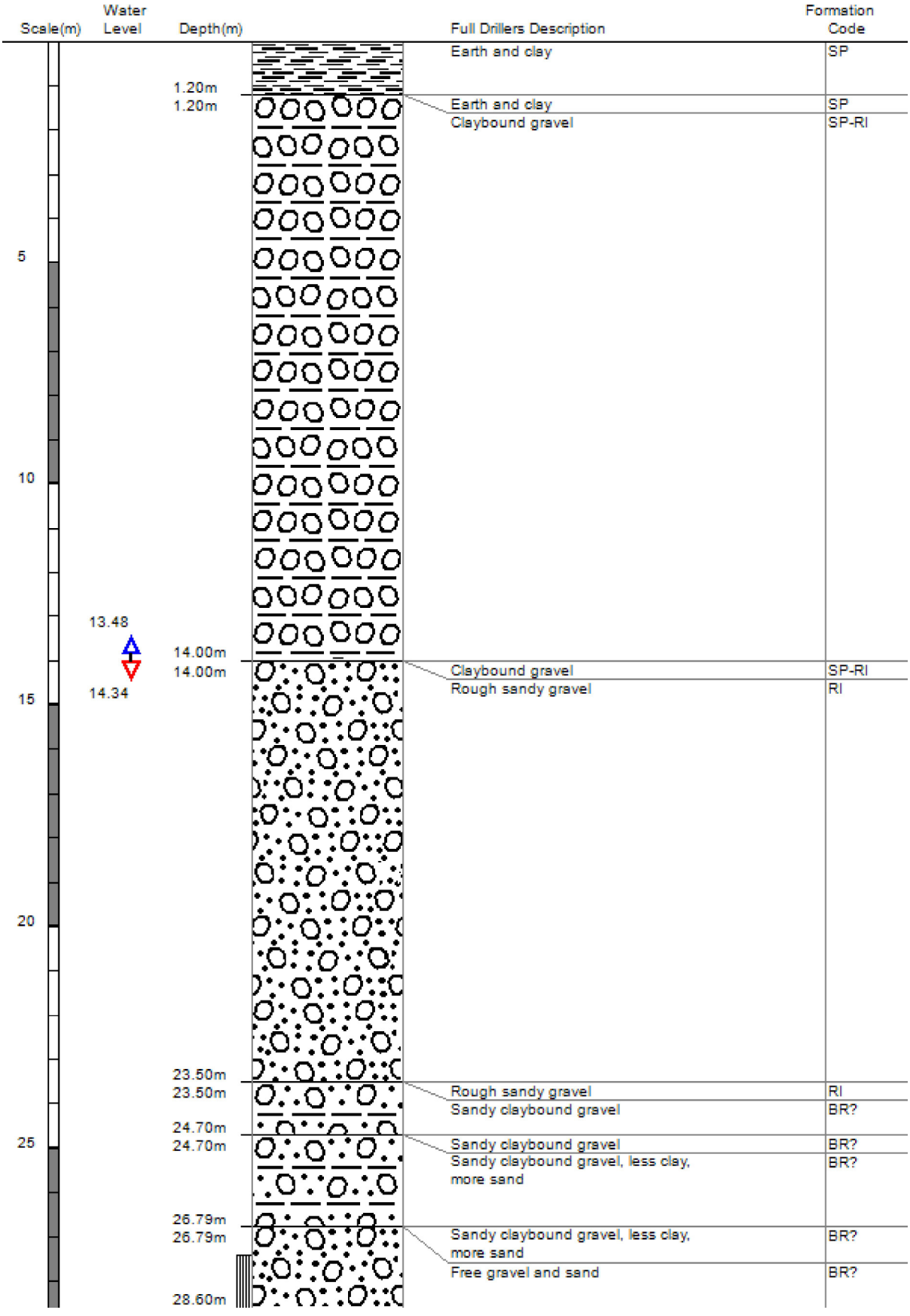
Map Created by Canterbury Maps on 12/10/2020 at 12:49 PM

M36/4839
M36/4743
M36/8287
M36/4430
M36/0127
M36/4427
M36/3036
644
M36/7766
618
M36/8240
61
M36/0254
M36/8518
BX23/0827
BX23/0508
M36/5292
M36/4870
M36/4865
M36/0328
BX23/0528
BX23/0420
BX23/0571
BX23/0620
M36/5359
BX23/0648
BX23/0618
M36/4894
Levi Rd
Lincoln Rolleston Rd
Reuben Ave
Turin Ave
Rory St
Branthwaite Dr
Falcon Rd
Gregra Ave
Nobeline Dr

Borelog for well M36/0328

Grid Reference (NZTM): 1552007 mE, 5172190 mN
Location Accuracy: 50 - 300m
Ground Level Altitude: 42.6 m +MSD Accuracy: < 0.5 m
Driller: McMillan Drilling Ltd
Drill Method: Cable Tool
Borelog Depth: 28.6 m Drill Date: 20-Aug-1980

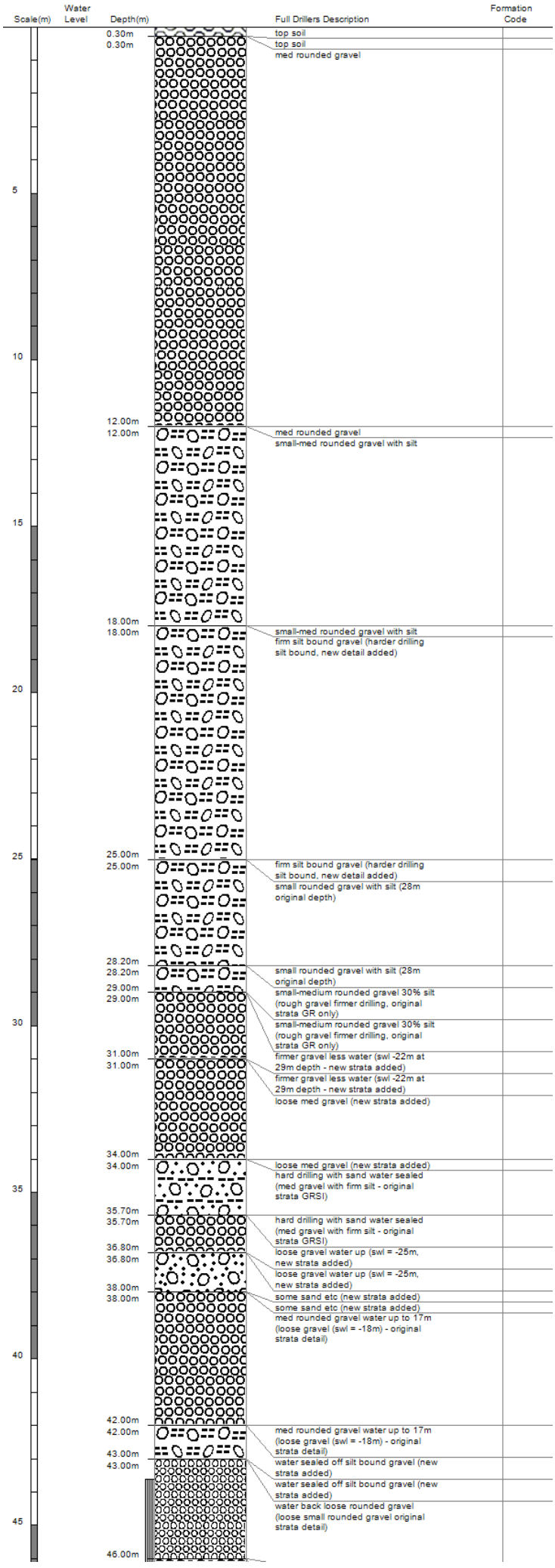
Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha



Borelog for well M36/8287

Grid Reference (NZTM): 1551585 mE, 5172834 mN
Location Accuracy: 2 - 15m
Ground Level Altitude: 45.9 m +MSD Accuracy: < 0.5 m
Driller: Dynes Road Drilling
Drill Method: Rotary/Percussion
Borelog Depth: 46.1 m Drill Date: 15-Jan-2007

