



Geotechnical Assessment Report Rosemerryn Farm Stages 3 to 6 Fulton Hogan Land Development Limited Report ref: 224464 23 April 2012 Revision 3



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**Geotechnical Assessment Report** 

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# 1. Introduction

Fulton Hogan Land Development Limited is proposing to subdivide an area of land, approximately 85ha, off Edward Street on the east side of Lincoln. It is intended to eventually develop approximately 891 residential lots on the greater site. This will be done by developing the subdivision in stages. Stage 1 has been developed and Stage 1A has been submitted for consent. It is proposed to carry out the civil engineering works for the next stage of the subdivision being Stages 3 to 6. These are located immediately off Edwards Street and around the recently completed Stage 1 and 1A (aka Stage 2). This report has been prepared for the purpose of Stages 3 to 6 only but draws on our findings from other stages.

Fulton Hogan Land Development Limited has engaged Aurecon New Zealand Ltd to undertake a geotechnical investigation of the entire Rosemerryn site. Aurecon recently submitted revision 2 of a geotechnical investigation report for Stage 1A, dated 8 March 2012.

The purpose of this geotechnical investigation is to identify any geotechnical issues including addressing any potential liquefaction risk and any remediation options that may be required as part of the residential development.

Our scope of works was as follows:

- A preliminary site walkover and reconnaissance.
- A detailed desk study considering geological and geotechnical information available for this site, including previous geotechnical investigation results.
- Undertake geotechnical investigation including CPT and test pitting. The investigation for Stage 3 to 6 was carried out as part of the investigation for the larger subdivision.
- Carry out machine excavated borehole holes and installation of piezometers.
- Undertake a liquefaction analysis based on the geotechnical investigation information.
- Provide recommendations on potential liquefaction remediation options for the site development, if required.
- Prepare a report detailing the investigation and analysis results, as well as provide development recommendations.

This work excludes the detailed design of any civil engineering which will be dealt with at the detailed design stage of the subdivision development.

This report outlines our geotechnical investigation and presents our assessment of potential liquefaction across Stages 3 to 6 and provides recommendations for liquefaction remediation options as part of the future site development.

Our limitations are attached as Section 9 of this report. This report shall be read as a whole.

# 2. Executive Summary

Fulton Hogan Land Development Limited is proposing to subdivide an area of land, approximately 85ha, off Edward Street on the east side of Lincoln. It is intended to eventually develop approximately 891 residential lots on the greater site. Previous stages include Stage 1 which has been developed and Stage 1A is currently at consent. It is proposed to carry out the civil engineering works for the next stage of the subdivision being Stages 3 to 6. These stages are located immediately off Edwards Street and around the recently completed Stages 1 and 1A. This report has been prepared for the purpose of Stages 3 to 6 only.

The purpose of the geotechnical investigation was to identify any geotechnical issues with Stages 3 to 6, including potential liquefaction risk, and any potential remediation options should these be required.

Based on the geotechnical test information, the ground conditions consist of predominantly silty sand with minor silt and sand layers, which is underlain by silt with minor silty sand and sand layers. Gravel is present at depths of 4.0m to 7.5m below ground level (bgl).

Groundwater levels were measured at depths of 2.3m to 4.2m bgl. The gravel layers are known to have confined water. Perched groundwater levels are likely to exist within the more permeable sand/silty sand layers in the upper soil profile.

To assess the potential for seismically induced liquefaction, we determined this by analysing the CPT logs using the following levels of ground shaking:

- 1. Serviceability limit state (SLS) earthquake based on the NZGS Guidelines.
- 2. Ultimate limit state (ULS) earthquake based on the NZGS Guidelines.

The liquefaction analysis identified the following:

- Under a conservative SLS earthquake case total settlements of up to 70mm can be expected and there is unlikely to be any liquefaction induced ground damage.
- Under a ULS earthquake case total settlements of up to 90mm can be expected. There is the
  potential for liquefaction induced ground damage in parts of the site. It is however noted that
  during the ULS design earthquake some building damage is likely at this level of shaking
  regardless of ground conditions and liquefaction potential.
- Lateral spreading damage was not observed at the site and given that the site has experienced ground accelerations equivalent or more to that of a ULS event, we have assessed the potential for lateral spreading to be low to very low.

For the Christchurch Region the Department of Building and Housing (DBH, 2011) has recently released a new classification system for residential 'Green Zone' land on the flat in regard to the liquefaction susceptibility. Based on the liquefaction and lateral spreading results we consider Stages 4 and 5 and the southern two thirds of Stage 3 to be classified as Technical Category (TC2), while Stage 6 and the northern one third of Stage 3 currently conforms to Technical Category (TC1).

For **TC1** areas the DBH has recommended Standard NZS3604:2011 type foundations with tied slabs are suitable.

For **TC2** areas the DBH has recommended types of foundation systems for residential houses in their publication '*Guidance on house repairs and reconstruction following the Canterbury Earthquake*', dated 20 December 2010. As required under the new DBH guidelines for detailed house design, a site

specific geotechnical assessment shall be carried out by suitability qualified chartered engineer with experience in residential house development.

Several foundation options are available for residential houses. These foundation options are house specific and will need to be selected and designed during the building consent stage of the property development. The suitable foundation options fall generally into two categories; shallow foundations, and deep foundations.

It should be noted that this report intends to provide guidance only on residential foundation design and should not be taken as detailed design. The recommendations provided below are for completeness and to present all currently available options. The recommendations provided below are in line with DBH document '*Revised guidelines on repairing and rebuilding houses affected by the Canterbury earthquake sequence*', dated November 2011.

Recommendations are also provided for the infrastructure, although we note that liquefaction induced ground damage under an SLS event is unlikely on Stages 3 to 6. The benefits in building additional seismic resilience into the residential development infrastructure for large earthquake events are discussed in this report. Recommendations are also provided in relation to the proposed subdivision earthworks.

# 3. Site Conditions

Rosemerryn Subdivision is located towards the north of Edward Street, Lincoln (see Figure 1 in Appendix A). The area of interest are Stages 3 to 6, which span perpendicular to Edward Street, from the western end of the subdivision towards the east (see Figure 2 Appendix A). A geotechnical assessment of Stage 1A was addressed in a previously issued geotechnical report dated 8 March 2012.

This report addresses geotechnical conditions on Stages 3 to 6 only but draws on our findings from past investigations on the greater site and surrounding.

### 3.1 Site Description

Stage 3 is located along the eastern edge of Eastfield Drive and comprises 53 lots. It is bound to the north by Stages 7 and 8, to the east by Stage 4 and to the south by Edwards Street.

Stage 4 is located towards the east of Eastfield Drive and comprises 46 lots. It is bound to the north by a reserve, to the east by Stages 14 and 15, to the south by Edward Street and the west by Stage 3.

Stage 5 is located towards the south western extent of the subdivision and comprises approximately 42 lots. It is bound to the north by Stage 6, to the east by Stage 1, to the south by residential properties bordering Edward Street and to the west by residential properties bordering Heathridge place.

Stage 6 is located towards the western extent of the subdivision and comprises approximately 51 lots. It is bound to the north by a reserve, to the east by Stage 3 and a reserve, to the south by Stages 1, 2 and 5 and the west by residential properties bordering Heathridge place.

The proposed subdivision plan is presented in Appendix B.

The topography across Stages 3 to 6 is relatively flat with the ground sloping gently by up to 0.8m vertically towards the road.

Stages 3 to 6 are vacant of any structures.

### 3.2 Site Access

The site access to the various stages is off the existing roads of Eastfield Drive, Temple Avenue and Cassidy Ave. Eastfield Drive is the main subdivision access and comes off Edward Street. Other access tracks on site include the driveway to the existing farm house on the eastern side of the site.

### 3.3 Vegetation

The site is primarily vegetated with pastoral grass. Mature trees are present forming wind breaks towards the north of Stages 3 to 6.

#### 3.4 Drainage

The following drainage features were present within Stages 3 to 6 and are shown on Figure 2 in Appendix A.

• A shallow stream is located north of the proposed area of the development. It appeared to be for the most part 0.5m deep, 2m to 3m wide and with a minor amount of ponded water. There is no properly defined stream bank and it appears to form more of a large swale drain.

- Along the tree line in the north east corner of the site is a small swale drain. It was noted as being approximately 0.3m in depth and approximately 1m wide.
- Along the southern edge of the development, adjacent to Edwards Street is a drainage channel that appears to have been recently modified with banked sides. It is up to 1.2m in depth and approximately 2.2m wide and at the time of our visit, had approximately 0.2m depth of water. Further along towards the east, the drain is boxed, which is up to 1.3m depth and approximately 0.5m wide, with 0.2m depth of water at the time of the inspection.
- Two stormwater retention ponds are located along the southern boundary of the site, adjacent to Edwards Street. The ponds are approximately 1m in depth with an approximate plan area of 40m by 45m each. We understand that ponds will be filled as part of the site development.
- None of the drainage channels or swales exhibited any form of land damage or lateral spreading as a result of the recent seismic events.

### 3.5 Regional Geology

The regional geology of the site is described by Forsyth et al. (2008) as "grey river alluvium beneath plains or low-level terraces (Q1a)".

The Institute of Geological and Nuclear Sciences (GNS) Active Fault System database (GNS, 2010a) indicates that the site is located approximately 12km east of the eastern end of the Greendale Fault. It is noted that the movement of the Greendale Fault generated the Magnitude 7.1 Canterbury Earthquake of 4 September 2010. The site is also located approximately 20km south west of the epicentre of the Magnitude 6.3 Christchurch Earthquake on 22 February 2011 and 22km south west of the Magnitude 6.3 aftershock on 13 June 2011 (GNS, 2011b).

# 4. Geotechnical Site Investigation

### 4.1 General

The objective of the ground investigation was to investigate the subsoil and groundwater conditions across the site. The investigation for Stages 3 to 6 was carried out as part of the investigation for the larger subdivision. Therefore the geotechnical investigation information used for these stages (Stages 3 to 6) are part of a large group of geotechnical information and only the tests that are relevant to these stages are discussed here. Consideration was given to information and data from outside the Stages 3 to 6 boundaries when assessing geotechnical hazards and issues.

The geotechnical investigation for Stages 3 to 6 comprised the following:

- Site walk over by a senior Engineering Geologist from Aurecon.
- 20 Cone Penetrometer Testing (CPT) undertaken by McMillan Drilling Services and supervised by a Geotechnical Engineer from Aurecon.
- 50 Test pits excavations to confirm soil and groundwater conditions.
- 1 Machine excavated boreholes and the installation of a piezometer.
- A review of the 15 Environment Canterbury GIS database borehole logs.

Overall we achieved an intrusive investigation density of at least one test per four lots. This is in line with the recommendations issued by DBH *Revised guidance on repairing and rebuilding houses affected by the Canterbury earthquake sequence*, dated November 2011. Overall our ground investigations indicated a relatively consistent and predictable geology underlying the site that is in line with our past experience in Lincoln.

### 4.2 Cone Penetrometer Testing

As part of the ground investigations carried out for the larger subdivision over 37 CPT probes were sunk, 20 of those were present within the Stage 3 to 6 boundaries or in very close proximity. The CPT tests were undertaken to effective refusal (tip pressure over 30MPa) of the rig and this generally occurred on thick deposits of dense gravels. The depths achieved were typically between 2.5m and 7.5m below ground level. The locations of the CPT tests are shown in Figure 3 in Appendix A and the logs are presented in Appendix C.

Towards the northern side of the site the ground conditions consist of predominantly silty sand with layers of silt and sand to depths of 2.5m to 3.8m. Below these depths the CPTs refused in dense gravels.

Further to the south the ground conditions consist of predominantly silty sand with layers of silt and sand to depths of 2.5m to 3.5m, which are underlain by interlayered silts, silty sands and sand to depths of 5.8m to 7m. The lower soil profile is predominantly silt to the west but further to the east it is predominantly silty sand and sand. Below these depths the CPTs refused in dense gravels.

The exception is CPT32 where interbedded medium dense to dense gravelly sand and sandy gravel was logged from a depth of 4m to 7.5m. Thin organic peat layers were noted in CPT8, CPT11, CPT30 and CPT37 at depths of 4m to 6m.

Based on the cone tip resistance, the silty sand and sand is typically loose although at depth the sand is medium dense. The silt is firm to very stiff and the gravel is medium dense to very dense.

### 4.3 Test Pit

Test pits were carried out across the site to confirm the continuity of the soil profile, allow calibration of the CPT logs as well as provide a measurement of indicative groundwater levels. The test pit excavations were undertaken by a 30 ton digger and generally reached a depth of 2.5m to 4m bgl with

a maximum achievable depth of 5m bgl. Test pits were generally terminated when the target depth was reached or due to groundwater being encountered. Of the investigations carried out for the larger subdivision, approximately 50 are present within Stages 3 to 6 or in close proximity. The locations of the test pits are shown in Figure 4 in Appendix A, and the logs are presented in Appendix D.

Towards the northern side of the site the ground conditions consist of predominantly loose to medium dense silt or silty sand and sand with firm to stiff silt layers to depths of 3m to 3.9m. Below these depths medium dense gravel was encountered.

Further to the south the ground conditions consist of predominantly silty sand with layers of silt and sand to depths of 3m to 4m, which are underlain by predominantly firm to stiff clayey silts, silts or sandy silts to the west and by loose to medium dense silty sand and sand to the east.

The exception to this general soil profile is around Test Pits TP4 and TP6, where a shallow gravel layer up to 1.5m thick was logged at a depth of 1m. In addition thin (20mm to 50mm) peat layers and tree branches were logged at depths of 2m to 3m below ground level in a number of the test pits.

The silty sand and sand was typically logged as fine to medium grained and loose, although at depth the sand was medium dense. The silts were typically logged as low plasticity, although the clayey silts appeared to have higher plasticity, with peak shear vane measurements from 40kPa to 100kPa, and therefore the silts are classified as firm to stiff.

The soil profiles logged in the test pits are consistent with the soil profile identified in the CPT logs.

#### 4.4 Borehole Logs

Four boreholes were undertaken as part of the wider subdivision investigation to determine the composition and strength of the deeper subsoils layers. Two boreholes were taken down to 15m bgl to confirm depth to gravels, continuity of the gravel unit and allow installation of piezometers for long term groundwater monitoring within the gravel. Two boreholes were taken down to shallower depths of 3m and 4.5m to allow installation of piezometers for long term groundwater monitoring within the upper layers, and to identify any potentially perched ground water levels. The locations of the boreholes are shown in Figure 5 in Appendix A and the logs are presented in Appendix E.

The boreholes indicate the ground conditions consist of interbedded silt, silty sand and sand overlying gravel. The upper soil layers consist of interbedded silt, sandy silt, silty sand and sand, with a silt layer overlying the gravel.

Borehole BH2, located to the north of Stages 3 to 6, identified sandy gravel at a depth of 3.2m and Borehole BH4, to the south east of the site, identified sandy gravel at 6.8m depth. The gravel was logged as dense, fine to coarse grained and rounded. SPT 'N' values in the gravel ranged from 35 to 50. The gravel layer was logged as being relatively consistent to 15m depth.

### 4.5 Environment Canterbury Borehole Logs

A review of the Environment Canterbury GIS System (ECan, 2011) has been undertaken to identify borehole logs within the direct vicinity of Stages 3 to 6. The borehole logs ranged from 5.2m to 83m bgl in depth. The borehole locations are shown in Figure 6 and the logs are presented in Appendix F.

The deeper ECan borehole logs located to the north and east of the site indicate that the depth to the top of gravel is in the order of 8m to 9m depth. These depths are slightly deeper than that indicated in the boreholes carried out as part of this investigation. While to the south ECan logs indicate the top of the gravels are in the order of 3.7 to 7.5m depth. This indicates that part of the larger subdivision area is underlain by gravel at shallower depth, which then drops off further to the north and east of the site but appears to be at a similar depth to the south of the site.

Borehole M36/7299, to the east of Stages 3 to 6, indicates the top of gravel at 5m bgl. It also indicates that an 'orange pug' layer, 1m thick, is located at 7m bgl. This layer was not identified in the boreholes carried out as part of this investigation and may be a localised seam in this area. The ECan logs generally confirm our borehole and CPT logs, with the gravel layer being consistent once encountered.

A review of the shallower ECan borehole logs indicate that adjacent to Edwards Street the ground conditions consist of interlayered silt/clay to 6m bgl. Further to the north the borehole logs indicate that the ground conditions consist of interbedded silt/clay overlying gravel at depths of 2.8m to 4.2m bgl. These borehole logs are reasonably consistent with the geotechnical testing carried out as part of this investigation.

In summary the past recorded information and geotechnical data correlate well with the current investigations.

#### 4.6 Liquefaction Induced Ground Damage

Based on our site walk over the following was noted:

- A review of high resolution aerial photographs taken on the 24 February 2011 did not identify any apparent surface manifestation of liquefaction on the site.
- Evidence of liquefaction surface ejector (i.e. sand boils) was not apparent during the site walkover carried out as part of this investigation. Even though the site walkover was carried out a significant period of time after the large seismic events, there was no apparent residual evidence, such as degraded sand boils or distinct mounds covered in recent grass growth that would indicate sand boils had been present. Nor was there any evidence of accumulation of sand and silt brought up by liquefaction within the drainage ditches.
- Other evidence of ground damage such as ground cracking or lateral spreading adjacent to the drainage ditches were not apparent on the site.

#### 4.7 Groundwater

The depth to groundwater was measured in the test pits and the CPT holes carried out across the site. The groundwater levels measured in the test locations are presented in Appendix G. The groundwater levels measured in the CPT holes are considered not to be accurate as the CPT probe may have drawn water up the probe hole.

Groundwater seepages and levels were measured in the test pits. To the west and north side of Stages 3 to 6 groundwater levels were measured at depths of 3.5m to 4.0m bgl. Where the gravels were encountered the groundwater rose from the base of the pit indicating confined water table. Groundwater seepages were also noted at shallower depths of 1.7m to 2.5m bgl, however the test pits were carried out during a period of high intensity rainfall and these seepages may represent stormwater runoff through the pit sides or perched groundwater.

To the south and east side of Stages 3 to 6 groundwater levels were measured at depths of 2.5m to 4.2m bgl. Seepages were noted at shallower depths of 0.6m to 2m. However, as noted above, the test pits were carried out during a period of high intensity rainfall and these seepages may represent stormwater runoff through the pit sides or perched groundwater.

The test pit logs indicate that at depth the soil was typically a dark grey colour, which is most likely a result of water logged soil due to seasonally high groundwater levels. The grey soils were logged at depths ranging from 2.3m to 3m bgl at the western end of the site however further to the east the grey soils were in the order of 1.65m to 2.4m bgl.

#### 4.8 Piezometers

Four piezometers were installed in the larger subdivision area. Two piezometers were installed to a depth of 15m to monitor any groundwater levels associated with the underlying gravels and two were installed at shallower depths of 3m and 4.5m bgl to monitor any perched groundwater levels within the upper soil layers.

Results of the monitoring are presented below. We have included the measurements for Boreholes BH1 and BH2 only as these are within the direct vicinity of the site.

Borehole Recorded Depth to Ground Water							
	At time of Drilling	21 September 2011	20 October 2011				
BH1	1.10m	1.40m	0.34m				
BH2	1.8m	1.39m	1.54m				

Table 1 - Recorded groundwater levels

The groundwater levels measured in the piezometers appear to vary. The change in the levels from the time of drilling to the September reading is likely to represent equalisation of the groundwater in the piezometer. The groundwater levels carried out on 20 October 2011 are relatively high. Test pits carried out on 19 to 20 October 2011 did not encounter groundwater levels at these depths. Therefore we consider that the October readings are likely to have been affected by the stormwater runoff rather than reflect an insitu groundwater level, particularly for borehole BH1.

Based on the test logs and piezometer monitoring we consider that a sub-artesian (confined) groundwater level is present within the gravel layer at depth, as groundwater 'bubbled' out of the base of the test pit when the gravels were encountered. The higher groundwater levels measured in Borehole BH2, located to the north of the site, are possibly representative of the head of the pressurised groundwater present in the gravels. The silt layer encountered overlying the gravel may act as a confining layer.

In the upper soil profile there is likely to be a perched groundwater level within the more permeable sand/silty sand layers, as groundwater seeps were noted within these layers and the layers were typically wet. It is possible that the perched groundwater levels are fed by the sub artesian groundwater pressures present in the underlying gravels. However, some of the groundwater seeps encountered are considered to represent stormwater runoff through saturated ground, as a result of the high intensity rainfall at the time of the test pit excavations.

# 5. Ground Model

Based on the geotechnical investigation the following schematic ground model has been defined for the site.



The testing indicates that the northern part of the site is underlain by medium dense gravels at consistently shallow depths of 3m to 4m. Further to the south the top of the gravel drops off steeply along a line through the middle of the site, refer to Figure 7 in Appendix A. To the south of this line the top of the gravel is relatively consistent at depths of 6m to 7m. Based on our past project work in the Lincoln area and our understanding of the local geology, we infer that the top of the gravel forms a series of terraces beneath the upper soil layers.

The gravel is overlain by predominantly loose to medium dense silty sands in the northern part of the site, while to the south the silty sands overlie a lower soil profile of interbedded firm to stiff clayey silts and silts with loose to medium dense silty sands and sand, which in turn overlie medium dense to dense gravel. The lower soil strata exhibit higher fines contents to the west, while to the east the lower soil strata typically comprise sandy deposits that exhibit lower fines content.

The CPT profiles for these geological areas are present in Figures 8, 9 and 10. Figure 8 is for the northern area, Figure 9 for the western area and Figure 10 for eastern area. With the exception of CPT32, the CPT profiles in each area are reasonably consistent with each other. CPT32 is likely to represent the soil profile along the transition between shallow and deeper gravel areas.

# 6. Engineering Considerations

### 6.1 General

Fulton Hogan Land Development Limited is proposing to subdivide an area of land, approximately 85ha off Edward Street, on the east side of Lincoln. It is intended to eventually develop approximately 891 residential lots on the site. Although it is intended to develop the larger subdivision, it is proposed to carry out the civil engineering works for Stages 3 to 6 of the subdivision, located immediately adjacent to the recently completed Stage 1 and recently consented Stage 1A. Due to the required civil engineering work, this report has been prepared for the purpose of Stages 3 to 6 only.

The proposed civil engineering works have not been finalised, however based on the ground conditions encountered during the geotechnical investigations we consider that the following geotechnical aspects need to be considered as part of the subdivision:

- Potential for seismically induced liquefaction
- Recommendations for liquefaction mitigation measures, if required
- Compliance with the intent and definition of NZS3604 for foundation design (Technical Category compliance)
- Implications for building foundations
- Recommendations for infrastructure construction
- Assessment against Resource Management Act (RMA) Section 106 a) to c)

Each of these is discussed in the following sections.

### 6.2 Seismically Induced Liquefaction

Under cyclic loading during an earthquake cohesionless material (gravels, sands, silty-sands) tends to decrease in volume. This tendency to decrease in volume is much greater in loose than dense soils. When cohesionless soils are saturated and rapid loading occurs under undrained conditions, the tendency is that soil densification causes excess 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 eventually liquefaction when the effective stress drops to zero. Liquefaction of loose sands can lead to large displacements of foundations, ground surface settlement, sand boils, and post-earthquake stability failures.

As part of our geotechnical assessment for the site we have a carried out a liquefaction analysis to determine the liquefaction potential for the site. Although we note that based on our observations and all available information the site did not suffer any seismically induced land damage from the recent series on earthquakes.

### 6.3 Liquefaction Assessment

For the site development the main factors to be considered for liquefaction are:

- What layers can liquefy?
- What is the likelihood of liquefaction in the future?
- What options are available to limit or prevent liquefaction?

Each of these is considered below.

#### 6.3.1 Liquefaction Potential Assessment

The three primary factors that contribute to liquefaction potential are:

- Loose, uniformly graded soils.
- High groundwater table.
- Sufficiently high, earthquake induced ground acceleration and sustained shaking.

Each of these is considered below together with conclusions on the site 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%). However, the test logs indicate Stages 2 to 5 is underlain by interlayered loose sand and silty-sand with silt, within the upper soil profile. Based on the nature of the upper soils, the site can be considered to be potentially liquefiable layers from a grading and density perspective. We note that the entire site is underlain by medium dense to very dense gravel layers that we do not consider to be liquefiable. Hence the liquefaction potential is limited in the vertical extent.

#### Groundwater

The depth to groundwater has been measured directly from test pits and the piezometers. Groundwater can also be indirectly measured from the test pits where the grey soil layers most likely represent a water logged soil due to seasonally high groundwater levels. Based on the test results, groundwater levels range from 1.5m to 4m below ground level at the south and east side of Stages 2 to 5 and from 2.1m to 4m at the north and west side of Stages 3 to 6. Soils are therefore potentially liquefiable from depths of 1.5m to 4m onward below ground level.

Groundwater levels used in our analysis are based on measurements carried out in Spring and are likely to be relatively high, hence are considered to be conservative. Groundwater levels will vary depending on the time of year, but we infer that we have encountered the likely highest levels.

