Centennial Hall, Spreydon

BU 1098-001 EQ2

Detailed Engineering Evaluation

Quantitative Report

Christchurch City Council

Christchurch City Council

Centennial Hall, Spreydon

Detailed Engineering Evaluation Quantitative Report

Opus International Consultants Ltd
Hamilton Office
Princes Street
Private Bag 3057, Waikato Mail Centre,
Hamilton 3240
New Zealand

Telephone: +64 7 838 9344
Facsimile: +64 7 838 9324

Date: September 2012
Reference: 6-QUCCC.88
Status: Final

Centennial Hall, Spreydon
BU 1098-001

Detailed Engineering Evaluation
Quantitative Report - SUMMARY
Final

Spreydon, Christchurch

Background

This is a summary of the quantitative report for the Centennial Hall building structure, and is based on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011, visual inspections on 29/02/12, available drawings and calculations.

Key Damage Observed

Key damage observed includes:-

- Cracks in the wall veneer and perimeter strip footing due to differential settlement,
- Failed and cracked piles.

Critical Structural Weaknesses

The following potential critical structural weaknesses have been identified

- No diaphragm in the hall area

Indicative Building Strength

Based on the information available, and from undertaking a quantitative assessment, the building's original capacity has been assessed to be 25%NBS along the building and 20%NBS across the building, limited by the capacity of the braced timber walls.

The building has been assessed to have a seismic capacity less than 34% NBS and is therefore earthquake prone in accordance with the Building Act 2004.

Recommendations

It is recommended that:

a) Prevent occupancy of the building until it is strengthened to at least 67% NBS.
b) Strengthen the building to at least 67% NBS.
c) Perform a level survey of the building to confirm the magnitude of settlement throughout the building does not give rise to usability concerns.
d) Check there have been no voids from liquefaction created under the structure.
e) Carry out inspection of the subfloor area to check there have been no voids from liquefaction created under the structure and that the bearers are adequately tied to the concrete piles.

Contents

1 Introduction

Opus International Consultants Limited has been engaged by Christchurch City Council (CCC) to undertake a detailed seismic assessment of the Centennial Hall, located at northern end of Centennial Park, Spreydon following the M6.3 Christchurch earthquake on 22 February 2011.

The purpose of the assessment is to determine if the building is classed as being earthquake prone in accordance with the Building Act 2004.

The seismic assessment and reporting have been undertaken based on the qualitative and quantitative procedures detailed in the Assessment and Improvement of the Structural Performance of Buildings in Earthquakes issued by the Structural Engineering Society (SESOC) on June 2006 and its supplement Assessment and Improvement of Unreinforced Masonry Building for Earthquake Resistance.

2 Compliance

This section contains a brief summary of the requirements of the various statutes and authorities that control activities in relation to buildings in Christchurch at present.

2.1 Canterbury Earthquake Recovery Authority (CERA)

CERA was established on 28 March 2011 to take control of the recovery of Christchurch using powers established by the Canterbury Earthquake Recovery Act enacted on 18 April 2011. This act gives the Chief Executive Officer of CERA wide powers in relation to building safety, demolition and repair. Two relevant sections are:

Section 38 – Works

This section outlines a process in which the chief executive can give notice that a building is to be demolished and if the owner does not carry out the demolition, the chief executive can commission the demolition and recover the costs from the owner or by placing a charge on the owners' land.

Section 51 – Requiring Structural Survey

This section enables the chief executive to require a building owner, insurer or mortgagee to carry out a full structural survey before the building is re-occupied.

We understand that CERA require a detailed engineering evaluation to be carried out for all buildings (other than those exempt from the Earthquake Prone Building definition in the Building Act). CERA have adopted the Detailed Engineering Evaluation Procedure (DEEP) document (draft) issued by the Structural Engineering Society (SESOC) on 19 July 2011. This document sets out a methodology for both initial qualitative and detailed quantitative assessments.