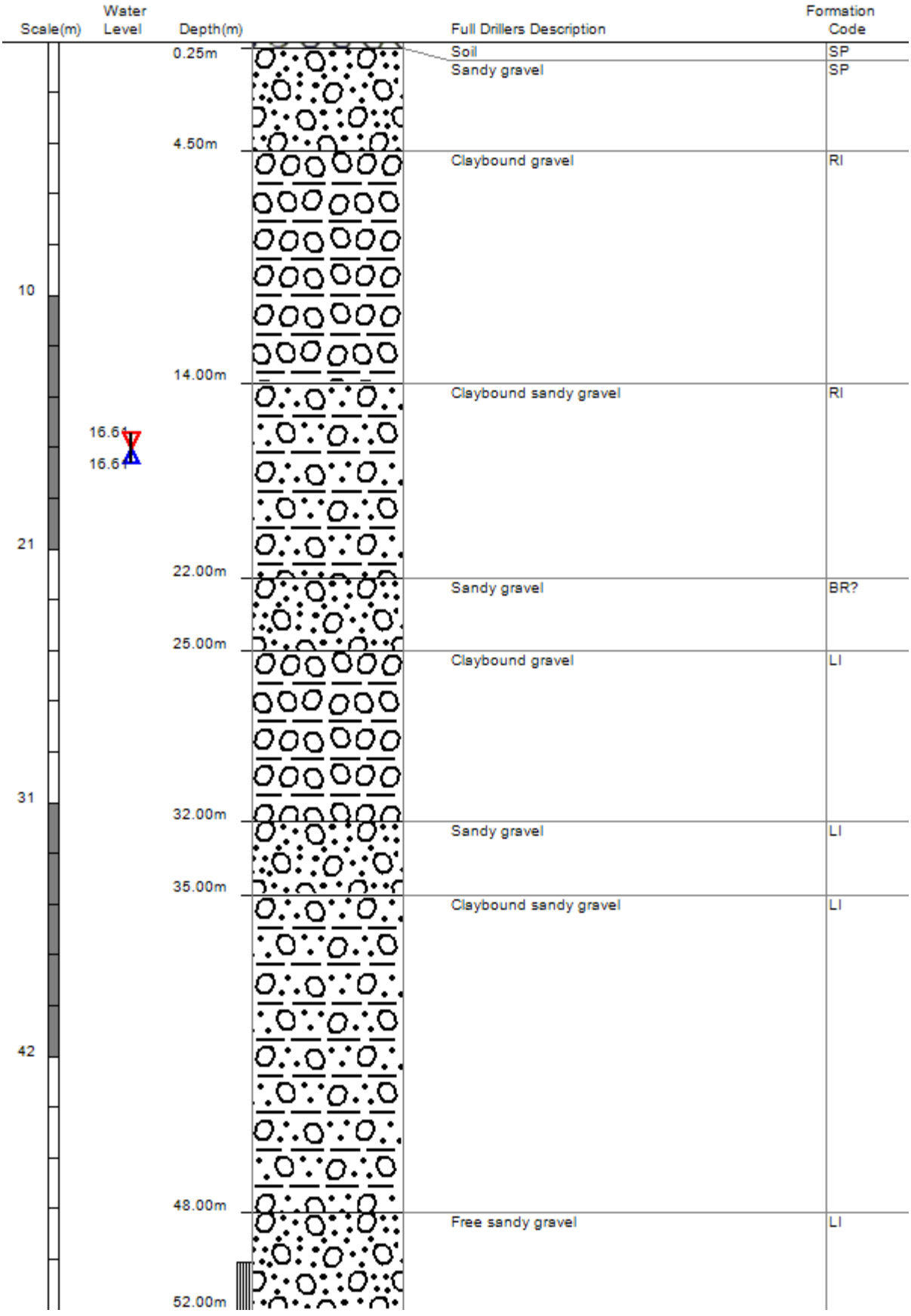
Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha



Borelog for well M36/5292

Grid Reference (NZTM): 1551672 mE, 5172222 mN
Location Accuracy: 2 - 15m
Ground Level Altitude: 44.4 m +MSD Accuracy: < 2.5 m
Driller: Smiths Welldrilling
Drill Method: Rotary Rig
Borelog Depth: 52.0 m Drill Date: 15-Sep-1997

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha



APPENDIX C

Test Pit Logs

LandTech CONSULTING

Client: Four Stars Development Ltd
Project: Geotechnical Investigation for Proposed Land Use Change
Address: 139 Levi Road, Rolleston

Test Pit No. TP01
Sheet No. 1 of 1

Drill Type:	6T Hydraulic Excavator	Project No:	LTC20264	Logged By:	M Gunn
Drilled By:	BM Contracting	Coordinates:	NZTM2000 E1551391 N5172741	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 / LOESS	0.5		SILT, some fine sand, brown, stiff, moist, non-plastic [ALLUVIAL DEPOSITS / LOESS]
	1.5		Fine sandy, SILT, light brown, stiff, moist, non-plastic
RIVER DEPS.	3.0		Fine sandy fine to coarse sub-rounded GRAVEL, brown, dense, moist [RIVER DEPOSITS]
	4		End of Test Pit 2.8m [TARGET DEPTH]
	5.0		

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

In-situ Field Testing

Shear Strength (kPa)
Peak:
Remoulded:
0 50 100 150 200
160

Dynamic Cone Penetrometer
Scala Blow
0 5 10 15 20

Depth (m)	Blow Count
-0.1	2
-0.2	3
-0.3	4
-0.4	4
-0.5	5
-0.6	3
-0.7	3
-0.8	3
-0.9	4
-1.0	3
-1.1	2
-1.2	2
-1.3	3
-1.4	2
-1.5	1
-1.6	2
-1.7	2
-1.8	2
-1.9	2
-2.0	2
-2.1	2
-2.2	2
-2.3	3
-2.4	4
-2.5	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 Scala Penetrometer Shear Vane Testing:

LandTech CONSULTING

Client: Four Stars Development Ltd
Project: Geotechnical Investigation for Proposed Land Use Change
Address: 139 Levi Road, Rolleston

Test Pit No. TP02
Sheet No. 1 of 1

Drill Type:	6T Hydraulic Excavator	Project No:	LTC20264	Logged By:	M Gunn
Drilled By:	BM Contracting	Coordinates:	NZTM2000 E1551545 N5172856	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, light brown, stiff, moist, non-plastic [ALLUVIAL DEPOSITS / LOESS]
	2.5		SILT, minor fine sand, light brown, mottled orange, stiff, moist, non-plastic
RIVER D.	3.0		Fine sandy, fine to coarse, subrounded to round GRAVEL, brown, very dense, moist [RIVER DEPOSITS]
	3.2		End of Test Pit 3.2m [TARGET DEPTH]

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	3	
-0.2	3	
-0.3	5	
-0.4	4	
-0.5	4	
-0.6	3	
-0.7	3	
-0.8	3	
-0.9	2	
-1.0	2	
-1.1	2	
-1.2	3	
-1.3	2	
-1.4	3	
-1.5	2	
-1.6	3	
-1.7	4	
-1.8	5	
-1.9	3	
-2.0	3	
-2.1	3	
-2.2	2	
-2.3	3	
-2.4	3	
-2.5	3	
-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

LandTech Consulting Ltd. (Christchurch): Unit 6, 31 Carlyle Street, Sydenham
LandTech Consulting Ltd. (Auckland): 17 Nils Andersen Road, Whenuapai
Phone: (03) 390 1371
Phone: (09) 930 9334
Email: info@landtech.nz
Website: www.landtech.nz

LandTech CONSULTING

Client: Four Stars Development Ltd
Project: Geotechnical Investigation for Proposed Land Use Change
Address: 139 Levi Road, Rolleston