#### Earthquake Intensity and Soil Resistance to Liquefaction

The level of ground shaking is one of the key factors in determining whether liquefaction will or will not occur. For this study, we have used two levels of ground shaking, Serviceability Limit State (SLS) and Ultimate Limit State (ULS) design earthquakes, derived using the NZGS (2010) method based on NZS1170:2004. It is generally accepted as a suitable method for liquefaction analysis as it ties into the building structural design criteria.

A back analysis of the 4 September 2010 Darfield earthquake was carried out. The nearest seismogram located to the site is on Lincoln Crop and Food Research site 3km to the northwest of the site and it is considered representative as the ground conditions are known to be similar. Peak ground acceleration (PGA) for the Darfield Earthquake was measured at 0.43g. Based on our current understand of the soil profile and groundwater levels, the site should have experienced liquefaction induced ground damage for a 0.43g and Magnitude 7.1 earthquake. However this is not the case, as we have been advised that no land damage occurred or visible sign were noted on the site following the Darfield Earthquake.

The discrepancy between the analysed results and what was observed is most likely a result of PGA and differences in groundwater levels, as well as the analytical method used for determining the liquefaction susceptibility of the site. A review of the PGA's experienced throughout the region indicates a reasonable variation between the seismograms, even for those with 3km of each other. The PGA for Rolleston on 4 September 2010, near the eastern end of the Greendale Fault, was 0.34g,

while at Templeton the PGA was measured as 0.28g. The variability of the acceleration would depend on a number of factors, such as underlying ground conditions and the shape that the seismic waves propagated from the epicentre and the location of the site in relation to the hypocentre and terminal lobes of the earthquake (spatial and temporal variation). Given the proximity of the seismograms we have considered them in our review and analysis.

Groundwater levels were measured at variable depths across the site and based on the groundwater levels encountered in the test pit logs these exhibited a tendency to fluctuate. This is evident in the Environment Canterbury monitoring well on the south side of Lincoln. The groundwater levels measured in well M36/0512 can vary depending on the time of year. This corresponds well with our observations in other parts of Lincoln.

We note that the current state of the art liquefaction analysis is based on semi-empirical analysis methods, whose accuracy varies depending on many factors and is generally 'calibrated' to provide conservative outcomes. Therefore for some sites the liquefaction analysis may be conservative for reasons not yet captured in current analysis methodologies. This was noted on several sites in the Canterbury area and is currently being reviewed.

Based on the potential variability of spatial and temporal variation from the earthquake centre and uncertainties and conservatisms associated with current analytical tools, it is considered that a back analysis of the Darfield Earthquake may not be accurate or representative. Therefore we have based the liquefaction analysis on Ultimate Limit State (ULS) and Serviceability Limit State (SLS) earthquake events derived using the NZGS method that in turn is based on NZS1170. This approach is generally accepted as a suitable method for liquefaction analysis as it ties into the building structural design criteria.

We are aware that new seismic design guidelines for the Canterbury area are being developed by the Department of Building and House (DBH) and GNS, with the timing of their publication unknown at this stage. According to the '*Requirements for Geotechnical Assessment of Liquefaction for Land Development – Canterbury Region*', these are likely to supersede the above guidelines for liquefaction analysis. Some indication has been given by the DBH that the SLS case PGA is in the order of 0.15g to 0.2g. However, in the absence of any updated guidelines and timeframes on when these will be published, it is considered appropriate to use the currently available guidelines.

Therefore based on the current guidelines available at the time of our analysis, we have used the following scenarios to assess the potential for liquefaction in a future seismic event:

#### Serviceability Limit State (SLS) Earthquake

For the site we have assessed the SLS earthquake return period based on the current NZS1170.0:2004 Loading Codes with the increased Z hazard factor of 0.3 (see Appendix G).

NZS1170.0:2004 Table 3.3 indicates that SLS level ground shaking be based on a 1 in 33 year event. However, we consider this value to be too low to be applicable when assessing liquefaction because of its discreet nature of liquefaction (i.e. the site either liquefies or does not and when a site has liquefied there is very little difference in expected deformations for a 'small' earthquake that causes liquefaction relative to a 'large' earthquake that causes liquefaction), and the disproportionate effect seismically induced liquefaction has on a building. We have therefore adopted a more severe (although not unrealistic) earthquake event that has a probabilistic return period of 150 years.

We have adopted the method outlined by the NZ Geotechnical Society for using the New Zealand Loadings Standard to obtain the design earthquake for the liquefaction assessment. A 1 in 150 year return period earthquake in Lincoln area for a Class D site has a Peak Ground Acceleration (PGA) of 0.2g. In accordance with NZGS we have adopted a Magnitude 7.5 earthquake event. We consider this event to be well above the requirements from NZS1170 for SLS criteria, but believe it is realistic.

#### Ultimate Limit State (ULS) Earthquake

For the site we have assessed the ULS earthquake return period based on the current NZS1170.0:2004 Loading Codes with the increased Z hazard factor of 0.3 (see Appendix G).

A 500 year return period earthquake has been adopted, which is based on the recommendations of NZS1170.0:2004 Tables 3.2 (Importance Level 2 building), and Table 3.3 (50 year design working life). We have adopted the method outlined by the NZ Geotechnical Society for using the New Zealand Loadings Standard to obtain the design earthquake for the liquefaction assessment. A 1 in 500 year return period earthquake in Lincoln area for a Class D soil (Deep Soil Site) has a PGA of 0.34g, and in accordance with NZGS we have adopted a Magnitude 7.5 earthquake event. We note that this level of shaking is lower than the level of shaking experienced in the M7.1 September 2010 Darfield Earthquake, as per the nearest seismogram station.

A summary of the shaking intensities are presented in Table 2.

Table 2 – Summary of ground shaking cases analysed							
Earthquake	PGA	Magnitude					
Serviceability Limit State – Based on NZS1170	0.20g	7.5					
Ultimate Limit State – Based on NZS1170	0.34g	7.5					

### Table 2 – Summary of ground shaking cases analysed

#### 6.4 Liquefaction Analysis Results

#### 6.4.1 Settlements

The ability of the subsoils to resist the effect of ground shaking associated with the earthquake cases has been assessed from the subsoil information obtained from the CPT logs. The National Centre for Earthquake Engineering Research (NCEER) method as outlined by Youd et. al. (2001) has been used to assess liquefaction potential. Based on recent experience in the Canterbury Region this method appears to give consistent results with liquefaction damage observed elsewhere in region but may possibly be conservative, although it is not considered unrealistic. We note that many other approaches are available but believe that this widely accepted method is representative for this site.

The ability of the subsoils to resist the effect of ground shaking associated with the two design earthquakes has been assessed using the CPT sounding results using Version 5 of the CivilTech Corporation *LiquefyPro* computer programme. The method of Robertson and Wride (1998) for the CPT soundings (the NCEER's recommended method), modified for fines content, was used to calculate the potential for liquefaction and the method of Tokimatsu and Seed (1987) for settlement.

The total settlements due to liquefaction as calculated are presented in Table 3.

Table J – Calcul	aleu nyueiaciion	muuceu (ioiai) a	Settlements
Test	Stage	SLS EQ	ULS EQ
CPT5	3	20mm	40mm
CPT8	3	20mm	40mm
CPT10	3	15mm	30mm
CPT38	3	10mm	25mm
CPT40	3	25mm	40mm
CPT11	4	45mm	75mm
CPT12	4	5mm	15mm
CPT14	4	70mm	90mm
CPT15	4	15mm	35mm
CPT34	4	0mm	0mm
CPT35	4	10mm	25mm
CPT36	4	30mm	45mm
CPT2	5	25mm	50mm
CPT4	5	20mm	45mm
CPT30	5	20mm	35mm
CPT37	5	10mm	35mm
CPT39	5	0mm	10mm
CPT1	5	0mm	10mm
CPT3	6	5mm	20mm
CPT6	6	5mm	10mm
CPT9	6	15mm	35mm
CPT32	6	5mm	25mm
CPT33	6	0mm	0mm
Average		15mm	30mm
Maximum		70mm	90mm
Minimum		0mm	0mm
Median		10mm	30mm

Table 3 – Calcula	ated inquefaction	i induced (to	otal) settlements
Test	Stage	SLS FO	ULS FQ

Note: The settlements presented in Table 3 above are to the nearest 5mm and have a likely error of ± 50%

#### 6.4.2 **Ground Damage**

Published information (after Ishihara, 1985) can be used to assess the potential for surface expression of liquefaction and the likelihood of ground induced damage. Our assessment of liquefaction induced ground damage, such as sand boils and ground cracking, is present in Table 4.

Test	SLS EQ	ULS EQ
CPT1	N	Ν
CPT2	N	Ν
CPT3	N	Ν
CPT4	N	Ν
CPT5	N	Y
CPT6	N	Ν
CPT8	N	Ν
CPT9	N	Y
CPT10	N	Y
CPT11	N	Y
CPT12	N	Ν
CPT14	N	Y
CPT15	N	Y
CPT30	N	Ν
CPT32	N	Ν
CPT33	N	Ν
CPT34	N	Ν
CPT35	N	Y
CPT36	N	Y
CPT37	N	Ν
CPT38	N	Ν
CPT39	N	Ν
CPT40	N	N

#### Table 4 – Liquefaction induced ground damage for design earthquakes

### 6.4.3 Lateral Spreading

Liquefaction induced lateral spreading or flow failures can occur when the shear stresses required to maintain static equilibrium are greater than the shear strength of the liquefied soil. Structures built on ground that experiences lateral spreading can be expected to sustain significant damage relative to the damage that would be expected from ground shaking alone.

No lateral spreading occurred at the site during the Darfield Earthquake that generated higher ground accelerations than a representative ULS design earthquake.

The watercourse and swales on the site are relatively shallow are unlikely to pose a lateral spreading risk to the development. An assessment was undertaken for the drainage channel along the southern boundary adjacent to Edward Street. We consider that there was no evidence of lateral spreading occurring adjacent to the stream from seismic activity in the last year. The drain is in the order of 1.2m to 1.3m in depth and groundwater measurements in the test pits adjacent to the drain were typically greater than 1.4m.

Therefore based on this evidence we have assessed the potential for lateral spreading to be low to very low. However there may be potential slope instability issue with the drain banks during a significant seismic event, which is discussed further in Section 6.1.

### 6.5 Discussion

The liquefaction analysis identified the following:

- Following an SLS earthquake liquefaction induced settlements of between 0mm and up to 70mm can be expected and there is unlikely to be any liquefaction induced ground damage.
- Following a ULS earthquake liquefaction induced settlements of up to 90mm can be expected. There is the potential for liquefaction induced ground damage in parts of the site. It is however noted that during the ULS design earthquake some building damage is likely at this level of shaking regardless of ground conditions and liquefaction potential. We also note that ground damage in the form of sand boils and cracking should have manifested following past events but has not been observed which may indicate analytical conservatisms being present.
- Lateral spreading damage was not observed at the site and given that the site has
  experienced ground accelerations equivalent to a ULS event we have assessed the potential
  for lateral spreading to be low to very low.

### 6.6 Land Classification Technical Categories

For the Christchurch Region the Department of Building and Housing (DBH, 2011) has recently 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.

The DBH has indicated the following liquefaction deformation limits for house foundations as summarised in Table 5 below:

Technical	Liqu	efaction Def	ormation L	Likely Implication for House			
Catagory	Ver	tical	Latera	Spread	Foundations (subject to		
Calegory	SLS ULS		SLS	ULS	individual assessment)		
TC1	15mm	25mm	NU	NU	Standard NZS3604 type		
	ISHIII	2511111	INII	INII	foundations with tied slabs		
TC2	50mm	100mm	50mm	100mm	DBH enhanced foundation		
102	3011111	TOOTIIT	301111	10011111	solutions		
TOO	50	100	50	100	Site specific foundation solution		
103	>50mm	>100mm	>50mm	>100mm			

#### Table 5 – Liquefaction deformation limits and house foundation implications

Based on results of the liquefaction and lateral spreading results presented in Section 6.4, we consider Stages 4 and 5 and the southern two thirds of Stage 3 can be classified as Technical Category (TC2), while Stage 6 and the northern one third of Stage 3 currently conforms to Technical

Category (TC1). The technical classification has been based partially on a conservative SLS earthquake PGA.

### 6.7 Foundation Options

The liquefaction assessment indicates that Stages 3 to 6 is classified as **TC1 and TC2**.

For **TC1** areas the DBH has recommended Standard NZS3604:2011 type foundations with tied slabs are suitable.

For **TC2** areas the DBH has recommended types of foundation systems for residential houses in their publication '*Guidance on house repairs and reconstruction following the Canterbury Earthquake'*, dated 20 December 2010. Schematics and typical cross sections of these foundation systems are presented in the DBH publication. As required under the new DBH guidelines for detailed house design, a site specific geotechnical assessment shall be carried out by suitability qualified chartered engineer with experience in residential house development. A chartered professional geotechnical engineer is not required for Technical Category 2 type residential lots.

Several foundation options are available for residential houses. These foundation options are house specific and will need to be selected and designed during the building consent stage of the property development. The suitable foundation options fall generally into two categories; shallow foundations, and deep foundations. Each of these is discussed below.

It should be noted that this report intends to provide guidance only on residential foundation design and should not be taken as detailed design. The recommendations provided below are for completeness and to present all currently available options. The recommendations provided below are in line with the DBH document '*Revised guidelines on repairing and rebuilding houses affected by the Canterbury earthquake sequence*', dated November 2011.

#### **Shallow Foundations**

A shallow foundation such as a raft is intended to hold the superstructure together and minimise any structural damage if there is any ground movement during or following a future major seismic event. Although a raft foundation is unlikely to prevent settlement of the dwelling it will minimise differential settlement to some extent. If detailed correctly it will also allow the house to be re-levelled if required. Raft foundations are generally suitable for dwellings with concrete floor slabs only. Raft foundation can take several forms, including:

- A gravel raft (either with or without geogrid reinforcement) with a reinforced concrete slab with localised thickening formed on top of the gravel raft.
- A thick, double reinforced concrete raft cast onto the in situ ground.
- An enhanced foundation slab with reinforced ground beam grid cast onto the in situ ground.
- A generic waffle slab (i.e. rib raft) cast onto the insitu ground.

Based on the previous scala penetrometer testing carried out across the site and the recent CPT information ultimate (rupture) bearing capacities of greater than 200kPa should be achievable and hence the raft type foundations above should be suitable.

#### **Deep Foundations**

Deep foundations such as piles will transfer structural loads from the structure to deeper and stronger non-liquefiable soil layers. Thereby minimising any structural damage associated with ground liquefaction and settlement during and after a major seismic event. Piled foundations will minimise both total and differential settlement. Piled foundations for a residential house typically comprise of driven piles and can be either concrete (typically used if a concrete floor system is to be used), or timber (typically used if a timber floor and sub-floor system is to be used). A pile foundation system does not require any special soil preparation, but will require site specific investigation and design. We note that all pile foundations are to be designed to carry the full structural loads and stresses with no reliance on the ground below the slab due to the potential of post-earthquake settlement.

### 6.7.1 Discussion and Recommendations

For the proposed properties located within the **TC2** categorised area, the DBH has recommended the above types of foundation systems for residential houses built in areas potentially susceptible to seismically induced liquefaction in their publication '*Revised guidelines on repairing and rebuilding houses affected by the Canterbury earthquake sequence'*, dated November 2011. Schematics and typical cross sections of these foundation systems are presented in the DBH publication.

The raft foundation options are likely to be cheaper than the piled foundation options. A piled foundation for a residential housing would minimise expected settlement and damage during a large seismic event, however the DBH guidelines indicate that although piles are an option for TC2 sites, this foundation option will require deep geotechnical investigation and design.

If the pile foundation option is adopted, then the floor slab should be sufficiently reinforced to provide continuity across the building floor and foundation elements. The objective will be to provide additional capacity in the floor slab and enhance its ability to redistribute loads, if necessary, during large seismic events. All pile heads need to be adequately tied into the floor slab.

As part of the detailed house foundation design, particular attention should be paid to detailing the connection joints of buried services (water and sewer pipes, power conduits, etc.) between the house foundation and the in situ ground. The design should allow sufficient movement and ductility to account for seismic shaking and liquefaction induced movement, and to allow for their easy reinstatement if they were to be damaged during a future seismic event.

As required under the new DBH guidelines for detailed house design, a site specific geotechnical assessment shall be carried out by a suitability qualified chartered engineer with experience in residential house development. Thereby, allowing site specific geotechnical information to be used in the foundation design.

It should be noted that the above discussion on the foundation options is generic only. The actual foundation option chosen and associated costs will depend upon the specific design of the proposed dwelling and the results of a site specific geotechnical and structural assessments.

#### 6.8 Infrastructure

Our analysis indicates the site is unlikely to be affected by liquefaction induced ground damage in a SLS event but could potentially be affected in a ULS event.

Buried services at the site are still potentially vulnerable to seismically induced liquefaction if inserted into potentially liquefiable soils. If site regrading is to be undertaken only, without further liquefaction mitigation measures being employed, then it is recommended that appropriate liquefaction mitigation measures are incorporated into the design of the council vested infrastructure to further minimise the risk of liquefaction induced damage during a major seismic event.

At this stage it is recommended to design the mitigation measures against the effects of a 1 in 150 year SLS earthquake. For seismic events with a return period greater than 1 in 150 years the system may become progressively less serviceable. This section outlines the possible liquefaction mitigation measures for the infrastructure for stages 3 to 6. Although liquefaction induced ground damage under an SLS event is unlikely there would be benefits in building additional seismic resilience into the residential development infrastructure to withstand large earthquake events.

### 6.8.1 Buried Structures

All buried services such as manhole risers, pump station chambers, and so forth founded below the groundwater level, should be designed to have neutral buoyancy and accommodate uplift forces associated with liquefied soil, not just hydrostatic groundwater buoyancy forces. This is in order to minimise lifting / floatation of these buried services. Spaces around buried structures should be backfilled with free draining granular non-liquefying fill in order to alleviate pore water pressure build up during a large seismic event thereby reducing the potential for liquefaction in the soils immediately surrounding the buried structure.

As it is unlikely that buried services are able to be founded directly into the underlying dense nonliquefiable sandy gravel material due to the depth, the manhole inverts and pipe entry and exit levels should be designed to accommodate differential settlement post liquefaction event. Based upon differential settlements calculated as part of the geotechnical assessment, the differential settlements are expected to be in the order of 25mm. Essentially the hydraulic design of the pipes coming into and out of the manhole risers should be designed to accommodate both positive (i.e. pipe gradient getting steeper) and negative (i.e. pipe gradient getting shallower) differential settlements of 25mm. The civil engineer will need to assess if this level of settlement will affect the hydraulic design of the pipe and detail the required engineering measures.

Manhole risers should have strap rings to hold the manhole riser sections together in order to reduce lateral displacement of the manhole risers. Additionally, manhole connectors with greater than 90mm sealing lengths should be used to minimise the potential for joint pull-out.

It is recommended that the finalised design of each buried service (manhole riser, pump station, etc.) is confirmed on a case by case basis during construction, as each development stage will require site specific design. This specific design is needed to define the mass concrete for dead weight, tie down anchors, etc. for each buried structure, if required.

#### 6.8.2 Pipes and Service Conduits

Pipes and service conduits should be made from flexible material (i.e. plastic) where practicable. For gravity reticulated sewer lines all pipe joints and intersections with manhole risers should be installed with short slip collars to allow greater capacity of joint movement and increase joint resilience. For pressurised sewer lines, all PE pipes should have end restraints at pump stations. Combined with the PE pipe material well designed end restraints will improve the resilience of the pressure line and help prevent damage.

Hydraulic pipes (sewer, and stormwater and possibly reticulated water), the pipe sizes and gradients should be designed in such a way that it can accommodate post liquefaction differential settlement, both positive (i.e. pipe gradient getting steeper) and negative (i.e. pipe gradient getting shallower). For design, differential settlements of 25mm between manhole risers should be used.

All pipes and conduits should be founded into the non-liquefiable crust material where possible. If the founding depth of the pipes and conduits is in the liquefiable silty sandy material the service trenches should be backfilled with non-liquefiable geotechnically competent fill.

All service trenches located below the water table should be lined with a geosynthetic filter fabric material (i.e. Bidim A19 or similar) to separate potentially liquefiable soils from non-liquefiable granular bedding and backfill material. For shallow service trenches founded above the water table then filter fabric is not required but generally recommended.

By providing a filter fabric and filling the service trenches with non-liquefiable geotechnically competent fill, the trench becomes non-liquefiable and will therefore limit liquefaction induced settlement. Additionally if a pipe was to rupture, by having a filter fabric encasing the bedding material there is less likelihood of sand material infiltrating into and blocking the pipeline.

### 6.8.3 Pavement

At this stage based on our liquefaction assessment it is inferred that the pavement is unlikely to be significantly affected by seismically induced liquefaction. However, to ensure robustness of the pavement following a liquefaction inducing major earthquake it is recommended that the pavement be designed to accommodate adverse effect of seismically induced liquefaction. The pavement should be designed in such a way that it can bridge any localised voids / settlements that may be caused by seismically induced liquefaction, and prevent liquefiable soil from penetrating into the pavement structure.

If subsoil drains are to be installed as part of the subdivision development for stormwater control, then it is recommended extending the subsoil drainage to below the footprint of the roading network. This will extend the thick non-liquefied crust below the pavement areas as well as the residential sections, thereby minimising the likelihood of liquefaction induced damage.

A geosynthetic filter fabric (i.e. Bidim A19 or similar) should be placed directly onto the in situ subgrade material prior to the placement of the granular sub-base fill. This filter fabric will act as a barrier to any fines migration from the sub-grade to the sub-base during a liquefaction inducing seismic event. Therefore, the pavements sub-base will not lose strength post the seismic event through fines infiltration and associated loss of effective thickness.

### 6.9 Slope Instability

There may be a potential slope instability issue with the open drain banks, located adjacent to Edward Street, during an extreme earthquake. We note that the drainage ditch is relatively shallow and based on observations of other drainage ditches within the Canterbury Region, where bank failure has occurred adjacent to these ditches it has typically not extended further than 2m from the edge of the ditch. We recommend to limit any slope stability issues affecting house foundations, the houses should be setback form the crest of the drain by a minimum of 5m.

# 7. Assessment Against RMA

Section 106 of the Resource Management Act (RMA) states inter alia

... "a consent authority may refuse to grant a subdivision consent, or may grant a subdivision consent subject to conditions, if it considers that:

- a) the land in respect of which a consent is sought, or any structure on the land, is or is likely to be subject to material damage by erosion, falling debris, subsidence, slippage, or inundation from any source; or
- any subsequent use that is likely to be made of the land is likely to accelerate, worsen, or result in material damage to the land, other land, or structure by erosion, falling debris, subsidence, slippage, or inundation from any source; or
- c) sufficient provision has not been made for legal and physical access to each allotment to be created by the subdivision."

No erosion was observed on the site. However the silty soils that directly underlie parts of the site are inferred to be potentially susceptible to erosion when the site is left without vegetation cover. We infer that the site is not susceptible to falling debris or slippage due to the topographical location. It is noted that issues surround stormwater discharge are being dealt with in the detailed civil engineering design by Davie Lovell-Smith. Therefore any potential "inundation" susceptibility due to stormwater has already been addressed.

Due to the potential for seismically induced liquefaction, we infer that the site is susceptible to subsidence and to a very minor extent to inundation. However, if the appropriate liquefaction mitigation measures, as outlined in this report, are undertaken then the risk of subsidence and inundation is significantly addressed. Therefore, with appropriate liquefaction mitigation measures where required, the site in our opinion will generally be free of "erosion", "falling debris", "subsidence", "slippage", or "inundation". The proposed subdivision development therefore generally complies with the intent of Section 106 (a).

Due to the site being partially underlain by fine grained soils, there exists the potential for erosion and rilling of the sandy and 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 sandy and silty soils can be minimised with appropriate industry standard design measures undertaken during construction. Revegetation should be carried out as soon as practicable post bulk earthworks.

The site has been identified as being partially susceptible to seismically induced liquefaction and hence has the potential for "subsidence", "and "inundation." Provided that appropriate liquefaction mitigation measures are implemented, as recommended in this report, subsequent use of the land following development is unlikely to accelerate, worsen, or result in material damage to the land, other land, or structures. In our opinion therefore, the development will comply with the intent of Section 106 (b).

Section 106 (c) is not directly relevant to a geotechnical appraisal and therefore has not been considered in detail in this report, although it is noted that the site is accessible from Edwards Street.

Thus in our opinion, under Section 106 of the RMA, there are no geotechnical reasons preventing the development, provided the appropriate engineering measures as recommended in this report are carried out.

## 8. References

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# 9. 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 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.

This report is not to be reproduced either wholly or in part without our prior written permission.

