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Project: Denwood Developments: Springs Road, Lincoln

Geotechnical Investigation Report for Residential Plan Change

Reference: 216391

Prepared for: Denwood Trustees Ltd.

Revision: 1

17 September 2012

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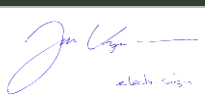
Author Signature		Approver Signature	
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Executive Summary

Denwood Trustees Ltd. are seeking a plan change to rezone a block of land in south-west Lincoln from rural to residential (See Figure 1, Appendix A). The site located at 1486 Springs Road in Lincoln has a legal description of Lot 1 DP12928 and is approximately 60ha in area.

Aurecon New Zealand Ltd. (Aurecon) has been engaged to provide engineering services for the plan change, part of which is to carry out a geotechnical investigation. The purpose of the geotechnical investigations described in this report is to identify any geotechnical issues with the land, including addressing potential liquefaction risk or geological hazards and any remediation options that may be required as part of the development.

The geotechnical investigation included a site reconnaissance survey, a review of geological and geotechnical information available for the site, and the excavation of 10 exploratory test pits. Although only shallow investigations have been undertaken as part of the geotechnical investigation, we have reviewed deeper soil investigations.

The geotechnical investigation identified that the site is typically underlain by 1.8m of silty/sandy material and below that is gravel. Groundwater was identified at approximately 2.0m in the west and approximately 3.0m in the east of the site.

Despite the silty/sandy soils directly underlying the site, the materials are above the groundwater table. Below the water table is gravel. As such, the site has been screened as having a low susceptibility to seismically induced liquefaction. This is backed by the lack of observed ground damage following the 4 September 2011 magnitude 7.1 Darfield earthquake.

Due to the site being directly underlain by fine grained soils, there exists the potential for erosion and rilling of the sandy/silty soils if vegetation cover is removed for prolonged periods of time from both stormwater runoff if it is not discharged in a controlled manner, and from the wind. This susceptibility to erosion of the silty soils can be minimised by using appropriate industry standard design measures during construction. Due to the subsoil profile and provided appropriate civil engineering design for stormwater control is implemented the site has low potential for “subsidence”, “and “inundation.” As such, the proposed rezoning of the land for residential development is unlikely to accelerate, worsen, or result in material damage to the land, other land, or structures.

As part of the site development, in particular during the subdivision consenting process it is recommended that additional geotechnical investigation is carried out to further quantify geotechnical parameters of the site.

Our limitations are given in section 6 of this report. This report shall be read as a whole.

1. Introduction

Denwoods Trustee Ltd. are seeking a plan change to rezone a block of land in south-west Lincoln from rural to residential (See Figure 1, Appendix A). The site has the physical address of 1486 Springs Road, Lincoln. It has a legal description of Lot 1 DP12928 and is approximately 60ha.

Aurecon has been engaged to provide engineering services for the plan change, part of which is to carry out a geotechnical investigation. The purpose of the geotechnical investigations described in this report is to identify any geotechnical issues with the land, including addressing potential liquefaction risk or geological hazards and any remediation options that may be required as part of the development.

The investigation comprised the following scope of works:

- A detailed desktop study based on the geological and geotechnical information available for the site.
- A site walkover and reconnaissance survey to determine any site specific hazards from a geotechnical perspective undertaken on 1 August 2012.
- Excavation of 10 test pits to confirm subsurface conditions and the groundwater level.
- The identification of any geotechnical issues with the site and the provision of recommendations for the development of the site, including seismically triggered liquefaction susceptibility.
- The provisions of recommendations for further testing (if required).
- The preparation of this geotechnical report detailing the above, and identifying the suitability of the site for residential development from a geotechnical perspective.

The conditions of our engagement and limitations are set out in our fee proposal dated 8 November 2010. Authorisation to proceed was given by Fiona Aston on behalf of Dennis Woods via email on 18 July 2012. This report outlines our geotechnical investigation and presents our recommendations for land rezoning as part of future site development.

Our limitations are given in section 6 of this report. This report shall be read as a whole.

2. Site Conditions

2.1 Site Description

The site is located at 1486 Springs Road in Lincoln (Refer to Figure 1 in Appendix A). It has a legal description Lot 1 DP12928 and is approximately 60ha in area. The following is a brief overview of the site:

- The site is gently sloping to the west where there is a small creek marking the western site boundary.
- There is a farm house in the centre of the site.
- The site is bound to the north, south and west by rural farmland, and to the east by Springs Road.

2.2 Site Access

Main access to the site is off Springs Road approximately one kilometre south from the Gerald St / Springs Road roundabout near Lincoln University.

2.3 Vegetation

The majority of the site is grassed and divided into paddocks. One paddock in the centre of the site was under crops at the time of the investigation.

2.4 Surface Water

Drainage channels border the paddocks. At the time of the initial site walk over these were predominately dry. There is a creek along the western site boundary which contains water year round.

2.5 Regional Geology

The regional geology of the site is described in the 1:250,000 scale geological map – 'Geology of Christchurch," published in 2008 by the Institute of Geological and Nuclear Sciences. The geological map (Figure 2, Appendix A) indicates the following:

- River deposits comprising *"grey river alluvium, beneath plains or low level terraces (Q1a)"*.

The Institute of Geological and Nuclear Sciences (GNS) Map Sheet 21 scale 1:250,000 show the site to be underlain by the Springston Formation, which consists of river gravel and finer alluvium.

The GNS Active Fault System database (GNS, 2011a & GNS, 2011b) indicates that the site is located approximately:

- 30km south east of the epicentre of the Magnitude 7.1 Darfield (Canterbury) Earthquake of 4 September 2010.
- 19km south west of the epicentre of the Magnitude 6.3 Christchurch Earthquake of 22 February 2011.
- 24km south west of the epicentre of the Magnitude 6.0 Christchurch aftershock of 13 June 2011.
- 26km south west of the epicentre of the Magnitude 6.0 Christchurch aftershock of 23 December 2011.

3. Geotechnical Investigation

3.1 General

It is proposed to rezone (via plan change) approximately 60ha of rural land to residential. As part of the plan change application, a geotechnical engineering assessment is required to determine the geotechnical suitability of the land for development.

The objective of the geotechnical investigation was to assess the ground and groundwater conditions across the site and to identify any geotechnical issues that may affect future residential development.

3.2 Previous Investigations

Aurecon Ltd. have carried out ground investigations at two sites within one kilometre of the site. The first site is on the eastern side of Springs Road and gravel to depth was encountered between 5 and 10m bgl (below ground level). The second site is directly to the south east of the site and encountered gravels at shallow depths which extend to greater than 10m bgl. This site is a consented gravel quarry for the Lincoln Land Development project.

We are aware that an area of the project site is designated as a gravel pit as shown on the New Zealand map series Topographic Plan. The gravel pit is shown on the north east corner of the block. This pit has since been in-filled and we believe it now comprises and area where gravels are observed close to the surface.

3.3 Environment Canterbury Borehole Logs

A review of the Environment Canterbury GIS System (ECan, 2011) was undertaken to identify borehole data within the vicinity of the site. There are two boreholes located within the 60ha block and 3 within 500m of the perimeter. The boreholes indicate gravels are generally encountered close to the surface and continue down to depth. Some boreholes logs contain minor horizons described as clay. The ECan boreholes from within the site or close to the site are summarised in Table 1 below. The ECan borehole locations are shown in Figure 3 in Appendix A and the logs are attached in Appendix B.

Table 1 - ECan Borehole Log Summary

Hole No.	Distance from Site	Depth (m)	Summary
M36/8494	Within site	10.0m	Fill and topsoil underlain by sandy Gravel to 10m depth. Groundwater not recorded.
M36/8493	Within site	10.0m	Sandy Gravel to 10m depth. Groundwater not recorded.
M36/0574	100m north west	15.2m	GRAVEL with minor sand and clay to 15.2m depth. Groundwater at 3.7m below ground level.
M36/8229	100m south	18.0m	Claybound and sandy GRAVEL to 18m depth. Groundwater not recorded.
M36/8495	50m north	10.0m	Silty to coarse sandy GRAVEL with minor silt to 10m depth. Groundwater not recorded.

3.4 Test Pits

A total of 10 test pits were excavated on 7 September 2012 using a 14t excavator to depths in the range of 2 to 4m bgl. The test pits were excavated across the site to determine the shallow subsurface conditions and the depth to groundwater. Test pits were carried out around the property where access was possible. Due to the presence of crops, no test pits were excavated in the centre of the site. The locations of the test pits are shown in Figure 4 Appendix A. Groundwater was encountered in the test pits closest to the creek along the western edge of the property.

The logging of the test pits was undertaken in accordance with NZ Geotechnical Society's "Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes: 2005". The test pit logs along with an explanatory sheet outlining the terms and descriptions used in the logs are attached in Appendix C.

The generalised soil profile from the test pit logs is outlined in Table 2 below.

Table 2 – Generalised soil profile on site

From	To	Description
Surface	0.2m – 0.5m	Topsoil – SILT; dark brown. Dry to moist; rootlets present.
0.2m – 0.5m	0.6m – 1.8m	SILT with some clay; yellowish brown with orange brown mottling. Moist; low to high plasticity. A fine sand horizon was encountered in Test Pit 1 between 1m and 1.8m.
0.6m – 1.8m	Exceeds depth of test pits (greater than 4m)	Sandy GRAVEL with minor silt and clay; orange brown. Wet; sand, fine; gravel, fine to medium, subangular to subrounded.

3.5 Groundwater

The following is a summary of the groundwater levels recorded at the site.

Table 3 - Recorded groundwater levels

Test Location	Recorded Depth to Ground Water (m) bgl
TP1	1.9
TP2	2.3
TP3	2.1
TP5	3.2
TP6	3.1

4. Engineering Consideration

4.1 General

As part of the plan change application a geotechnical engineering assessment has been undertaken to quantify the underlying ground conditions and identify any potential geotechnical hazards that may affect the proposed residential rezoning and eventual development.

This section of the report outlines details of our assessment of potential geotechnical hazards at the site and makes recommendations for potential site development.