It is anticipated that a number of factors, including the following, will determine the extent of evaluation and strengthening level required:

1. The importance level and occupancy of the building.
2. The placard status and amount of damage.
3. The age and structural type of the building.
4. Consideration of any critical structural weaknesses.

Any building with a capacity of less than 34% of new building standard (including consideration of critical structural weaknesses) will need to be strengthened to a target of 67% as required by the CCC Earthquake Prone Building Policy.

2.2 Building Act

Several sections of the Building Act are relevant when considering structural requirements:

Section 112 - Alterations

This section requires that an existing building complies with the relevant sections of the Building Code to at least the extent that it did prior to the alteration.

This effectively means that a building cannot be weakened as a result of an alteration (including partial demolition).

Section 115 – Change of Use

This section requires that the territorial authority (in this case Christchurch City Council (CCC)) is satisfied that the building with a new use complies with the relevant sections of the Building Code 'as near as is reasonably practicable'.

This is typically interpreted by CCC as being 67% of the strength of an equivalent new building. This is also the minimum level recommended by the New Zealand Society for Earthquake Engineering (NZSEE).

Section 121 – Dangerous Buildings

This section was extended by the Canterbury Earthquake (Building Act) Order 2010, and defines a building as dangerous if:

1. In the ordinary course of events (excluding the occurrence of an earthquake), the building is likely to cause injury or death or damage to other property; or
2. In the event of fire, injury or death to any persons in the building or on other property is likely because of fire hazard or the occupancy of the building; or
3. There is a risk that the building could collapse or otherwise cause injury or death as a result of earthquake shaking that is less than a 'moderate earthquake' (refer to Section 122 below); or
4. There is a risk that other property could collapse or otherwise cause injury or death; or
5. A territorial authority has not been able to undertake an inspection to determine whether the building is dangerous.

Section 122 – Earthquake Prone Buildings

This section defines a building as earthquake prone (EPB) if its ultimate capacity would be exceeded in a 'moderate earthquake' and it would be likely to collapse causing injury or death, or damage to other property.

A moderate earthquake is defined by the building regulations as one that would generate loads 33% of those used to design an equivalent new building.

Section 124 – Powers of Territorial Authorities

This section gives the territorial authority the power to require strengthening work within specified timeframes or to close and prevent occupancy to any building defined as dangerous or earthquake prone.

Section 131 – Earthquake Prone Building Policy

This section requires the territorial authority to adopt a specific policy for earthquake prone, dangerous and insanitary buildings.

2.3 Christchurch City Council Policy

Christchurch City Council adopted their Earthquake Prone, Dangerous and Insanitary Building Policy in 2006. This policy was amended immediately following the Darfield Earthquake on 4 September 2010.

The 2010 amendment includes the following:

1. A process for identifying, categorising and prioritising Earthquake Prone Buildings, commencing on 1 July 2012;
2. A strengthening target level of 67% of a new building for buildings that are Earthquake Prone;
3. A timeframe of 15-30 years for Earthquake Prone Buildings to be strengthened; and,
4. Repair works for buildings damaged by earthquakes will be required to comply with the above.

The council has stated their willingness to consider retrofit proposals on a case by case basis, considering the economic impact of such a retrofit.

If strengthening works are undertaken, a building consent will be required. A requirement of the consent will require upgrade of the building to comply 'as near as is reasonably practicable' with:

- The accessibility requirements of the Building Code.
- The fire requirements of the Building Code. This is likely to require a fire report to be submitted with the building consent application.

2.4 Building Code

The Building Code outlines performance standards for buildings and the Building Act requires that all new buildings comply with this code. Compliance Documents published by The Department of Building and Housing can be used to demonstrate compliance with the Building Code.

On 19 May 2011, Compliance Document B1: Structure was amended to include increased seismic design requirements for Canterbury as follows:

- 36% increase in the basic seismic design load for Christchurch (Z factor increased from 0.22 to 0.3);
- Increased serviceability requirements.