# Appendix A Figures





Note: Not to scale; boundaries	ote: Not to scale; boundaries and locations are approximate only					Source: QuickMap (2011)				
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Aurecon New Zealand Limited Unit 1, 150 Cavendish Road	Telephone:	+64 3 366 0821 +64 3 379 6955	Project	Rosemerryn Farm, Lincoln		Sile L	ocation		Revision	
PO Box 1061 Christchurch - New Zealand	Email: Website:	christchurch@ap.aurecongroup.com www.aurecongroup.com	Ву	RBS	Date	May 2012	Job Number	224464	3	

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Client Paper Size Figure 2 Fulton Hogan Land Development Limited con A4 Site Plan Project Aurecon New Zealand Limited Rosemerryn Farm, Lincoln Revision Unit 1, 150 Cavendish Road Telephone: +64 3 366 0821 +64 3 379 6955 Casebrook Facsimile: 3 By Date Job Number PO Box 1061 Email: christchurch@ap.aurecongroup.com May 2012 RBS 224464 Christchurch - New Zealand Website: www.aurecongroup.com

Source: LINZ (2011)



Client Paper Size Figure 3 Fulton Hogan Land Development Limited A4 **CPT** Location Plan Project Aurecon New Zealand Limited Rosemerryn Farm, Lincoln Revision Unit 1, 150 Cavendish Road Telephone: +64 3 366 0821 +64 3 379 6955 Casebrook Facsimile: 3 By Date Job Number PO Box 1061 Email: christchurch@ap.aurecongroup.com May 2012 RBS 224464 Christchurch - New Zealand Website: www.aurecongroup.com

Source: LINZ (2011)

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Client Paper Size Figure 5 Fulton Hogan Land Development Limited on A4 **Borehole Location Plan** Project Aurecon New Zealand Limited Rosemerryn Farm, Lincoln Revision Unit 1, 150 Cavendish Road Telephone: +64 3 366 0821 +64 3 379 6955 Facsimile: Casebrook 3 By Date Job Number PO Box 1061 Email: christchurch@ap.aurecongroup.com May 2012 224464 RBS Christchurch - New Zealand Website: www.aurecongroup.com

Source: LINZ (2011)



			Project			ECan Boreho	le Location F	lan	
Aurecon New Zealand Limited Unit 1, 150 Cavendish Road	Telephone:	+64 3 366 0821		Rosemerryn Farm, Lincoln					Revision
PO Box 1061 Christchurch - New Zealand	Email: Website:	christchurch@ap.aurecongroup.com www.aurecongroup.com	Ву	RBS	Date	May 2012	Job Number	224464	3



Source: LINZ (2011)

aurecon	Client Fulton Hogan Land Development Limited	Fig Geolog	ure 7 ical Areas	Paper Size A4
Aurecon New Zealand Limited Unit 1, 150 Cavendish Road Telephone: +64 3 366 0821 Combrook +64 3 379 6055	Rosemerryn Farm, Lincoln	_		Revision
PO Box 1061 Email: christchurch@ap.aurecongroup.com Christchurch - New Zealand Website: www.aurecongroup.com	<sup>By</sup> RBS	Date May 2012	Job Number 224464	3


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

Source: LINZ (2011)

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aurecon				Client Fulton Hogan Land Development Limited		Figure 8			Paper Size A4	
Aurecon New Zealand Limited Unit 1, 150 Cavendish Road Telephone: +64 3 366 0821		Project Rosemerryn Farm, Lincoln		i ecnnical Category Areas Aerial			Revision			
PO Box 1061 Ei Christchurch - New Zealand W	mail: ch /ebsite: wv	christchurch@ap.aurecongroup.com www.aurecongroup.com	m By RBS Dat	Date	May 2012	Job Number	224464	3		



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

aurecon	Client Fulton Hogan Land Development Limited	Fig	Paper Size A4	
Aurecon New Zealand Limited Unit 1, 150 Cavendish Road Cavendrack Factoria (1997) Cavendrack Factoria (1997)	Project Rosemerryn Farm, Lincoln	Approximate Boundary Between TCT & TC2 Areas		Revision
PO Box 1061 Email: christchurch@ap.aurecongroup.com Christchurch - New Zealand Website: www.aurecongroup.com	<sup>By</sup> RBS	Date May 2012	Job Number 224464	3



aurecon			Client Fulton Hogan Land Development Limited		Figure 10		
Aurecon New Zealand Limited Unit 1, 150 Cavendish Road Telephone: +64 3 366 0821		+64 3 366 0821 +64 3 379 6955	Project Rosemerryn Farm, Lincoln		CPT Profile in Northern Area of Site		
PO Box 1061 Christchurch - New Zealand	Email: Website:	christchurch@ap.aurecongroup.com	<sup>By</sup> RBS	Date	May 2012	Job Number 224464	3

# **CPT Profile in Western Area of Site**



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

aurecon			Client Fulton Hogan Land Development Limited			Figure 11			
Aurecon New Zealand Limited Unit 1, 150 Cavendish Road Telephone: +64 3 366 0821		+64 3 366 0821	Project Rosemerryn Farm, Lincoln		CP1 Profile in Western Area of Site			Revision	
PO Box 1061 Christchurch - New Zealand	Email: Website:	christchurch@ap.aurecongroup.com www.aurecongroup.com	<sup>By</sup> RBS		Date	May 2012	Job Number 224464	3	



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

aurecon			Client Fulton Hogan Land Development Limited			Figure 12		
Aurecon New Zealand Limited Unit 1, 150 Cavendish Road	Aurecon New Zealand Limited Unit 1, 150 Cavendish Road Telephone: +64 3 366 0821		Project Rosemerryn Far	ryn Farm, Lincoln		astern Area of Site	Revision	
PO Box 1061 Christchurch - New Zealand	Email: Website:	christchurch@ap.aurecongroup.com www.aurecongroup.com	<sup>By</sup> RBS		Date	May 2012	Job Number 224464	3

# Appendix B Subdivision Plan





# Appendix C Cone Penetrometer Logs



#### **CPT ANALYSIS NOTES**

#### Soil Type

Interpretation using chart of Robertson & Campanella (1983). This is a simple but well proven interpretation using cone tip resistance ( $q_c$ ) and friction ratio ( $f_R$ ) only. No normalisation for overburden stress is applied. Cone tip resistance measured with the piezocone is corrected with measured pore pressure ( $u_c$ ).



#### **Liquefaction Screening**

The purpose of the screening is to highlight susceptible soils, that is sand and siltsand in a relatively loose condition. This is not a full liquefaction risk assessment which requires knowledge of the particular earthquake risk at a site and additional analysis. The screening is based on the chart of Shibata and Teparaksa (1988).



High susceptibility is here defined as requiring a shear stress ratio of 0.2 to cause liquefaction with  $D_{50}$  for sands assumed to be 0.25 mm and for silty sands to be 0.05 mm.

Medium susceptibility is here defined as requiring a shear stress ratio of 0.4 to cause liquefaction with  $D_{50}$  for sands assumed to be 0.25 mm and for silty sands to be 0.05 mm.

Low susceptibility is all other cases.

#### **Relative Density (D<sub>R</sub>)**

Based on the method of Baldi et. al. (1986) from data on normally consolidated sand.

#### Undrained Shear Strength (Su)

Derived from the bearing capacity equation using  $S_U = (q_c - \sigma_{VO})/15$ .









DRILLING SERVICES





DRILLING SERVICES































**MCMILLAN** DRILLING SERVICES







DRILLING SERVICES





















# Appendix D Test Pit Logs



# aurecon

1.0

1.5

2.0

2.5

3.0

3.5

4.0

4.5

5.0

Remarks:

Aurecon (New Zealand) Unit 1, 150 Cavendish R PO BOX 1061 Christchurch 8140 New Zealand www.aurecongu.com Telephone: +64 3 366 0821 Facsimile: +64 3 379 6955

#### Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN Project Reference: 224464

SAND; Grey brown with brown mottles. Loose. Moist. Sand fine to medium

SAND; Grey brown with brown mottles. Loose to medium dense. Wet. Sand

SILT with minor sand and trace clay; Grey brown with brown mottling. Firm. Moist. Low plasticity. Sand fine to medium grained.

SILT with minor clay and sand; Dark grey. Wet. Low to high plasticity. Sand

Sheet 1 of 1

LFS LFS JSM

JK

Elevation (m)

**TP01** 

	Email: ch	ristchurch@ap.a	aurecongroup	.com					
TE Exe Te: Co	ST PIT cavator st Pit D ntracto	Type: 30 imensions r: Fulton	ATION Dt Excav :: Hogan	ator	C E N G	O-ORDINATE asting: orthing: iround Level:	<b>S NZTM</b> 1558997 m 5168035 m N/A	Date Started: 9/6/2011 Date Completed: 9/6/2011	Logged by: LF Input by: LF Checked by: JS Verified by: JK
	Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests		Soil Description	
0.				$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	Shear vane at 0.5m: 67/31kPa /kPa	Pocket Penetrometer at 0.5m kN/m <sup>2</sup>	TOPSOIL SILT with tra plasticity. Sand fine gra Sandy SILT; Grey brow fine to medium grained	ace sand and rootlets; Dark brov ained. vn with brown mottles. Low plas d.	<i>r</i> n. Firm. Moist. Low ticity. Moist. Firm. Sand

Shear vane at 2.5m: 89/38kPa /kPa /kPa Pocket Penetro at 2.5m: kN/m<sup>2</sup> Shear vane at 3m: 53/16kPa /kPa /kPa Pocket Penetro at 3m: kN/m<sup>2</sup> × × × × x × × × × × Shear var 3.5m: 43/33kPa /kPa /kPa ar vane at Pocket Penetro at 3.5m kN/m<sup>2</sup> × × × × ×

/kPa /kPa

Shear van 1m: 61/18kPa /kPa /kPa

Shear vane at 1.5m: 207/0kPa /kPa /kPa

Shear vane at 2m: 44/31kPa /kPa /kPa

Pocke Penetr

at 1m: kN/m<sup>2</sup>

Pocket Penetro at 1.5m: kN/m<sup>2</sup>

Pocket Penetro at 2m: kN/m<sup>2</sup>

grained.

fine to medium grained.

fine to medium grained.

End of Test Pit at 4m (GW Reached)

×

÷× ×

.× × × × ×

×

×

× × × × × ×

▼

Groundwater seepage @ 2.3 Groundwater table encountered at 4.0m

× × × . × × ×

×

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Input by:	LFS
Checked by:	JSM
Verified by:	JK

Sheet 1 of 1

Database File: TEST PITS.GPJ, Library: COPY OF CHCH LIBRARY FEB 2017;GLB, Data template: CHCH DATA TEMPLATE NOV 2010;GDT, Last Generated: 3/30/2012.

# aurecon

Aurecon (New Zealar Unit 1, 150 Cavendisl PO BOX 1061 Christchurch 8140 New Zealand Telephone: +64 3 366 0821 Facsimile: +64 3 379 6955 www.aurecongroup.com Email: christchurch@ap.au ongroup.c

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Last

#### Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN Project Reference: 224464

1559137 m 5168085 m

Sheet 1 of 1

**TP02** 

TEST PIT INFORMATION CO-ORDINATES NZTM Excavator Type: 30t Excavator Test Pit Dimensions: Easting: Northing: Contractor: Fulton Hogan Ground Level: N/A

Date Started: 9/6/2011 Date Completed: 9/6/2011

Logged by: Input by: Checked by: LFS LFS JSM Verified by: JK

Water Level (m) Pocket Penetrometer Tests Elevation (m) Graphic Log Shear Vane Tests Depth (m) Sample Soil Description <u>\./. \//</u> TOPSOIL SILT with trace sand and rootlets; Dark brown. Firm. Moist. Low plasticity. Sand fine grained. N1. N1. SILT with minor sand; Brown. Firm. Moist. Low plasticity. Sand fine grained. × × × 0.5 X Sandy SILT; Brown. Firm. Moist. Low plasticity. Sand fine grained. × × 0.5m: 59/33kPa /kPa /kPa Penetro at 0.5m kN/m<sup>2</sup> × × ·× × × × 1.0 Shear vane at Pocke Penetr ٠× 1m: 47/24kPa /kPa /kPa .× at 1m: kN/m<sup>2</sup> × Database File: TEST PITS. GPJ, Library: COPY OF CHCH LIBRARY FEB 2015. GHB. Data tempiate: CHCH DA1A. TEMPLATE NOY 2010; CDPT, Last Generated: 3/307.2012 1.5 Shear vane at 1.5m: 53/24kPa /kPa /kPa Pocket Penetro at 1.5m: kN/m<sup>2</sup> × × `× 2.0 Shear vane at Pocket Sandy SILT; Grey with orange brown mottling. Stiff. Moist. Low plasticity. Sand × Penetr at 2m: kN/m<sup>2</sup> × 2m: 99/27kPa /kPa /kPa fine grained. × ·× × .× × × 2.5 × Shear vane at 2.5m: 38/24kPa /kPa /kPa Pocket × ٠× Penetr at 2.5r kN/m<sup>2</sup> .x SAND with some silt; Grey with orange brown mottling. Loose to medium dense. Moist. Fine grained. 3.0 SAND with some silt and organic inclusions; Dark grey. Loose to medium dense. Moist. Fine grained. 312 1.1 3.5 11/ 3.90 000 4.00 GRAVEL with some sand; Grey and dark orange brown. Dense. Wet to T 4.0 saturated. Gravel fine grained. Rounded to sub-rounded. Sand fine grained. End of Test Pit at 4m (GW Reached) 4.5 5.0 Logged by: LFS Remarks: LFS Input by: Checked by: JSM Tree branches @ 3.3m Tree roots @ 3.5m Verified by: JK Groundwater table encountered at 4.0m Sheet 1 of 1

Aureon (New Zealand) Limited Unit 1, 150 Cavendish Rd PO BOX 1061 Christedwurch R140

Last Generated: 3/30/2012 4:23:00 PM

# Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN

Christchur New Zeala www.aureo	rch 8140 and congroup.com	Telephon Facsimile	e: +64 3 366 0821 e: +64 3 379 6955	Project	t Reference	ce: <b>224464</b>		Sheet	1 of 1
TEST PIT Excavator Test Pit Di Contractor	INFORMA Type: 30 imensions r: Fulton I	A <b>TION</b> It Excave Hogan	ator		CO-ORDINATES Easting: Northing: Ground Level: N	<b>S NZTM</b> 1559200 m 5167950 m √/A	Date Started: 9/6/2011 Date Completed: 9/6/2011	Logged by: LFS Input by: LFS Checked by: JSM Verified by: JK	1
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests		Soil Description		Elevation (m)
- - - 0.5 -			<u> </u>	Shear vane at 0.5m: 160/43kPa	Pocket Penetrometer at 0.5m:	TOPSOIL SILT plasticity. Sand <sup>0.30</sup> Sandy SILT; B	T with trace sand and rootlets; Dark brov d fine grained. brown. Firm to Stiff. Moist. Low plasticity.	vn. Firm. Moist. Low Sand fine grained.	-
1.0 —			× × × × × × × × × × × × × × × × × × ×	/kPa /kPa Shear vane at 1m: 44/24kPa /kPa /kPa	Pocket Penetrometer at 1m: kN/m <sup>2</sup>	<sup>1.20</sup> SAND with mir	nor silt; Grey brown with orange brown n	nottling. Loose to	-
1.5 -			× × × × × × × × × × × × × × × × × × ×	Shear vane at 1.5m: 44/21kPa /kPa /kPa	Pocket Penetrometer at 1.5m: kN/m <sup>2</sup>	1.40 medium dense SILT with som grained.	e. Moist. Sand fine grained. e sand; Brown. Firm to Stiff. Moist. Low	plasticity. Sand fine	-
2.0 —				Shear vane at 2m: 36/21kPa /kPa /kPa	Pocket Penetrometer at 2m: kN/m <sup>2</sup>				
2.5 -			× × × ×	Shear vane at 2.5m: 47/33kPa /kPa /kPa	Pocket Penetrometer at 2.5m: kN/m <sup>2</sup>	SAND with mir medium dense	nor silt; Grey brown with orange brown n e. Moist to wet. Sand fine grained.	nottling. Loose to	-
3.0 —			× × × × × × × × ×	Shear vane at 3m: 50/36kPa /kPa /kPa	Pocket Penetrometer at 3m: kN/m <sup>2</sup>	SILT with some and grained. SILT with some plasticity. Sand	e sand; Dark grey. Firm to Stiff. Moist. L e sand and some clay; Dark grey. Firm t d fine grained.	ow plasticity. Sand fine o Stiff. Moist. Low	-
3.5 -			$ \begin{array}{c} & & & \\ & \times & & \times \\ & \times & & \times \\ \hline & & \times & & \times \\ & & & \times & & \times \\ & & & & \times & & \times \\ & & & &$	Shear vane at 3.5m: 44/18kPa /kPa /kPa	Pocket Penetrometer at 3.5m: kN/m <sup>2</sup>	400			
4.0						End of Test Pit	t at 4m (Pit Collapse)		
+.3 - - - - -									
5.0 — - -									
Remarks No grour	s: ndwater e	ncounte	ered					Logged by: LFS Input by: LFS Checked by: JSM Verified by: JK	

Database File: TEST PITS.GPU, Library: COPY OF CHCH LIBRARY FEB 2014.GEB, Data template: CHCH DATA TEMPLATE NOV 2010.GDT, Last Generated: 330/2012.

**TP03**
## aurecon

Aurecon (New Zealand) Lin Unit 1, 150 Cavendish Rd PO BOX 1061 Christchurch 8140 New Zealand www.aurecongroup.com

### Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN Telephone: +64 3 366 0821 Facsimile: +64 3 379 6955 Project Reference: **224464**

Sheet 1 of 1

Email: ch TEST PIT Excavator Test Pit D Contracto	r Type: 3 Dimensions Dr: Fulton	aurecongroup ATION Ot Excav S: Hogan	ator Easting: 1559340 m Date Started: 9/6/2011 Logged by Input by: Checked Ground Level: N/A								
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description		Elevation (m)			
			$\frac{\sqrt{I_2}}{V_2} = \frac{\sqrt{I_2}}{\sqrt{I_2}} = \frac{\sqrt{I_2}}{\sqrt{I_2}}$			TOPSOIL SILT with trace sand and rootlets; Dark brown. Firm. Mo plasticity. Sand fine grained.	oist. Low				
0.5 -	-		$\begin{array}{c c} \underline{i_{\ell}} & \underline{\sqrt{i_{\ell}}} & \underline{\sqrt{i_{\ell}}} \\ \hline \times & \times \\ \times & \times \\ \times & \times \\ \times & \times \\ \times & \times \end{array}$			SILT; Light grey with orange brown mottling. Firm. Moist. Low plas	sticity.				
1.0 —	-					<sup>1.00</sup> GRAVEL with minor cobbles; Grey. Dense. Moist. Gravel medium	grained.	_			
1.5 - -	-										
2.0 — -											
2.5 – -	-					SILT with minor peat inclusions; Light blue grey. Firm. Wet. Fine g plasticity.	Irained. Low	V			
3.0 —	-					3.20 SAND; Grey brown. Loose to medium dense. Saturated. Sand me grained.	dium				
3.5 – -	-										
4.0 —	-	Ţ				End of Test Pit at 4m (GW Reached)					
4.5 — -	-										
5.0 — -											
Remarks Groundy Tree Bra	s: water see anch @ 3	page @	2.5m			Logged b Input by: Checked Verified b	by: LFS LFS by: JSM by: JK				
Groundwater tabel reached at 4.0m Sheet 1 of 1								et 1 of 1			

## aurecon

Aurecon (New Zealand) Limited Unit 1, 150 Cavendish Rd PO BOX 1061 Christchurch 8140 New Zealand Tre www.aurecongroup.com Fa Email: christchurch@ap.aurecom

### Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN Telephone: +64 3 366 0821 Fassimile: +64 3 379 6605 recongroup.com

Sheet 1 of 1

Logged by: MHD Input by: MHD Checked by: JSM Verified by: JK

TEST PIT INFORMATION Excavator Type: 25t Excavator Test Pit Dimensions: Contractor: Texco	CO-ORDINATES NZTM Easting: 1559379 m Northing: 5167849 m Ground Level: N/A	Date Started: 10/20/2011 Date Completed: 10/20/2011

	Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
	0.5	-		1         1         1         1         1           1         1         1         1         1         1           1         1         1         1         1         1           X         X         X         X         X         X           X         X         X         X         X         X           X         X         X         X         X         X           X         X         X         X         X         X           X         X         X         X         X         X           X         X         X         X         X         X           X         X         X         X         X         X           X         X         X         X         X         X           X         X         X         X         X         X	Shear vane at 0.3m: 62/44kPa /kPa /kPa	Pocket Penetrometer at 0.3m: kN/m <sup>2</sup>	TOPSOIL SILT with some rootlets; Dark Brown. Soft. Saturated. Low plasticity. <sup>0.30</sup> Sandy SILT; Light yellow brown with some orange brown mottling. Firm. Moist. Low plasticity. Sand fine to medium grained.	-
	1.0	-		× × × × × × × × × × × × × × × × × × ×			1.30 SAND with minor citt. Light brown grow with orange brown mottling. Medium	p -
	1.5 - - -	-					dense. Wet. Sand fine to medium grained.	
	2.0 —	-					<sup>220</sup> SAND with a trace of gravel; Orange brown with grey mottling. Medium dense. Wet. Sand fine to medium grained. Gravel fine grained.	
	2.5 -	-					<sup>250</sup> SAND; Light grey. Medium dense to dense. Moist to wet. Sand fine to medium grained.	
	3.0 —				Shear vane at 3m: 59/30kPa /kPa /kPa	Pocket Penetrometer at 3m: kN/m <sup>2</sup>	<sup>300</sup> Clayey SILT with some tree matter; Light blue grey. Firm to stiff. Wet. High plasticity.	
	3.5 -	-		* * * * * * * * * <u>* *</u>			380 End of Test Pit at 3.8m (Pit Collapse)	R Lata template:
	4.0 —	-						ARV FFR 2011 G
	4.5 -	-						V OF CHCH LIBR
:23:01 PM	5.0							GPL Lihraw, COP
Last Generated: 3/30/2012 4.	Remark Ground	ı s: water seep	page @	2.2m	I	1	Logged by: MHD Input by: MHD Checked by: JSM Verified by: JK Sheet 4	L of 1

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Aureon (New Zealand) Limited Unit 1, 150 Cavendish Rd PO BOX 1051 Christchurch 8140 New Zealand www.aurecongroup.com Facsimi

### Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN Telephone: +64 3 366 0821 Facsimile: +64 3 379 6955 Project Reference: 224464

Sheet 1 of 1

**TP06** 

Email: ch	ristchurch@ap.a	urecongroup	.com						
TEST PIT Excavator Test Pit D Contractor	EST PIT INFORMATION Excavator Type: 30t Excavator est Pit Dimensions: Contractor: Fulton Hogan				CO-ORDINATE Easting: Northing: Ground Level:	ES NZTM 1559432 m 5167960 m N/A	Date Started: 9/6/2011 Date Completed: 9/6/2011	Logged by: Input by: Checked by: Verified by:	LFS LFS : JSM JK
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests		Soil Description		Elevation (m)
0.5			$\begin{array}{cccccccccccccccccccccccccccccccccccc$			TOPSOIL SILT with plasticity. Sand fine	trace sand and rootlets; Dark brow grained. n orange brown mottling. Firm. Mois	n. Firm. Moist. Low	
1.0 —						GRAVEL with some medium grained	sand; Grey. Dense. Wet. Gravel co	barse grained. Sand	t
1.5 -						2.00 SAND with minor sil	t; Light blue grey. Medium dense. S	Saturated. Sand fine	
2.5 -						grained.			
3.0 —		Ţ				<sup>3,20</sup> End of Test Pit at 3.	2m (GW Reached)		
3.5 -									
4.0									
5.0									
-								Logged by: I F!	
Remarks Groundw	:: vater reac	⊧hed @	3.2m					Input by: LFS Checked by: JSI Verified by: JK	S M

### Sheet 1 of 1

Aureon (New Zealand) Limited Unit 1, 150 Cavendish Rd PO BDX 1061 Christedwardh 8140

Last Generated: 3/30/2012 4:23:02 PM

# Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN

Christchur New Zeala www.aure Email: chi	ch 8140 and congroup.com ristchurch@ap.a	Telephon Facsimile	e: +64 3 366 0821 a: +64 3 379 6955 .com	Projec	t Reference	ce: <b>224464</b>		S	Sheet 1 of 1	
TEST PIT Excavator Test Pit D Contractor	INFORMA Type: 30 imensions r: Fulton	ATION It Excave Hogan	ator		CO-ORDINATE Easting: Northing: Ground Level: 1	<b>S NZTM</b> 1559471 m 5168052 m N/A	Date Started: 9/6/2011 Date Completed: 9/6/2011	Logged by: Input by: Checked by Verified by:	LFS LFS JSM JK	
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests		Soil Description		Elevation (m)	
0.5 -			<u> </u>			TOPSOIL SILT with t plasticity. Sand fine <u>c</u> SAND; Brown. Loose	race sand and rootlets; Dark brow grained. e. Moist. Sand fine grained.	n. Firm. Moist. Low		
1.0 —			× × × × × × ×	Shear vane at 1m: 59/30kPa /kPa /kPa	Pocket Penetrometer at 1m; kN/m <sup>2</sup>	<sup>1.00</sup> SILT; Grey with orang	ge brown mottling. Very stiff. Moist	. Non plastic.		D
1.5 – - 2.0 –				Shear vane at 1.5m: 41/30kPa /kPa /kPa	Pocket Penetrometer at 1.5m: kN/m <sup>2</sup>	220 SAND with minor silt	Light blue grey. Medium dense. S	Saturated Sand fine		
2.5 -						grained.	, Eight blue grey. Medium dense. e		, 	
3.0 —			× × × × × × × × × × × × × × × × × × ×			SILT with minor peat	inclusions. Light blue grey. Wet. I	Low plasticity.		
3.5 -		Ţ	× × ×			End of Test Pit at 3.5	m (GW Reached)			
4.0 —										
4.5 -										
5.0 —										
Remarks	s: vater reac	hed @	 3.5m	<u> </u>		]		Logged by: LF Input by: LF Checked by: JS Verified by: JK	S S M	
								SI	neet 1 of 1	