Test Pit No. TP03
Sheet No. 1 of 1

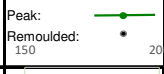
Drill Type:	6T Hydraulic Excavator	Project No:	LTC20264	Logged By:	M Gunn
Drilled By:	BM Contracting	Coordinates:	NZTM2000 E1551724 N5172860	Shear Vane No:	2255
Date Started:	21-Sep-20	Ground Conditions:	Near level, grass	Calibration Factor:	1.333
Date Finished:	21-Sep-20	Groundwater Level (m):	Not Encountered (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 / LOESS	0.5		Fine sandy SILT, yellowish light brown, very stiff, moist, non-plastic [ALLUVIAL DEPOSITS / LOESS]
	1.0		
RIVER DEPOSITS	1.5		Fine to coarse sandy, sub rounded GRAVEL, minor silt, brown, dense, moist [RIVER DEPOSITS] trace subrounded to round boulders
	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)



Dynamic Cone Penetrometer

Depth (m)	Blow Count
-0.1	3
-0.2	3
-0.3	3
-0.4	4
-0.5	3
-0.6	3
-0.7	3
-0.8	3
-0.9	4
-1.0	3
-1.1	9
-1.2	12
-1.3	25+
-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	
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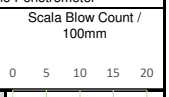
-4.7	
-4.8	
-4.9	
-5.0	



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

LandTech Consulting Ltd. (Christchurch): Unit 6, 31 Carlyle Street, Sydenham
LandTech Consulting Ltd. (Auckland): 17 Nils Andersen Road, Whenuapai
Phone: (03) 390 1371
Phone: (09) 930 9334
Email: info@landtech.nz
Website: www.landtech.nz

LandTech CONSULTING	Client: Four Stars Development Ltd Project: Geotechnical Investigation for Proposed Land Use Change Address: 139 Levi Road, Rolleston	Test Pit No.	TP04
		Sheet No.	1 of 1

Drill Type:	6T Hydraulic Excavator	Project No:	LTC20264	Logged By:	M Gunn
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 / LOESS	0.5		Fine sandy SILT, yellowish light brown, stiff, moist, non-plastic [ALLUVIAL DEPOSITS / LOESS]
	1.0		
	1.5		
RIVER DEPOSITS	2.0		Fine to coarse sandy, sub rounded GRAVEL, minor silt, brown, dense, moist [RIVER DEPOSITS]
	2.5		trace subrounded to round bouders, wet
	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+

Dynamic Cone Penetrometer

Depth (m)	Blow Count	Scala Blow Count / 100mm
-0.1	7	
-0.2	5	
-0.3	4	
-0.4	3	
-0.5	3	
-0.6	3	
-0.7	3	
-0.8	2	
-0.9	3	
-1.0	3	
-1.1	3	
-1.2	4	
-1.3	3	
-1.4	5	
-1.5	14	
-1.6	25+	
-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		

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

LandTech CONSULTING	Client: Four Stars Development Ltd Project: Geotechnical Investigation for Proposed Land Use Change Address: 139 Levi Road, Rolleston	Test Pit No.	TP05
		Sheet No.	1 of 1

Drill Type:	6T Hydraulic Excavator	Project No:	LTC20264	Logged By:	M Gunn
Drilled By:	BM Contracting	Coordinates:	NZTM2000 E1551650 N5172615	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 / LOESS	0.5		Fine sandy SILT, yellowish light brown, stiff, moist, non-plastic [ALLUVIAL DEPOSITS / LOESS]
	1.0		
RIVER DEPOSITS	1.5		Fine to coarse sandy, sub rounded GRAVEL, minor silt, brown, dense, moist [RIVER DEPOSITS] trace to minor subrounded boulders
	2.0		
	2.5		
	3.0		End of Test Pit 3.0m [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	5
-0.2	7
-0.3	5
-0.4	5
-0.5	3
-0.6	3
-0.7	3
-0.8	3
-0.9	2
-1.0	3
-1.1	3
-1.2	6
-1.3	7
-1.4	25+
-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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LandTech Consulting Ltd. (Auckland): 17 Nils Andersen Road, Whenuapai
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Phone: (09) 930 9334
Email: info@landtech.nz
Website: www.landtech.nz

LandTech CONSULTING	Client: Four Stars Development Ltd Project: Geotechnical Investigation for Proposed Land Use Change Address: 139 Levi Road, Rolleston	Test Pit No.	TP06
		Sheet No.	1 of 1

Drill Type:	6T Hydraulic Excavator	Project No:	LTC20264	Logged By:	M Gunn
Drilled By:	BM Contracting	Coordinates:	NZTM2000 E1551614 N5172361	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 / LOESS	0.5		Fine sandy SILT, light brown, stiff, moist, non-plastic [ALLUVIAL DEPOSITS / LOESS]
	1.0		
RIVER DEPOSITS	1.5		Fine to coarse sandy, sub rounded GRAVEL, minor silt, brown, dense, moist [RIVER DEPOSITS]
	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 50 100 150 200

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Dynamic Cone Penetrometer

Depth (m)	Blow Count	Scala Blow Count / 100mm (0 5 10 15 20)
-0.1	2	
-0.2	2	
-0.3	3	
-0.4	3	
-0.5	3	
-0.6	2	
-0.7	3	
-0.8	2	
-0.9	3	
-1.0	4	
-1.1	3	
-1.2	4	
-1.3	9	
-1.4	25+	
-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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APPENDIX D

Soakage Test Results

	Client:	Four Stars Development Limited	
	Project:	Proposed Land Use Change	
	Address:	Lincoln Rolleston Road, Rolleston	
Test Type:	On-site soakage test	Project No:	LTC20264
Tested By:	L Challies	Test Date:	21-Sep-20

Test ID:	TP05/SP01	Test ID:	
Coordinates:	NZTM2000 E1551650 N5172615	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

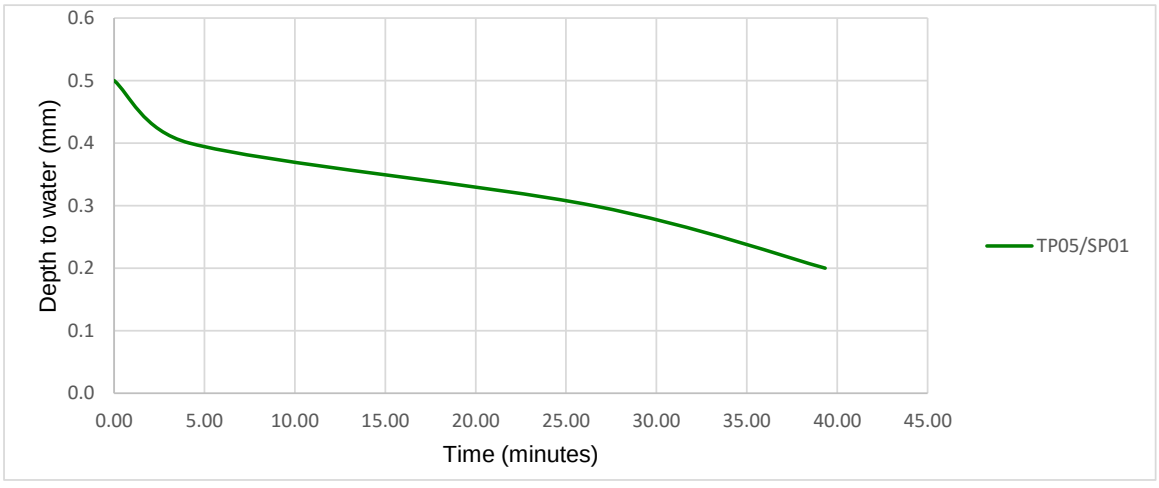
Time (Sec)	Time (min)	Depth (m)	Soak Rate (m/min)
0	0.00	0.5	-
250	4.17	0.4	0.024
1590	26.50	0.3	0.004
2360	39.33	0.2	0.008

2) Calculate Minimum Gradient

0.01	m/min	368	mm/h

3) Calculate percolation rate

10	L/m2/min
587	L/m2/hr



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

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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	
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Table of Contents:

Appendices:

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.