4.2 Geotechnical Ground Model

Based on the results of our geotechnical site investigation we infer that the site is underlain by:

Table 4 – Inferred Ground Profile

Layer	Depth	Thickness	Material
1	Surface to 0.2 – 0.5m	0.2 – 0.5m	Silty TOPSOIL
2	0.2 – 0.5m to 0.6 – 1.8m	0.4 – 1.3m	Low to high plasticity SILT with some clay with lenses of SAND.
3	0.6 – 1.8m to over 10m.	Greater than 10m	Fine to coarse Sandy GRAVEL with some boulders.

Based on the test pit logs we infer groundwater to be approximately 2.0m bgl in the west of the site and approximately 3.0m bgl in the east of the site.

4.3 Liquefaction

4.3.1 Introduction

Under cyclic loading (i.e. during an earthquake) loose non-cohesive materials (gravels, sands, silty-sands) tend to decrease in volume. This tendency to decrease in volume is much greater in loose than in dense soils. When loose non-cohesive soils are saturated and rapid loading occurs under undrained conditions, the soil densification causes pore water pressure to increase. The increase in pore water pressure results in a loss of soil strength due to a decrease in effective stress and once the effective stress drops to zero liquefaction occurs. Liquefaction can lead to large displacements of foundations, flow failures of slopes, ground surface settlement, sand boils, and post-earthquake stability failures.

For the site subdivision and residential development the main factors to be considered are:

- Will liquefaction occur?
- What level of liquefaction is expected to occur in the future?
- What options are available to limit or prevent the effects of liquefaction?

Each of these is considered below.

4.3.2 Liquefaction Potential

Soil Grading and Density

Liquefiable soils generally have a Coefficient of Uniformity of less than 5 and a low proportion of soil finer than 75 microns in size (typically less than 5% to 10% but up to 30%). The test pit logs over the site are interpreted as showing layers and lenses of loose sandy material interbedded with low to high plasticity Silt with some clay in the upper 1.8 of the subsoil profile. As such, the sandy soil in the upper 1.8m of the subsoil at the site is potentially susceptible to liquefaction.

Based on the nature of the interbedded layers within the upper soils (i.e. Layer 2), the site can be considered to be potentially liquefiable from a grading and density perspective between 0.2 to 1.8m depth only.

Groundwater

The depth to groundwater has been measured directly from test pits. From these measurements, soils are therefore potentially liquefiable from a minimum depth of 2.0m bgl. However, it is likely that the groundwater levels will vary depending on the time of year. Based on our observation of the groundwater profile at the adjacent quarry site we understand that the current site investigation was conducted at a time when higher groundwater levels are present.

Earthquake Intensity and Soil Resistance to Liquefaction

It is noted that a review of Geonet strong motion seismograph records (Geonet, 2012) of the Darfield Earthquake indicate the presence of a seismographs at the Lincoln Crop and Food Research Centre located approximately 5km north of the site. This seismograph recorded a Peak (horizontal) Ground Accelerations (PGA) of 0.42g with a Magnitude of 7.1. This seismograph recorded is inferred to be representative of the ground shaking experienced at the site.

The recently released Department of Building and Housing *Interim guidance for repairing and rebuilding foundations in Technical Category 3* (DBH, 2012) indicates that the design earthquake for liquefaction for residential development is an Ultimate Limit Stage design earthquake with a PGA of 0.35g and a Magnitude of 7.5. As such the site has effectively been exposed to a ULS design earthquake equivalent during the Darfield Earthquake.

Due to the Sandy material being located in the upper 1.8m of the soil profile only and the groundwater level being located below this in the gravel material, the site is considered to have a low susceptibility to liquefaction. No liquefaction ground damage was observed on the site during the Darfield Earthquake which has been inferred to have been equivalent to, or greater than ULS design event.

The Geotech Consulting Ltd (2011) report to the Selwyn District Council includes a map outlining potentially liquefiable ground in the Selwyn District (Figure 5). The Denwood Development site is located outside the zone of potentially liquefiable ground.

As such at this stage we infer the site to have a low susceptibility to seismically induced liquefaction. Therefore, no further liquefaction analysis has been undertaken at this stage.

4.3.3 Likely Technical Category Classification

For the Christchurch Region the Department of Building and Housing (DBH, 2011) has released a new classification system for residential 'Green Zone' land on the flat in regard to the liquefaction

susceptibility. This new classification system is divided into three technical categories that reflect both the liquefaction experience to date and future performance expectations. The categories and corresponding criteria are summarised as follows:

- **Technical Category 1 (TC1)** – Future land damage from liquefaction is unlikely, and ground settlements are expected to be within normally accepted tolerances.
- **Technical Category 2 (TC2)** – Minor to moderate land damage from liquefaction is possible in future large earthquakes.
- **Technical Category 3 (TC3)** – Moderate to significant land damage from liquefaction is possible in future large earthquakes.

Based on geotechnical investigations to date and the lack of observed ground damage at the site following the Darfield Earthquake we infer that the site is likely to have a Technical Category 1 Classification, i.e. future land damage from liquefaction is unlikely, and ground settlements are expected to be within normally accepted tolerances. However, it must be noted that without further geotechnical testing (see Section 4.9 blow) the Technical Category Classification cannot be fully quantified within the settlement tolerance limits of the Technical Category classification system.

4.4 Erosion

No erosion was observed on site. However the silty soils that directly underlie the site are inferred to be potentially susceptible to erosion when left un-vegetated. As such the site should be vegetated as soon as practical after earthworks operations are completed.

4.5 Falling Debris

Due to the flat site topography and a lack of any source material there is risk of falling debris at the site in its current form.

4.6 Subsidence

Due to the nature of the underlying soil and the identified lack of liquefaction susceptibility we infer the risk of subsidence is low.

4.7 Inundation

The risk of inundation form stormwater or the creek that runs along the western boundary of the site should be dealt with in the detailed civil engineering assessment of the site. Due to the lack of any identified liquefaction susceptibility at the site and provided that stormwater discharge is appropriately managed we infer the risk inundation at the site to be low.

4.8 Conclusion

Due to the site being directly underlain by fine grained soils, there exists the potential for erosion and rilling of the sandy/silty soils if vegetation cover is removed for prolonged periods of time from both stormwater runoff if it is not discharged in a controlled manner, and from the wind. This susceptibility to erosion of the silty soils can be minimised by using appropriate industry standard design measures during construction. The site has been identified as having a low susceptible to seismically induced liquefaction. Due to the subsoil profile and provided appropriate civil engineering design for stormwater control is implemented the site has low potential for “subsidence”, “and “inundation.” As

such, the proposed rezoning of the land for residential development is unlikely to accelerate, worsen, or result in material damage to the land, other land, or structures.

4.9 Recommendations

As part of the further site development, in particular during the subdivision consenting process, it is recommended that further geotechnical testing is undertaken. At this stage it is recommended that:

- A nominal six to eight exploratory boreholes with Standard Penetration Testing (SPT) be undertaken across the site to a minimal depth of 15m. From these boreholes more detailed engineering properties of the subsoil profile can be made.
- Undertake test pit excavations across the site to confirm the shallow subsoil profile, in particular depth to gravel, in the areas between the boreholes. The final number of test pits would be in accordance with the DBH recommendations (DBH, 2011) and depend upon the final number of residential allotments proposed.
- Along the western boundary by the creek, depending upon the subsoil profile identified from the test pit excavations, i.e. silty-sandy material located below the water table, then undertake a series of Cone Penetrometer Tests (CPT). It is noted that the CPT is not recommended across the majority of the site as it is of no use to assess the engineering properties of the gravelly soil that underlies the site.

5. References

DBH (2011), Department of Building and Housing *Revised guidance on repairing and rebuilding houses affected by the Canterbury earthquake sequence – Canterbury Region,* dated November 2011

DBH (2012), Department of Building and Housing *Interim guidance for repairing and rebuilding foundations in Technical Category,* dated April 2012.

Canterbury Earthquake Recovery Authority http://cera.govt.nz/maps. (12/09/12)

ECan, 2011. http://arcims.ecan.govt.nz/ecanmapping/

Geonet, 2011. ftp://ftp.geonet.org.nz/strong/processed/Proc (12/09/12)

Geotech Consulting Ltd (2011) *2010 Canterbury Earthquake Liquefaction Report* – Selwyn District Council

GNS, 2011a. http://maps.gns.cri.nz/website/af/viewer.htm (12/09/12)

GNS, 2011b. http://www.gns.cri.nz/Home/News-and-Events/Media-Releases/earthquake-part-of-aftershock-sequence

Resource Management Act 1991 (RMA), Section 106.

Selwyn District Council (2011) – Engineering Code of Practise.