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Aureon (New Zealand) Limited Unit 1, 50 Cavendian Rd PO BOX 1061 Christchurch 8140 New Zealand www.aurecongroup.com

## Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN Project Reference: 224464

Christchur New Zeala www.aure Email: chi	ch 8140 and congroup.com ristchurch@ap.a	Telephon Facsimile urecongroup.	e: +64 3 366 0821 a: +64 3 379 6955 .com	Proje	ct Reference	ce: 224464				S	heet <b>1</b> (	of <b>1</b>
<b>TEST PIT</b> Excavator Test Pit D Contractor	INFORMA Type: 30 imensions: r: Fulton I	ATION It Excava Hogan	ator		CO-ORDINATE Easting: Northing: Ground Level: 1	<b>S NZTM</b> 1559446 m 5167737 m N/A		Date Started: 9/9/20 Date Completed: 9/9/20	11 11	Logged by: Input by: Checked by: Verified by:	LFS LFS JSM JK	
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests			Soil Descript	ion			Elevation (m)
						TOPSOIL SI <sup>0.20</sup> plasticity. Sa SAND; Brow	LT with trac nd fine gra n. Loose. N	ce sand and rootlets; ined. Noist. Sand fine to me	Dark brown. Firm. edium grained.	Moist. Low		
0.5 -						1.00						
1.0 -						Silty SAND; I grained.	Brown with	orange mottling. Loc	ose. Moist. Sand fi	ne to mediu	m	
2.0 —			× × × × × × × × × × × × × × × × × × ×			SAND with s dense. Wet.	ome silt; Li Sand fine t	ght brown with browr o medium grained.	n mottling. Loose to	o medium		
2.5 -												
3.0 —			× × × × × × × × × × × × × × × × × × ×			3.00 Sandy SILT v Sand fine gra	with tree br ained.	anches; Light blue gi	rey. Soft. Moist. Lo	w plasticity.		
3.5 -		Ţ	× × ×			End of Test F	Pit at 3.5m	(Pit Collapse)				
4.0 —												
4.5 -												
5.0 —												
Remarks	s: vater reac	hed @	3.5m						Logg Input Chec Verifi	ed by: LFS by: LFS ked by: JSN ed by: JK	6 6 7	
										Sh	eet 1 o	f <b>1</b>

Aureon (New Zasiand) Linited Uhit 1, 150 Cavendish Rd PO BOX 1061 Christchurch 8140 New Zeidan New Zeidan Frank christchurch 8:ep.aurecongrou

### Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN Telephone: +64 3 366 0821 Facsimile: +64 3 379 6955 Project Reference: **224464**

Sheet 1 of 1

**TP13** 

Email: chri TEST PIT Excavator Test Pit Dir Contractor	stchurch@ap.a INFORMA Type: 30 mensions: : Fulton I	A <b>TION</b> At Excava : Hogan	ator		<b>CO-ORDINATE</b> Easting: Northing: Ground Level: 1	ES NZTM     Date Started:     9/9/2011     Logged by:     LFS       1559538 m     Date Completed:     9/9/2011     Input by:     LFS       5167698 m     N/A     Verified by:     JK	
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
0.5 -			$\frac{\frac{1}{1}}{\frac{1}{1}} \frac{\sqrt{1}}{\sqrt{1}} \frac{\sqrt{1}}{\sqrt{1}}$ $\frac{\frac{1}{1}}{\sqrt{1}} \frac{\sqrt{1}}{\sqrt{1}} \frac{\sqrt{1}}{\sqrt{1}}$ $\frac{\sqrt{1}}{\sqrt{1}} \frac{\sqrt{1}}{\sqrt{1}} \frac{\sqrt{1}}{\sqrt{1}}$ $\frac{\sqrt{1}}{\sqrt{1}} \frac{\sqrt{1}}{\sqrt{1}}$ $\frac{\sqrt{1}}{\sqrt{1}} \frac{\sqrt{1}}{\sqrt{1}}$			TOPSOIL SILT with trace sand and rootlets; Dark brown. Firm. Moist. Low plasticity. Sand fine grained. <sup>0.40</sup> Sandy SILT; Grey with orange brown mottling. Soft. Moist. Low plasticity. Sand fine grained.	
1.0 —							
1.5 -			· · · · · · · · · · · · · · · · · · ·			<sup>1.80</sup> Silty SAND; Grey. Loose to medium dense. Moist. Sand medium grained.	
2.5 -			* * * * * * * * * * * * * * * * * * *				
3.0 —			× × × × × × × × × × × × × × × × × × ×			<sup>3.00</sup> SILT with some sand and tree roots; Blue grey. Stiff. Wet. Low plasticity. Sand fine grained.	
3.5 -			× × × × × × × × × × × × × × × × × × ×				
4.0 —			× × ×			End of Test Pit at 4m (Pit Collapse)	
4.5 -							
5.0 —							
Remarks Tree root Groundw	: s @ 3.0n ater seep	n page @	2.0m			Logged by: LFS Input by: LFS Checked by: JSM Verified by: JK	
						Sheet 1 o	1 1

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## aurecon

### FULTON HOGAN LAND DEVELOPMENT Client: Aurecon (New Zealand) Limited Unit 1. 150 Cawandish Rd PO B0X 1081 New Zealand Dirischurch 8140 New Zealand New Zealand New Zealand New Zealand Telephone: +64 3 396 0821 Faschille: +64 3 376 0821 Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION

Sheet 1 of 1

**TP14** 

CO-ORDINATES NZTM Easting: 1559655 Northing: 5167974 Ground Level: N/A TEST PIT INFORMATION Logged by: LFS Input by: LFS Checked by: JSM Date Started: 9/6/2011 Date Completed: 9/6/2011 Excavator Type: 30t Excavator Test Pit Dimensions: 1559655 m 5167974 m Contractor: Fulton Hogan Verified by: JK Water Level (m) Pocket Penetrometer Tests Elevation (m) Graphic Log Shear Vane Tests Depth (m) Sample Soil Description TOPSOIL SILT with trace sand and rootlets; Dark brown. Firm. Moist. Low T

		0.	plasticity. Sand fine grained.
0.5			
1.0	X X X X X X X X X X X X X X X X X X X X	Pocket Penetrometer at 1m: kN/m <sup>2</sup>	<sup>300</sup> SILT; Light brown. Soft. Moist. Low plasticity.
1.5		1.	<sup>50</sup> SAND; Brown orange. Loose. Wet. Sand fine grained.
2.0 —		2.	<sup>200</sup> SAND; Grey. Loose. Wet. Sand fine grained.
2.5	× · · · · · · · · · · · · · · · · · · ·	2.	<sup>80</sup> Sandy SILT; Blue grey. Firm. Wet. Low plasticity. Sand is fine grained.
3.0 -	$\begin{array}{c} & \cdot $		
3.5 -	▼ × · · · × · · · × · · · × · · × · · · × · × · · · × · × · · · × ·	3.	<sup>70</sup> End of Test Pit at 3.7m (GW Reached)
4.0 -			
4.5			
5.0 —			
Remarks: Beneficial Remarks: Beneficial Remarks: Groundwater read	n ched 3.7m		Logged by: LFS Input by: LFS Checked by: JSM Verified by: JK
Labi			Sheet 1 of 1

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Aureon (New Zealand) Linited Unit 1, 50 Cavendiah Rd PO BOX 1061 Christohurch 8140 New Zealand New Zealand New Zealand New Zealand Telephon Yacsimil

# Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN Project Reference: 224464

www.aurecongroup.com Facsimile: +64 3 379 6955 Email: christchurch@ap.aurecongroup.com	Project Referen	ce: 224464	Sheet 1 of 1
TEST PIT INFORMATION Excavator Type: 30t Excavator Test Pit Dimensions: Contractor: Fulton Hogan	CO-ORDINATE Easting: Northing: Ground Level:	SNZTM         Date Started:         9/9/2011           1559630 m         Date Completed:         9/9/2011           5167659 m         N/A         N/A	Logged by: LFS Input by: LFS Checked by: JSM Verified by: JK
		·	
Depth (m) Sample Water Level (m) Graphic Log	Shear Vane Tests Pocket	Soil Description	Elevation (m)
		TOPSOIL SILT with trace sand and rootlets; Dark brown. Firm. plasticity. Sand fine grained.	Moist. Low
0.5		Sandy SILT; Grey brown with brown mottles. Firm. Moist. Low fine to medium grained.	plasticity. Sand
		Silty SAND; Grey brown with orange brown mottling. Loose to Moist. Sand fine to medium grained.	nedium dense.
1.5 - <b>1.5</b>		<sup>1.65</sup> SILT; Grey. Firm. Saturated. Low plasticity.	
2.0 -		End of Test Pit at 1.8m (GW Reached)	
2.5 -			
3.0 —			
3.5 -			
4.0			
4.5 -			
5.0 -			
Remarks: Groundwater reached 1.8m		Logg Input Chec Verifi	ed by: LFS by: LFS ked by: JSM ed by: JK

Caurecon (New Zealand) Limited Unit 1, 150 Cavendish Rd PO BOX 1061 Christchurch 8140 New Zealand www.aurecomroup.com

### FULTON HOGAN LAND DEVELOPMENT Client: Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN Telephone: +64 3 366 0821 Farsimile: +64 3 376 6955 Project Reference: 224464

Sheet 1 of 1

TEST PIT Excavator Test Pit Di Contractor	TEST PIT INFORMATION Excavator Type: 30t Excavator Test Pit Dimensions: Contractor: Fulton Hogan				MATION         CO-ORDINATES NZTM         Date Started:         9/9/2011         Logged by:         LFS           30t Excavator         Easting:         1559669 m         Date Completed:         9/9/2011         Input by:         LFS           ons:         Northing:         5167751 m         Date Completed:         9/9/2011         Input by:         LFS           on Hogan         Ground Level:         N/A         Verified by:         JK						
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests		Sc	bil Description		Elevation (m)	
0.5 -				Shear vane a 0.5m: 89/15kPa /kPa /kPa	t Pocket Penetrometer at 0.5m: kN/m <sup>2</sup>	TOPSOIL SILT <sup>0.20</sup> plasticity. Sand Sandy SILT; G fine grained.	with trace sand ar I fine grained. rey with orange bro	nd rootlets; Dark brown	n. Firm. Moist. Low ist. Low plasticity. S	and	
1.0 -			× × × × × × × × × × × × × × ×	Shear vane a 1m: 44/24kPa /kPa /kPa	t Pocket Penetrometer at 1m: kN/m <sup>2</sup>						
1.5 – -			× × × × × × × × × × × × × ×	Shear vane a 1.5m: 38/21kPa /kPa /kPa	t Pocket Penetrometer at 1.5m: kN/m <sup>2</sup>						
2.0 —			× × × × × × × × × × × × × × × × × × ×								
2.5 -			× × × × × × × × × × × × × × × × × × ×			2.80 Sandy SII T wi	th tree roots: Dark	blue grov Stiff Wet L	ow placticity Sand		
3.0			× × × × × × × × × × × × × × × × × × ×			fine grained.			ew plasholy. Cana		
3.5 -			$\begin{array}{c} \times & \times \\ \times & \times & \times \\ \times & \times & \times \\ \times & \times &$			3.80 Sandy CRAV/E	L : Brown Donco \	Not Gravel fine to see	area grained		
4.0 — -						Sandy GRAVE Sub-rounded.	at 4m (Pit Collaps	e)	arse granieu.		
4.5 -											
5.0 —											
Remarks	s: ots @ 2.2n	n	I	L		1			Logged by: LFS Input by: LFS Checked by: JSI Verified by: JK	5 5 M	

Aureon (New Zealand) Limited Unit 1, 150 Cavendah Rd PO BOX 1061 Christchurch 8140 New Zealand Telepho

### Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN

New Zeala www.aure Email: ch	and congroup.com ristchurch@ap.a	Telephor Facsimile urecongroup	e: +64 3 366 0821 e: +64 3 379 6955 .com	Project	Reference	ce: <b>224464</b>		Sheet	1 of 1
TEST PIT Excavator Test Pit D Contracto	Type: 30 imensions r: Fulton	A <b>TION</b> )t Excav : Hogan	ator	C E N C	CO-ORDINATE Easting: Northing: Ground Level: 1	<b>S NZTM</b> 1559708 m 5167843 m √A	Date Started: 9/9/2011 Date Completed: 9/9/2011	Logged by: LFS Input by: LFS Checked by: JSM Verified by: JK	
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests		Soil Description		Elevation (m)
- - - 0.5			<u>     (1/2)</u> (1/2)	Shear vane at 0.5m: 95/24kPa	Pocket Penetrometer at 0.5m:	TOPSOIL SILT wit <sub>0.20</sub> plasticity. Sand fin Sandy SILT; Grey fine grained.	th trace sand and rootlets; Dark brow e grained. with orange brown mottling. Stiff. Mo	n. Firm. Moist. Low ist. Low plasticity. Sand	
1.0 —			* * * * * * * * * * * * * * * * * * *	/kPa /kPa Shear vane at 1m: 71/15kPa /kPa /kPa	kN/m <sup>2</sup> Pocket Penetrometer at 1m: kN/m <sup>2</sup>				
1.5 -			× × × × × × × × × × × × × × ×	Shear vane at 1.5m: 30/15kPa /kPa /kPa	Pocket Penetrometer at 1.5m: kN/m <sup>2</sup>	Sandy SILT; Grey Sand fine grained.	with orange brown mottling. Stiff. Sat	urated. Low plasticity.	
2.0 —			× × × × × × × × × × × ×			SILT with minor sa medium grained. 220 SAND with tree ro	ands; Dark blue grey. Soft. Wet. Low	plasticity. Sand fine to dense. Moist. Sand	
2.5 -			× × × × × ×			SILT with minor sa 2.00 medium grained. SAND with tree ro	ands; Dark blue grey. Soft. Wet. Low ots; Dark blue grey. Loose to medium	plasticity. Sand fine to	
3.0 —						medium grained.			
3.5 – -						3.80			
4.0 —						Sandy GRAVEL; E 400 Sub-rounded. San End of Test Pit at	Brown. Dense. Saturated. Gravel fine ad medium grained. 4m (GW Reached)	to coarse grained.	
4.5 -									
5.0 —									
Remarks Tree roo Groundy	s: ots @ 2.2r vater read	n hed 4.0	 )m					Logged by: LFS Input by: LFS Checked by: JSM Verified by: JK	

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Sheet 1 of 1

Database File: TEST PITS.GPJ, Library: COPY OF CHCH LIBRARY FEB 2015CEB, Data template: CHCH DA1A TEMPLATE NOV 2010.GDT, Last Generated: 330/2012.

## aurecon

Aurecon (New Zealand) Lin Unit 1, 150 Cavendish Rd PO BOX 1061

### FULTON HOGAN LAND DEVELOPMENT Client: Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN

**TP19** 

Christchu New Zeal www.aure Email: ch	rch 8140 and econgroup.com nristchurch@ap.a	Telephon Facsimile aurecongroup	ne: +64 3 366 0821 e: +64 3 379 6955 .com	Project	n: SEE I Referen	PLAN Ice: 224464 Sheet 1 of
TEST PIT Excavator Test Pit D Contractor	INFORM/ Type: 30 Dimensions or: Fulton	ATION Dt Excava Hogan	ator	C E N G	O-ORDINATE asting: orthing: round Level:	ES NZTMDate Started:9/6/2011Logged by:LFS1559747 mDate Completed:9/6/2011Input by:LFS5167935 mChecked by:JSMN/AVerified by:JK
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description
0.5 -			<u>     (1)</u> (1)     (1)			TOPSOIL SILT with trace sand and rootlets; Dark brown. Firm. Moist. Low plasticity. Sand fine grained. <sup>0.30</sup> SILT; Light brown. Soft. Moist. Low plasticity.
1.0			× × × × × × × × × ×			SAND with minor silt; Light brown. Loose to medium dense. Moist. Sand fine grained. SILT with minor sand; Grey with brown mottling. Stiff. Moist. Low plasticity. Sand fine to medium grained.
1.5 – -			$\begin{array}{c} & \times & \times \\ \times & \times & \times \\ \times & \times & \times \\ \times & \times &$			1.70 cm SILT with some peat inclusions: Light blue grey. Wet Low plasticity
2.0 —			× ×			SAND; Blue. Loose to medium dense. Wet. Fine grained.
2.5 -						

End of Test Pit at 2.8m (GW Reached)

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## Remarks: Tree branch @ 1.8m Groundwater seepage @ 1.7m Tree root @ 2.5m Groundwater table reached at 2.8m

Ţ

3.0

3.5

4.0

4.5

5.0

Logged by: Input by: Checked by: Verified by: LFS LFS JSM JK Database File: TEST PITS, GPJ, Library: COPY OF CHCH LIBRARY FEB 2011; GLB, Data template: CHCH DATA TEMPLATE NOV 2010; GDT, Last Generated: 3730/2012.

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# Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN

New Zealar www.aurec Email: chri	nd :ongroup.com istchurch@ap.a	Telephon Facsimile urecongroup	e: +64 3 366 0821 e: +64 3 379 6955 .com	Projec	ct Reference	ce: <b>224464</b>				S	heet 1 of 1
TEST PIT Excavator Test Pit Dir Contractor	INFORMA Type: 30 mensions: : Fulton I	A <b>TION</b> )t Excava : Hogan	ator		CO-ORDINATE Easting: Northing: Ground Level:	ES NZTM 1559684 m 5167528 m N/A	Date Started: 9/9/2011 Date Completed: 9/9/2011	Lo In C Ve	ogged by: put by: hecked by: erified by:	LFS LFS JSM JK	
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests			Soil Description			Elevation (m)
0.5 -			<u>\$16</u> <u>\$16</u> \$ <u>16 \$16 \$16</u> \$ <u>\$16 \$16 \$</u>			TOPSOIL SILT plasticity. Sand 040 SAND; Dark gr	with trac l fine grai	e sand and rootlets; Dark brown ned. e to medium dense. Moist. Sand	n. Firm. Mo I fine graine	ist. Low	
1.0 -			<u> </u>			<sup>1.00</sup> Silt with some p	peat inclu	isions. Light blue grey. Soft. We	t. Low plas	ticity.	
1.5 -						SAND; Brown. 1.70 SAND; Grey. Lu	Loose to oose to r	medium dense. Moist. Sand medium dense. Wet. Sand medi	edium grair um grained	ned. I.	
2.0 —			× × × × × × × × ×			<sup>2.00</sup> Silty SAND; Gru	ey. Loose	e to medium dense. Wet. Sand i	nedium gra	ained.	
2.5 -			× × × × × × × × × × × × × × ×			2.70 Silty SAND with grained.	n tree roc	nts; Light blue grey. Medium den	se. Wet. S	and fine	
3.0 —			× × × × × × × × × × × × × × ×								
3.5 -			× × × × × × × × × × × × × × ×								
4.0 —						End of Test Pit	at 4m (P	it Collapse)			
4.5 -											
5.0 —											
Remarks Tree root Tree root No aroun	: ts @ 1.0n ts @ 3.0n ndwater e	n n ncounte	I		]	1			Logged b Input by: Checked Verified b	y: LFS LFS by: JSM by: JK	 } M
										Sh	eet 1 of 1

Aureon (New Zesland) Limited Unit 1, 150 Caverdish Rd PO BOX 1051 Christchurch 8140 New Zesland Telephon www.aurecongroup.com Fascing

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### Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN Telephone: +64 3 366 0821 Facsimile: +64 3 379 6955 Project Reference: 224464

Sheet 1 of 1

Email: chris TEST PIT I Excavator Test Pit Din Contractor:	NFORMA Type: 30 mensions Fulton	urecongroup. A <b>TION</b> )t Excava : Hogan	ator		CO-ORDINATES Easting: 1 Northing: 5 Ground Level: N	559762 m 559762 m 5167712 m /A		Date Started: 9/9/2 Date Completed: 9/9/2	2011 2011	Logged by: Input by: Checked by: Verified by:	LFS LFS JSM JK
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests			Soil Descri	otion		Elevation (m)
			$\begin{array}{c} \underline{\langle 1 1_{1} \\ 1_{2} \\ 1_{3} \\ 1$			TOPSOII 0.20 plasticity Sandy SI fine grair	L SILT with tra . Sand fine gra ILT; Grey with ned.	ce sand and rootlet: ined. orange brown mottl	s; Dark brown. F ing. Stiff. Moist.	ïrm. Moist. Low Low plasticity. Sa	and
0.5 -			^	Shear vane at 0.5m: 104/18kPa /kPa /kPa	Pocket Penetrometer at 0.5m: kN/m <sup>2</sup>						
1.0			× × × × × × × × × × × × × × × × × × ×	Shear vane at 1m: 44/27kPa /kPa /kPa	Pocket Penetrometer at 1m: kN/m <sup>2</sup>						D
1.5 -			* * * * * * * * * * * * * * *	Shear vane at 1.5m: 30/27kPa /kPa /kPa	Pocket Penetrometer at 1.5m: kN/m <sup>2</sup>						
2.0 —			× × × × × × × × × × × × × × × × × ×		-	Sandy SI Sand fine	ILT with tree ro e grained.	ots; Dark blue grey	. Stiff. Saturated	. Low plasticity.	
2.5 -			× × × × × × × × × × × × × × ×								
3.0 —			× × × × × × × ×			<sup>3.10</sup> SAND; B	rown. Loose to	o medium dense. Sa	aturated. Sand n	nedium grained.	
3.5 -		-									
4.0		<u> </u>				End of Te	est Pit at 3.8m	(GW Reached)			
4.5 -											
5.0 —											
-											
Remarks	ater enco	ountered	d @ 3.8m						Li Ir C V	ogged by: LFS put by: LFS hecked by: JSM erified by: JK	страна В М
										Sh	eet 1 of 1

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# Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN Drainet Deference: 224464

www.aurecongroup.con Email: christchurch@a	n Facsimile p.aurecongroup	e: +64 3 379 6955 .com	Projec	t Referenc	ce: 224464		Sheet	1 of 1
TEST PIT INFORM Excavator Type: Test Pit Dimensior Contractor: Fulto	MATION 30t Excav ns: n Hogan	ator		CO-ORDINATE Easting: Northing: Ground Level: N	<b>S NZTM</b> 1559840 m 5167896 m N/A	Date Started: 9/6/2011 Date Completed: 9/6/2011	Logged by: LFS Input by: LFS Checked by: JSM Verified by: JK	
Depth (m) Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Penetrometer Tests		Soil Description		Elevation (m)
0.5 -		$\begin{array}{c} \underbrace{\sqrt{1}}_{1} & \underbrace{\sqrt{1}}_{2} & \underbrace{\sqrt{1}}_{2} \\ \underbrace{\sqrt{1}}_{2} & \underbrace{\sqrt{1}}_{2} & \underbrace{\sqrt{1}}_{2} \\ \hline \\ \times & \times \end{array}$			TOPSOIL with some	e rootlets and minor silt; Dark brown	1. Moist. Low plasticity.	
1.0 -		× ×			SAND with minor si grained.	lt; Light brown. Loose to medium de	anse. Moist. Fine	
1.5 -					SAND with some sil dense. Wet. Fine gr	t; Grey with orange brown mottling. ained.	Loose to medium	
2.0 -		× × × × × × × × × ×			SILT; Light blue gre	y. Soft. Wet. Low plasticity.		
2.5 -	Ţ	× × ×			2.50 SAND; Reddish bro 2.80 End of Test Pit at 2	wn. Loose. Wet. Sand medium gra 8m (GW Reached)	ined.	
3.0 -								
3.5 -								
4.0								
4.5								
5.0 -								
Remarks: Groundwater se	epage @	2.2			1		Logged by: LFS Input by: LFS Checked by: JSM Verified by: JK	<u> </u>
							Sheet 1	of <b>1</b>

## aurecon

## Client: FULTON HOGAN LAND DEVELOPMENT

Aurecon (I Unit 1, 15 PO BOX 11 Christchur New Zeala www.aure Email: ch TEST PIT Excavator Test Pit D Contracto	Aureon (New Zealand) Limited Unit 1, 150 Cavendan Rd PO BOX 1001 Christhurch 8140 New Zealand Telephone: +64 3 366 0821 www.aurecongroup.com Email: christhurch@iga.aurecongroup.com TEST PIT INFORMATION Excavator Type: 25t Excavator Test Pit Dimensions: Contractor: Texco			Client: Project Locatic Project	Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN Project Reference: 224464 C CO-ORDINATES NZTM Easting: 1559333 m Northing: 5167682 m Ground Level: N/A Coordinates NZTM							
		-										
Depth (m)	Sample	Water Level (m	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests		Soil Description		Elevation (m)			
			<u>NI NI NI</u>			TOPSOIL SILT with so	me rootlets; Dark Brown. Soft. M	loist. Low plasticity.				
0.5 -				Shear vane at 0.3m: 37/22kPa /kPa /kPa	Pocket Penetrometer at 0.3m: kN/m <sup>2</sup>	<ul> <li><sup>0.30</sup> Silty SAND; Light yello fine to medium grained</li> <li><sup>0.70</sup> SAND with traces of grained</li> </ul>	<sup>230</sup> Silty SAND; Light yellow brown with orange brown mottling. Loose. Wet. Sand fine to medium grained.					
1.0 —						to coarse grained. Gra	vel fine grained.					
1.5 -						SAND with minor tree Moist. Sand fine to me	natter; Light orange brown with b dium grained.	olue mottling. Dense.	-			
2.0 —												
2.5 -			× - × - - × - × - - × - × - - × - × - - × - ×	Shear vane at 2.4m: 37/22kPa /kPa /kPa	Pocket Penetrometer at 2.4m: kN/m <sup>2</sup>	<sup>240</sup> Clayey SILT with some Firm. Wet. High plastic	dark brown fibrous peat inclusio	ons; Light blue grey.				
3.0 —												
3.5 -			^ × - × × - × - × - × - × × - × -			0.70						

End of Test Pit at 3.7m (Pit Collapse)

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4.0

4.5

5.0

Remarks:

Groundwater seepage @ 2.4m

> MHD MHD JSM JK Logged by: Input by: Checked by: Verified by:

Database File: TEST PITS.GPJ, Library: COPY OF CHCH LIBRARY FEB 2011; CIB, Datarienine: CHCH DATA TEMPLATE NOV 2010; CDT, Last Generated: 339/2012.