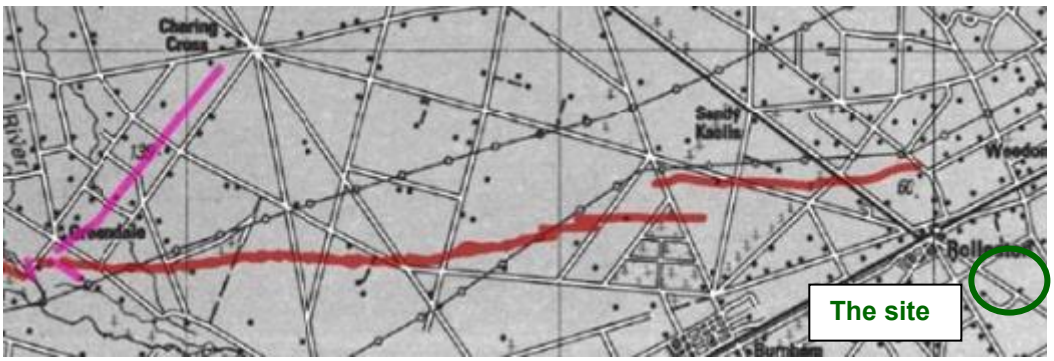


Figure 2: shows excerpt from figure A.1e of the referenced report (red line is a definite or likely fault).

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.

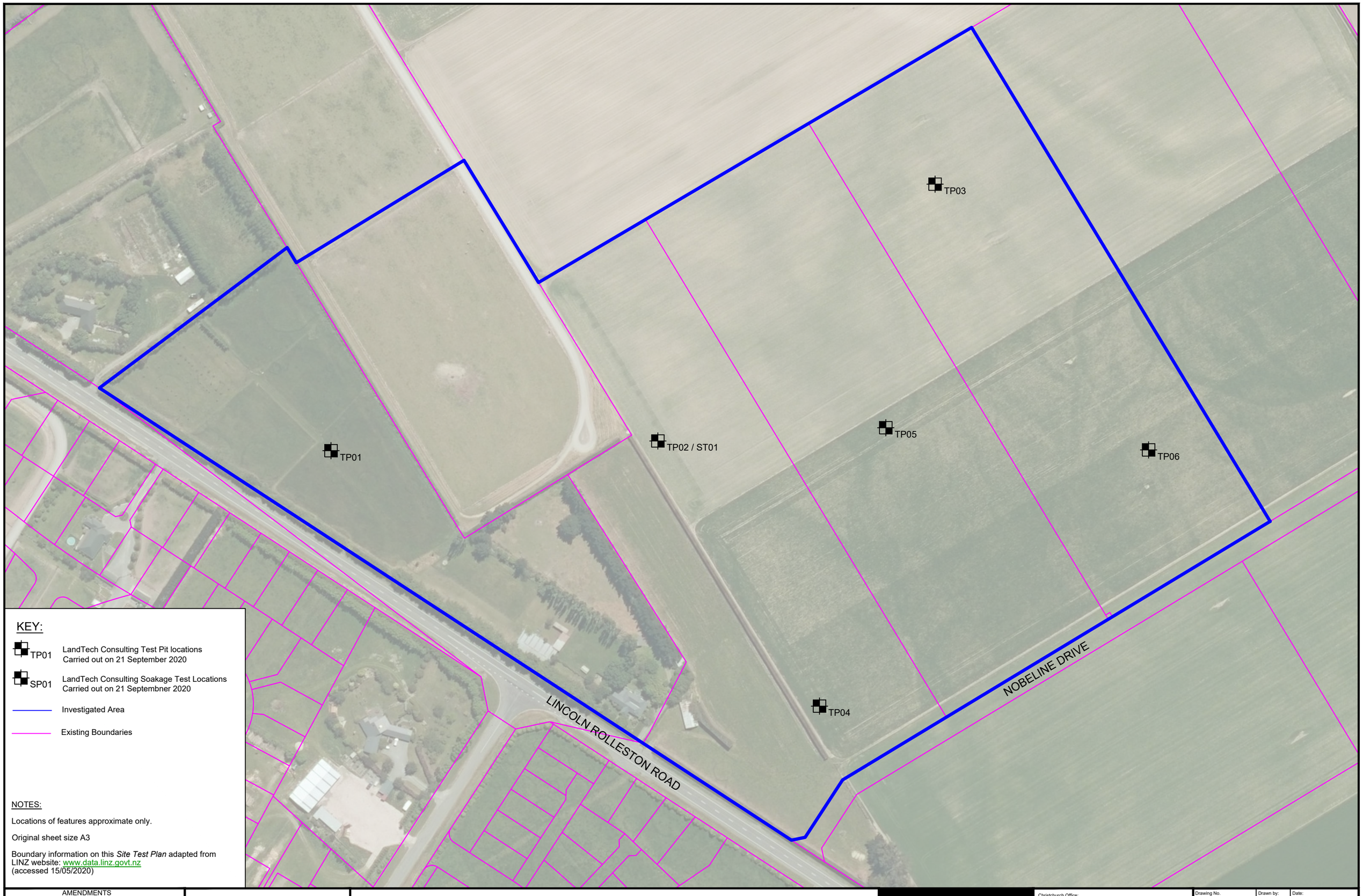
This report has been based on the results of tests at point locations; therefore, subsurface conditions could vary away from the assumed geotechnical model. Should exposed soil conditions vary from those described herein we request to be informed to determine the continued applicability of our recommendations. 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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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

N

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

M36/4839
M36/4743
M36/8287
M36/4430
M36/0127
M36/4427
M36/3036
644
M36/7766
618
M36/8240
61
M36/0254
M36/8518
BX23/0827
BX23/0508
M36/5292
M36/4870
M36/4865
M36/0328
BX23/0528
BX23/0420
BX23/0571
BX23/0620
M36/5359
BX23/0648
BX23/0618
M36/4894
Levi Rd
Lincoln Rolleston Rd
Reuben Ave
Lunn Ave
Rory St
Branthwaite Dr
Falcon Rd
Gerda Ave
Nobelline Dr

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

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

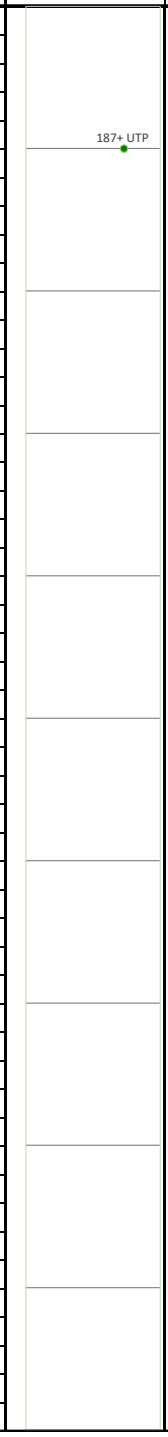
Drill Type:	6T Hydraulic Excavator	Project No:	LTC20265	Logged By:	L Challies
Drilled By:	BM Contracting	Coordinates:	NZTM2000 E1552266 N5172044	Shear Vane No:	2255
Date Started:	21-Sep-20	Ground Conditions:	Near level, grass	Calibration Factor:	1.333
Date Finished:	21-Sep-20	Groundwater Level (m):	Not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

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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Phone: (03) 390 1371
Phone: (09) 930 9334
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
Phone: (03) 390 1371
Phone: (09) 930 9334
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.	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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Phone: (03) 390 1371
Phone: (09) 930 9334
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.	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)