6. Limitations

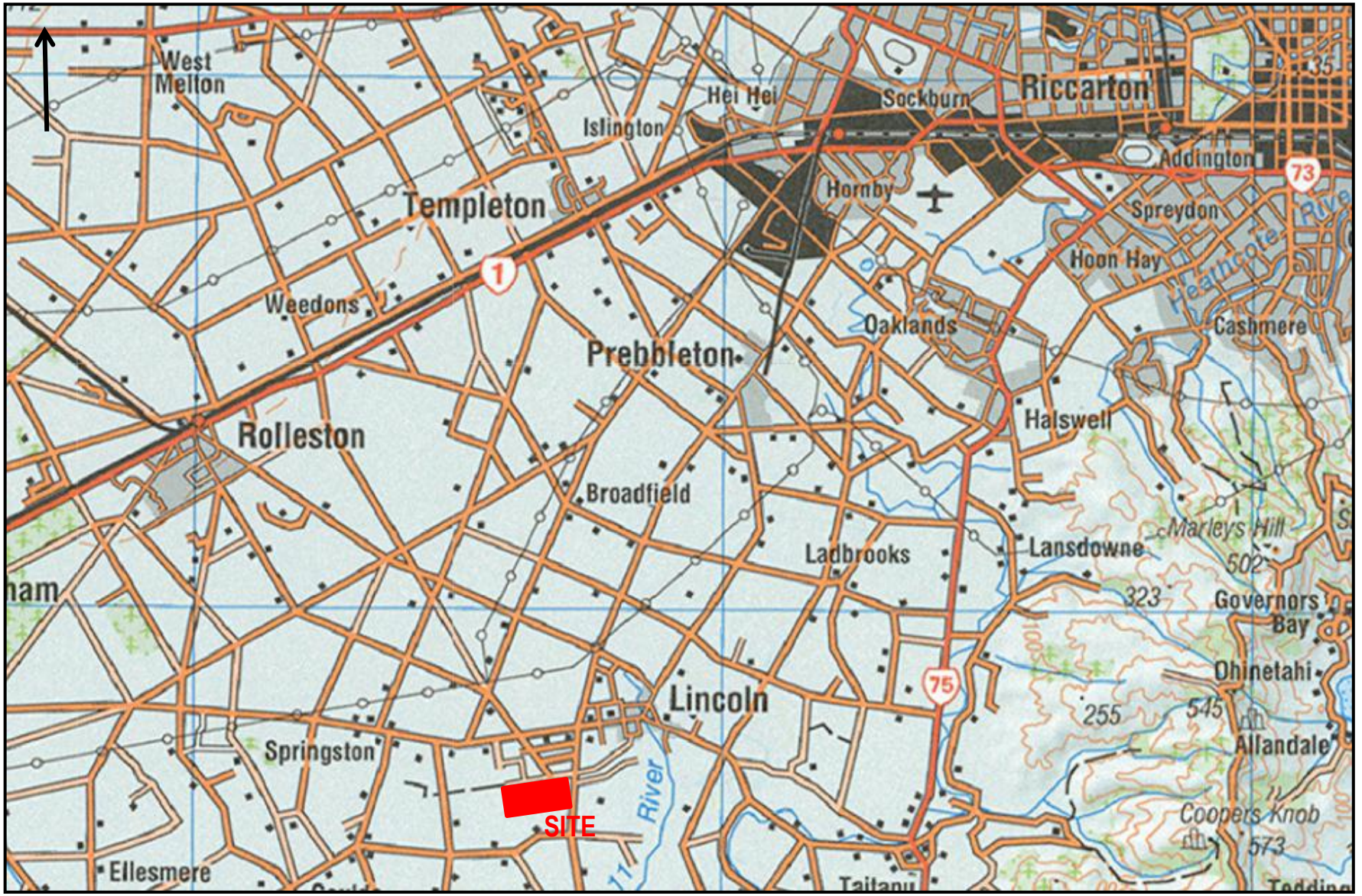
We have prepared this report in accordance with the brief as provided. The contents of the report are for the sole use of the Client and the Selwyn District Council and no responsibility or liability will be accepted to any third party. Data or opinions contained within the report may not be used in other contexts or for any other purposes without our prior review and agreement.

The recommendations in this report are based on data collected at specific locations and by using appropriate investigation methods with limited site coverage. Only a finite amount of information has been collected to meet the specific financial and technical requirements of the Client's brief and this report does not purport to completely describe all the site characteristics and properties. The nature and continuity of the ground between test locations has been inferred using experience and judgment and it must be appreciated that actual conditions could vary from the assumed model.

Subsurface conditions relevant to construction works should be assessed by contractors who can make their own interpretation of the factual data provided. They should perform any additional tests as necessary for their own purposes.

Subsurface conditions, such as groundwater levels, can change over time. This should be borne in mind, particularly if the report is used after a protracted delay.

Appendix A Figures



Note: Not to scale; boundaries and locations are approximate only

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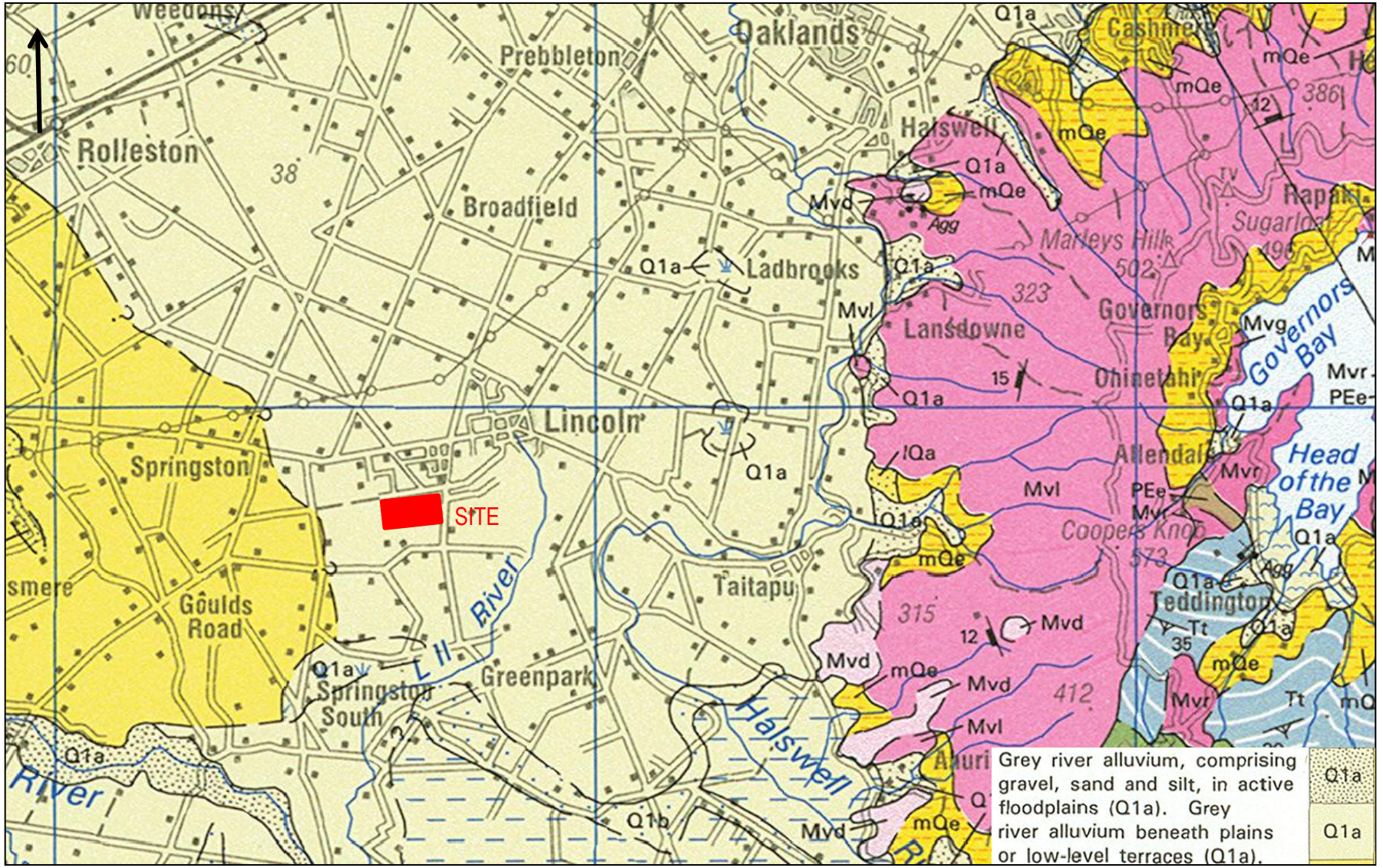
Figure 1
Site Location (Koordinates, 2012)

Paper Size	A4
Revision	1



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Client: Denwood Trustees Ltd.	Figure 2		Paper Size: A4
Project: Denwood Developments Plan Change	Regional Geology (Brown et al, 1992)		Revision: 1
By: AJW	Date: 12 September 2012	Job Number: 216391	