2.5 Institution of Professional Engineers New Zealand (IPENZ) Code of Ethics

One of the core ethical values of professional engineers in New Zealand is the protection of life and safeguarding of people. The IPENZ Code of Ethics requires that:

Members shall recognise the need to protect life and to safeguard people, and in their engineering activities shall act to address this need.

1.1 Giving Priority to the safety and well-being of the community and having regard to this principle in assessing obligations to clients, employers and colleagues.

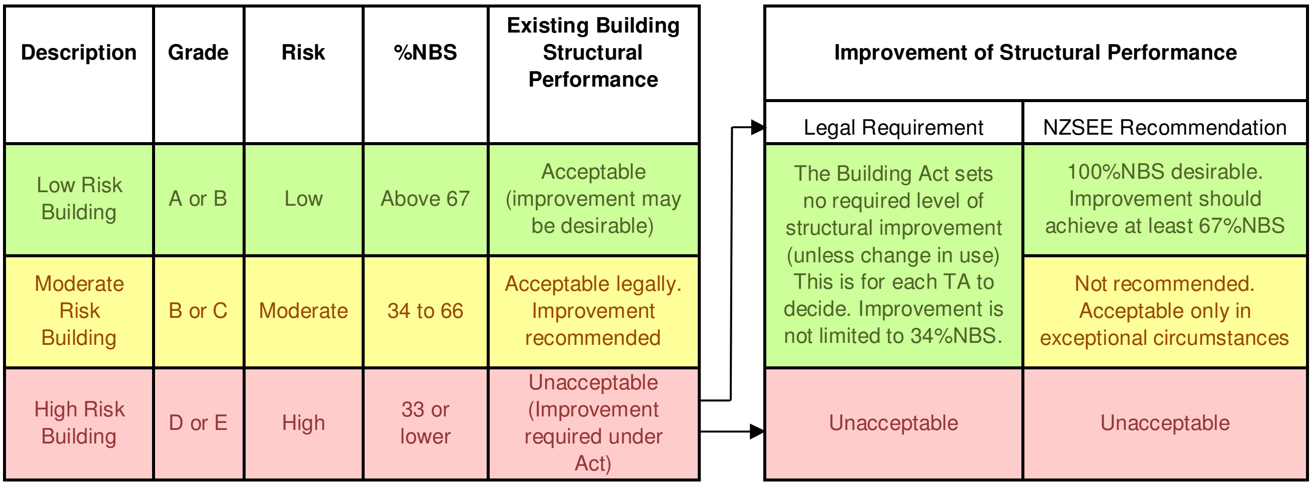
1.2 Ensuring that responsible steps are taken to minimise the risk of loss of life, injury or suffering which may result from your engineering activities, either directly or indirectly.

All recommendations on building occupancy and access must be made with these fundamental obligations in mind.

3 Earthquake Resistance Standards

For this assessment, the building's earthquake resistance is compared with the current New Zealand Building Code requirements for a new building constructed on the site. This is expressed as a percentage of new building standard (%NBS). The loadings are in accordance with the current earthquake loading standard NZS1170.5 [1].

A generally accepted classification of earthquake risk for existing buildings in terms of %NBS that has been proposed by the NZSEE 2006 [2] is presented in Figure 1 below.



Description	Grade	Risk	%NBS	Existing Building Structural Performance	Improvement of Structural Performance	
					Legal Requirement	NZSEE Recommendation
Low Risk Building	A or B	Low	Above 67	Acceptable (improvement may be desirable)	The Building Act sets no required level of structural improvement (unless change in use) This is for each TA to decide. Improvement is not limited to 34%NBS.	100%NBS desirable. Improvement should achieve at least 67%NBS
Moderate Risk Building	B or C	Moderate	34 to 66	Acceptable legally. Improvement recommended		Not recommended. Acceptable only in exceptional circumstances
High Risk Building	D or E	High	33 or lower	Unacceptable (Improvement required under Act)	Unacceptable	Unacceptable

Figure 1: NZSEE Risk Classifications Extracted from Table 2.2 of the NZSEE 2006 AISPBE Guidelines

Table 1 below compares the percentage NBS to the relative risk of the building failing in a seismic event with a 10% risk of exceedance in 50 years (i.e. 0.2% in the next year). It is noted that the current seismic risk in Christchurch results in a 6% risk of exceedance in the next year.