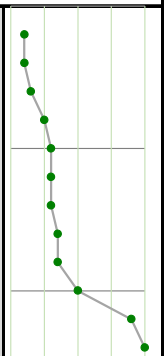
In-situ Field Testing

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

LandTech Consulting Ltd. (Christchurch): Unit 6, 31 Carlyle Street, Sydenham
LandTech Consulting Ltd. (Auckland): 17 Nils Andersen Road, Whenuapai
Phone: (03) 390 1371
Phone: (09) 930 9334
Email: info@landtech.nz
Website: www.landtech.nz

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

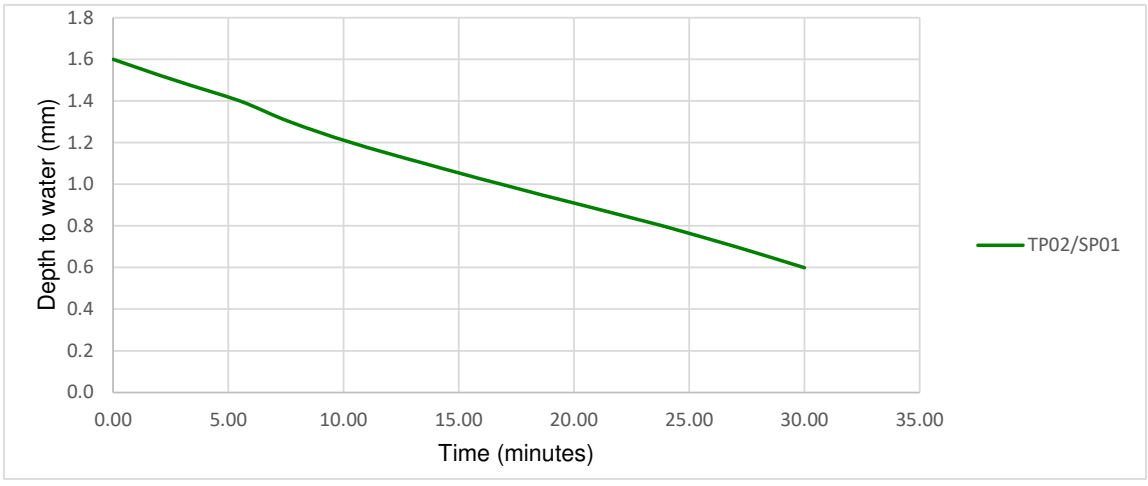
Time (Sec)	Time (min)	Depth (m)	Soak Rate (m/min)
0	0.00	1.6	-
160	2.67	1.5	0.038
330	5.50	1.4	0.035
460	7.67	1.3	0.046
620	10.33	1.2	0.038
810	13.50	1.1	0.032
1010	16.83	1.0	0.030
1220	20.33	0.9	0.029
1430	23.83	0.8	0.029
1620	27.00	0.7	0.032
1800	30.00	0.6	0.033

2) Calculate Minimum Gradient

0.03	m/min	1836	mm/h

3) Calculate percolation rate

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



PATERSONPITTSGROUP
Surveying • Planning • Engineering

Appendix C

Figure 19-5 SDC's 5Waters

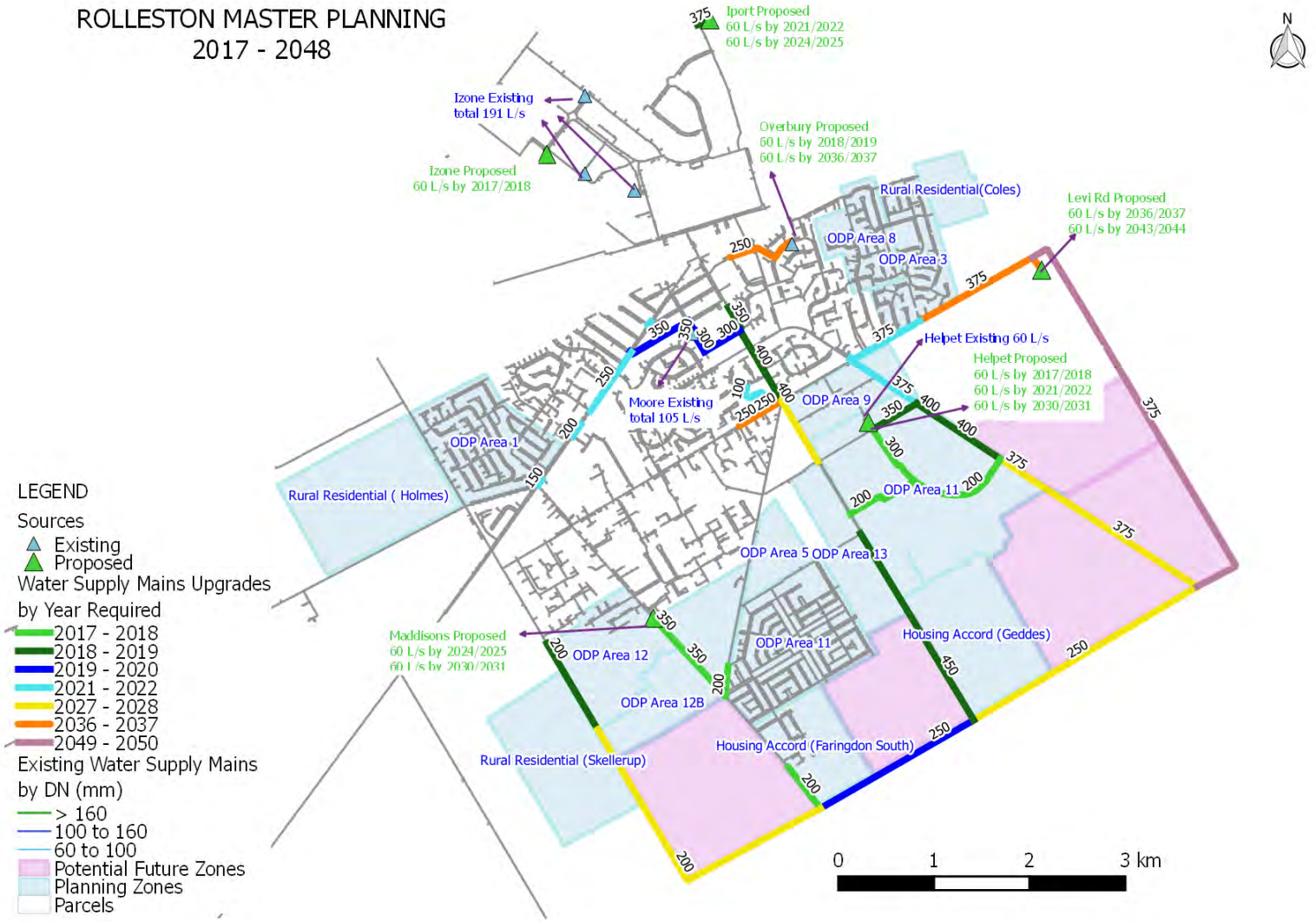


Figure 19-5 Rolleston Master Plan

PATERSONPITTSGROUP
Surveying • Planning • Engineering

Appendix D

Rolleston Stormwater Report

Briefing Paper

Comparison of Rolleston Stormwater Runoff Quality with Other Data

Authors: Ingrid Cooper – Pattle Delamore Partners
Ben Throssell – Pattle Delamore Partners
Andrew Brough – Pattle Delamore Partners
Sampling/Review: Murray England – Selwyn District Council

Introduction

Pattle Delamore Partners Limited (PDP) has been commissioned by Selwyn District Council (SDC) to report on the monitoring carried out on the 18th January 2011 at Vasari Grange and Izone during a rainfall event. Four stormwater samples were collected at each site throughout the rainfall event, the samples were analysed at Hill Laboratories for suspended solids, heavy metals - total and dissolved, nitrogen, phosphorous, E. coli and total petroleum hydrocarbons (TPHs). The samples were collected at two hourly intervals after approximately, 0.6 mm, 3.5 mm, 8.0 mm and 16.0 mm of rainfall. SDC also required that the results be compared with generic stormwater data.