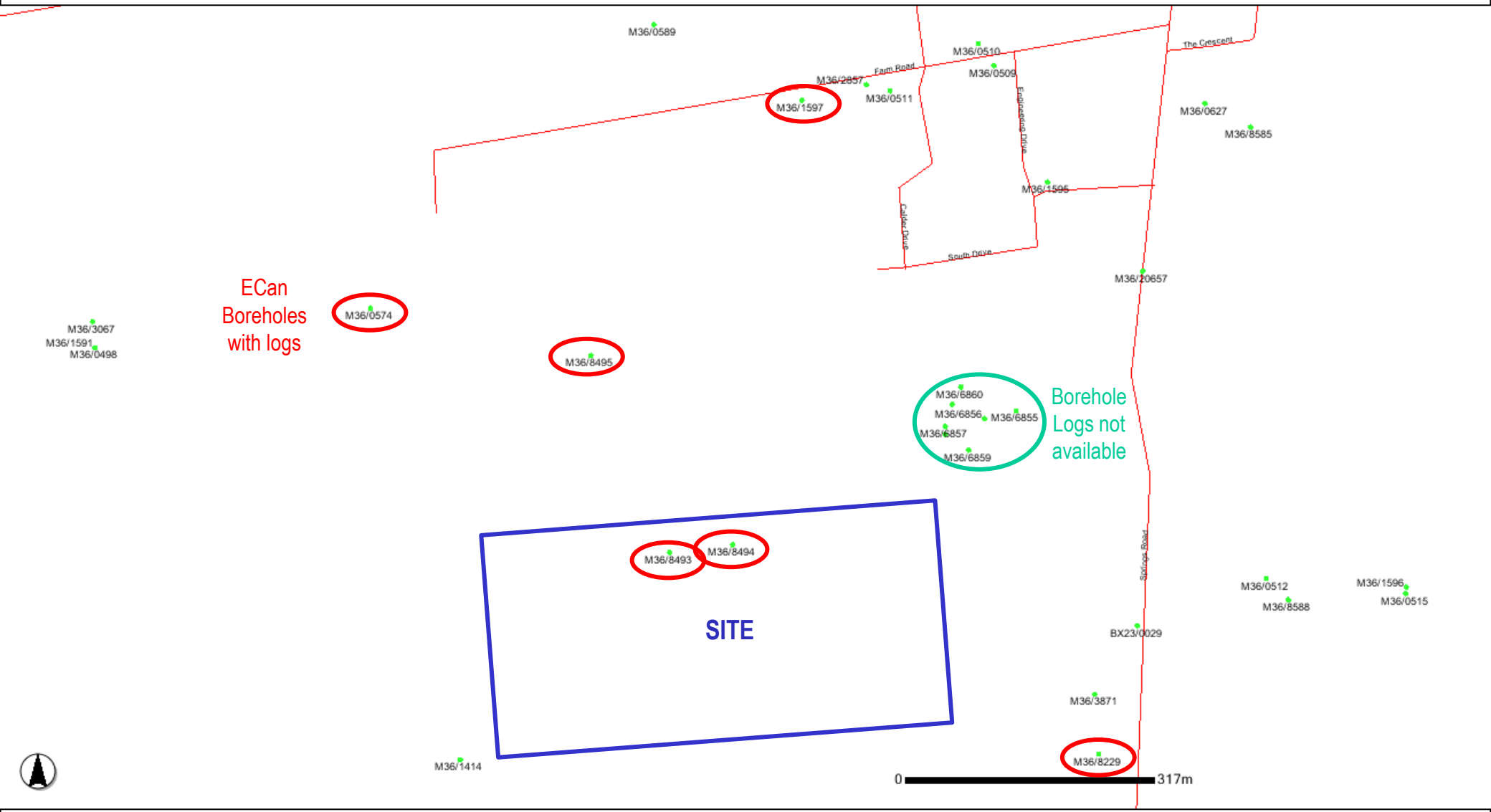

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Figure 3

Plan of Ecan Boreholes

Paper Size	A4
Revision	1

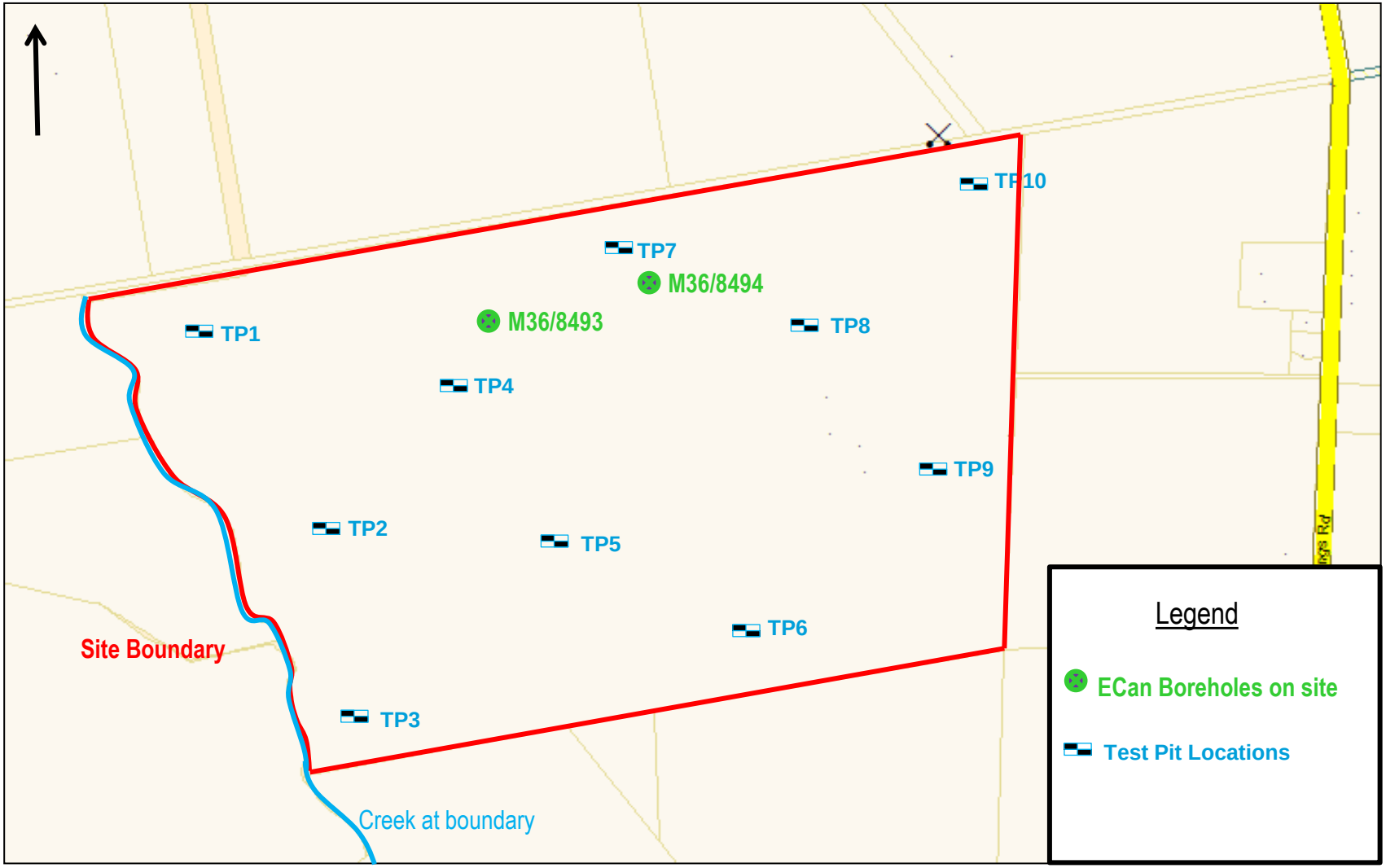

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Figure 4

Plan of Test Pit and ECan Boreholes on site

Paper Size	A4
Revision	1

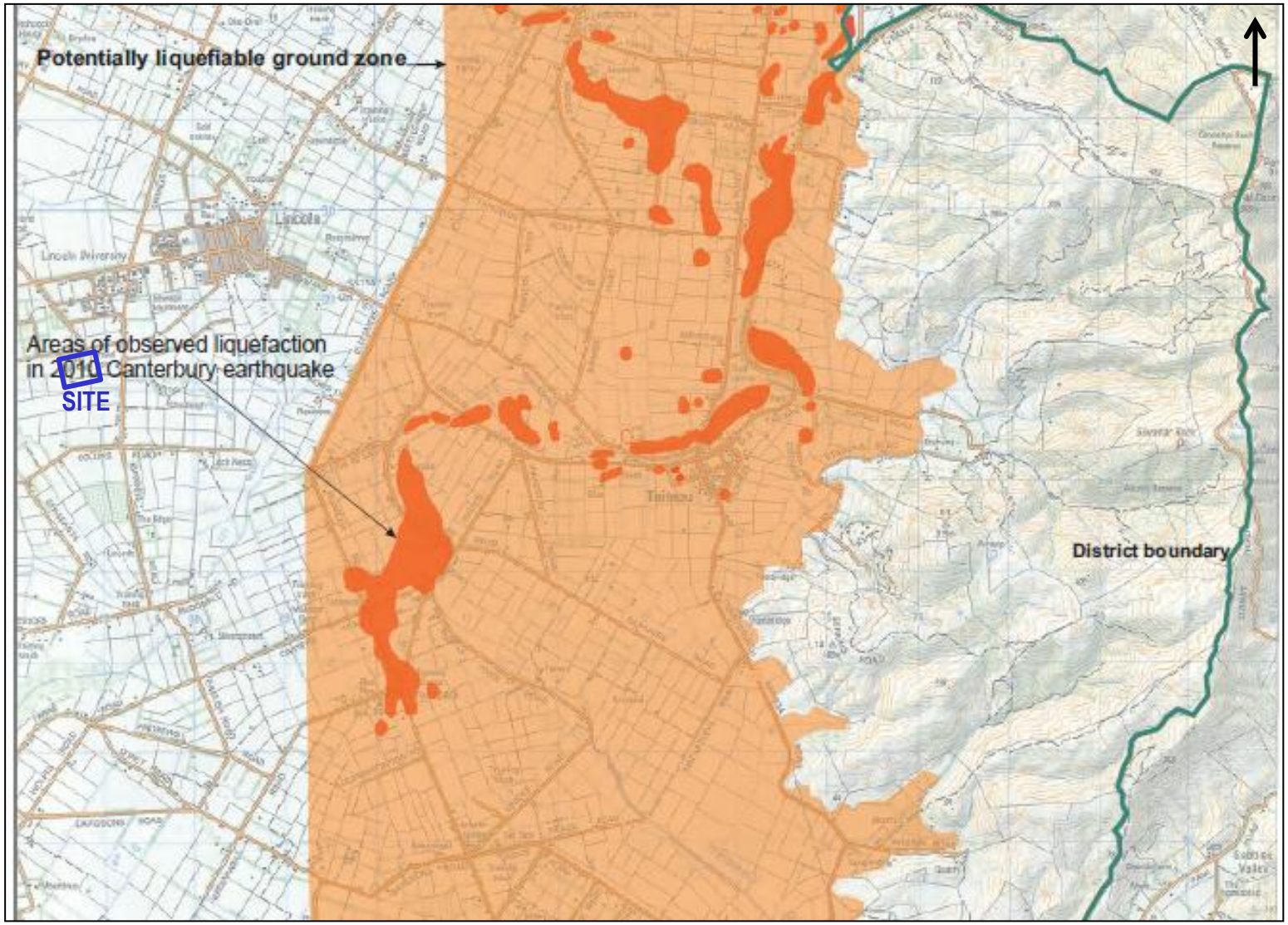

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Figure 5
Map of potentially liquefiable ground in the Selwyn District (Geotech Consulting Ltd, 2011)