Table 1: %NBS compared to relative risk of failure

Percentage of New Building Standard (%NBS)	Relative Risk (Approximate)
>100	<1 time
80-100	1-2 times
67-80	2-5 times
33-67	5-10 times
20-33	10-25 times
<20	>25 times

3.1 Minimum and Recommended Standards

Based on governing policy and recent observations, Opus makes the following general recommendations:

3.1.1 Occupancy

- The Canterbury Earthquake Order[1] in Council 16 September 2010, modified the meaning of "dangerous building" to include buildings that were identified as being

---

[1] This Order only applies to buildings within the Christchurch City, Selwyn District and Waimakariri District Councils authority

EPB's. As a result of this, we would expect such a building would be issued with a Section 124 notice, by the Territorial Authority, or CERA acting on their behalf, once they are made aware of our assessment. Based on information received from CERA to date, this notice is likely to prohibit occupancy of the building (or parts thereof), until its seismic capacity is improved to the point that it is no longer considered an EPB.

3.1.2 Cordoning

- Where there is an overhead falling hazard, or potential collapse hazard of the building, the areas of concern should be cordoned off in accordance with current CERA/Christchurch City Council guidelines.

3.1.3 Strengthening

- Industry guidelines (NZSEE 2006 [2]) strongly recommend that every effort be made to achieve improvement to at least 67%NBS. A strengthening solution to anything less than 67%NBS would not provide an adequate reduction to the level of risk.

- It should be noted that full compliance with the current building code requires building strength of 100%NBS.

3.1.4 Our Ethical Obligation

- In accordance with the IPENZ code of ethics, we have a duty of care to the public. This obligation requires us to identify and inform CERA of potentially dangerous buildings; this would include earthquake prone buildings.

4 Building Description

4.1 General

Centennial Hall is a single storey timber framed building with brick veneer and a heavy clay tile roof with timber sarking. The building sits on circular concrete pile foundations with a concrete perimeter foundation wall.

The building is situated on a flat section and is approximately 23.1m long in the east-west direction and 15.3m wide in the north-south direction. The building internal timber framed walls are lined with wooden panelling. The apex of the roof is approximately 6m above the ground and the building has a wall stud height of approximately 3.5m.

The building was constructed in 1955.

4.2 Gravity Load Resisting System

The roof is a timber framed and sarked roof with heavy clay tiles.

The external walls are timber framed with an unreinforced brick masonry veneer with a height of approximately 3.5m, with reinforced concrete lintels above all window and doors. The internal walls consist of timber framing lined with timber panelling.

The subfloor consists of timber flooring on suspended timber framing which sits on circular concrete pile foundations. The spacing between the ground level and the top of the piles is approximately 400mm.

4.3 Seismic Load Resisting System

Lateral support for the roof is provided through its hip roof design and timber sarking.

The main lateral support for the building in both principal directions is provided by the perimeter and internal timber framed wall linings which consist of timber panelling with cut-in timber braces.

No subfloor bracing was noted during our inspection.

5 Survey

It is understood that the building is not currently occupied.

No copies of the design calculations or structural drawings have been obtained for this building.

The non-intrusive inspections have been used to confirm the structural systems, investigate potential critical structural weaknesses (CSW) wherever possible and identify details which required particular attention.

6 Damage Assessment

The building shows a lot of damage to the external masonry veneer that appears to have been the result of the recent earthquake events. The following damage has been noted:

6.1 Pile Damage

At least one pile has failed and the floor is being temporarily supported by timber blocks. Other piles have visible cracks.