Vasari Grange

Vasari Grange is a 27 lot residential subdivision in Rolleston township. Grab samples of stormwater flow in a kerb and channel comprising road and driveway runoff was collected 4 times throughout a rainfall event. The area of the road catchment from which the samples were taken is approximately 1110 m^2. In addition there would have been some runoff from driveways and footpaths at the front of properties. The concentrations of determinands found in the samples are shown in Table 2 (attached) along with stormwater monitoring results from other sites to allow for comparison of values. Reported results for Vasari Grange and Izone are maximum concentrations from the four samples taken during the First Flush (FF). It should be noted that other results are Event Mean Concentrations (EMC) and it is likely that EMC will under estimate the FF concentration.

Figure 1 shows the normalised concentrations for determinands in the Vasari Grange samples. Normalised concentrations were obtained by dividing each of the four concentrations by the maximum respective concentration recorded. Figure 1 shows that the first sample (after 0.6 mm of rainfall) contained the highest concentrations for all determinands. The second highest concentrations were generally recorded in the third sample whilst the third highest concentrations are generally recorded in the second sample. This is slightly unusual, generally the concentration of a determinand would be expected to decrease as cumulative rainfall increases, i.e. the highest concentrations are found

at the start of the event and the lowest at the end of the event with concentrations taken during the event decreasing as the event goes on. One factor that may account for this trend is the intensity of the preceding rainfall. Intuitively, higher rainfall intensity may result in greater determinand concentrations. Figure 2 shows the cumulative rainfall profile and the time each sample was taken. The intensity of the rainfall event before each sample was taken was calculated. These results are shown in Table 1 below.

Table 1: Rainfall Intensity at Time of Each Sample

Sample Number	Intensity (mm/hr)
1	1.3
2	2.7
3	9.2
4	2.5

The higher rainfall intensity before sample 3 was taken may have resulted in a greater dislodgement of material from the impervious services which then resulted in a higher concentration of the determinands. The high concentration after the first sample can be attributed to the initial runoff generally containing higher determinand concentrations, also known as the first flush effect.

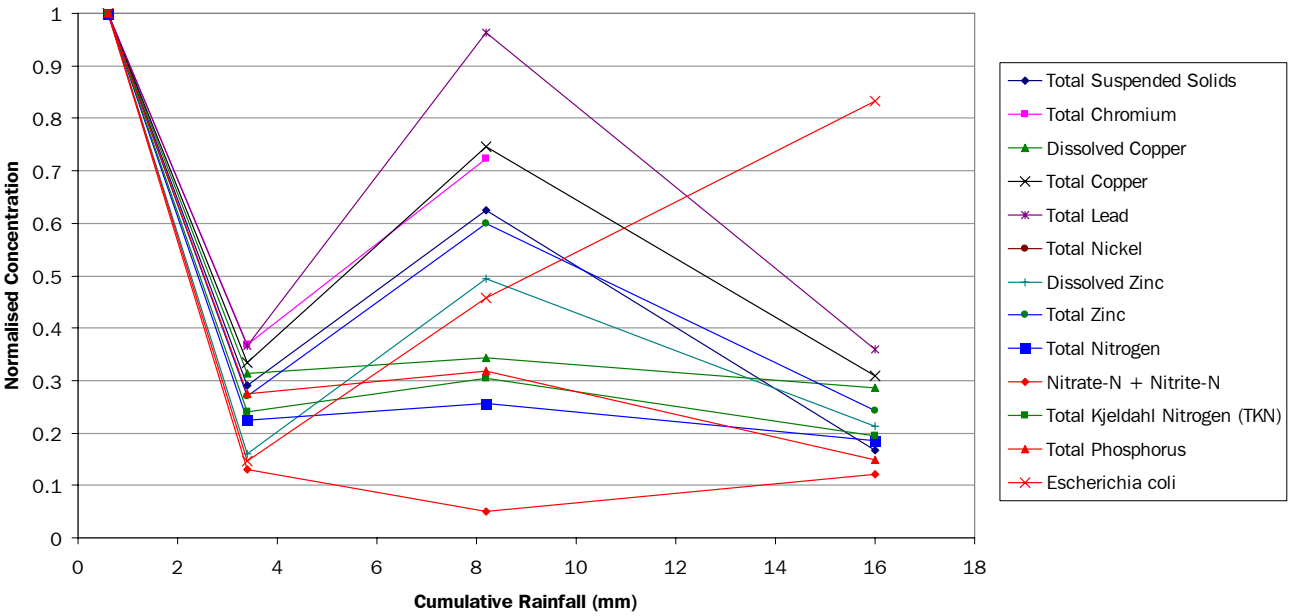


Figure 1: Plot of Normalised Determinand Concentrations for Vasari Grange

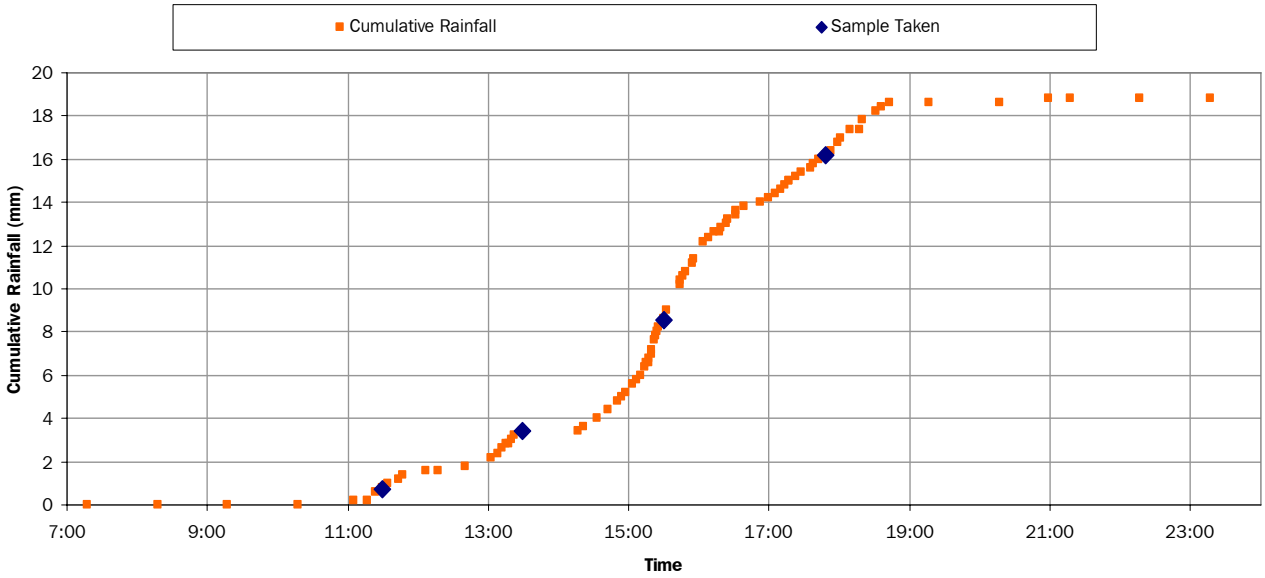


Figure 2: Plot of Cumulative Rainfall and Sampling Time

Note that in addition to the determinands plotted in Figure 1 the samples were also analysed for total petroleum hydrocarbons (TPH). All the TPH results were below the level of detection. The only determinand which has concentrations that exceed the Maximum Acceptable Value (MAV) or Guideline Value (GV) in the Drinking Water Standards for New Zealand (DWSNZ) is E. coli where the concentration of all samples was greater than the MAV of less than 1 per 100 mL sample. E. coli values did not follow the same trend as other determinands throughout the storm. From the data we have it appears E. coli values are random and do not follow any observable trend. High concentrations of E. coli are not unusual in stormwater.