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# Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN Project Reference: 224464

www.aurecong Email: christcl	group.com hurch@ap.au	Facsimile recongroup.	e: +64 3 379 6955 .com	Projec	t Reference	ce: <b>224464</b>		S	Sheet 1 of 1
TEST PIT IN Excavator Ty Test Pit Dime Contractor:	IFORMA ype: 251 ensions: Texco	TION Excava	ator		CO-ORDINATE Easting: Northing: Ground Level:	<b>S NZTM</b> 1559271 m 5167797 m N/A	Date Started: 10/20/2011 Date Completed: 10/20/2011	Logged by: Input by: Checked by: Verified by:	MHD MHD JSM JK
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests		Soil Description		Elevation (m)
0.5 -						TOPSOIL SILT with <sup>0.30</sup> Silty SAND; Light ye Moist. Sand fine to	n some rootlets; Dark Brown. Soft. Mo ellow brown with some orange browr medium grained.	oist. Low plasticity.	
1.0			× × × × × × × × × × × × × × × × × × ×	Shear vane al 1.3m: 118/44kPa /kPa /kPa	t Pocket Penetrometer at 1.3m: kN/m <sup>2</sup>	<sup>1.00</sup> SAND; Light yellow grained. <sup>1.30</sup> SILT; Light grey. St	rbrown. Medium dense. Moist. Sand	fine to medium	
2.0						SAND; Light grey. I	Medium dense. Moist. Sand fine to m	iedium grained.	
3.0 -			× × × × × × × × × × × × × × × × × × ×			2.80 Clayey SILT; Light I	blue grey. Firm to stiff. Wet. High pla	sticity.	
3.5			× × × × × × × × × × ×			End of Test Pit at 3	.7m (Pit Collapse)		
4.5									
5.0 -									
Remarks: No grounde	water er	ncounte	ered	<u> </u>				Logged by: MH Input by: MH Checked by: JSI Verified by: JK	ID ID M
								Sh	neet 1 of 1

## aurecon

Aurecon (New Zealand) Li Unit 1, 150 Cavendish Rd

## Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION

1 of 1

Elevation (m)

**TP50** 

PO Chi Nei	BOX 1061 ristchurch 8140 w Zealand	Telepho	me: +64 3 366 0821	Location	n: SEE F	PLAN					
ww Em	w.aurecongroup.com ail: christchurch@a	Facsimi aurecongrou	le: +64 3 379 6955 p.com	FIUJECLI	Nelelelia	JE. 224404			Sh	neet	
TEST Excav Test F Contr	PIT INFORM vator Type: 3 Pit Dimension actor: Fultor	IATION 30t Excav s: n Hogan	vator	CC Ea No Gr	D-ORDINATE asting: orthing: round Level:	<b>:S NZTM</b> 1559060 m 5167900 m N/A	9/6/2011 9/6/2011	Logged by: Input by: Checked by: Verified by:	LFS LFS JSM JK		
Depth (m)	Depth (m) Sample Sample Mater Level (m) Graphic Log Shear Vane Tests Shear Vane Tests					Soil Description					
	-		$\frac{\underline{\langle \mathbf{h}   \mathbf{j}_{1}}}{\underline{\mathbf{h}}_{1}} \cdot \underline{\langle \mathbf{h}   \mathbf{j}_{2}} \cdot \underline{\langle \mathbf{h}   \mathbf{j}_{2}}$			TOPSOIL silt with trace plasticity. Sand fine gra	e sand and rootl ained.	ets; Dark brown. Firm. M	oist. Low		
0.5	-			Shear vane at 0.5m: 102/40kPa /kPa /kPa	Pocket Penetrometer at 0.5m: kN/m <sup>2</sup>	Sandy SILT; Brown. St	iff. Moist. Low p	lasticity. Sand fine graine	d.		
1.0			× × × × × × × × × × × × × × × × × × ×	Shear vane at 1m: 121/27kPa /kPa	Pocket Penetrometer at 1m: kN/m <sup>2</sup>	I 20 SILT with minor sand: I	Brown. Firm. Mc	pist. Low plasticity. Sand t	fine grained.		
1.5				Shear vane at 1.5m: 52/28kPa /kPa /kPa	Pocket Penetrometer at 1.5m: kN/m <sup>2</sup>						
2.0						SAND; Grey with brown medium grained.	n mottling. Loos	e to medium dense. Wet	. Fine to		
2.5											

End of Test Pit at 4m (Pit Collapse)

Pocket Penetro at 3m: kN/m<sup>2</sup>

Pocket Penetro at 3.5m kN/m<sup>2</sup>

Shear var 3m: 75/37kPa /kPa /kPa e at

Shear van 3.5m: 80/33kPa /kPa /kPa vane at

× × × × × × ×

×

× × × × × × × × x × × SILT with minor sand and trace clay and rootlets; Grey with brown mottling. Stiff. Wet. Low plasticity. Sand fine to medium grained.

-		
Remarks:		
Groundwater see	page @	2.1m

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3.0

3.5

4.0

4.5

5.0

LFS LFS JSM JK Logged by: Input by: Checked by: Verified by:

### Sheet 1 of 1

## Aurceor (New Zealand) Limited Unit 1, 150 Cavadians Rd P 0 BOX 1061 Christhurch 8140 New Zaeland Telephone: #64 3 366 0821 www.aurecongroup.com Email: christhurch@ap.aurecongroup.com FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN

Sheet 1 of 1

**TP51** 

TEST PIT INFORMATION	CO-ORDINATES N/A	Date Started:	9/19/2011
Excavator Type: 12t Excavator	Easting: N/A	Date Completed:	9/19/2011
Test Pit Dimensions:	Northing: N/A		
Contractor: Fulton Hogan	Ground Level: N/A		

Logged by: JSM Input by: JSM Checked by: JK Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description		Elevation (m)
-	-		<u>\</u>			TOPSOIL SILT; Dark brown. Stiff. Moist. Low plasticity.		
0.5 -	-					<ul> <li><sup>0.30</sup> Silty SAND; Light yellow brown with orange brown mottling. I dense. Moist. Sand fine to medium grained.</li> <li><sup>0.55</sup> Sandy SILT; Light yellow brown with orange brown mottling. Low plasticity. Sand fine to medium grained.</li> </ul>	Loose to medium Stiff. Moist to wet.	
1.0 —	-		× × × × × × × × × × × × × × ×			Silty SAND; Light yellow brown with orange brown mottling. I dense. Wet. Sand fine to medium grained.	Loose to medium	
1.5 -	- - - -	Ţ	× × × × × × × × × × × × × × × × × × ×			<ul> <li>Dark yellow brown with orange brown and grey mottling</li> <li>Low plasticity.</li> <li>Silty SAND; Dark orange brown. Loose to medium dense. W</li> <li>Sand fine to medium grained.</li> </ul>	ng. Stiff. Moist.	
2.0 —	- - -							
2.5 -	-		***** ********************************			Sandy SILT; Dark blue grey. Stiff. Moist. Sand fine to mediur	m grained.	
3.0 -	-		× `× `			End of Test Pit at 3m (Maximum Reach)		
3.5 -	-							
4.0 —	-							
4.5 -	-							
5.0 —	- - - - -							
t Generated: 3/30/2012 t Generated: 3/30/2012 t Ground	us: water see	bage @	1.5m		1	Log Inp Chi Vei	gged by: JSM out by: JSM necked by: JK prified by: JK	

Aureon (New Zealand) Limited Unit 1, 190 Cavendish Rd PO BOX 1081 Christchurch 8140 New Zealand Kew Zealand Email: christchurch 8:ep.aurecongroup Email: christchurch 8:ep.aurecongroup

### Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN Telephone: +64 3 366 0821 Facsimile: +64 3 379 6955 econoroue.com

Sheet 1 of 1

Logged by: MHD Input by: MHD Checked by: JSM Verified by: JK

VFORMA ype: 25 nensions: Texco	TION t Excav	ator	C E N G	O-ORDINATE asting: orthing: round Level:	E <b>S NZTM</b> 1559355 m 5167756 m N/A	Date Started: 10/20/2011 Date Completed: 10/20/2011		
Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests		Soil Description		
$\frac{\langle v_1 \rangle_{-} \langle v_1 \rangle_{-} \langle v_2 \rangle_{-}}{\langle v_1 \rangle_{-} \langle v_1 \rangle_{-} \langle v_2 \rangle_{-} \langle v_1 \rangle_{-} \langle v_2 \rangle_{-} \langle v_1 \rangle_{-} \langle v_2 \rangle_{-} \langle v_1 \rangle_{-} \langle v_1 \rangle_{-} \langle v_2 \rangle_{-} \langle v_1 \rangle_{-} \langle$					TOPSOIL SILT with so plasticity.	me rootlets; Dark Brown. Soft. Mo	oist	
	a a b b b c c c c c c c c c c c c c c c	Matter Level (m)	IFORMATION ype: 251 Excavator ensions: Texco	All of the second state     Comparison of the second state     Comparison of the second state       Version of the second state     Sample     Sample       Texco     G     Sample       Sample     G     Sample <td>CO-ORDINATE special constraints of the special constraints of the special</td> <td>IFORMATION ype:     CO-ORDINATES NZTM Easting:       ype:     25t Excavator ensions:       Texco     559355 m Ground Level:       Image: State of the state</td> <td>IFORMATION ype: 25t Excavator ensions:     CO-ORDINATES NZTM Easting:     Date Started:     10/20/2011 Date Completed:       Texco     Date Started:     10/20/2011       Image: Started: Started:     10/20/2011       Image: Started: Started:     10/20/2011</td>	CO-ORDINATE special constraints of the special	IFORMATION ype:     CO-ORDINATES NZTM Easting:       ype:     25t Excavator ensions:       Texco     559355 m Ground Level:       Image: State of the state	IFORMATION ype: 25t Excavator ensions:     CO-ORDINATES NZTM Easting:     Date Started:     10/20/2011 Date Completed:       Texco     Date Started:     10/20/2011       Image: Started: Started:     10/20/2011       Image: Started: Started:     10/20/2011	

	Depth (m)	Sample	Water Level (m	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
	0.5 -			$\begin{array}{c} \underbrace{(1,1)}_{1},\underbrace{(1,1)}_{2$	Shear vane at 0.3m: 59/44kPa /kPa /kPa	Pocket Penetrometer at 0.3m: kN/m <sup>2</sup>	TOPSOIL SILT with some rootlets; Dark Brown. Soft. Moist to wet. Low plasticity. <sup>0.30</sup> SILT; Light yellow with some orange brown mottling. Firm. Moist. Low plasticity.	
	1.0			× × × × × × × × × × × × × × × × × × ×				D
	2.0 —	-		× × × × × × × × × × × × × × × × × ×	Shear vane at 1.6m: 74/37kPa /kPa /kPa	Pocket Penetrometer at 1.6m: kN/m <sup>2</sup>	<sup>1,60</sup> SILT; Light grey with some orange brown mottling. Firm. Moist. Low plasticity.	
	2.5 -	-					SAND with a trace of gravel; Orange brown. Loose to medium dense. Wet. Sand coarse to medium grained. Gravel fine grained. 240 SAND; Grey. Medium dense. Moist to wet. Sand fine to medium grained. 260 SAND; Light blue grey. Dense. Wet. Sand fine to medium grained.	
	3.0 —			× - × - × - × - × - × - × - × - × - × -	Shear vane at 2.9m: 44/30kPa /kPa /kPa	Pocket Penetrometer at 2.9m: kN/m <sup>2</sup>	<sup>2.90</sup> Clayey SILT with some tree matter/roots; Light blue grey. Firm to stiff. Wet. High plasticity.	
	3.5 -	-			-		3.80 End of Test Pit at 3.8m (Pit Collapse)	
	4.0 —	-						
	4.5 -	- - - -						
012 4:23:10 PM		-						
-ast Generated: 3/30/20	Remark Ground Ground	s: water see water see	page @ page @	2.1m 2.9m			Logged by: MHD Input by: MHD Checked by: JSM Verified by: JK Sheet 1	of <b>1</b>

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# Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN Decision Deference 201101

www.aureco Email: chris	u ongroup.com stchurch@ap.a	Facsimile urecongroup.	e: +64 3 366 0821 : +64 3 379 6955 com	Projec	t Reference	ce: 224464			Sheet 1	of <b>1</b>
TEST PIT I Excavator Test Pit Dir Contractor:	NFORMA Type: 25 nensions: Texco	ATION it Excava	ator		<b>CO-ORDINATE</b> Easting: Northing: Ground Level:	ES NZTM 1559085 m 5167947 m N/A	Date Started: 10/19/2011 Date Completed: 10/19/2011	Logged by Input by: Checked b Verified by	MHD MHD y: JSM : JK	
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests		Soil Description			Elevation (m)
0.5 -			1     1     1       1     1       1 <td></td> <td></td> <td>TOPSOIL SILT with so plasticity. <sup>0.30</sup> Silty SAND; Light yello</td> <td>ome rootlets; Dark Brown. Soft. M</td> <td>oist to wet. Low to medium grained</td> <td>3</td> <td></td>			TOPSOIL SILT with so plasticity. <sup>0.30</sup> Silty SAND; Light yello	ome rootlets; Dark Brown. Soft. M	oist to wet. Low to medium grained	3	
1.5 -			× × × × × × × × × × × × × × × × × × ×			SILT; Light yellow brov	wn. Firm. Wet. Low plasticity.			
2.5 -			× × × × × × ×			3.00 Clayey SILT with some High plasticity	e tree matter/roots; Light blue gre	y. Firm to stiff. We	t.	
3.5 -		▼	<pre>x x x x x x x x x x x x x x x x x x x</pre>							
4.0		-	- × - × × - × -			End of Test Pit at 4m	(GW Reached)			
4.5										
5.0 —										
Remarks:	ater reac	hed @	3.9m					Logged by: M Input by: M Checked by: JS Verified by: JH	HD HD SM K	of <b>1</b>

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## Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN . . .

www.aurecongroup.com Facsimile: +64 3 379 6955 Facility Email: christchurch@ap.aurecongroup.com	Project Reference	e: <b>224464</b>		Sheet 1 of 1
TEST PIT INFORMATION Excavator Type: 25t Excavator Test Pit Dimensions: Contractor: Texco	CO-ORDINATES Easting: 1 Northing: 5 Ground Level: N	<b>5 NZTM</b> 559004 m 5167925 m //A	Date Started: 10/19/2011 Date Completed: 10/19/2011	Logged by: MHD Input by: MHD Checked by: JSM Verified by: JK
Depth (m) Sample Water Level (m) Graphic Log	Shear Vane Tests Pocket		Soil Description	Elevation (m)
$\frac{\overline{\gamma_{1}\gamma_{2}}}{\overline{\gamma_{1}\gamma_{2}}} \cdot \overline{\gamma_{1}\gamma_{2}} \cdot \overline{\gamma_{1}\gamma_{2}}$		TOPSOIL SILT with plasticity.	n some rootlets; Dark Brown. Soft. Mois	st to wet. Low
		<sup>0.30</sup> Sandy SILT; Light y plasticity. Sand fine	rellow brown with orange brown mottlin to medium grained.	g. Soft. Moist. Low
$1.5 - \left  \begin{array}{c} x & x \\ x & x \\ x & x \\ x \\ x \\ x \\ x \\$		<sup>1.60</sup> SILT; Light yellow b plasticity.	prown with orange brown mottling. Soft.	Moist. Low
$2.0 - \begin{bmatrix} & & & & \\ & & & & \\ & & & & \\ & & & &$		2.30 Clavev SILT <sup>-</sup> Linht	blue grev, Firm to stiff, Wet, High plasti	city.
		e.e.jej e. <u>.</u> ., <u>.</u> .g		
3.0 - 3.0		3.20 SAND; Light blue g	rey. Dense. Wet. Sand is fine grained.	
3.5				
4.0 -				
4.5				
5.0 -		5.00 End of Test Pit at 5	m (Pit Collapse)	
Remarks: Groundwater seepage @ 2.3m Tree trunk @ 2.6m				Logged by: MHD nput by: MHD Checked by: JSM /erified by: JK
				Sheet 1 of 1

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## Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN

EST PIT Excavator Test Pit D Contracto	INFORM/ Type: 28 imensions r: Texco	ATION ot Excava	ator		CO-ORDINATES NZTMDate Started:10/19/2011Easting:1558962 mDate Completed:10/19/2011Northing:5167965 mGround Level:N/A					Logged by: Input by: Checked by: Verified by:	MHD MHD JSM JK
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests			Soil Description			i
- - - - -			$\begin{array}{c} \underbrace{(i_{1}, \ldots, i_{l}, \ldots, i_{l})}_{i_{1}} \\ \underbrace{(i_{1}, \ldots, i_{l}, \ldots, \ldots, i_{l}, \ldots, \ldots, i_{l}, \ldots, \ldots, i_{l}, \ldots, \ldots,$			TOPSOIL S plasticity.  Sandy SILT to medium g	LT with sor	ne rootlets; Dark Brown. S v brown. Firm. Moist to we	Soft. Moist to w et. Low plastici	et. Low ty. Sand fin	le
1.0 —											
I.5 –											
2.0 —			× × × × × × × × × × × × × × × × × × ×								
2.5 -						2.80 Clayey SILT	Γ; Light blue	grey. Firm to stiff. Wet. Hi	igh Plasticity.		
3.0			× × × × × × × ×								
3.5 -						3.70 Silty SAND;	Light blue ç	rey. Dense. Wet. Sand fir	ne grained.		
4.0 — - -		_									
I.5 –		<u> </u>	<u>xaaxxdd</u>			End of Test	Pit at 4.5m	(GW Reached)			
5.0 — - -											
Remarks Groundv Groundv	s: vater see vater read	bage @	2.8m 4.5m			1			Logge Input b Check Verifie	d by: M⊢ by: M⊢ ed by: JS d by: JK	ID ID M
										Sh	neet 1 of

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### Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN

New Zeal www.aure Email: ch	and econgroup.com hristchurch@ap.a	Telephor Facsimil aurecongrour	ne: +64 3 366 0821 e: +64 3 379 6955 b.com	Proje	ct Referen	ce: 224464					S	heet 1 of
TEST PIT Excavato Test Pit D Contracto	INFORMA r Type: 25 Dimensions Dr: Texco	ATION St Excav	ator		<b>CO-ORDINATE</b> Easting: Northing: Ground Level:	<b>ES NZTM</b> 1559066 m 5168041 m N/A		Date Started: Date Completed:	10/19/2011 10/19/2011		Logged by: Input by: Checked by: Verified by:	MHD MHD JSM JK
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests			Soil De	escription			Elevation (m)
			$\frac{\sqrt{I_{f}}}{V} \frac{\sqrt{I_{f}}}{\sqrt{I_{f}}} \frac{\sqrt{I_{f}}}{\sqrt{I_{f}}}$			TOPSOIL SIL	LT with som	e rootlets; Da	ark Brown. Soft.	Moist to we	et. Low	
0.5 -						SILT; Light ye plasticity.	ellow brown	with orange l	brown mottling.	Firm. Mois	t to wet. Lo	w
1.0	· · ·											
1.5 –			× × × × × × × × × × × × × × × × × × ×									
2.0 —			× × × × × × × × × × × ×									
2.5 -			× × × × × × × × × × × × × × ×									
3.0 —	· ·		× × × × × × × × × × × × × × × × × × ×			320 Clayey SILT w	with some t	ee matter; Li	ght blue grey. F	irm to stiff.	Wet. High	
3.5 -						plasticity. 360 Sitly SAND; Li	_ight blue g	ey. Dense. W	/et. Sand fine g	rained.		
4.0 —												
4.5 -			× · · · · × · · · · · · · · · · · · · ·			4.50 End of Test Pi	Pit at 4.5m (	Pit Collapse)				
5.0 —												
Remark	s: water see	page @	2.6m							Logger Input b Check Verifie	d by: MH y: MH ed by: JSM d by: JK	D D M
											Sh	eet 1 of 1

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## Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN Telephone: +64 3 366 0821 Economical 4 4 3 376 0855 Project Reference: 224464

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www.aureo Email: chr	congroup.com istchurch@ap.a	Facsimile urecongroup	e: +64 3 379 6955 .com	FIUJECI	Kelelelic	26. 224404		S	heet 1 of 1
TEST PIT Excavator Test Pit Di Contractor	INFORMA Type: 25 imensions r: Texco	ATION 5t Excave	ator	C E N C	CO-ORDINATE Easting: Northing: Bround Level: 1	<b>S NZTM</b> 1559038 m 5168131 m N/A	Date Started: 10/19/2011 Date Completed: 10/19/2011	Logged by: Input by: Checked by: Verified by:	MHD MHD JSM JK
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests		Soil Description		Elevation (m)
-			<u> 11 11 11 1</u> 11 11 11 11			TOPSOIL SILT with so plasticity.	me rootlets; Dark Brown. Soft. M	loist to wet. Low	
0.5 -						<sup>0.30</sup> Sandy SILT, Light yello medium grained.	w grey. Firm. Moist to wet. Low p	plasticity. Sand fine	to
1.0 -			× × × × × × × × × × × × × ×			<sup>120</sup> Silty sandy GRAVEL; L	ight yellow brown. Medium dens	e to dense. Wet.	
1.5 – -						Graver fine to coarse g	rained. Sub rounded. Sand line i	o coarse grained.	
2.0 —									
2.5 -									
3.0 —						End of Test Pit at 3.2m	(Pit Collapse)		
3.5 -									
4.0									
4.5 -									
5.0									
Remarks	s: ndwater e	encounte	ered					Logged by: MH Input by: MH Checked by: JSI Verified by: JK	D D M
								Sh	eet 1 of 1

Aureon (New Zealand) Limited Unit 1,190 Cavendais Rd PO BOX 1061 Christotruch 8140 New Zealand New Zealand Enait, christotruch Bap.aureocongroup

### Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN Telephone: +64 3 366 0821 Facsimile: +64 3 379 6955 Project Reference: **224464**

Sheet 1 of 1

**TP58** 

Email: c	christchurch@ap.a	aurecongroup	.com									
TEST PI Excavato Test Pit I Contracto	T INFORM or Type: 25 Dimensions or: Texco	ATION 5t Excave ::	ator		CO-ORDINATE Easting: Northing: Ground Level:	ES NZTM 1559187 m 5168095 m N/A	NZTMDate Started:10/19/2011Logged by:i59187 mDate Completed:10/19/2011Input by:168095 mChecked byAVerified by:					
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests		Soil D	escription				
	-		$\frac{\langle \underline{v}, \underline{v} \rangle}{ \underline{v} } \frac{\langle \underline{v}, \underline{v} \rangle}{ \underline{v} }$			TOPSOIL SILT with so plasticity. 0.30 Silty SAND; Light yello	ome rootlets; Da	ark Brown. Soft. M ome orange brow	loist to wet. Low n mottling. Loose.			