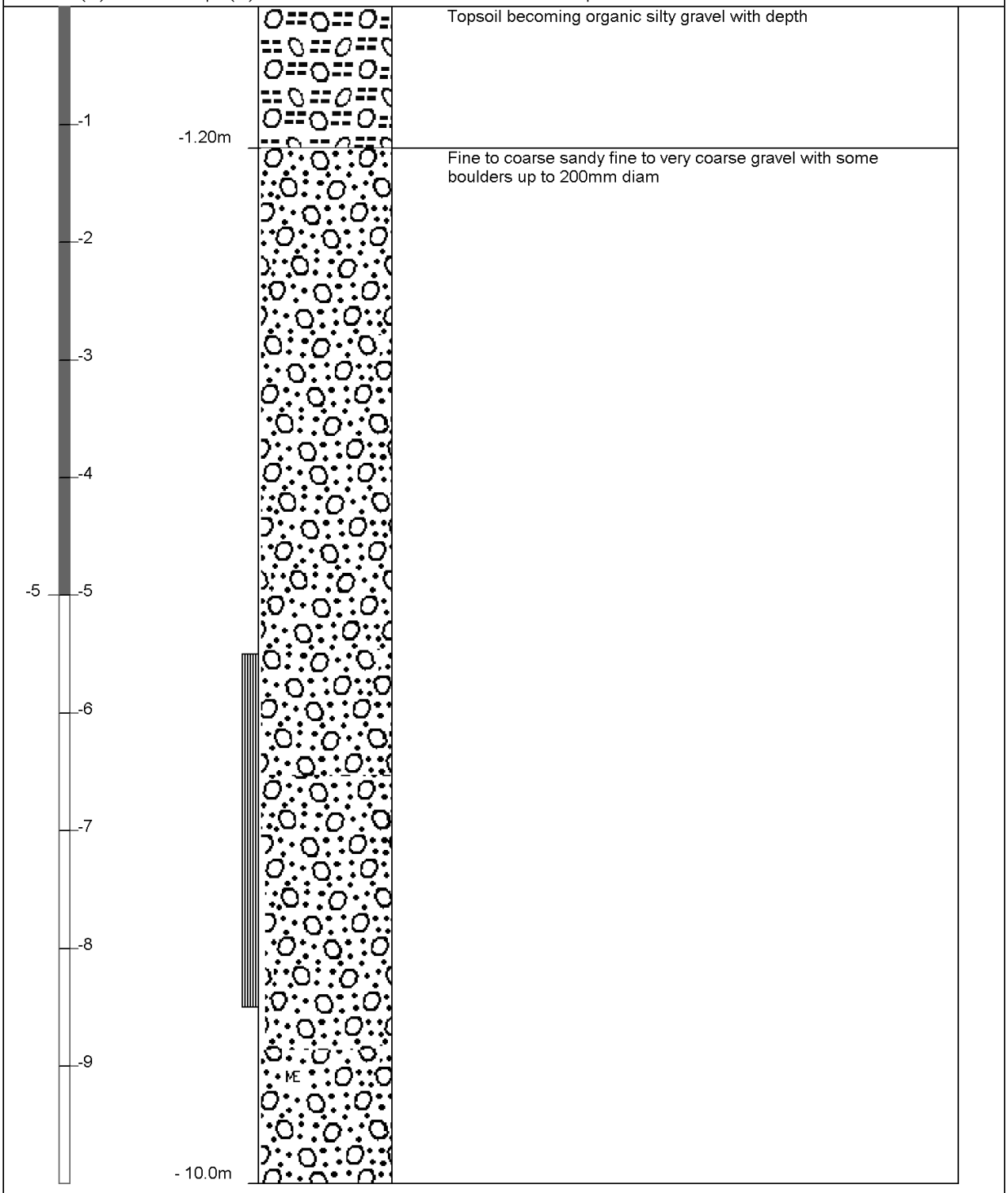
Paper Size	A4
Revision	1

Appendix B ECan Borehole Logs

Borelog for well M36/8493

Gridref: M36:6662-2843 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 10 +MSD
Driller : Texco Drilling Ltd
Drill Method : Cable Tool
Drill Depth : -10m Drill Date : 30/11/2007

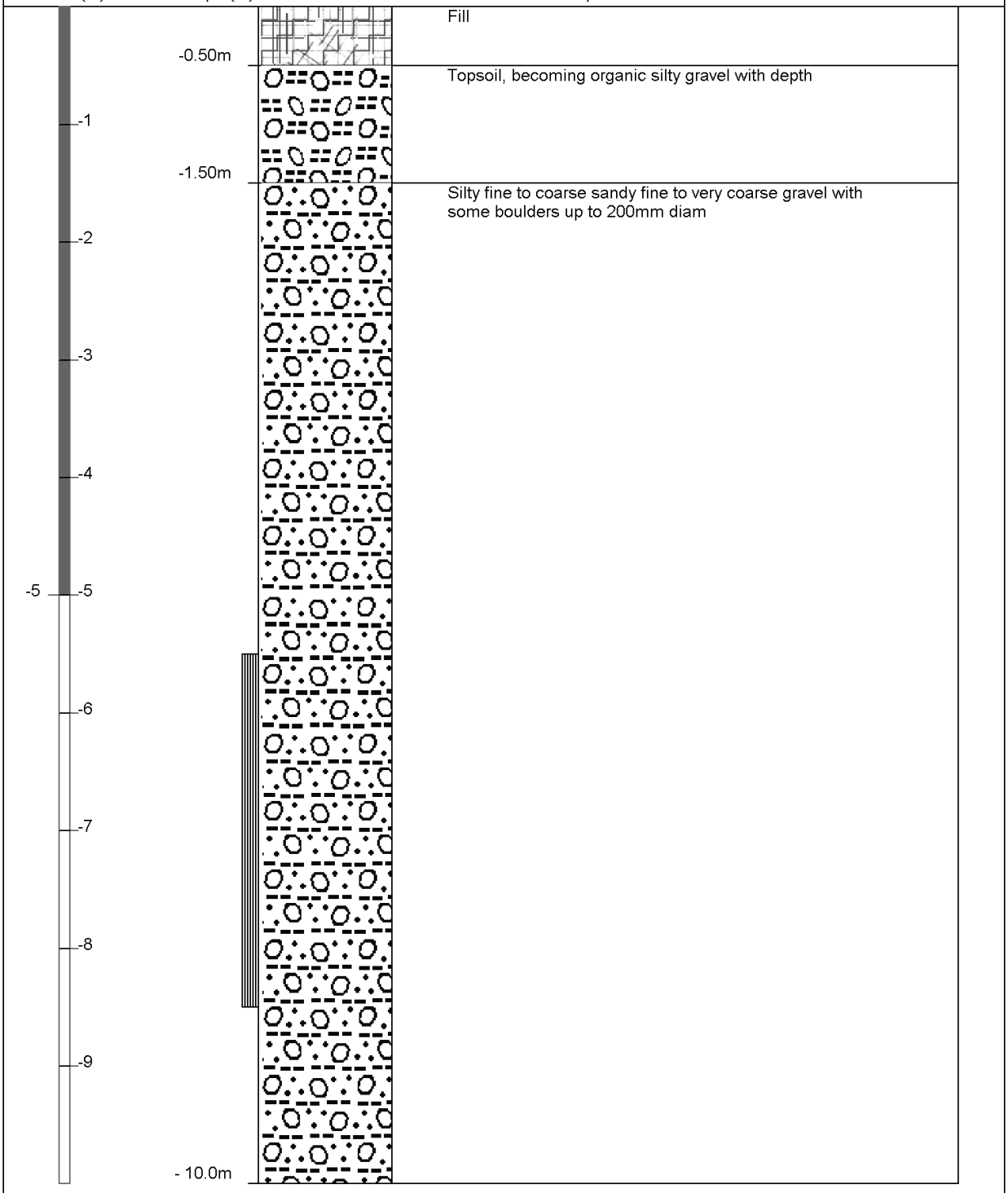
Environment Canterbury Regional Council



Borelog for well M36/8494

Gridref: M36:6670-2844 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 9 +MSD
Driller : Texco Drilling Ltd
Drill Method : Cable Tool
Drill Depth : -10m Drill Date : 30/11/2007

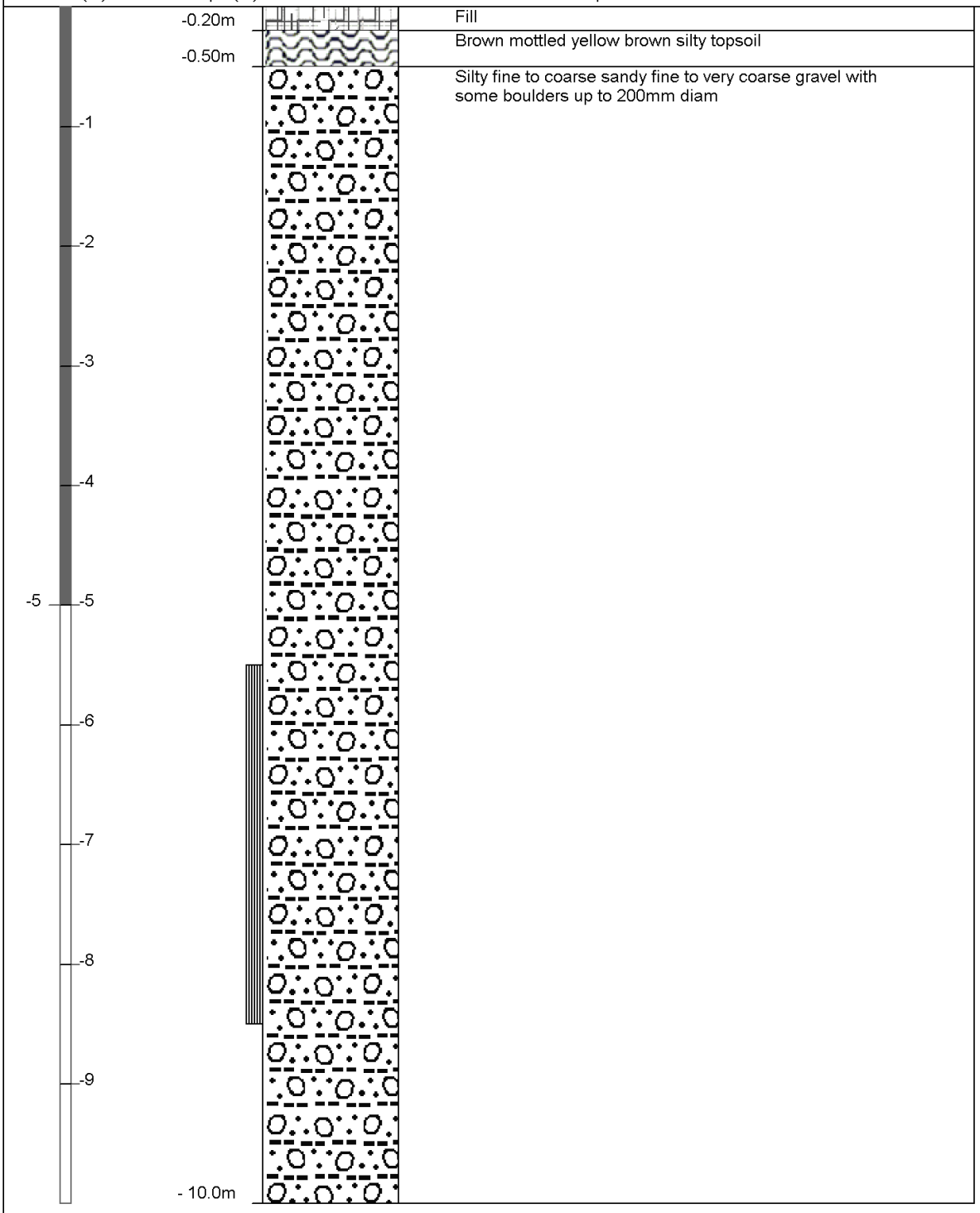
Environment Canterbury Regional Council



Borelog for well M36/8495

Gridref: M36:6652-2868 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 9 +MSD
Driller : Texco Drilling Ltd
Drill Method : Cable Tool
Drill Depth : -10m Drill Date : 30/11/2007