Figure 3 shows the concentrations of the recent round of monitoring at Vasari Grange in comparison to historical monitoring carried out in other residential subdivisions. Data for the plot (with the exception of Vasari Grange) was obtained from the Christchurch City Council's (CCC's) Waterways Wetlands and Drainage Guide (WWDG) which provides EMC values not FF concentration values. Results from Vasari Grange are FF concentration values. Not all samples had recordings for all concentrations and therefore they are not displayed in Figure 3. Figure 3 shows that Vasari Grange has the lowest recorded concentrations of total copper and zinc. Figure 3 also shows a lower metal concentration for samples taken more recently. This may imply that stormwater is becoming "cleaner". This could be that more roofs use colour steel which is factory bonded paint on zinc-alum corrugated iron. Additionally modern vehicles do not leak as much as older vehicles, and lead has been removed from petrol. It should be noted that roofwater in the Vasari Grange subdivision is discharged directly to ground via separate sealed systems and does not contribute to the runoff sampled.

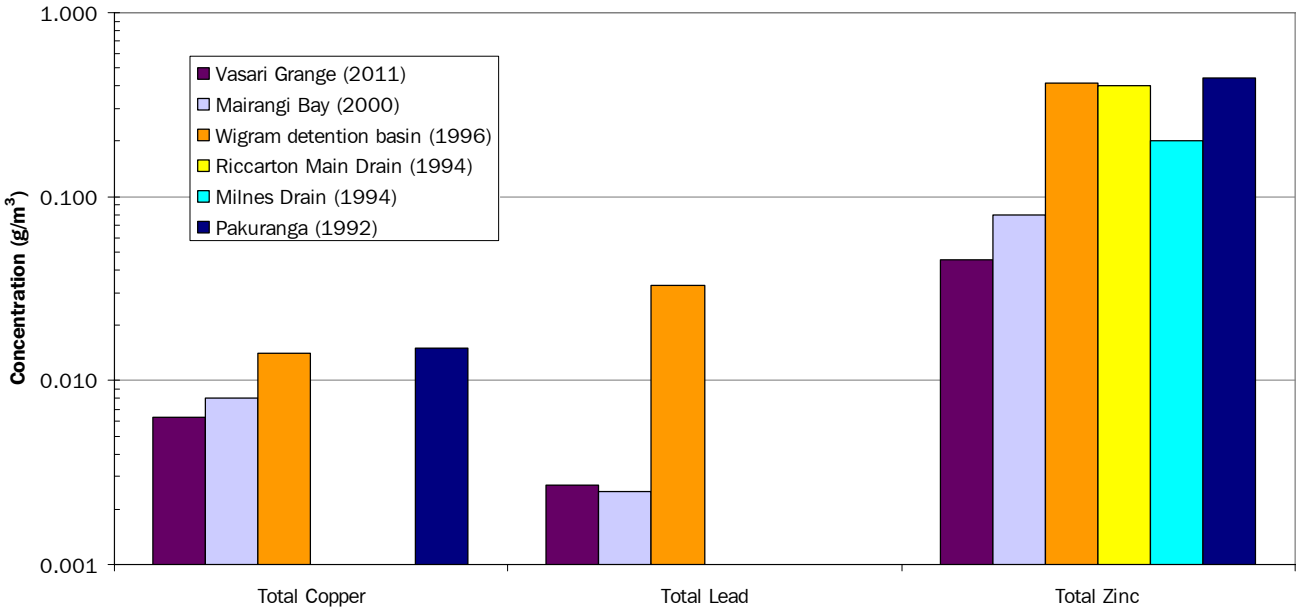


Figure 3: Recorded Determinand Concentrations of Stormwater for Various Residential Areas

Izone

Izone is a commercial/industrial subdivision adjacent to Rolleston township. Once again 4 grab samples were taken of kerb and channel flow. The contributing area of the road catchment was 1200 m^2. In addition there would have been some runoff from driveways and footpaths.

The concentrations of determinands found in the samples from Izone are shown in Table 2 (attached) along with other stormwater monitoring results to allow for comparison of values. Reported results for Izone and Vasari Grange are maximum concentrations from the four samples taken during the First Flush (FF). It should be noted that other results are Event Mean Concentrations (EMC). It is likely that EMC will under estimate the FF concentration.

Figure 4 shows the normalised concentrations for determinands in Izone. Normalised concentrations were obtained by dividing each of the four concentrations by the maximum respective concentration recorded. Figure 4 shows that the first sample (after 0.6 mm of rainfall) contained the highest concentrations for almost all determinands. Once again the second highest concentrations were generally recorded in the third sample whilst the third highest concentrations are generally recorded in the second sample. As discussed with the Vasari Grange site, one factor that may account for this trend is the intensity of the preceding rainfall. Intuitively, higher rainfall intensity may result in greater dislodgement of determinands and therefore higher determinand concentrations.

Note that in addition to the determinands plotted in Figure 4 the samples were also analysed for TPH. All the TPH results were below the level of detection. The only determinand which has concentrations which exceed the MAV or GV in the DWSNZ is E. coli. The concentrations of all samples were greater than the MAV of less than 1 per 100 mL sample. Once again E. coli results showed no observable trend. High concentrations of E. coli are not unusual in stormwater.

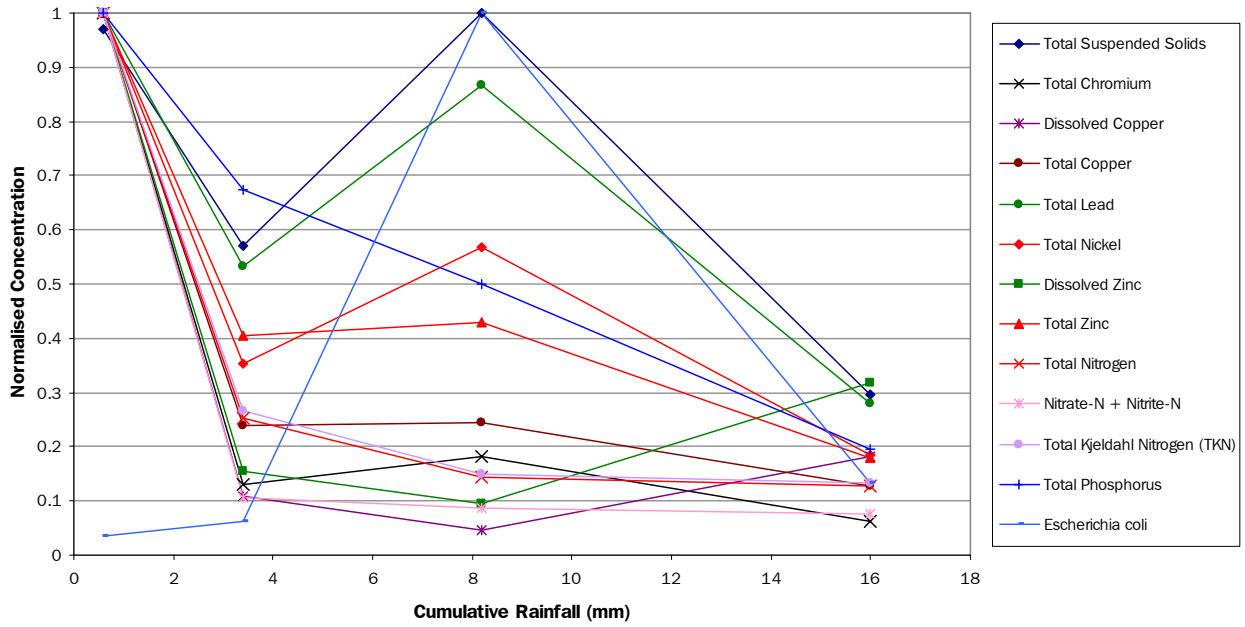


Figure 4: Plot of Normalised Determinand Concentrations for Izone

Figure 5 shows the concentrations of the recent round of monitoring at Izone in comparison to historical monitoring carried out in other commercial/industrial areas. Data for the plot (with the exception of Izone) was obtained from the CCC's WWDG which provides values for EMC not FF concentrations. Results from Izone are FF concentrations. Not all samples had recordings for all concentrations and therefore they are not displayed in Figure 5. Figure 5 shows that Izone has the lowest recorded concentrations of total lead and zinc.