	$\frac{\sqrt{M_2}}{M_1} \frac{\sqrt{M_2}}{\sqrt{M_1}} \frac{\sqrt{M_2}}{\sqrt{M_2}}$		TOPSOIL SILT with some rootlets; Dark Brown. Soft. M plasticity.	oist to wet. Low
0.5			Silty SAND; Light yellow brown with some orange brown Moist to wet. Sand fine to medium grained.	n mottling. Loose.
			SAND; Light yellow brown with some orange brown mot wet. Sand fine to medium grained.	ttling. Loose. Moist to
1.0				
1.5				
2.0				
2.5			<sup>270</sup> Clayey SILT with some tree matter; Light blue grey. Firn	n to stiff. Wet. High
3.0			plasticity.	
3.5			Silty SAND; Light blue grey. Dense. Wet. Sand fine gra	nea.
4.0			End of Test Pit at 4m (Pit Collapse)	
4.5				
5.0				
4:23:13 PM				
Rema Gorur Tree	arks: ndwater seepage @ 2.7m branches / trunk @ 2.7m	·		Logged by: MHD Input by: MHD Checked by: JSM Verified by: JK
Last Ge				Sheet 1 of 1

Elevation (m)

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Aureon (New Zealand) Limited Unit 1, 150 Cavendish Rd PO BOX 1061 Christchurch 8140 New Zealand Telephon

## Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN

New Zeal www.aure Email: ch	land econgroup.com hristchurch@ap.a	Telepho Facsimil aurecongroup	ne: +64 3 366 0821 e: +64 3 379 6955 o.com	Proje	ct Referen	ce: <b>224464</b>				S	heet 1 of 1
TEST PIT Excavator Test Pit D Contracto	r Type: 25 Dimensions Dir: Texco	ATION 5t Excav	ator		<b>CO-ORDINATE</b> Easting: Northing: Ground Level:	E <b>S NZTM</b> 1559166 m 5168014 m N/A		Date Started: 10/19/20 Date Completed: 10/19/20	11 11	Logged by: Input by: Checked by: Verified by:	MHD MHD JSM JK
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests			Soil Descriptio	n		Elevation (m)
-			$\frac{\sqrt{h_{f}}}{h_{f}} \frac{\sqrt{h_{f}}}{\sqrt{h_{f}}} \frac{\sqrt{h_{f}}}{\sqrt{h_{f}}}$			TOPSOIL SI plasticity.	ILT with sor	ne rootlets; Dark Brown	n. Soft. Moist to	wet. Low	
0.5 –						Silty SAND; Moist. Sand	Light yellow fine to med	v brown with some oran ium grained.	nge brown mott	ling. Loose.	
- - 1.0 — -	-										
1.5 – -											
2.0 — -											
- 2.5 - - -			× × × × × × × × × × × × × × × × × × ×			2.70 Clayey SILT	with some	tree matter; Light blue	grey. Firm to st	iff. Wet. High	
3.0 — -	-					3.30 Silty SAND:	Light blue o	urey Dense Wet San	t fine to mediur	ngrained	
3.5 – -	-					Sity SAND,		iey. Dense. Wet. San		n graineu.	
۔ +.0 —			× × × × × × × × × × × × × × ×								
4.5 –			×···×···×·			End of Test	Pit at 4.5m	(Pit Collapse)			
5.0 —	- - - -										
Remark	s: water see	page @	2.7m						Log Inpu Che Veri	ged by: MH it by: MH cked by: JSI fied by: JK	ID ID M
										Sh	neet 1 of 1

Aureon (New Zealand) Limited Unit 1, 150 Cavendish Rd PO BOX 1061 Christchurch 8140 New Zealand www.aurecongroup.com Telephor

### Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN Telephone: +64 3 366 0821 Economical 4 4 3 376 0855 Project Reference: 224464

**TP60** 

www.aurec Email: chri	ongroup.com istchurch@ap.a	Facsimile urecongroup.	e: +64 3 379 6955 .com	FIUJEC	( iveletein	JC. <b>224404</b>		Sheet	1 of 1
TEST PIT Excavator Test Pit Di Contractor	INFORM/ Type: 28 mensions : Texco	ATION 5t Excava :	ator		CO-ORDINATE Easting: Northing: Ground Level:	<b>S NZTM</b> 1559133 m 5167951 m N/A	Date Started: 10/19/2011 Date Completed: 10/19/2011	Logged by: MHE Input by: MHE Checked by: JSM Verified by: JK	) ) 
		1				1			
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests		Soil Description		Elevation (m)
-			<u> \. \. \. \. \. \. \. \. \. \. \. \. \. </u>			TOPSOIL SILT with so plasticity.	me rootlets; Dark Brown. Soft. M	oist to wet. Low	
0.5 -						<sup>0.30</sup> Silty SAND; Light yello Moist. Sand fine to me	w brown with some orange browr dium grained.	n mottling. Loose.	
1.0 —			× × × × × × × × × × × ×						
1.5 -			× × × × × × × × × × × × × ×						
2.0 —			× × × × × × × × × × × ×			2.30			
2.5 -						SAND; Orange brown.	medium dense. Wet. Sand is fine	e to coarse grained.	
3.0 —			× - × - × - × - × - × - × - × - × - × -			Clayey SILT with some plasticity.	tree matter; Light blue grey. Firn	n to stiff. Wet. High	
3.5 -			* * * × * * × * * × * × *			3.60 Silty SAND; Light blue	grey. Dense. Wet. Sand fine to r	nedium grained.	-
4.0 —			× × × × × × × × × × × × × × ×						
4.5 -			× × × ×			4.50 End of Test Pit at 4.5m	ı (Pit Collapse)		
5.0 —									
Remarks Tree brai No grour	:: nches @ ndwater e	3.6m	ered		-	1		Logged by: MHD Input by: MHD Checked by: JSM Verified by: JK	

Database File: TEST PITS.GPJ, Library: COPY OF CHCH LI<mark>BRARY FEB 2011.GLB, Data tempate: CHCH DATA TEMPLATE NOV 2010.GDT, Last Generated: 339/2012.</u></mark>

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# Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN Project Reference: 224464

Email: christchurch@ap.au	recongroup.com	6955 <b>1 10 JC</b>		C. <b>224404</b>		Sheet 1 o
ST PIT INFORMA cavator Type: 25t	TION t Excavator		CO-ORDINATE Easting:	<b>5 NZTM</b> 559266 m	Date Started: 10/19/2011 Date Completed: 10/19/2011	Logged by: MHD Input by: MHD Checked by: ISM
ractor: Texco			Ground Level: N	I/A		Verified by: JK
Depth (m) Sample	Water Level (m) Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests		Soil Description	
-	<u>ir</u> <u>v</u> <u>v</u>	<u>1/- X</u> - <u>X 1/-</u>		TOPSOIL SIL plasticity.	T with some rootlets; Dark Brown. Soft. Mo	ist to wet. Low
		· · · · · · · · · · · · · · · · · · ·		Silty SAND; Li Moist. Sand fir	ght yellow brown with some orange brown ne to medium grained.	mottling. Loose.
		× * *				
		× . 				
-		× : × : : × : : × : : × : : × : : × : : : : : : : : : : : : : : : : :		2.80		
- 	× - × - × - × - × - × - × - × - × - × -	- × - × - × - ×		Clayey SILT w plasticity.	rith some tree matter; Light blue grey. Firm	to stiff. Wet. High
		- - - - - - - - - - - - - - - - - - -		3.60 Silty sandy GR 3.80 Gravel fine to	RAVEL; Light yellow brown. Medium dense coarse grained. Sub rounded. Sand fine to	to dense. Wet.
-	<u> </u>			End of Test Pi	t at 3.8m (GW Reached)	
narks:	page @ 2.8m					Logged by: MHD Input by: MHD Checked by: JSM Vorified by: JSM
undwater enco	ountered @ 3.8	m				Sheet 1 of

Aurecon (New Zealand) Limited Unit 1, 150 Cavendish Rd POBOX 1061 Christchurch 8140

## FULTON HOGAN LAND DEVELOPMENT Client: Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN

New Zeala www.aure Email: ch	and congroup.com ristchurch@ap.a	Telephon Facsimile urecongroup	e: +64 3 366 0821 e: +64 3 379 6955 .com	Project	t Reference	ce: <b>224464</b>				Sheet	1 of 1
TEST PIT Excavator Test Pit D Contracto	INFORMA Type: 25 imensions r: Texco	TION t Excave	ator		CO-ORDINATE Easting: Northing: Ground Level: 1	<b>S NZTM</b> 1559395 m 5167934 m N/A		Date Started: 10/19/2011 Date Completed: 10/19/2011		Logged by: MHD Input by: MHD Checked by: JSM Verified by: JK	)
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests			Soil Description			Elevation (m)
0.5 - - - 1.0 - - - - - - - - - - - - - - - - - - -						TOPSOIL SILT plasticity. <sup>0.30</sup> Silty SAND; Lig Moist. Sand fine	with son	ne rootlets; Dark Brown. Soft. M	n mottling	t. Loose.	
2.5 -			× × × × × × × × × × × × × × × × × × ×			2.60 Clayey SILT wit	h some :	ree matter; Light blue grey. Soft	. Wet. Hi	gh plasticity.	
3.0 — -			× × × × × × × × × × × × × × ×			3.00 Silty SAND; Ligi	ht blue g	rey. Dense. Wet. Sand fine to r	edium gr	ained.	
3.5 -		Ţ	· · · · · · · · · · · · · · · · · · ·			3.60 End of Test Pit a	at 3.6m	(GW Reached)			
4.0 —											
4.5 - -											
5.0 —											
Remarks	s: vater enco	ountere	d @ 3.6m						Logged Input by Checke Verified	by: MHD r: MHD d by: JSM by: JK	

Database File: TEST PITS.GPJ, Library: COPY OF CHCH LIBRARY FEB 2011.GLB, Data lemplate: CHCH DATA TEMPLATE NOV 2010.GDT, Last Generated: 3302.2012.

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Aureon (New Zealand) Limited Unit 1, 150 Cavendish Rd PO BOX 1061 Christhurok 1410 New Zealand Telephon United Auronation (Telephon one: +64 3 366 0821

# Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN Project Reference: 224464

PIT INFORMATION				
ator Type: 25t Excavator it Dimensions: actor: Texco	CO-ORDINATE Easting: Northing: Ground Level: N	<b>S NZTM</b> 1559402 m 5168010 m V/A	Date Started: 10/19/2011 Date Completed: 10/19/2011	Logged by: MHD Input by: MHD Checked by: JSM Verified by: JK
Sample Water Level (m) Graphic Log	Shear Vane Tests Pocket Penetrometer Tests		Soil Description	Elevation (m)
$\frac{\langle v_1 v_2, v_1 v_3, v_4 v_4 \rangle}{\langle v_1 v_2, v_4 v_4, v_4 v_4 \rangle} = \frac{\langle v_1 v_2, v_4 v_4 v_4 \rangle}{\langle v_1 v_2, v_4 v_4 v_4 v_4 v_4 v_4 v_4 v_4 v_4 v_4$		TOPSOIL SILT plasticity.	with some rootlets; Dark Brown. Soft. Mo	bist to wet. Low
		Silty SAND; Lig Moist. Sand fir	ght yellow brown with some orange brown e to medium grained.	n mottling. Loose.
		2.80		
		Cla <mark>yey SILT w</mark> plasticity.	ith some tree matter; Light blue grey. Firm	n to stiff. Wet. High
		3.60 Silty Sandy GF	RAVEL; Light brown. Dense. Saturated. G ounded. Sand fine to coarse grained.	ravel fine to coarse
		End of Test Pit	t at 3.8m (GW Reached)	
arks: ndwater seepage @ 2.8m				Logged by: MHD Input by: MHD Checked by: JSM Varified by: JK
nawater encountered @ 3.8m				Sheet 1 of 1

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## Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN Telephone: +64 3 366 0821 Economical 4 4 3 376 0855 Project Reference: 224464

Sh + 1 - - - -

TEST PIT Excavator Test Pit D Contracto	ristchurch@ap.a <b>INFORM/</b> Type: 25 imensions r: Texco	Facsimile urecongroup ATION 5t Excav	a: +64 3 379 6955 .com ator		CO-ORDINATI Easting: Northing: Ground Level:	ES NZTM 1559395 m 5168079 m N/A		Date Started: 10/19/2011 Date Completed: 10/19/2011		Logged by: Input by: Checked by: Verified by:	MHD MHD JSM JK
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests			Soil Description			Elevation (m)
0.5 -			$\begin{array}{c c} & & & & \\ \hline \hline & & \\ \hline \hline & & \\ \hline \\ \hline$			TOPSOIL S plasticity. <sup>0.30</sup> Silty SAND Moist. San	SILT with sol D; Light yellov Ind fine to med	ne rootlets; Dark Brown. S v brown with some orange lium grained.	Soft. Moist to brown mottli	wet. Low ng. Loose.	
1.0 —											
1.5 – 2.0 –											
- - 2.5 - -			× × × × × × × × × × × × × × × × × × ×			Clayey SIL plasticity.	T with some.	tree matter; Light blue gre	ey. Firm to stif	f. Wet. High	
3.0 —			× × × × × × × × × × ×			Silty SAND medium gr	D with minor trained.	ree matter; Light blue grey	y. Dense. We	t. Sand fine t	to
3.5 -		Ţ				grained. Si 360 End of Tes	at Pit at 3.6m	(GW Reached)	ed.		
4.0 — -											
4.5 -											
5.0 —											
Remarks	s: water enco	ountere	u I		1	1			Logg Input Chec Verifi	ed by: MH by: MH ked by: JSI ed by: JK	ID ID M
										Sh	eet 1 of 1

## aurecon

## Client: FULTON HOGAN LAND DEVELOPMENT

Aureon ( Unit 1, 15 PO BOX Christchu New Zeal www.aure Email: ch TEST PIT Excavator Test Pit D Controctor	New Zealand) Lin 00 Cavendish Rd 1061 rch 8140 and rch 8140 and rongroup.com ristchurch @ap.a <b>TINFORMA</b> Type: 25 Dimensions:	Telephor Facsimile urecongroup ATION of Excave	ie: +64 3 366 0821 x: +64 3 379 6955 com ator	Client: Project Locatio Project	FULTO Name: on: SEE P Reference Co-ORDINATE: Sorthing:	N HOGAN LAND DE ROSEMERRYN RESI PLAN ce: 224464 S NZTM 1559600 m 5167990 m	Date Started: 10/19/2011 Date Completed: 10/19/2011	TP6 Sheet 1 Logged by: MHD Input by: MHD Checked by: JSM	of 1
Contracto	I. TEXCO				Siduna Level. 1	VA		Venned by. JK	
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests		Soil Description		Elevation (m)
-			NI NI NI			TOPSOIL SILT with so plasticity.	me rootlets; Dark Brown. Soft. Mc	bist to wet. Low	
0.5 -						<sup>0.30</sup> Silty SAND; Light yello Moist. Sand fine to me	w brown with some orange brown dium grained.	mottling. Loose.	
1.0 —			× × × × × × × × × × × ×						
1.5 -									
2.0 —			* * * * * *			2.20			
2.5 -				Shear vane at 2.2m: 60/30kPa /kPa /kPa	Pocket Penetrometer at 2.2m: kN/m <sup>2</sup>	Clayey SILT with some plasticity.	tree matter; Light blue grey. Firm	to Stiff. Wet. High	
3.0 —			× × × × × × × × × × × ×			Silty SAND with minor medium grained.	tree matter; Light blue grey. Dens	e. Wet. Sand fine to	
3.5 -		Ţ	× × × × • · · · · · · · · · · · · · · · · · · ·			Silty Sandy GRAVEL; 3.60 grained. Sub rounded.	ight brown. Dense. Saturated. Gr Sand fine to coarse grained. (GW Reached)	avel fine to coarse	
-									

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4.0

4.5

5.0

Remarks:

Groundwater seepage @ 1.7m Groundwater encountered @ 3.6m

MHD MHD JSM JK Logged by: Input by: Checked by: Verified by:

Sheet 1 of 1

Database File: TEST PITS.GPJ, Library: COPY OF CHCH LIBRARY FEB 2011.GLB, Data tempate: CHCH DATA TEMPLATE NOV 2010.GDT, Last Generated: 3/30/2012.

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Caureon (New Zealand) Limited Unit 1, 150 Cavendish Rd PO BOX 1061 Christchurch 8140

## Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN

New Zeala www.aureo Email: chr	nd congroup.com istchurch@ap.a	Telephon Facsimile urecongroup	e: +64 3 366 0821 e: +64 3 379 6955 .com	Project	Referenc	ce: <b>224464</b>		S	Sheet 1 of 1
TEST PIT Excavator Test Pit Di Contractor	INFORMA Type: 25 imensions r: Texco	ATION 5t Excave	ator		CO-ORDINATE Easting: Northing: Ground Level: 1	<b>S NZTM</b> 1559491 m 5167958 m WA	Date Started: 10/19/2011 Date Completed: 10/19/2011	Logged by: Input by: Checked by: Verified by:	MHD MHD : JSM JK
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests		Soil Description		Elevation (m)
0.5 -			<u> </u>			TOPSOIL SILT with so plasticity. <sup>0.40</sup> Silty SAND; Light yello Moist, Sand fine to me	me rootlets; Dark Brown. Soft. M w brown with some orange brown	oist to wet. Low	
1.0 —							an gran can		
1.5 -									
2.0 —			× × × × * × × × × × × × × × × × × × × ×	Shear vane at	Pocket	<sup>2.30</sup> Clavev SILT with some	tree matter: Light blue grey. Firr	n to stiff. Wet. Hiah	
2.5 -			× × × × × * × × × × * × × × × * × × ×	2.3m: 60/30kPa /kPa /kPa	Penetrometer at 2.3m: kN/m <sup>2</sup>	plasticity.		J.	
3.0 —		•				320 Silty Sandy GRAVEL; I grained. Sub rounded.	ight brown. Dense. Saturated. G Sand fine to coarse grained.	Gravel fine to coarse	9
3.5 -		<u> </u>				End of Test Pit at 3.5m	(GW Reached)		
4.0 -									
4.5 -									
5.0 —									
Remarks Tree bra Groundw	s: nches @ vater enco	3.0m ountere	l d @ 3.5m	<u> </u>				Logged by: MH Input by: MH Checked by: JS Verified by: JK	ID ID M neet <b>1</b> of <b>1</b>
								1	

Aureon (New Zealand) Limited Unit 1, 150 Cavendish Rd PO BOX 1061 Christchurch 8140 New Zealand Telephor

# Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN

New Zeala www.aure Email: ch	and congroup.com ristchurch@ap.a	Telephor Facsimil	10: +64 3 366 0821 e: +64 3 379 6955 0.com	Proje	ct Referen	ce: <b>224464</b>					Sł	neet 1 of 1
TEST PIT Excavator Test Pit D Contracto	INFORM Type: 28 imensions r: Texco	ATION 5t Excav	ator		<b>CO-ORDINATE</b> Easting: Northing: Ground Level:	E <b>S NZTM</b> 1559454 m 5167843 m N/A		Date Started: 10 Date Completed: 10	)/19/2011 )/19/2011	Lo Inp Ch Ve	ogged by: put by: necked by: erified by:	MHD MHD JSM JK
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests			Soil Desc	ription			Elevation (m)
			$\frac{\sqrt{h_{f}}}{h_{f}} \frac{\sqrt{h_{f}}}{\sqrt{h_{f}}} \frac{\sqrt{h_{f}}}{\sqrt{h_{f}}}$			TOPSOIL SILT plasticity.	Γ with som	e rootlets; Dark	Brown. Soft. M	oist to wet.	Low	
).5 -						Silty SAND; Lig Moist. Sand fine	ght yellow ne to medi	brown with som um grained.	e orange browr	n mottling. L	_00Se.	
.0 —			× × × × × × × × × × × ×									
.5 -												
.0			× × × × × × × × × × × × × × × × × × ×			2.20 SILT with minor	or sand; Li	ght yellow browr	with orange b	rown mottlir	ng. Firm.	
2.5 -			× × × × × × × × × × - × - × - × -			Wet. Low plasti 2.60 Clayey SILT wit plasticity.	ticity. Sand	fine to medium	grained	n to stiff. We	et. High	
.0 — -			× × × × × × ×			3 30						
i.5 –						Silty SAND with medium grained	h minor tre ed.	ee matter; Light	blue grey. Dens	se. Wet. Sa	nd fine to	0
- - 0 -			×···×··×· ×···×··×· ×···×··×· ×···×··×· *···×··×·			4.20 End of Test Pit	t at 4.2m (	Pit Collapse)				
.5 -												
;.0 —												
Remarks	s: ndwater e	encount	ered							Logged by Input by: Checked Verified b	y: MHI MHI by: JSM y: JK	
											She	eet 1 of 1

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Aureon (New Zealand) Limited Unit 1, 150 Cavendish Rd PO BOX 1061 Christchurch 8140 New Zealand Telephor

# Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN

New Zea www.aun Email: cl	land econgroup.com hristchurch@ap.a	Telepho Facsimil urecongroup	ne: +64 3 366 0821 e: +64 3 379 6955 com	Proje	ct Referen	ce: <b>224464</b>	Ļ			S	Sheet 1 of 1
TEST PIT Excavato Test Pit D Contracto	<b>FINFORMA</b> r Type: 25 Dimensions pr: Texco	ATION 5t Excav	rator		<b>CO-ORDINATI</b> Easting: Northing: Ground Level:	E <b>S NZTM</b> 1559412 m 5167697 m N/A		Date Started: 1 Date Completed: 1	0/19/2011 0/19/2011	Logged by: Input by: Checked by: Verified by:	MHD MHD JSM JK
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests			Soil Des	cription		Elevation (m)
			NI NI SI			TOPSOIL	L SILT with sor	ne rootlets; Dark	Brown. Soft. We	et. Low plasticity.	
0.5 -	-					Silty SAN Saturated	ND; Light yellov d. Sand fine to	v brown with son medium grainec	ne orange brown I.	mottling. Loose.	
1.0 —	-										
1.5 -	-		× × × × × × × × × × × ×								
2.0 —			× × × × × × × × × × × × × × ×								
2.5 -	-					2.80					
3.0 —	-		x x x x x x x x x x x x x x x x x x x			Clayey S Saturated	ILT with some d. High plastici	fibrous dark brov ty.	wn peat; Light blu	ue grey. Firm to sti	ff.
3.5 -	-		^ * * × × * × × × × × × × × × · × ×								
4.0 —	-		- × - × - × - × - × - × - × - × - × - ×								
4.5 -	-		× × × ×			4.50 End of Te	est Pit at 4.5m	(Pit Collapse)			
5.0 —											
	-										
Remark Ground <sup>e</sup>	s: water see	page @	9 0.6m							Logged by: MH Input by: MH Checked by: JSI Verified by: JK	iD ID M
										Sh	neet 1 of 1

Aureon (New Zealand) Limited Unit 1, 150 Cavendish Rd PO BOX 1061 Christchurch 8140 New Zealand Telephon Facsimil

# Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN

www.aurecongroup.com Facsimile: +64 3 379 6955 Email: christchurch@ap.aurecongroup.com			Project Reference: 224464 She						
TEST PIT I Excavator 7 Test Pit Din Contractor:	NFORMA Type: 25 nensions: Texco	TION t Excave	ator		CO-ORDINATES Easting: 1 Northing: 5 Ground Level: N	<b>S NZTM</b> 1559467 m 5167685 m V/A	Date Started: 10/19/2011 Date Completed: 10/19/2011	Logged by: MHE Input by: MHE Checked by: JSM Verified by: JK	)
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests		Soil Description		Elevation (m)
0.5 -			1     1     1       1     1       1 <td></td> <td></td> <td>TOPSOIL SILT with so plasticity. <sup>0.30</sup> Silty SAND; Light yellor Saturated. Sand fine to <sup>1.80</sup> SAND with trace of silt;</td> <td>me rootlets; Dark Brown. Soft. Sa w brown with some orange browr o medium grained.</td> <td>aturated. Low n mottling. Loose. ed. Sand fine to</td> <td></td>			TOPSOIL SILT with so plasticity. <sup>0.30</sup> Silty SAND; Light yellor Saturated. Sand fine to <sup>1.80</sup> SAND with trace of silt;	me rootlets; Dark Brown. Soft. Sa w brown with some orange browr o medium grained.	aturated. Low n mottling. Loose. ed. Sand fine to	
2.0		¥				medium grained.			
3.5 -			x 'x 'x 'x 'x 'x 'x' x' x' x' x' x' x' x			Clayey SIL I with some High plasticity.	tree matter; Light blue grey. Firm	to stiff. Saturated.	
4.5 -			<u> </u>			End of Test Pit at 4.5m	(GW Reached)		
Remarks: Groundwa	ater encc	ountere	d @ 3.3m					Logged by: MHD Input by: MHD Checked by: JSM Verified by: JK	

Database File: TEST PITS.GPJ, Library: COPY OF CHCH LI<mark>BRARY FEB 2011;GLB, Data template: CHCH DATA TEMPLATE NOV 2010;GDT, Last Generates: 3/30/2012.</u></mark>
# Aureon (New Zealand) Limited Unit 1, 150 Cavendish Rd PO BOX 1061 Chiardanove 94(40)

Last Generated: 3/30/2012 4:23:20 PM

# Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN

Christchu New Zeal: www.aure Email: ch	rch 8140 and congroup.com ristchurch@ap.a	Telepho Facsimil	ne: +64 3 366 0821 e: +64 3 379 6955	Projec	ct Reference	ce: 224464			She	et 1 of 1
TEST PIT Excavator Test Pit D Contracto	Type: 25 Type: 25 imensions r: Texco	TION t Excav	ator		CO-ORDINATE Easting: Northing: Ground Level:	<b>S NZTM</b> 1559470 m 5167777 m N/A		Date Started: 10/19/2011 Date Completed: 10/19/2011	Logged by: MI Input by: Mi Checked by: JS Verified by: Jr	HD HD SM K
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests			Soil Description		Elevation (m)
-			<u>\\</u> <u>\</u> <u>\</u> \ <u>\</u> \\ \ \ \ \ \ \ \ \ \ \			TOPSOIL SIL plasticity.	T with sor	ne rootlets; Dark Brown. Soft. S	aturated. Low	
0.5 -			× × × × × × × × × × × × × × × × × ×			Silty SAND; L Saturated. Sa	ight yellov and fine to	v brown with some orange brow medium grained.	n mottling. Loose.	
1.0										
2.0 —			× × × × × × × × × × × × × × × × × × ×			<sup>2.10</sup> Clayey SILT v High plasticity	with some y.	tree matter; Light blue grey. Firr	n to stiff. Saturated.	_
2.5 -						<sup>2.60</sup> Silty SAND wi fine to mediur	ith some t m grained	ree matter; Light blue grey. Den	se. Saturated. Sand	_
3.0 —										
3.5 -		Ţ	* * * * * * * * * * * * * * *			3.80 Fnd of Test P	Pit at 3.8m	(GW Reached)		
4.0 —								(,		
4.5 -										
5.0 —										
Remarks	s: water seep	bage @	2.1m d @ 3.8m						Logged by: MHD Input by: MHD Checked by: JSM Verified by: JK	

Database File: TEST PITS.GPJ, Library: COPY OF CHCH LIBRARY FEB 2011.GLB, Data template: CHCH DATA TEMPLATE NOV 2010.GDT, Last Generated: 3730/2012.