6.2 Masonry Cracks

The building has a large number of cracks around the outside that are the result of combination of seismic actions and differential settlement. Some cracks predate the earthquakes and have had repairs made which have subsequently re-cracked during the earthquakes. In a couple of locations large gaps in the masonry have opened up though these are confined to corners of the building.

6.3 Concrete Lintels

The mortar joining most of the lintels to the masonry walls has cracked but as the lintels provide no lateral support this does not affect the capacity. The lintels still provide gravity load support and are not likely to fail in this respect.

6.4 Perimeter Concrete Foundation

Cracks up to 3mm have appeared in the concrete foundation and were most likely caused by differential settlement. Some of this settlement appears to be historic but has been exacerbated by the earthquakes.

7 General Observations

Overall the building has performed well under seismic conditions, as expected of timber buildings, but the unreinforced brick masonry veneer has suffered extensive cracking due to differential settlement. The building has sustained little internal damage but has been closed pending detailed assessment.

Due to the non-intrusive nature of the original survey, many connection details could not be ascertained.

8 Detailed Seismic Assessment

8.1 Seismic Coefficient Parameters

The seismic design parameters based on current design requirements from NZS1170.5:2004 and the NZBC clause B1 for this building are:

- Site soil class D, clause 3.1.3 NZS 1170.5:2004
- Site hazard factor, Z=0.3, B1/VM1 clause 2.2.14B
- Return period factor R_u = 1.0 from Table 3.5, NZS 1170.5:2004, for an Importance Level 2 structure with a 50 year design life.
- Ductility factor μ_{max} = 1.25 for a timber framed building with a masonry veneer.

8.2 Critical Structural Weaknesses

As outlined in the Critical Structural Weakness and Collapse Hazards draft briefing document, issued by the Structural Engineering Society (SESOC) on 7 May 2011, the term 'Critical Structural Weakness' (CSW) refers to a component of a building that could contribute to increased levels of damage or cause premature collapse of the building.

We have identified the following potential critical structural weaknesses in the building

a) There does not appear to be a diaphragm in the hall area.

8.3 Detailed Seismic Assessment Results

A summary of the structural performance of the building is shown in the following table. Note that the values given represent the worst performing elements in the building, as these effectively define the building's capacity. Other elements within the building may have significantly greater capacity when compared with the governing element.

The capacity of the walls is assumed to be 3kN per meter of length as recommended by NZSEE 2006 [2]. This value assumes the walls are lined with wooden panelling with unblocked edges, have cut-in diagonal timber braces and have some ductility capacity.

Table 2: Summary of Seismic Performance

Structural Element/System	Failure mode and description of limiting criteria	Critical Structural Weakness and Collapse Hazard	% NBS based on calculated capacity
Walls in the north south direction i.e. across the building	Bracing capacity of the walls across the building	No	20%
Walls in the east west direction i.e. along the building	Bracing capacity of the walls along the building	No	25%
Roof diaphragm	Capacity of the roof plane sarking	Yes	<67%
Subfloor bracing capacity	Subfloor bracing capacity of the concrete pile foundations and concrete perimeter wall	No	100%

8.4 Discussion of Results

The building has a calculated capacity of 20% NBS, with the capacity being limited by the bracing capacity of the timber walls. The building is therefore earthquake prone in accordance with the Building Act 2004 as it has a seismic capacity less than 34% NBS.

As the building is earthquake prone it is recommended that the building remains unoccupied until the building is strengthened to at least 67% NBS in accordance with the Christchurch City Council earthquake prone building policy.

The building has a flexible roof diaphragm which creates greater deflection in the out of plane walls compared to the in plane walls that are resisting the lateral movement. These out of plane deflections will lead to increased damage and increased risk of failure of the brick veneer.