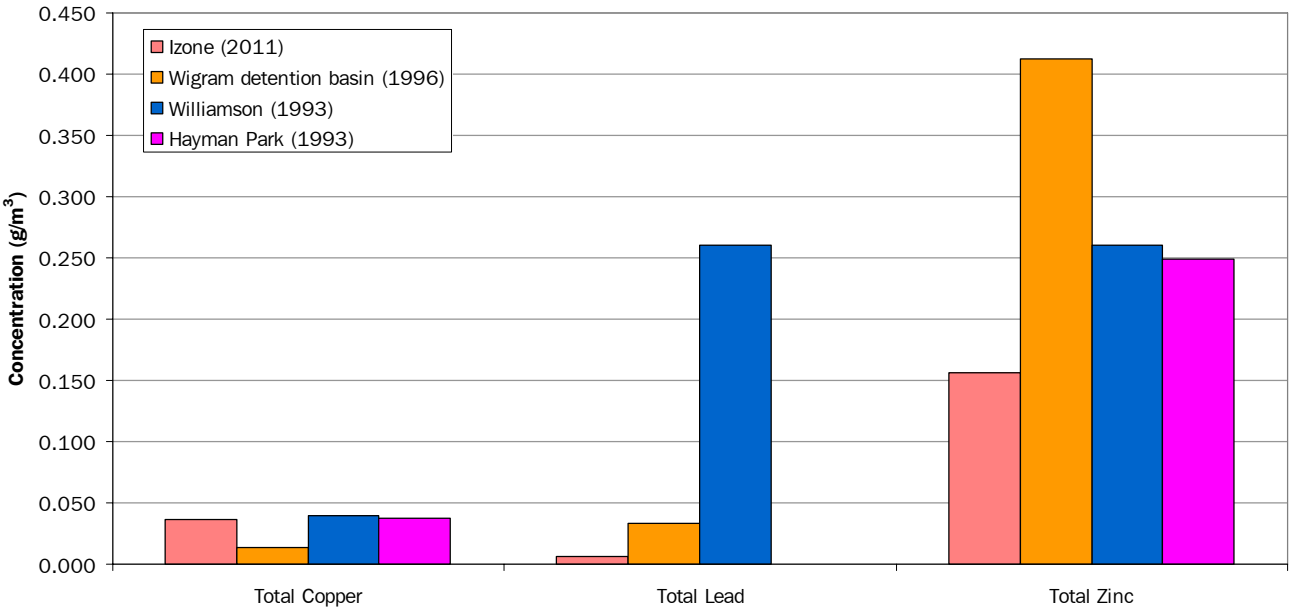


Figure 5: Recorded Determinand Concentrations of Stormwater for Various Commercial/industrial Areas

Discussion and Conclusion

In general, the concentrations of determinands were greater at the Izone site than Vasari Grange site. This is expected as generally concentrations of determinands in stormwater runoff from industrial areas are higher than stormwater runoff from residential areas. All values were well below the relevant DWSNZ MAV or GV, with the exception of E. coli. No TPHs were recorded, above the level of detection, at either site. Results from the first samples from both sites contained the highest concentrations for almost all determinands. The second highest concentrations were generally recorded in the third sample whilst the third highest concentrations were generally recorded in the second sample. A possibility for this trend is the intensity of the preceding rainfall since higher rainfall intensities may result in greater amounts of material being washed off the land surface.

Concentrations of determinands recorded at both Vasari Grange and Izone are similar to other samples taken from modern developments. These concentrations are generally lower than historic literature values. It is suggested that this is because of three main factors:

- Better roofing materials
- Less leakages from modern vehicles
- Removal of lead from petrol

The lower determinand concentrations observed in recent stormwater samples indicates that these should form the basis for environmental assessments from modern residential subdivisions rather than historic data which has been used to date. The data also indicates that different catchment types result in different concentrations of contaminants. Therefore the type and scale of treatment required for stormwater runoff should reflect the concentrations of contaminants in the stormwater and the receiving environment and there should not be a generic approach for all stormwater.

Table 2: Analyses of Stormwater Samples

Determinand	Units	Mairangi Bay[1] (2000)	Pakuranga[1] (1992)	Hayman Park[1] (1993)	Wigram Detention Basin[1] (1996)	Vasari Grange (2011)	Izone (2011)	Williamson[1] (1993)
		Residential	Residential	Commercial	Mixed	Residential	Commercial	Urban
Total Suspended Solids	g/m^3			30	101	48	97	170
Dissolved Copper	g/m^3					0.0035	0.022	
Total Copper	g/m^3	0.008	0.015	0.0380	0.0140	0.0063	0.036	0.04
Dissolved Lead	g/m^3					0.00005	0.00115	
Total Lead	g/m^3	0.0025			0.0330	0.0027	0.006	0.26
Dissolved Zinc	g/m^3					0.0075	0.066	
Total Zinc	g/m^3	0.08	0.444	0.2490	0.4120	0.045	0.156	0.26
Total Nitrogen	g/m^3					2.1	4.2	2.5
Nitrate-N + Nitrite-N	g/m^3					0.36	0.42	
Total Kjeldahl Nitrogen (TKN)	g/m^3					1.74	3.8	1.9
Escherichia coli	cfu / 100mL					240	4,100	
Total Petroleum Hydrocarbons in Water								
C7 – C9	g/m^3					< 0.10	< 0.10	
C10 – C14	g/m^3					< 0.2	< 0.2	
C15 – C36	g/m^3					< 0.4	< 0.4	
Total hydrocarbons (C7 – C36)	g/m^3					< 0.7	< 0.7	1 – 5

1 – Results are Event Mean Concentrations not First Flush concentrations which are likely to underestimate First Flush concentrations.

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Appendix E

Orion Capacity Letter

Direct: +64 3 363 9534
Email: Steve.Hancock@oriongroup.co.nz
Ref **ES: 421605**

11 September 2020

Paterson Pitts Group
PO Box 160094
Hornby
CHRISTCHURCH 8441

Attention: Will Salmond

Dear Will,

Proposed Sub-Division connection to the Orion network – R/No 510232 Lincoln Rolleston Road, Rolleston

The letter is not suitable for Section 224 Title Clearance.

I refer to your letter and the above-named property. I have investigated your request and comment as follows;

1. Orion has the capacity on the upper network to supply the proposed subdivision of the above lot(s).
2. To comply with Orion's network security conditions, an alternative feed from adjoining developments may also be required.
3. There are presently no specific connections available for this Sub-Division; however,
4. Connection(s) could be made available with alteration / addition to the Orion network.
5. There will be costs associated with providing the connection(s). These will be in line with our 'Extensions and Connections Policy'.
6. This type of work would be a typical design build project. If you proceed; please have your designer forward their proposal to Orion for approval.

The terms and conditions presented will encompass Orion's policies and practices current at the time.

Please don't hesitate to contact me on (*03*) *363 9534*, or email me at: *Steve.Hancock@oriongroup.co.nz*

Yours faithfully

Steve Hancock
Contract Manager Sub-Divisions

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Appendix F

Enable Capacity Letter

13th October 2020

Will Salmond

Paterson Pitts Group

Christchurch

Dear Will

UFB Fibre delivery to the Levi Lincoln Sites

- In response to your query on the 3rd September, requesting confirmation from Enable of fibre delivery into the subdivisions at

139 Levi Road

232 Lincoln Rolleston Road

274 Lincoln Rolleston Road

294 Lincoln Rolleston Road

5 Nobeline Drive

15 Nobeline Drive

25 Nobeline Drive

In the areas shown in red, yellow blue

, I am pleased to be able to confirm the following;

Enable has the service capacity/ capability to fee this parcel of land. Feed can be provided, at standard network extension fees and Greenfield Development fees, from the existing Enable chamber 2320

I trust that the above confirmation allows you to fulfill council requirements

Yours sincerely

Rob Armstrong

Business Development Manager

Enable Networks Ltd