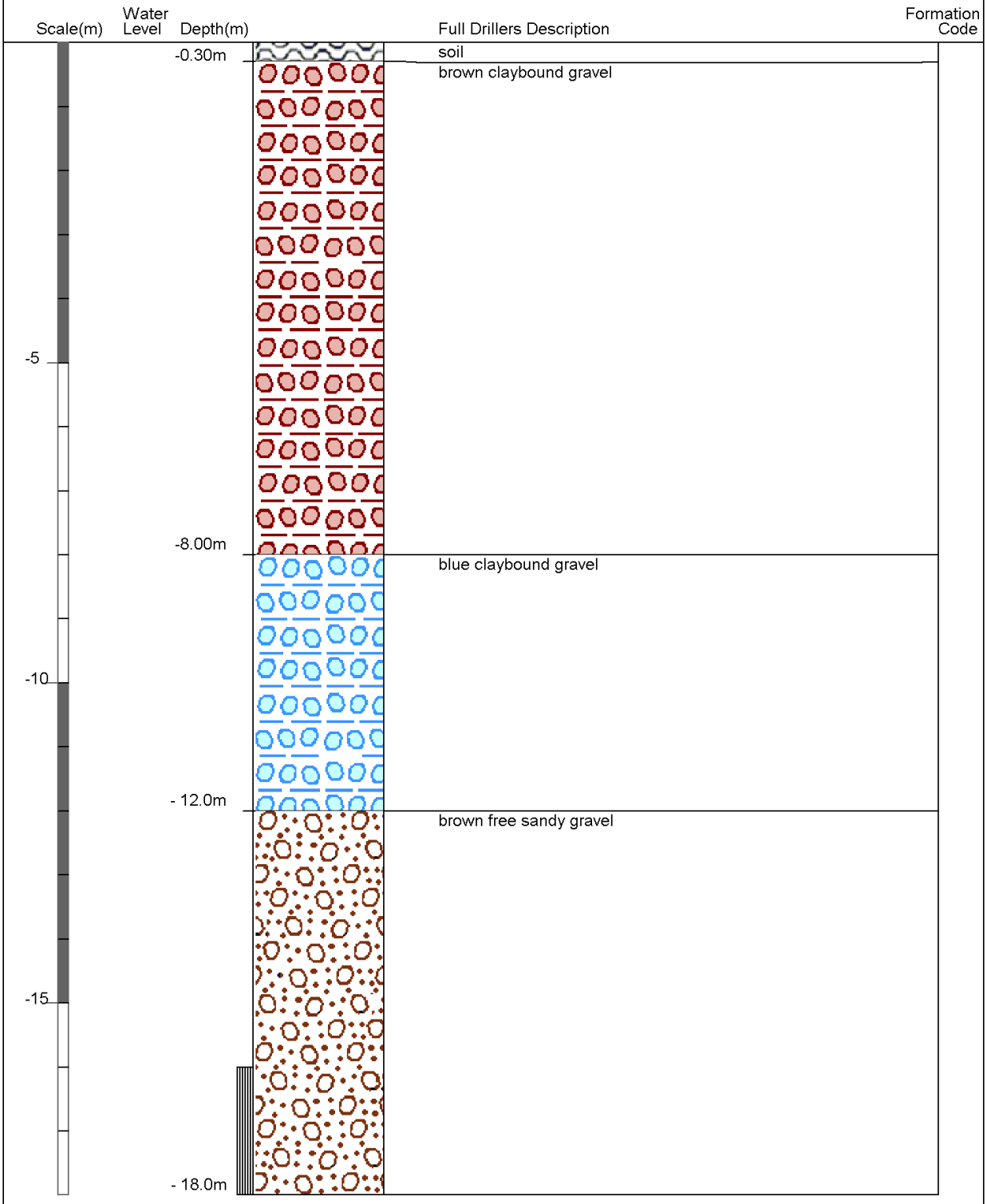
Environment Canterbury Regional Council



Borelog for well M36/8229

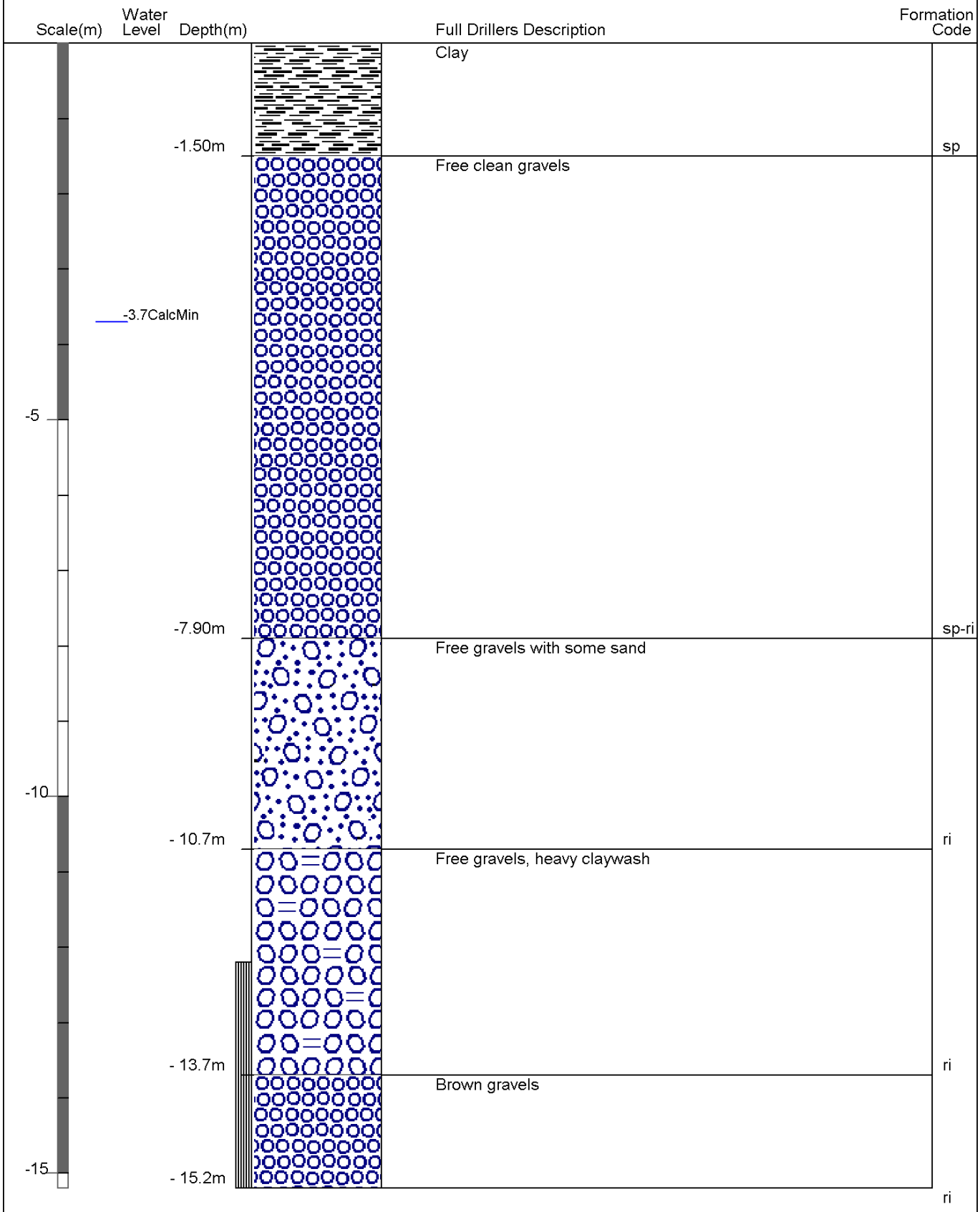
Gridref: M36:67165-28174 Accuracy : 2 (1=high, 5=low)
Ground Level Altitude : 8.04 +MSD
Driller : Daly Water Wells Ltd
Drill Method : Rotary Rig
Drill Depth : -18m Drill Date : 24/04/2006

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha



Borelog for well M36/0574

Gridref: M36:6624-2874 Accuracy : 3 (1=best, 4=worst)
Ground Level Altitude : 10 +MSD
Driller : A M Bisley & Co
Drill Method : Cable Tool
Drill Depth : -15.2m Drill Date : 19/10/1967



Appendix C Test Pit Logs

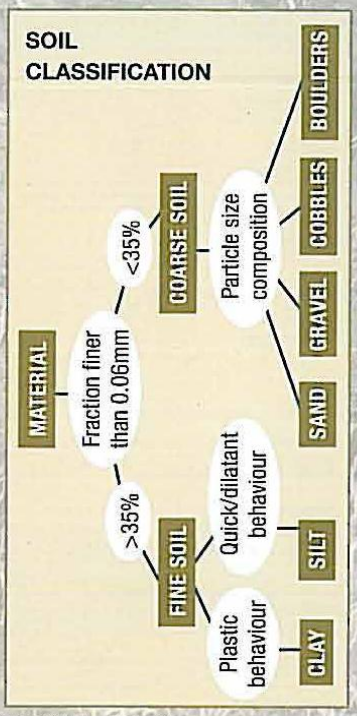
SOIL > field guide sheet

FIELD DESCRIPTION OF SOIL

SEQUENCE OF TERMS – fraction – colour – structure – strength – moisture – bedding – plasticity – sensitivity – additional

GRAIN SIZE CRITERIA

TYPE	COARSE								FINE		ORGANIC
	Boulders	Cobbles	Gravel			Sand			Silt	Clay	Organic Soil
			coarse	medium	fine	coarse	medium	fine			
Size Range (mm)	200		60	20	6	2	0.6	0.2	0.06	0.002	
Graphic Symbol											



PROPORTIONAL TERMS DEFINITION (COARSE SOILS)

Fraction	Term	% of Soil Mass	Example
Major	(....) [UPPER CASE]	≥ 50 [major constituent]	GRAVEL
Subordinate	(....) y [lower case]	20 – 50	Sandy
Minor	with some ... with minor ...	12 – 20 5 – 12	with some sand with minor sand
	with trace of (or slightly)...	< 5	with trace of sand (slightly sandy)