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### Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN Telephone: +64 3 366 0821 Project Reference: 224464

www.aurecong Email: christch	group.com hurch@ap.au	Facsimile recongroup.	: +64 3 379 6955 com	FIUJE		JE. <b>224404</b>		Shee	et 1 of 1
TEST PIT INI Excavator Ty Test Pit Dime Contractor:	PORMA /pe: 25 ensions: Texco	TION Excava	ator		CO-ORDINATE Easting: Northing: Ground Level:	<b>S NZTM</b> 1559516 m 5167759 m N/A	Date Started: 10/19/2011 Date Completed: 10/19/2011	Logged by: Mi Input by: Mi Checked by: JS Verified by: Jk	HD HD SM
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests		Soil Description		Elevation (m)
0.5 -						TOPSOIL SILT with plasticity. <sup>0.30</sup> Silty SAND; Light y Moist. Sand fine to	n some rootlets; Dark Brown. Soft. S ellow brown with some orange brow medium grained.	aturated. Low	
2.0						<sup>1,80</sup> SAND with trace of 200 fine to medium grai Clayey SILT with so Wet. High plasticity	silt; Light blue grey. Medium dense ined. ome fibrous dark brown peat; Light b v.	. Moist to wet. Sand plue grey. Firm to stiff.	_
3.0 —			× × × × × ×			medium grained.			
3.5 -			× × × × × × × × × × × × × × ×						
4.0			····×····×· ×····×···			End of Test Pit at 4	m (Pit Collapse)		
4.5									
5.0 -									
Remarks: Groundwate	ter seep	age @	2.0		- 1			Logged by: MHD Input by: MHD Checked by: JSM Verified by: JK Shee	t 1 of 1

Last Generated: 3/30/2012 4:23:25 PM

Aureon (New Zealand) Limited Unit 1, 150 Cavendish Rd PO BOX 1061 Christchurch 8140 New Zealand Telephor

# Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN

**TP72** 

Database File: TEST PITS.GPJ, Library: COPY OF CHCH LIBRARY FEB 2011.GEB, Data template: CHCH DATA TEMPLATE NOV 2010.GDT, Last Generated: 330/2012.

New Zealar www.aurec Email: chri	id ongroup.com stchurch@ap.ai	Telephon Facsimile	e: +64 3 366 0821 e: +64 3 379 6955 .com	Projec	t Referenc	ce: <b>224464</b>					Sh	eet 1 of 1
TEST PIT Excavator Test Pit Dir Contractor	NFORMA Type: 25 mensions: Texco	ATION it Excave	ator		CO-ORDINATE Easting: Northing: Ground Level: 1	<b>S NZTM</b> 1559471 m 5167648 m N/A		Date Started: 10/ Date Completed: 10/	'20/2011 '20/2011	Logg Input Chec Verifi	ed by: by: ked by: ed by:	MHD MHD JSM JK
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests			Soil Desci	ription			Elevation (m)
0.5 -						TOPSOIL SILT plasticity. <sup>0.30</sup> Silty SAND; Lic Moist. Sand fin	「with son ght yellow ne to med	ne rootlets; Dark E v brown with some lium grained.	Brown. Soft. Sa	mottling. Low	ose.	
1.0			× × × × × × × × × × ×			120 SAND with a tr Wet. Sand fine	race of gr	avel; Orange brov um grained. Grave	vn with grey mo	ottling. Mediu	m den:	se.
1.5 -						1.80		-	-			
2.0 —			x x x x x x x x x x x x x x x x x x x	Shear vane at 1.8m: 33/18kPa /kPa /kPa	Pocket Penetrometer at 1.8m: kN/m <sup>2</sup>	Clayey Sandy S High plasticity.	SILT with Sand find	some tree matter e to medium grain	; Light blue gre led.	ey. Firm to stit	f. Wet	
2.5 -			* * * * *									
3.0 -			x x x x x x x x x x x x x x x x x x x									
3.5 -			× × × × × × × × × × × × × × × × × × ×									
4.0 —						End of Test Pit	t at 4m (P	rit Collapse)				
4.5 -												
5.0 -												
Remarks Groundw Groundw	ater seep ater seep	bage @ bage @	0.6m 1.8m			1				Logged by: Input by: Checked by Verified by:	MHI MHI : JSM JK	) ) 
											She	et 1 of 1

# Aurecon (New Zealand) Limited Unit 1, 150 Cavendish Rd

Last Generated: 3/30/2012 4:23:26 PM

# Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION

Christchurd New Zealan www.aureco	61 h 8140 d ongroup.com	Telephor Facsimilr	ne: +64 3 366 0821 e: +64 3 379 6955	Locati Projec	on: SEE F	<b>2LAN</b> ce: <b>224464</b>					S	heet 1 of 1
TEST PIT I Excavator Test Pit Dir Contractor:	NFORMA Type: 25 mensions: Texco	TION	ator		CO-ORDINATE Easting: Northing: Ground Level:	<b>S NZTM</b> 1559580 m 5167562 m N/A		Date Started: 1 Date Completed: 1	0/20/2011 0/20/2011	Log Inp Ch Ve	gged by: out by: ecked by: rified by:	MHD MHD JSM JK
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests			Soil Des	cription			Elevation (m)
			$\frac{\sqrt{h}}{h} = \frac{\sqrt{h}}{\sqrt{h}} = \frac{\sqrt{h}}{\sqrt{h}}$			TOPSOIL SIL plasticity.	_T with sor	ne rootlets; Dark	Brown. Soft. M	oist to wet. I	Low	
0.5 -			× × × × × × × × × × × × × ×	Shear vane a 0.3m: 74/33kPa /kPa /kPa	at Pocket Penetrometer at 0.3m: kN/m <sup>2</sup>	SILT; Light gr	rey with ora	ange brown mott	ling. Stiff. Moist	to wet. Low	r plastici	ity.
1.0 —			× × × × × × × × × × × × × ×									
1.5 -												
2.0 —			^ × × × × × × × × × × × × × × × × × × ×	Shear vane a 2m: 53/30kPa /kPa /kPa	at Pocket Penetrometer at 2m: kN/m <sup>2</sup>	<sup>2.00</sup> Clayey SILT v plasticity.	with some	tree matter; Ligh	t blue grey. Firn	n to stiff. We	et. High	
2.5 -			^									
3.0 —			× × × × × × × × × × × × × × × × × × ×									
3.5 -												
4.0 —		Ţ				4.20 End of Test P	Pit at 4.2m	(GW Reached)				
4.5 -								(,				
5.0 —												
Remarks: Groundwa	ater seep ater enco	bage @ buntere	1.3m d @ 4.2m							Logged by Input by: Checked I Verified by	y: MH MH by: JSI y: JK	

Last Generated: 3/30/2012 4:23:27 PM

Aureon (New Zealand) Limited Unit 1, 150 Cavendish Rd PO BOX 1061 Christedwurch R140

### FULTON HOGAN LAND DEVELOPMENT Client: Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN

Christchur New Zeala www.aure Email: chi	ch 8140 ind congroup.com ristchurch@ap.ar	Telephon Facsimile	e: +64 3 366 0821 e: +64 3 379 6955	Project	t Reference	ce: <b>224464</b>			Sheet 1 c	of <b>1</b>
TEST PIT Excavator Test Pit D Contractor	INFORMA Type: 25 imensions: r: Texco	ATION it Excave	ator		CO-ORDINATE Easting: Northing: Ground Level: 1	<b>S NZTM</b> 1559572 m 5167617 m N/A	Date Started: Date Completed:	10/20/2011 10/20/2011	Logged by: MHD Input by: MHD Checked by: JSM Verified by: JK	
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests		Soil Des	scription		Elevation (m)
0.5 -						TOPSOIL SILT v plasticity. <sup>0.30</sup> Silty SAND; Ligh Moist. Sand fine	vith some rootlets; Darl t yellow brown with sor to medium grained.	KBrown. Soft. Saturat	ed. Low tling. Loose.	
1.5 -			× × × × × × × × × × × × ×			SAND with a trac Wet. Sand fine to Silty SAND; Ligh Moist. Sand fine	ce of gravel; Orange br o medium grained. Gra t yellow brown with sor to medium grained.	own with grey mottling vel fine grained. ne orange brown mot	g. Medium dense. tling. Loose.	
2.5 -				Shear vane at 2.3m: 44/30kPa /kPa /kPa	Pocket Penetrometer at 2.3m: kN/m <sup>2</sup>	<sup>230</sup> Clayey Sandy SI plasticity. Sand f	LT with some tree matt ine to medium grained.	er; Light blue grey. Fi	rm. Wet. High	
3.0 —			* * * *			240				
3.5 -						End of Test Pit a	t 3.4m (Pit Collapse)			
4.0 —										
4.5 -										
5.0 —										
Remarks	s: vater seep	bage @	1.5m					Log Inpu Che Ver	iged by: MHD ut by: MHD ecked by: JSM ified by: JK	

Sheet 1 of 1

Database File: TEST PITS.GPJ, Library: COPY OF CHCH LIBRARY FEB 2011.GLB, Data template: CHCH DATA TEMPLATE NOV 2010.GDT, Last Generated: 3/30/2012.

Last Generated: 3/30/2012 4:23:28 PM

Aureon (New Zealand) Limited Unit 1, 150 Cavendish Rd PO BOX 1061 Christchurch 8140 New Zealand Telephor

# Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN

New Zeal www.aure Email: ch	land econgroup.com hristchurch@ap.a	Telephor Facsimile aurecongroup	1e: +64 3 366 0821 e: +64 3 379 6955 o.com	Proje	ct Referen	ce: <b>224464</b>				S	heet 1 of 1
TEST PIT Excavator Test Pit D Contracto	r Type: 25 Dimensions Dir: Texco	ATION it Excav	ator		<b>CO-ORDINATI</b> Easting: Northing: Ground Level:	E <b>S NZTM</b> 1559641 m 5167721 m N/A		Date Started: 10/20/2 Date Completed: 10/20/2	2011 2011	Logged by: Input by: Checked by: Verified by:	MHD MHD JSM JK
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests			Soil Descript	ion		Elevation (m)
	-		$\frac{\sqrt{I_2}}{\frac{\sqrt{I_2}}{\sqrt{I_2}}} \frac{\sqrt{I_2}}{\sqrt{I_2}} \frac{\sqrt{I_2}}{\sqrt{I_2}}$			TOPSOIL S plasticity.	GILT with sor	ne rootlets; Dark Bro	wn. Soft. Saturated	. Low	
0.5 — -	-		× × × × × × × × × × × × × × × × × × ×			SILT; Light y wet. Low pla	yellow brow asticity.	n with orange brown	mottling. Firm to sti	ff. Moist to	
1.0 — - -											
I.5 -	-		× × × × × × × × × × ×			Silty SAND; fine to medi	; Light grey v ium grained.	vith some orange bro	wn mottling. Firm.	Moist. Sand	
2.0 —						220 Clayey Sand	dy SILT with	some tree matter; Li	ight blue grey. Firm	to stiff. We	t.
2.5 – -	-					r ligh plastic	ny. Janu iin	e to medium grained			
3.0 — -						320 SAND with s fine to medi	some tree ro	oots and branches; L	ight blue grey. Den	se. Wet. Sa	ind
3.5 - -	-										
4.0 —	-					End of Test	t Pit at 4m (F	tit Collapse)			
1.5 - -	-										
5.0 —											
Remark: No grou	s: ndwater e	encount	ered.						Logge Input I Check Verifie	d by: MH by: MH ed by: JSI	
										Sh	eet 1 of 1

#### Client: FULTON HOGAN LAND DEVELOPMENT Aurecon (New Zealand) Limited Unit 1. 150 Cawandish Rd PO B0X 1081 New Zealand Dirischurch 8140 New Zealand New Zealand New Zealand New Zealand Telephone: +64 3 396 0821 Faschille: +64 3 376 0821 Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN

Sheet 1 of 1

Email: United and the gap date of group to an			
TEST PIT INFORMATION Excavator Type: 25t Excavator Test Pit Dimensions: Contractor: Texco	CO-ORDINATES NZTM Easting: 1559716 m Northing: 5167688 m Ground Level: N/A	Date Started: 10/20/2011 L Date Completed: 10/20/2011 II	.ogged by: MHD nput by: MHD Checked by: JSM /erified by: JK
ppth (m) ample r Level (m) phic Log	Pocket ometer Tests	Soil Description	

	Depth (m)	Sample	Water Level (m	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
	0.5	-		$\begin{array}{c} \begin{array}{c} \begin{array}{c} \begin{array}{c} \begin{array}{c} \begin{array}{c} \end{array} \\ \end{array} \\ \end{array} \\ \begin{array}{c} \begin{array}{c} \end{array} \\ \end{array} \\ \end{array} \\ \end{array} \\ \end{array} \\ \begin{array}{c} \end{array} \\ \end{array} \\ \end{array} \\ \end{array} \\ \begin{array}{c} \end{array} \\ \end{array} \\ \end{array} \\ \end{array} \\ \begin{array}{c} \end{array} \\ \end{array} \\ \end{array} \\ \begin{array}{c} \end{array} \\ \end{array} \\ \end{array} \\ \end{array} \\ \begin{array}{c} \end{array} \\ \end{array} \\ \end{array} \\ \end{array} \\ \end{array} \\ \begin{array}{c} \end{array} \\ \end{array} \\ \end{array} \\ \end{array} \\ \end{array} \\ \end{array} \\ \begin{array}{c} \end{array} \\ \end{array} $	Shear vane at 0.3m: 74/37kPa /kPa /kPa	Pocket Penetrometer at 0.3m: kN/m <sup>2</sup>	TOPSOIL SILT with some rootlets; Dark Brown. Soft. Moist. Low plasticity <sup>0.30</sup> SILT; Greyish white with some orange brown mottling. Stiff to very stiff. Mo Low plasticity.	pist.
	1.0 —	-		× × × × × × × × × × × ×				D
	1.5 -			× × × × × × × × × × × × × × ×				
	2.0 —			× ×			<ul> <li>SAND with traces of gravel; Orange brown. Medium dense. Moist to wet.</li> <li>Sand fine to coarse grained. Gravel fine grained.</li> </ul>	
	2.5 -	-			Shear vane at 2.4m: 44/33kPa /kPa /kPa	Pocket Penetrometer at 2.4m: kN/m <sup>2</sup>	Clayey Sandy SILT with some tree matter; Light blue grey. Firm to stiff. Saturated. High plasticity. Sand fine to medium grained.	
	3.0 —			* *			300 SAND with some tree roots and branches; Light blue grey. Dense. Saturat Sand fine to medium grained.	ed.
	3.5 -							
	4.0 —			<u></u>			End of Test Pit at 4m (Pit Collapse)	
	4.5 -							
1:23:28 PM	5.0	•						
Last Generated: 3/30/2012 4	Remark Ground	s: water see	page @	2.0m	1	<u> </u>	Logged by: Mi Input by: Mi Checked by: JS Verified by: Jk S	HD HD M heet <b>1</b> of <b>1</b>

### Aurceor (New Zealand) Limited Unit 1, 150 Cavadians Rd P 0 BOX 1061 Christhurch 8140 New Zaeland Telephone: #64 3 366 0821 www.aurecongroup.com Email: christhurch@ap.aurecongroup.com FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN

Sheet 1 of 1

Logged by: MHD Input by: MHD Checked by: JSM Verified by: JK

TEST PIT Excavato Test Pit D Contracto	r Type: 25 imensions or: Texco	ATION 5t Excava :	ator		CO-ORDINAT Easting: Northing: Ground Level:	<b>ES NZTM</b> 1559646 m 5167588 m N/A	Date Started: Date Completed:	10/20/2011 10/20/2011
		(m)	D	its	sts			

	Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
	-	-		1, <u>1, 1, 1</u> , 1			TOPSOIL SILT with some rootlets; Dark Brown. Soft. Moist. Low plasticity.	
	0.5 -	-		X X	Shear vane at 0.3m: 44/33kPa /kPa /kPa	Pocket Penetrometer at 0.3m: kN/m <sup>2</sup>	<sup>0.30</sup> Sandy SILT; Light yellow brown with orange brown mottling. Firm. Moist. Friable. Low plasticity. Sand fine to medium grained.	
	1.0	-					1.30	D
	1.5 -	-					SAND with a trace of gravel; Orange brown with grey mottling. Medium dense Wet. Sand fine to medium grained. Gravel fine grained.	
	2.0 —	-					<ul> <li>Sandy SILT; Light yellow brown with orange brown mottling. Firm. Moist to wet. Low plasticity. Sand fine to medium grained.</li> <li>210</li> <li>210</li> </ul>	
	2.5 –	-					SAND with some free roots and branches; Light blue grey. Dense. Wet. Sand fine to medium grained.	
	3.0 —	- - - - -		× - × - × - × - × - × - × - × - × - × -			<sup>300</sup> Clayey SILT with some tree matter; Light blue grey. Firm to stiff. Wet. Cohesive. High plasticity.	_
	3.5 -	-						
	4.0 —	-		× × × × - × -			End of Test Pit at 4m (Pit Collapse)	
	4.5 -							
:29 PM	5.0 —	-						
Last Generated: 3/30/2012 4:23	Remark Ground	s: water seep	page @	1.3m			Logged by: MHD Input by: MHD Checked by: JSM Verified by: JK Shee	1 of 1

#### Client: FULTON HOGAN LAND DEVELOPMENT Aurecon (New Zealand) Limited Unit 1. 150 Cawandish Rd PO B0X 1081 New Zealand Dirischurch 8140 New Zealand New Zealand New Zealand New Zealand Telephone: +64 3 396 0821 Faschille: +64 3 376 0821 Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN

Sheet 1 of 1

Logged by: MHD Input by: MHD Checked by: JSM Verified by: JK

TEST PIT Excavator Test Pit D Contractor	INFORM/ Type: 25 imensions r: Texco	ATION 5t Excava :	ator	CO-ORDINATI Easting: Jorthing: Ground Level:	E <b>S NZTM</b> 1559697 m 5167558 m N/A	Date Started: Date Completed:	10/20/2011 10/20/2011
		(		(0			

	Depth (m)	Sample	Water Level (m	Graphic Log	Shear Vane Tests	Pocket Penetrometer Test	Soil Description	Elevation (m)
	0.5	-		$\begin{array}{c} \underbrace{\langle \mathbf{r}_{1} \rangle}_{\mathbf{r}_{1}} \underbrace{\langle \mathbf{r}_{1} \rangle$	Shear vane at 0.3m: 98/33kPa /kPa /kPa	Pocket Penetrometer at 0.3m: kN/m <sup>2</sup>	TOPSOIL SILT with some rootlets; Dark Brown. Soft. Moist. Low plasticity. <sup>0.30</sup> SILT with trace of gravel; Greyish white with some orange brown mottling. Stiff to very stiff. Moist. Low plasticity. Gravel fine grained	
	1.0	-					<sup>1.10</sup> SAND with a trace of gravel; Orange brown with grey mottling. Medium dense. <sub>1.30</sub> Wet. Sand fine to medium grained. Gravel fine grained.	p
	1.5 – -	-					SAND; Light brown grey. Dense. Wet. Sand fine to medium grained.	
	2.0 —	- - - -					fine to medium grained.	
	2.5 -	-		× - × - × - × - × - × - × - × - × - × - ×			<sup>2.40</sup> Clayey SILT with some tree matter; Light blue grey. Firm to stiff. Wet. High plasticity.	
	3.0 —			* * * * * * * * * * * * * * *	-			
	3.5 -	-		× - × × -				
	4.0 —	-		× ~ × ~ × × ×	-		End of Test Pit at 4m (Pit Collapse)	
	4.5 -	1 - - -						
29 PM	5.0 —							
-ast Generated: 3/30/2012 4:23:	Remark Groundy Groundy	s: water seep	page @ page @	1.1m 2.4m		<u> </u>	Logged by: MHD Input by: MHD Checked by: JSM Verified by: JK Sheet 1	l of 1

#### Client: FULTON HOGAN LAND DEVELOPMENT Aurecon (New Zealand) Limited Unit 1. 150 Cawandish Rd PO B0X 1081 New Zealand Dirischurch 8140 New Zealand New Zealand New Zealand New Zealand Telephone: +64 3 396 0821 Faschille: +64 3 376 0821 Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN

Sheet 1 of 1

Logged by: MHD Input by: MHD Checked by: JSM Verified by: JK

TEST PIT Excavato Test Pit D Contracto	r Type: 25 imensions or: Texco	ATION 5t Excava ::	ator	CC Ea No Gi	D-ORDINATE asting: orthing: round Level:	<b>S NZTM</b> 1559753 m 5167717 m N/A	Date Started: Date Completed:	10/20/2011 10/20/2011
				1	1			
Ê		(m)	bo	ests	[ests			

	Depth (m)	Sample	Water Level (m	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description		Elevation (m)
		-					TOPSOIL SILT with some rootlets; Dark Brown. Soft. Me	oist. Low plasticity.	
	0.5 -	- - - -		× × × × × × × × × × × × × × × × × × ×	Shear vane at 0.3m: 163/44kPa /kPa /kPa	Pocket Penetrometer at 0.3m: kN/m <sup>2</sup>	<sup>0.30</sup> SILT; Light yellow with some orange brown mottling. Ve plasticity.	ry stiff. Moist. Low	
	1.0 —	-					120		p
	1.5 –	-					Silty SAND; Light yellow brown with some orange browr Moist. Sand fine to medium grained.	n mottling. Loose.	
	2.0 —	- - - -		× × × × × × × × × × × × × × × × × × ×			<sup>2.00</sup> SAND with some tree roots and branches; Light blue grafine to medium grained.	ey. Dense. Wet. Sand	
	2.5 -	-		x - x -			270 Clavey SILT with some tree matter: Light blue grey. Firm	n to stiff Wet High	-
	3.0 —	- - - - -					plasticity.	no dun viel rign	
	3.5 -	-	Ţ	× × ×			End of Test Pit at 3.5m (GW Reached)		
	4.0 —	- - - - -							
	4.5 -	-							
:23:30 PM	5.0 —	- - - - -							
ast Generated: 3/30/2012 4:	Remark Ground Ground	l ss: water seep water enco	page @ ountere	l 2.7m d @ 3.5m	1	1		Logged by: MHD Input by: MHD Checked by: JSM Verified by: JK	l of 1
Ľ								0.1001	

#### Client: FULTON HOGAN LAND DEVELOPMENT Aurecon (New Zealand) Limited Unit 1. 150 Cawandish Rd PO B0X 1081 New Zealand Dirischurch 8140 New Zealand New Zealand New Zealand New Zealand Telephone: +64 3 396 0821 Faschille: +64 3 376 0821 Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN

Sheet 1 of 1

Logged by: MHD Input by: MHD Checked by: JSM Verified by: JK

TEST PIT Excavator Test Pit D Contracto	Type: 25 imensions or: Texco	ATION 5t Excava ::	ator	Eas Noi Gro	-ORDINATE sting: rthing: bund Level:	E <b>S NZTM</b> 1559645 m 5167785 m N/A	Date Started: Date Completed:	10/20/2011 10/20/2011
			1					