8.5 Limitations and Assumptions in Results

Our analysis and assessment is based on an assessment of the building in its undamaged state. Therefore the current capacity of the building will be lower than that stated.

The results have been reported as a %NBS and the stated value is that obtained from our analysis and assessment. Despite the use of best national and international practice in this analysis and assessment, this value contains uncertainty due to the many assumptions and simplifications which are made during the assessment. These include:

- Simplifications made in the analysis, including boundary conditions such as foundation fixity;
- Assessments of material strengths based on limited drawings, specifications and site inspections;
- The normal variation in material properties which change from batch to batch;
- Approximations made in the assessment of the capacity of each element, especially when considering the post-yield behaviour.

9 Geotechnical Assessment

This geotechnical assessment is a summary of the Geotechnical Desktop Study, which is included as Appendix C of this report.

9.1 Site Description

The Centennial Hall building is bound by Sparks Road to the North-West, Lyttelton Road to the North-East and a Retirement Housing complex to the South. A stream is located 170m south west of the building. Refer to Site Walkover Plan Appendix B of the Geotechnical Desktop Study.

The ground profile is relatively flat and level with the carpark and playground, but gently slopes towards the adjacent roads. All surrounding areas are surfaced with asphalt, paving or bark.

9.2 Regional Geology

The published geological map of the area, (Geology of the Christchurch Urban Area 1:25,000, Brown and Weeber, 1992) indicates the site is located on a Yaldhurst Member with dominantly alluvial sand and silt overbank deposits.

9.3 Peak Ground Acceleration

The nearest accelerogram at Cashmere High School experienced a horizontal Peak Ground Acceleration (PGA) of 0.42g during the 22nd February 2011 Earthquake according to GNS science. Due to being less than 1km from the accelerogram it is expected that the building felt a similar horizontal PGA.

9.4 Expected Ground Conditions

A review of the Environmental Canterbury (ECan) wells database showed six wells located within approximately 130m of the building. The nearest CPT is located 150m south west of the building. Material logs available from ECan wells have been used to infer the ground conditions at the site as shown in the Geotechnical Desktop Study.

9.5 Liquefaction Hazard

A liquefaction hazard study was conducted by the Canterbury Regional Council (ECan) in 2004 to identify areas of Christchurch susceptible to liquefaction during an earthquake. According to this study, the ground may be affected by 100mm to 300mm of subsidence.

The University of Canterbury drive-through reconnaissance 23 February – 1 March (Cubrinovski & Taylor, 2011) indicated that there were areas of moderate to severe liquefaction to the north and east of the building, but no liquefaction to the west and south.

9.6 Site Observations

A walkover inspection of the exterior and adjacent areas was carried out by an Opus Geotechnical Engineer on 26 March 2012. The following observations were made (refer to the Walkover Inspection Plan and Site Photos in the geotechnical desktop study attached to this report):

- An area of pavement, approximately 4m^2, has been affected by up to 50mm of heave in the carpark north of the building.
- Multiple cracks up to 3mm wide were observed at several locations around the concrete perimeter strip footing (Photos 2, 5 and 6).
- Cracking (approximately 5mm wide) at the patio and down the steps on the north elevation of the building. One crack extends into the masonry wall (Photo 3).
- It appears there has been an extension of the original buildings footprint on the southern elevation. There is a 5mm wide crack at the join between the old and new perimeter strip footings (Photo 4).
- Minor surface rupture of liquefaction has occurred in the children's area directly south of the building (Photo 9).
- Approximately 10mm of settlement appears to have occurred at the bus lay by area, 10m east of the Centennial Hall building (Photo 7).
- It appears that the retirement housing on the southern boundary has suffered from differential settlement estimated to be 50mm.

9.7 Conclusions and Discussion

Minor land damage has occurred to the Centennial Hall due to the Canterbury Earthquake Sequence following the 4 September 2010 earthquake. Moderate damage has occurred to the neighbouring retirement housing on the southern boundary.