DENSITY INDEX (RELATIVE DENSITY) TERMS

Descriptive Term	Density Index (R_D)	SPT "N" value (blows / 300 mm)	Dynamic Cone (blows / 100 mm)
Very dense	> 85	> 50	> 17
Dense	65 – 85	30 – 50	7 – 17
Medium dense	35 – 65	10 – 30	3 – 7
Loose	15 – 35	4 – 10	1 – 3
Very loose	< 15	< 4	0 – 2

Note: • No correlation is implied between Standard Penetration Test (SPT) and Dynamic Cone Test values.
• SPT "N" values are uncorrected. • Dynamic Cone Penetrometer (Scala)

CONSISTENCY TERMS FOR COHESIVE SOILS

Descriptive Term	Undrained Shear Strength (kPa)	Diagnostic Features
Very soft	< 12	Easily exudes between fingers when squeezed
Soft	12 – 25	Easily indented by fingers
Firm	25 – 50	Indented by strong finger pressure and can be indented by thumb pressure
Stiff	50 – 100	Cannot be indented by thumb pressure
Very stiff	100 – 200	Can be indented by thumb nail
Hard	200 – 500	Difficult to indent by thumb nail

ORGANIC SOILS/ DESCRIPTORS

Term	Description
Topsoil	Surficial organic soil layer that may contain living matter. However topsoil may occur at greater depth, having been buried by geological processes or man-made fill, and should then be termed a buried topsoil.
Organic clay, silt or sand	Contains finely divided organic matter; may have distinctive smell; may stain; may oxidise rapidly. Describe as for inorganic soils.
Peat	Consists predominantly of plant remains. ***Firm***: Fibres already compressed together ***Spongy***: Very compressible and open stucture ***Plastic***: Can be moulded in hand and smears in fingers ***Fibrous***: Plant remains recognisable and retain some strength ***Amorphous***: No recognisable plant remains
Roolets	Fine, partly decomposed roots, normally found in the upper part of a soil profile or in a redeposited soil (e.g. colluvium or fill)
Carbonaceous	Discrete particles of hardened (carbonised) plant material.

MOISTURE CONDITION

Condition	Description	Granular Soils	Cohesive Soils
Dry	Looks and feels dry	Run freely through hands	Hard, powdery or friable
Moist	Feels cool, darkened in colour	Tend to cohere	Weakened by moisture, but no free water on hands when remoulding
Wet			Weakened by moisture, free water forms on hands when handling
Saturated	Feels cool, darkened in colour and free water is present on the sample		

GRADING (GRAVELS & SANDS)

Term	Description	
Well graded	Good representation of all particle sizes from largest to smallest	
Poorly graded	Limited representation of grain sizes - further divided into:	
	Uniformly graded	Most particles about the same size
	Gap graded	Absence of one or more intermediate sizes

PLASTICITY (CLAYS & SILTS)

Term	Description
High plasticity	Can be moulded or deformed over a wide range of moisture contents without cracking or showing any tendency to volume change
Low plasticity	When moulded can be crumbled in the fingers; may show quick or dilatant behaviour

compiled by KATE WILLIAMS design KARRYN MUSCHAMP

NZ GEOTECHNICAL SOCIETY INC

This field sheet has been taken from and should be used and read with reference to the document FIELD DESCRIPTION OF SOIL AND ROCK. Guideline For the Field Classification and Description of Soil and Rock for Engineering Purposes. NZ Geotechnical Society Inc, December 2005. **www.nzgeotechsoc.org.nz**

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TEST PIT RECORD

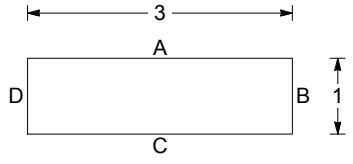
TEST PIT NO. **TP01**

PROJECT NO. **216391**

PROJECT	**Denwood Development Plan Change** **Springs Road, Lincoln**		
METHOD **Trial Pit/trench**	CO-ORDINATES (NZTM) **E 1555843** **N 5166600**	LOGGED **AJW**	CHECKED **MD**
MACHINE & NO. **14t excavator**		DATE **7/09/2012**	DATE **11/09/2012**
CONTRACTOR **Kasia**	GROUND LEVEL **+9.00** m RL		

STRATA			SAMPLES & TESTS		
Depth	Legend	Description	Depth	No	Remarks/Tests
0.00-0.20		SILT; dark brown. Moist; rootlets present (TOPSOIL).			
0.20-1.00		SILT with some clay; yellowish brown with orange brown mottling. Moist; high plasticity.			
1.00-1.80		Fine SAND with some silt and clay; grey with orange brown mottling. Moist; loosely packed.			
1.80-2.00		Sandy fine to medium GRAVEL, brown. Wet; loosely packed; sand, fine; gravel, subrounded to rounded. 1.90 Becomes saturated.			
		End of Trial pit/trench at 2.00m, on 07/09/2012 *Termination Reason:* Encountered groundwater			

SHORING/SUPPORT: **None**
STABILITY: **Test Pit walls collapsed during excavation**



GENERAL REMARKS

All dimensions in metres

CLIENT **Denwood Trustees Ltd.**

Pocket Penetrometer Test **Insitu Vane Shear Test** **Water Level**

Aurecon New Zealand Ltd, 150 Cavendish Road, Christchurch 8140. Tel: +64 3 375 0761 Fax: +64 3 379 6955 christchurch@aurecongroup.com

TEST PIT RECORD

TEST PIT NO. **TP02**

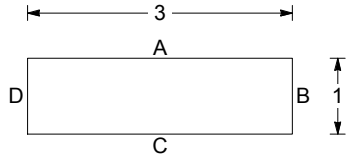
PROJECT NO. **216391**

PROJECT **Denwood Development Plan Change**
Springs Road, Lincoln

METHOD **Trial Pit/trench**	CO-ORDINATES (NZTM) **E 1555963** **N 5166309**	LOGGED **AJW**	CHECKED **MD**
MACHINE & NO. **14t excavator**		DATE **7/09/2012**	DATE **11/09/2012**
CONTRACTOR **Kasia**	GROUND LEVEL **+13.00** m RL		

STRATA			SAMPLES & TESTS		
Depth	Legend	Description	Depth	No	Remarks/Tests
0.00-0.20		SILT; dark brown. Dry; rootlets present (TOPSOIL).			
0.20-1.20		SILT with some clay; yellowish brown with orange brown mottling. Moist; low plasticity.			
1.20-2.40		Sandy fine to coarse GRAVEL, brown. Wet; loosely packed; sand, fine; gravel, subrounded to rounded.			
		2.30 Becomes saturated.			
		End of Trial pit/trench at 2.40m, on 07/09/2012 *Termination Reason:* Encountered groundwater			

SHORING/SUPPORT: **None**
STABILITY: **Test Pit walls collapsed during excavation**



GENERAL REMARKS

All dimensions in metres

CLIENT **Denwood Trustees Ltd.**

Pocket Penetrometer Test **Insitu Vane Shear Test** **Water Level**

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TEST PIT RECORD

TEST PIT NO. **TP03**

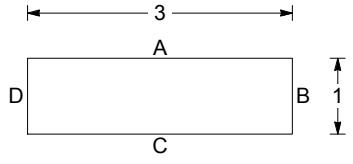
PROJECT NO. **216391**

PROJECT **Denwood Development Plan Change**
Springs Road, Lincoln

METHOD	CO-ORDINATES (NZTM)	LOGGED	CHECKED
Trial Pit/trench	**E 1556014**	**AJW**	**MD**
MACHINE & NO. **14t excavator**	**N 5166106**	DATE	DATE
CONTRACTOR **Kasia**	GROUND LEVEL **+13.00** m RL	**7/09/2012**	**11/09/2012**

STRATA			SAMPLES & TESTS		
Depth	Legend	Description	Depth	No	Remarks/Tests
0.00-0.30		SILT; dark brown. Dry becoming moist; rootlets present (TOPSOIL).			
0.30-1.50		SILT with some clay; yellowish brown with orange brown mottling. Moist; moderate plasticity.			
1.50-1.80		Fine SAND with some silt and clay; grey with orange brown mottling. Moist.			
1.80-2.20		Sandy fine to medium GRAVEL, brown. Wet; loosely packed; sand, fine; gravel, subrounded to rounded. 2.10 Becomes saturated.			
		End of Trial pit/trench at 2.20m, on 07/09/2012 *Termination Reason:* Encountered groundwater			

SHORING/SUPPORT: **None**
STABILITY: **Test Pit walls collapsed during excavation**



GENERAL REMARKS

All dimensions in metres

CLIENT **Denwood Trustees Ltd.**

Pocket Penetrometer Test **Water Level**
Insitu Vane Shear Test

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TEST PIT RECORD

TEST PIT NO. **TP04**

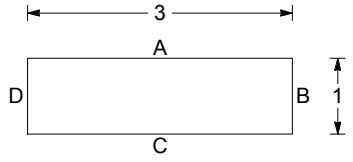
PROJECT NO. **216391**

PROJECT **Denwood Development Plan Change**
Springs Road, Lincoln

METHOD **Trial Pit/trench**	CO-ORDINATES (NZTM) **E 1556211** **N 5166572**	LOGGED **AJW**	CHECKED **MD**
MACHINE & NO. **14t excavator**		DATE **7/09/2012**	DATE **11/09/2012**
CONTRACTOR **Kasia**	GROUND LEVEL **+15.00** m RL		

STRATA			SAMPLES & TESTS		
Depth	Legend	Description	Depth	No	Remarks/Tests
0.00-0.20		SILT; dark brown. Dry becoming moist; rootlets present (TOPSOIL).			
0.20-1.20		SILT with some clay; yellowish brown with orange brown mottling. Moist; moderate plasticity.			
1.20-3.90		Sandy fine to medium GRAVEL with some silt, brown. Wet; loosely packed; sand, fine; gravel, subrounded to rounded. 2.30 With some subangular to subrounded cobbles.			
		End of Trial pit/trench at 3.90m, on 07/09/2012 *Termination Reason:* Target depth reached			

SHORING/SUPPORT: **None**
STABILITY: **Test Pit walls collapsed during excavation**