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
	-		<u></u>			TOPSOIL SILT with some rootlets; Dark Brown. Soft. Moist. Low plasticity.	
0.5 -	-		$\begin{array}{cccccccccccccccccccccccccccccccccccc$	Shear vane at 0.3m: 100/44kPa /kPa /kPa	Pocket Penetrometer at 0.3m: kN/m <sup>2</sup>	<sup>0.30</sup> SILT; Light yellow with some orange brown mottling. Very stiff. Moist. Low plasticity.	_
1.0 —	-		× × × × × × × × × × × × × × ×			1.20	D
1.5 -	-		× × × × × × × × × × × × × × ×			Silty SAND; Light yellow brown with some orange brown mottling. Loose. Moist. Sand fine to medium grained.	
2.0 —	-		× × × ×			SAND with some tree roots and branches; Light blue grey. Dense. Wet. Sand fine to medium grained.	_
2.5 -	-						
3.0 —	-					<sup>2.90</sup> Clayey SILT with some tree matter; Light blue grey. Firm to stiff. Wet. High plasticity.	_
3.5 -	-	Ţ	^ * ^ × * * * * * × * * *			End of Test Pit at 3.6m (GW Reached)	_
4.0 —	-						
4.5 -	- - - -						
5.0 —	-						
	-						
Ground	s: water enc	ountere	d at 3.6m			Logged by: MHD Input by: MHD Checked by: JSM Verified by: JK	1 of 1
Ŭ						Sheet	1 01 1

## Client: FULTON HOGAN Project Name: ROSEMER Do BX 161 Christhurch 8140 New Zealand Wew Zealand Wew Zealand Email: Christhurch 8140 New Zealand Wew Zealand Email: Christhurch 8140 New Zealand Market H43 376 6061 Facsimile: H43 476 476 476 476 476 476 4 FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN RESIDENTIAL SUBDIVISION Location: SEE PLAN

Sheet 1 of 1

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Logged by: MHD Input by: MHD Checked by: JSM Verified by: JK

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TEST PIT Excavator Test Pit D Contracto	TINFORM/ r Type: 25 Dimensions pr: Texco	ATION 5t Excava ::	ator	CC Ea No Gi	D-ORDINATE Isting: orthing: ound Level:	<b>S NZTM</b> 1559316 m 5167821 m N/A	Date Started: Date Completed:	10/20/2011 10/20/2011
m)	Θ	el (m)	Log	Tests	r Tests			

	Depth (i	Sampl	Water Leve	Graphic I	Shear Vane	Penetrometer	Soil Description		Elevation
	0.5 -	-		$\begin{array}{c c} & & & \\ \hline \\$	Shear vane at 0.3m: 44/30kPa /kPa /kPa	Pocket Penetrometer at 0.3m: kN/m <sup>2</sup>	TOPSOIL SILT with some rootlets; Dark Brown. Soft. Mo <sup>0.30</sup> Silty SAND; Light yellow brown with some orange brown Moist. Sand fine to medium grained.	bist. Low plasticity.	
	1.0 —	-			Shear vane at 1m: 89/30kPa /kPa /kPa	Pocket Penetrometer at 1m: kN/m <sup>2</sup>	<sup>1.00</sup> SILT; Light yellow brown with orange brown mottling. Sti plasticity.	iff. Moist to wet. Low	,p
	1.5 -	-							
	2.0 —	-		× × × ×			<sup>200</sup> SAND; Grey. Medium dense. Wet. Sand fine to medium	grained.	
	2.5 -	-		× - × -	Shear vane at 2.7m:	Pocket Penetrometer	270 Clayey SILT with some tree matter; Light blue grey. Firm	n to stiff. Wet. High	_
	3.0 —	-			4//TokPa /kPa /kPa	kN/m <sup>2</sup>	prostory.		
	3.5 -	-							
	4.0 —	-		× _× _ × _ × _ × _ × _ × _ × _			End of Test Pit at 4.1m (Pit Collapse)		_
	4.5 -	-							
3:32 PM	5.0 —	- - - -							
Last Generated: 3/30/2012 4:2:	Remark Ground <sup>-</sup> Ground	] water seep water seep	page @ page @	2.0m 3.3m				Logged by: MHE Input by: MHE Checked by: JSM Verified by: JK She	) ) eet 1 of 1

# Appendix E Borehole Logs



aurecon Auracon (New Zealer, Unit 1, 150 Cevendial PO BOX 1061 Christchurch 8140 New Zealand d) Lim

### Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN FARM SUBDIVISION Location: SEE PLAN Project Reference: 224464

# **BH01**

+64 3 366 0821 +64 3 379 6955 Tel Fac www.aurecongroup.com Enseil: christohurch@ap.au bongn BOREHOLE INFORMATION

## CO-ORDINATES N/A

Sheet 1 of 1 .....

Drilli Dian Con	REHC ing M neter tracto	DLE I letho Core	NFOI d: C 8: 10 M	RMA1 AT 3 Omm cMilla	12 Tr 12 Tr an Dr	ack R illing	G CO-ORDINATES N/A Easting: N/A Northing: N/A Ground Level: N/A	Dat Dat Incli Orie	e Starl e Com ination entatio	ed: plete : n:	1! d: 1! 9	9/09// 9/09// )	2011 2011		Logged by: Input by: Checked by: Verified by:	JSM JSM JSM JK	
Method/Casing	Core Recovery (%)	Water Loss (%)	Groundwater Level (m)	R.L. (m)	Depth (m)	Graphic Log	Material Description		USC Description	Consistency/Density	Moisture	Sample	In-Situ Testing	Laboratory Testing	Notes	Backfill	Geological Unit
			Ţ		- 1		TOPSOIL SILT with trace sand and occai rootlets; Dark brown. Firm. Moist. Low pla Sand fine grained. SILT with minor sand; Yellow brown. Low Firm. Moist. Sand fine to medium grained Silty SAND; Yellow brown with orange bro Loose. Moist to wet. Sand fine to medium	isional asticity. plasticity. l. own mottles. n grained.	OL ML SM							Neverations (K	
WASH					- 3	× * * * * * * * * * * * * * * * * * * *	<ul> <li>Silty SAND; Dark blue grey. Loose. Moist Sand fine to medium grained.</li> <li>SILT with some sand: Dark blue grey. Low</li> </ul>	t to wet.	SM			D	SPT et 3m			CARACTER STORE	
					- 4	* × × × × × × ×	Stiff. Moist.		ML				N ≈ 5 1, 1/1, 1, 1, 2 450mm (SC)	5NIL			
					- 5		Borehole Terminated at 4.5m (Target Dep	th)						NO LABORATORY TES			
					- 6 - 7												
					8												
					9												
ethod C SA SA ASH 23 23 MLC	conc open solid hollo wash PQ T HQ T NQ Direc Dual	rete o barn stern v ster inple inple Triple C Triple Tube	core el nauge mauge Tube Tube Tube Tube ple Tu sh a (70m	ir jər be		Class Inorgan Inorgan Clayey Silty GF Poorty ( Well Gr Inorgan Inorgan ORGAN ORGAN ORGAN PEAT a Clayey	fifcation     Consistency     Soll Sa       c CLAYS indefium plasticity     VS very soft     B bull       c CLAYS indefium plasticity     S Soft     B ull       c CLAYS indefium plasticity     S Soft     B ull       GRAYEL     S Soft     U und       AYEL     S Stiff     If       add GRAYEL     H hard     Water       c Sill T low plasticity     C Clays existiff     V data       c Sill T low plasticity     Density     V at except to clays except to loose       C Sill T low plasticity     VL very loose     V at in loose       C Sill T low plasticity     MD medium dense     except to loose	Imples In Situ PP pe listurbed VS vs urbed SS sp SC sc HB ha avation Moistu avation D dry b dry main main fill and the state of the avation D dry b dry b dry the state of the state of the	Testin an pend ane she d. pen. blid con ammer nks und re	etrome etrome bound bound bound bound	ater cing vn wei		iraphic Log Topsoil SILT Silty SAND	Stough Baok	ni: 1 (,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	Mad Pips: 1	pípe

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	Enull BOREH Drilling Diameti Contrac	HOLLE Meth er Ca	E INF( nod: ore:	DRM CAT 100m McM	ATK 312 1m illan	NC NC Tra	ck Rlg	9	CO-ORDINA Easting: Northing: Ground Leve	<b>TES N/A</b> N/A N/A 91: N/A		Date Date Inclir Orier	e Star Con nation ntatio	ted: ipleted i: n:	16 d: 19 90	3/09/2 3/09/2 )	2011 2011		Logged by Input by: Checked by Verified by	JSM JSM y: JSM : JK	
	Method/Casing Core Recovery (%)		Water Loss (%)		Kili (m)	Depth (m)	Graphic Log	į	Ma	terlal Descripti	ion		USC Description	Consistency/Density	Moisture	Sample	In-Situ Testing	Laboratory Testing	Notes	Backfill	Geological Unit
ſ							<u>\$4</u> 5	TOPSOI rootlets;	L SILT with Dark brown	trace sand an . Firm. Moist.	d occaisional Low plasticity.		OL					1		×.	8
					•			SAND; C	Brey brown Moist. Sand	with orange br fine grained.	own mottles.	/	SP			1				ienti	
				7		1 2 3	× × × × × × × × × × × × × × × × × × ×	<sup>™</sup> SILT; Da	rk blue gre	y. Low plasticit	y. Stiff. Moist.		ML			В	SPTet3m. N=35				KOKOKOKOKOKOKOKOKOK
Me	thod		te con					Sandy G mottling. coarse g grained.	RAVEL: Da Dense. We rained and	rk grey with or it to saturated. rounded. Sanc	ange brown Gravel fine to I fine to mediun Soll Samples B bulk	n Situ PP p	GW	ng	eter		N = 35 6, 9/6, 9, 9, 8 450mm (SC)	NO LABORATORY TESTING			
OSHWPH NOT		ben b blid st blidw ash d 2 Trit 2 Trit 2 Trit 2 Trit VILC rect I val Tu asing	arrel stem al ble Tu ble Tu ble Tu ble Tu ble Tu ble Tu ble (7	iger auger be be Tube Omm			norgan Diayey Silty GF Poorty ( Vell Gr norgan DRGAN DRGAN DRGAN DRGAN DRGAN DRGAN SILty SA Poorty ( Vell Gr	In CLAYS medium is CLAYS how plas GRAVEL TaveL TaveL aded GRAVEL to SILT high plastil is SILT how plastic IC CLAY medium IIC SILT how plastic IC CLAY medium IIC SILT how plastic IC CLAY medium IIC SILT how plastic SAND TaveL SAND TaveL SAND	plessicity dicity by ty to high plesticity city solls	S soft F firm S stiff VS very stiff H hard Density VL very loose L loose MD medium dens D dense VD very dense	U undisturbed       U undisturbed       disturbed       Water       ✓ at end of excavation       ▼ at time of excavation       ▼ at time of closure	VS va SPT sto SS SP SC SC HB ha SH sh Moistu D dry M moi W wet S satu	ane sh d. per bilt spo bild co amme nks ur re st	near n. test pon ne r boun nder or Bac	cing wn we		SAND SILT SILT Bendy ORAVE Cement Seel: 1 pipe group, 1 pipe Bentonite Seel: 1 pipe group, 1 pipe	L Slough Ba pipe group Slotted Pip	okfili: 1 1 pipe a: 1 pipe a: 1 pipe		

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Dia: Con	nete tract	r Con	e: 1 N	00m 1cMi	m Ilan	Drill	Ing		Northing: Ground Lev	N/A vel: N/A		Incli	nation	n:	90	)			Checked by: /erified by:	JSM JK	
Method/Casing	Care Recovery (%)	Water Loss (%)	Groundwater Level (m)	(w) 10	fuil and	Depth (m)	Graphic Log		M	aterial Description	on		USC Description	Consistency/Density	Maisture	Sample	In-Situ Testing	Laboratory Testing	Notes	Backfill	Geological Unit
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etho		crete e	core			6 7 8 8 6 6 7	ilassifi	cation CLAYS high pla		Consistency VS very soft	Soll Samples B. bulk	In Situ PP pe	Testin n pen	g	eter	G	raphic Log	NO LABOR			
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Method/Casing	Core Recovery (%)	Water Loss (%)	Groundwater Level (m)	R.L. (m)	Depth (m)	Graphic Log	Μ	aterial Descriptio	'n		USC Description	Consistency/Density	Moisture	Sample	In-Situ Testing	Laboratory Testing	Notes	Backfill	Geological Unit
WASH			Ţ		1		TOPSOIL SILT wit rootlets; Dark brow Sand fine grained. Sandy SILT; Yelloo Moist. Sandy SILT; Dark	h trace sand and n. Firm. Moist. Lo v brown. Low pla grey. Low plastici	occaisional ow plasticity. sticity. Firm. ity. Firm. Mois	/	OL ML				SPT at 1.5m N = 7 1, 1/1, 1.2, 3 450mm (SC)				
					- 7 - 8 - 9			ed at 3m (Target	Depth)							NO LABORATORY TESTING			
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Method/Casing	Core Recovery (%)	Water Loss (%)	Groundwater Level (m)		R.L. (m)	Depth (m)	Graphic Log		M	aterial Description	วก		USC Description	Consistency/Density	Moisture	Sample	In-Situ Testing	Laboratory Testing	Notes	Backfill	Geological Unit
			Ţ	2	· · · · · · · · · · · · · · · · · · ·	- 1	<u></u>	TOPSO rootlets; Sand fin SILT wit Firm. Mo	L SILT with Dark brow e grained. h minor sa bist. Sand f	h trace sand and m. Firm. Moist. L nd; Yellow brown ine to medium g	l occaisional ow plasticity n. Low plastic rained.	city.	OL							×	8
WASH					· · · · · · · · · · · · · · · · · · ·	2 3 4 5 2 2 2 3 6 2 2 2 2 3 6 2 2 2 2 3 6 2 2		Silty SAr Moist to SILT: Da Moist.	ND; Dark b wet. Sand	lue grey. Loose fine to medium g	to medium d grained.	ense.	SM				SPT at 3m N = 12 2, 2/3, 3, 3 450mm (SC)	NO LABORATORY TESTING		akarakarakarakarakarararararararara	ACALANCHONONONONONONONONONONONONONONONONONONO
sthoo					······································		<mark>9 D.O. D.O. D.O. D.O. D.O. D.( </mark>	Sandy GF mottling. coarse gr grained.	AVEL: Da Dense. We ained and	ark grey with ora et to saturated. rounded. Sand f	nge brown Gravel fine to fine to mediu Soll Samples	In Situ	GW	19			iraphic Log				
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<b>BO</b> Dril Dia	Email: REH ling N mete	ohriston OLE I Aetho r Con	NFOF d: C e: 10	AUTOCON AT 31	ION 12 Tra	m ack Rig	CO-ORDIN Easting: Northing:	IATES N/A N/A N/A		Date Date Inclin	Starte Complication:	ed: pletec	15 1: 15 90	5/09/2 5/09/2	011 011		Logged by: Input by: Checked by:	JSM JSM JSM	
Cor	tract	or:	(L)				Ground Le	vel: N/A		Orier	tation	: sity				l	Verified by:	<u>JK</u>	
Method/Casing	Core Recovery (	Water Loss (%	Groundwater Leve	R.L. (m)	Depth (m)	Graphic Log	Μ	laterial Descriptio	n		USC Descriptio	Consistency/Dens	Moisture	Sample	In-Situ Testing	Laboratory Testir	Notes	Backfill	Geological Unit
WASH					- 11		Sandy GRAVEL: I mottling. Dense. V coarse grained an grained. <i>(Layer Co</i>	Park grey with ora /et to saturated. d rounded. Sand ntinued from prev	nge brown Gravel fine to fine to medlur <i>ious page)</i>	m	GW				SPT et 10m N = 49 3, 6/10, 15, 9, 16 460mm (SC)	NORY TESTING			
					- 16 - 17 - 18											NO LABORA			
Veth CC DB SSA ISA VASI IG3 IG3 IG3 VMLC DP T	H WAG	Increte an bai id stei low st sh dril Triple Triple Triple Triple Triple Triple Triple Triple Triple Sing	core Tel n aug em al Tube e Tube e Tube e Tube so Tube e (70)	ier iger ie ube mm)	USC CCCCGGP WILL CCCCGG G WILL CCCGG WILL CCCCGG WILL CCCGG WILL CCCCGG WILL CCCGG WILL CCCCGG WILL CCCGG W	Classe Inorgan Inorgan Clayey Silty GF Poorty ( Well Gr Inorgan ORGAN ORGAN ORGAN ORGAN ORGAN ORGAN Silty SA Poorty ( Well Gr	Ification ic CLAYS high plasticity ic CLAYS medium plasticity is CLAYS we plasticity GRAVEL AVEL Stated GRAVEL asted GRAVEL is SLT fow plasticity it SLT fow plasticity IC CLAY medium to high plastici US LLT fow plasticity IC SLT we plasticity is SLT fow plasticity is SLT fow plasticity is SLT fow plasticity is SLT fow plasticity is stated SAND preded SAND plasticity SLT	Consistency VS very soft 5 soft F firm S stiff VS very stiff H hard VI very loose L loose MD medium dense D dense VD very dense	Soil Samples B bulk U undisturbed D disturbed Water V at end of excavation at time of excavation V at time of cheures	In Situ PP pe VS va SPT str SS sp SC soc HB ha SH sin Moistu D dry W wet S satu	Testin en pen- ine she d. pen. lift spo- lift spo- lift spo- lift spo- re st st	9 etromesar test on te bound der ov	eter cing vn we	ight ight ight ight ight ight ight ight	Staphic Log	pipe group Stotted hy group 1 -	oktili: 1 1, 1 pipe 160	.£	

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## Appendix F Environment Canterbury Borehole Log

































# Appendix G Groundwater Levels


Project	Rosemerryn Farm Subdivision
Project Number	224464
Title	Groundwater Levels

Test Location	Recorded Depth to	Groundwater	Comments
	Ground Water	Seepages	
	3.0m		ivieasurea down CPT hole
0012			
CP13	Not Recorded		Margan Library ODT halo
CP14	2.0m		Measured down CPT hole
CP15	Not Recorded		
CPT6	1.9m		Measured down CPT hole
CPT7	Not Recorded		
CPT8	Not Recorded		
CPT9	1.5m		Measured down CPT hole
CPT10	Not Recorded		Measured down CPT hole
CPT11	Not Recorded		
CPT12	1.5m		Measured down CPT hole
CPT13	Not Recorded		
CPT14	Not Recorded		Measured down CPT hole
CPT15	Not Recorded		
CPT16	Not Recorded		
CPT17	Not Recorded		
CPT18	Not Recorded		
CPT19	1.0m		Measured down CPT hole
CPT20	Not Recorded		
CPT21	1.5m		Measured down CPT hole
CPT22	0.9m		Measured down CPT hole
CPT23	1.4m		Measured down CPT hole
CPT24	Not Recorded		
CPT25	1.0m		Measured down CPT hole
CPT26	Not Recorded		
CPT27	Not Recorded		
CPT28	Not Recorded		
CPT29	0.9m		Measured down CPT hole
CPT30	1.5m		Measured down CPT hole
CPT31	Not Recorded		
CPT32	Not Recorded		
CPT33	Not Recorded		
CPT34	Not Recorded		
CPT35	Not Recorded		
CPT36	Not Recorded		
CPT37	Not Recorded		
TP1	4.0m	2.3m	Dark grey soil from 3m
TP2	4.0m	-	
TP3	Not Recorded		Dark grev soil from 3m
TP4	4.0m	2.5m	Dark grev soil from 2.5m
TP5		2.2m	Grev soil from 2.5m
TP6	3.2m		Dark grey soil from 2m
-	0.2111		Built groy soil noin 2m

TP7	3.5m		Dark grey soil from 3m	1
TP9	3.5m		Dark grey soil from 3m	
TP10	3.3m		Dark grey soil from 2.3m	
TP13	2.0m		Dark grey soil from 3m	
TP14	3.7m		Dark grey soil from 2m	
TP16	1.8m		Dark grey soil from 1.65m	
TP17			Dark grey soil from 2.8m	
TP18	4.0m		Dark grey soil from 1.8m	
TP19	2.8m	1.7m	Dark grey soil from 1.8m	
TP23	Not Recorded		Dark grey soil from 1.7m	
TP24	3.8m		Dark grey soil from 2m	
TP25	2.8m		Dark grey soil from 2m	
TP48		0.7m & 2.4m	Grey soil from 1.1m	×
TP49			Grey soil from 1.3m	*
TP50	Not Recorded	2.1m		×
TP52		2.1m & 2.9m	Grey soil from 2.4m	*
TP53	3.9m		Grey soil from 3m	k
TP54		2.3m	Grey soil from 2.3m	×
TP55	4.5m	2.8m	Grey soil from 2.8m	k
TP56		2.6m	Grey soil from 3.2m	×
TP57				k
TP58		2.7m	Grey soil from 2.7m	×
TP59		2.7m	Grey soil from 2.7m	×
TP60			Grey soil from 2.8m	×
TP61	3.8m	2.8m	Grey soil from 2.8m	×
TP62	3.6m		Grey soil from 2.6m	×
TP63	3.8m	2.8m	Grey soil from 2.8m	×
TP64	3.6m		Grey soil from 2.2m	k
TP65	3.6m	1.7m	Grey soil from 2.2m	4
TP66	3.5m		Grey soil from 2.3m	*
TP67			Grey soil from 2.6m	k
TP68		0.6m	Grey soil from 2.8m	×
TP69	3.3m		Grey soil from 1.8m	*
TP70	3.8m	2.1m	Grey soil from 2.1m	*
TP71		2m	Grey soil from 1.8m	×
TP72		0.6m & 1.8m	Grey soil from 1.8m	*
TP73	4.2m	1.3m	Grey soil from 2m	k
TP74		1.5m	Grey soil from 2.3m	k
TP75			Grey soil from 2.2m	k
TP76		2m	Grey soil from 2.4m	k
TP77		1.3m	Grey soil from 2.1m	k
TP78		1.1m & 2.4m	Grey soil from 1.7m	۶
TP79	3.5m	2.7m	Grey soil from 2m	۶
TP80	3.6m		Grey soil from 2m	k
TP81		2m	Grey soil from 2m	×

\* - Test pitting carried out in intense rainfall event. Therefore seepages from stormwater runoff were evident in the test pits and the soil samples were typically logged as wet.

## Appendix H LiquifyPro Results







## **ULS Event**














































































**CPT38** 





SLS

**CPT39** 





SLS



**CPT40** 

## Appendix I Geotechnical Certification



## Statement of Professional Opinion on the Suitability of Land for Building Construction

ISSUED BY:	Aurecon NZ Limited (Engineering firm or suitably qualified Engineer)
TO:	Fulton Hogan Land Development Limited (Owner/Developer)
TO BE SUPPLIED TO:	Selwyn District Council (Territorial authority)
IN RESPECT OF:	Stage 3 to 6 Rosemerryn Subdivision
AT:	Lot 26 DP 432078, Lincoln, Christchurch
	(Address)
	I, Dr Jan Kupec, (Geotechnical Engineer)
	on behalf of Aurecon NZ Limited
	(Engineering firm)

hereby confirm that:

1. I am a suitably qualified and experienced Geotechnical Engineer and was retained by the owner/developer as the Geotechnical Engineer on the above development.

2. The extent of my inspections, and the results of all tests carried out are as described in the geotechnical report *Geotechnical Assessment Report, Rosemerryn Farm Stage 3 to 6, Fulton Hogan Land Development Ltd, Rev3, dated 23 May 2012.* 

3. In my professional opinion, not to be construed as a guarantee, I consider that:

(a) The completed works give due regard to land slope and foundation stability considerations.

(b) The original ground not affected by filling and the filled ground are suitable for the construction of a development/subdivision and are not subject to erosion, subsidence or slippage in accordance with the provisions of Section 106 of the Resource Management Act 1991 provided that:

(i) The recommendations made in the Aurecon Report *Geotechnical Assessment Report, Rosemerryn Farm Stage 3 to 6, Fulton Hogan Land Development Ltd, Rev3, dated 23 April 2012* are followed.

4. This professional opinion is furnished to the territorial authority and the owner/developer for their purposes alone, on the express condition that it will not be relied upon by any other person and does not remove the necessity for the normal inspection of foundation conditions at the time of erection of any building.

5. This certificate shall be read in conjunction with my/the geotechnical report referred to in Clause 2 above, and shall not be copied or reproduced except in conjunction with the full geotechnical completion report.

6. The geotechnical engineering firm issuing this statement holds a current policy of professional indemnity insurance of no less than \$250,000.

(Minimum amount of insurance shall be commensurate with the current amounts recommended by IPENZ, ACENZ, TNZ, INGENIUM.)

Chy (Signature of Engineer)

(Date)

\_\_\_23 May 2012\_\_\_\_\_

Qualifications and experience:

PhD, MSc, candIng, MIPENZ, CPEng(Geotechnical & Project Management), IntPE