GENERAL REMARKS

Groundwater not encountered

All dimensions in metres

CLIENT **Denwood Trustees Ltd.**

Pocket Penetrometer Test **Insitu Vane Shear Test** **Water Level**

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TEST PIT RECORD

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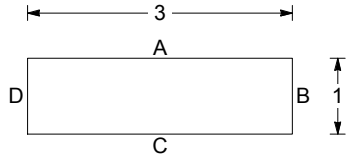
TEST PIT NO.	**TP05**
PROJECT NO.	**216391**

PROJECT	**Denwood Development Plan Change** **Springs Road, Lincoln**		
METHOD **Trial Pit/trench**	CO-ORDINATES (NZTM) **E 1556262** **N 5166283**	LOGGED **AJW**	CHECKED **MD**
MACHINE & NO. **14t excavator**		DATE **7/09/2012**	DATE **11/09/2012**
CONTRACTOR **Kasia**	GROUND LEVEL **+16.00** m RL		

STRATA			SAMPLES & TESTS		
Depth	Legend	Description	Depth	No	Remarks/Tests
0.00-0.30		SILT; dark brown. Dry becoming moist; rootlets present (TOPSOIL).			
0.30-0.60		SILT with some clay; yellowish brown with orange brown mottling. Moist; moderate plasticity.			
0.60-3.40		Sandy fine to coarse GRAVEL with some silt, brown. Wet; loosely packed; sand, fine; gravel, subrounded to rounded.			
		3.20 Becomes saturated.			
		End of Trial pit/trench at 3.40m, on 07/09/2012 *Termination Reason:* Encountered groundwater			

SHORING/SUPPORT: **None**
STABILITY: **Test Pit walls collapsed during excavation**



GENERAL REMARKS

All dimensions in metres

CLIENT **Denwood Trustees Ltd.**

Pocket Penetrometer Test **Insitu Vane Shear Test** **Water Level**

AGS4 TEST PIT RECORD (NO SKETCH) DENWOODSLINCOLNLOGS.GPJ AGS 4.GDT 11/9/2012

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TEST PIT RECORD

TEST PIT NO. **TP06**

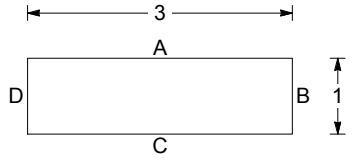
PROJECT NO. **216391**

PROJECT **Denwood Development Plan Change**
Springs Road, Lincoln

METHOD **Trial Pit/trench**	CO-ORDINATES (NZTM) **E 1556487** **N 5166236**	LOGGED **AJW**	CHECKED **MD**
MACHINE & NO. **14t excavator**			
CONTRACTOR **Kasia**	GROUND LEVEL **+13.00** m RL	DATE **7/09/2012**	DATE **11/09/2012**

STRATA			SAMPLES & TESTS		
Depth	Legend	Description	Depth	No	Remarks/Tests
0.00-0.20		SILT; dark brown. Moist; rootlets present (TOPSOIL).			
0.20-1.30		SILT with some clay; yellowish brown with orange brown mottling. Moist; low plasticity.			
1.30-3.20		Sandy fine to coarse GRAVEL with minor silt and clay, orange brown. Wet; loosely packed; sand, fine; gravel, subrounded to rounded. 1.60 Becomes sandy GRAVEL with no clay or silt. 2.20 With some subrounded cobbles.			
		End of Trial pit/trench at 3.20m, on 07/09/2012 *Termination Reason:* Encountered groundwater			

SHORING/SUPPORT: **None**
STABILITY: **Test Pit walls collapsed during excavation**



GENERAL REMARKS

All dimensions in metres

CLIENT **Denwood Trustees Ltd.**

Pocket Penetrometer Test **Insitu Vane Shear Test** **Water Level**

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TEST PIT RECORD

TEST PIT NO. **TP07**

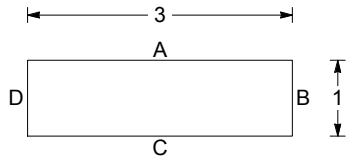
PROJECT NO. **216391**

PROJECT **Denwood Development Plan Change**
Springs Road, Lincoln

METHOD **Trial Pit/trench**	CO-ORDINATES (NZTM) **E 1556374** **N 5166726**	LOGGED **AJW**	CHECKED **MD**
MACHINE & NO. **14t excavator**			
CONTRACTOR **Kasia**	GROUND LEVEL **+16.00** m RL	DATE **7/09/2012**	DATE **11/09/2012**

STRATA			SAMPLES & TESTS		
Depth	Legend	Description	Depth	No	Remarks/Tests
0.00-0.20		SILT; dark brown. Moist; rootlets present (TOPSOIL).			
0.20-1.20		SILT with some clay; yellowish brown with orange brown mottling. Moist; low plasticity.			
1.20-4.00		Sandy fine to coarse GRAVEL, brown. Wet; loosely packed; sand, fine; gravel, subrounded to rounded. 2.50 With some subangular to rounded cobbles.			
		End of Trial pit/trench at 4.00m, on 07/09/2012 *Termination Reason:* Target depth reached			

SHORING/SUPPORT: **None**
STABILITY: **Test Pit walls collapsed during excavation**



GENERAL REMARKS

Groundwater not encountered

All dimensions in metres

CLIENT **Denwood Trustees Ltd.**

Pocket Penetrometer Test **Insitu Vane Shear Test** **Water Level**

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TEST PIT RECORD

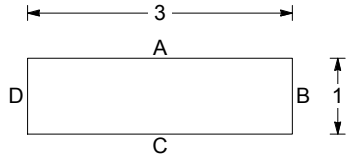
TEST PIT NO. **TP08**

PROJECT NO. **216391**

PROJECT	**Denwood Development Plan Change** **Springs Road, Lincoln**		
METHOD **Trial Pit/trench**	CO-ORDINATES (NZTM) **E 1556536** **N 5166741**	LOGGED **AJW**	CHECKED **MD**
MACHINE & NO. **14t excavator**		DATE **7/09/2012**	DATE **11/09/2012**
CONTRACTOR **Kasia**	GROUND LEVEL **+22.00** m RL		

STRATA			SAMPLES & TESTS		
Depth	Legend	Description	Depth	No	Remarks/Tests
0.00-0.30		SILT; dark brown. Moist, rootlets present (TOPSOIL).			
0.30-0.90		SILT with some clay; yellowish brown with orange brown mottling. Moist; low plasticity.			
0.90-3.80		Sandy fine to coarse GRAVEL, brown. Wet; loosely packed; sand, fine; gravel, subrounded to rounded. 1.30 With some subangular to rounded cobbles.			
		End of Trial pit/trench at 3.80m, on 07/09/2012 *Termination Reason:* Target depth reached			

SHORING/SUPPORT: **None**
STABILITY: **Test Pit walls collapsed during excavation**



GENERAL REMARKS

Groundwater not encountered

All dimensions in metres

CLIENT **Denwood Trustees Ltd.**

Pocket Penetrometer Test **Insitu Vane Shear Test** **Water Level**

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TEST PIT RECORD

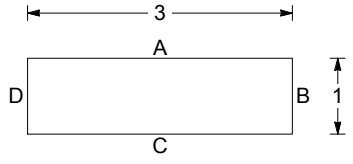
TEST PIT NO. **TP09**

PROJECT NO. **216391**

PROJECT	**Denwood Development Plan Change** **Springs Road, Lincoln**		
METHOD **Trial Pit/trench**	CO-ORDINATES (NZTM) **E 1556714** **N 5166357**	LOGGED **AJW**	CHECKED **MD**
MACHINE & NO. **14t excavator**		DATE **7/09/2012**	DATE **11/09/2012**
CONTRACTOR **Kasia**	GROUND LEVEL **+25.00** m RL		

STRATA			SAMPLES & TESTS		
Depth	Legend	Description	Depth	No	Remarks/Tests
0.00-0.50		SILT; dark brown. Moist; rootlets present (TOPSOIL).			
0.50-1.90		SILT with some clay; yellowish brown with orange brown mottling. Moist; low plasticity.			
1.90-3.80		Sandy fine to coarse GRAVEL with minor silt and clay, orange brown. Wet; loosely packed; sand, fine; gravel, subrounded to rounded. 2.00 With highly plastic grey SILT inclusions. 2.50 Becomes sandy GRAVEL with some subangular to subrounded cobbles.			
		End of Trial pit/trench at 3.80m, on 07/09/2012 *Termination Reason:* Target depth reached			

SHORING/SUPPORT: **None**
STABILITY: **Test Pit walls collapsed during excavation**



GENERAL REMARKS

Groundwater not encountered

All dimensions in metres

CLIENT **Denwood Trustees Ltd.**

Pocket Penetrometer Test **Insitu Vane Shear Test** **Water Level**

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TEST PIT RECORD

TEST PIT NO. **TP10**

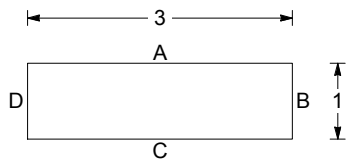
PROJECT NO. **216391**

PROJECT **Denwood Development Plan Change**
Springs Road, Lincoln

METHOD	**Trial Pit/trench**	CO-ORDINATES (NZTM)	LOGGED	CHECKED
MACHINE & NO.	**14t excavator**	**E 1556623** **N 5166769**	**AJW**	**MD**
CONTRACTOR	**Kasia**	GROUND LEVEL **+17.00** m RL	DATE **7/09/2012**	DATE **11/09/2012**

STRATA			SAMPLES & TESTS		
Depth	Legend	Description	Depth	No	Remarks/Tests
0.00-0.30		SILT; dark brown. Moist; rootlets present (TOPSOIL).			
0.30-0.90		SILT with some clay; yellowish brown with orange brown mottling. Moist; low plasticity.			
0.90-3.90		Sandy fine to coarse GRAVEL, brown. Wet; loosely packed; sand, fine; gravel, subrounded to rounded. 1.20 With some subangular to rounded cobbles. 2.00 With some silt; mottled orange brown. 2.30 Becomes sandy GRAVEL with no silt.			
		End of Trial pit/trench at 3.90m, on 07/09/2012 *Termination Reason:* Target depth reached			

SHORING/SUPPORT: **None**
STABILITY: **Test Pit walls collapsed during excavation**



GENERAL REMARKS

Groundwater not encountered

All dimensions in metres

CLIENT **Denwood Trustees Ltd.**

Pocket Penetrometer Test **Insitu Vane Shear Test** **Water Level**

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