The perimeter strip footings have performed well. Cracking on the perimeter footings, generally less than 5mm, has been observed, which may indicate that settlement has occurred.

The building's southern extension foundations have separated from the original building foundations by 5mm. The cracking becomes wider as it goes up the wall, which suggests that settlement has occurred in the south west corner of the building.

The existing foundations are consistent with the type of foundations recommended by the DBH for Technical Category 2 areas. Subject to a structural inspection, the existing foundations with repairs are considered suitable for this building.

It is recommended that a level survey be undertaken to confirm the magnitude of settlement throughout the building. It is also recommended that a detailed subfloor inspection be completed to check there have been no voids from liquefaction created under the structure and to check that the bearers are adequately tied to the concrete piles.

10 Remedial Options

Any remedial options for increasing the seismic capacity to at least 67% NBS would need to address the roof diaphragm in the Hall, timber wall bracing capacity throughout the building in both directions and the cracked and broken piles.

11 Conclusions

(a) The building has a seismic capacity of 20% NBS and is therefore considered to be earthquake prone in accordance with the Building Act 2004.

(b) The building should remain unoccupied until it has been strengthened to at least 67% NBS.

(c) Due to the calculated capacity the building is classed as grade D, high risk and has a relative risk of failure of approximately 25 times that of building complying with current codes.

(d) The seismic capacity is governed by the bracing capacity of the timber walls.

(e) Repairs are required to the damaged wall veneer and foundation elements.

(f) It is recommended that the building is strengthened to at least 67%NBS.

(g) The existing foundations are consistent with the type of foundations recommended by the DBH for Technical Category 2 areas. Subject to a structural inspection, the existing foundations with repairs are considered suitable for this building.

(h) It is recommended that a level survey be undertaken to check the extent of settlement.

(i) A subfloor inspection should be undertaken to check there have been no voids from liquefaction created under the structure and to check that the bearers are adequately tied to the concrete piles.

12 Recommendations

(a) Prevent occupancy of the building until it is strengthened to at least 67% NBS.

(b) Strengthen the building to at least 67% NBS.

(c) Perform a level survey of the building to confirm the magnitude of settlement throughout the building does not give rise to usability concerns.

(d) Check there have been no voids from liquefaction created under the structure.

(e) Carry out inspection of the subfloor area to check there have been no voids from liquefaction created under the structure and that the bearers are adequately tied to the concrete piles.

13 Limitations

(a) This report is based on an inspection of the structure with a focus on the damage sustained from the 22 February 2011 Canterbury Earthquake and aftershocks only. Some non-structural damage is mentioned but this is not intended to be a comprehensive list of non-structural items.

(b) Our professional services are performed using a degree of care and skill normally exercised, under similar circumstances, by reputable consultants practicing in this field at the time.

(c) This report is prepared for the CCC to assist with assessing remedial works required for council buildings and facilities. It is not intended for any other party or purpose.

14 References

[1] NZS 1170.5: 2004, *Structural design actions, Part 5 Earthquake actions,* Standards New Zealand.

[2] NZSEE: 2006, *Assessment and improvement of the structural performance of buildings in earthquakes,* New Zealand Society for Earthquake Engineering.

[3] Engineering Advisory Group, *Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings in Canterbury, Part 2 Evaluation Procedure*, Draft Prepared by the Engineering Advisory Group, Revision 5, 19 July 2011.

[4] Engineering Advisory Group, *Guidance on Detailed Engineering Evaluation of Non-residential buildings, Part 3 Technical Guidance*, Draft Prepared by the Engineering Advisory Group, 13 December 2011.

[5] SESOC, *Practice Note – Design of Conventional Structural Systems Following Canterbury Earthquakes*, Structural Engineering Society of New Zealand, 21 December 2011.

Appendix A – Photographs

Photo 1: Northern perimeter wall

Photo 2: View of the south eastern perimeter wall


23/06/2011 13:27

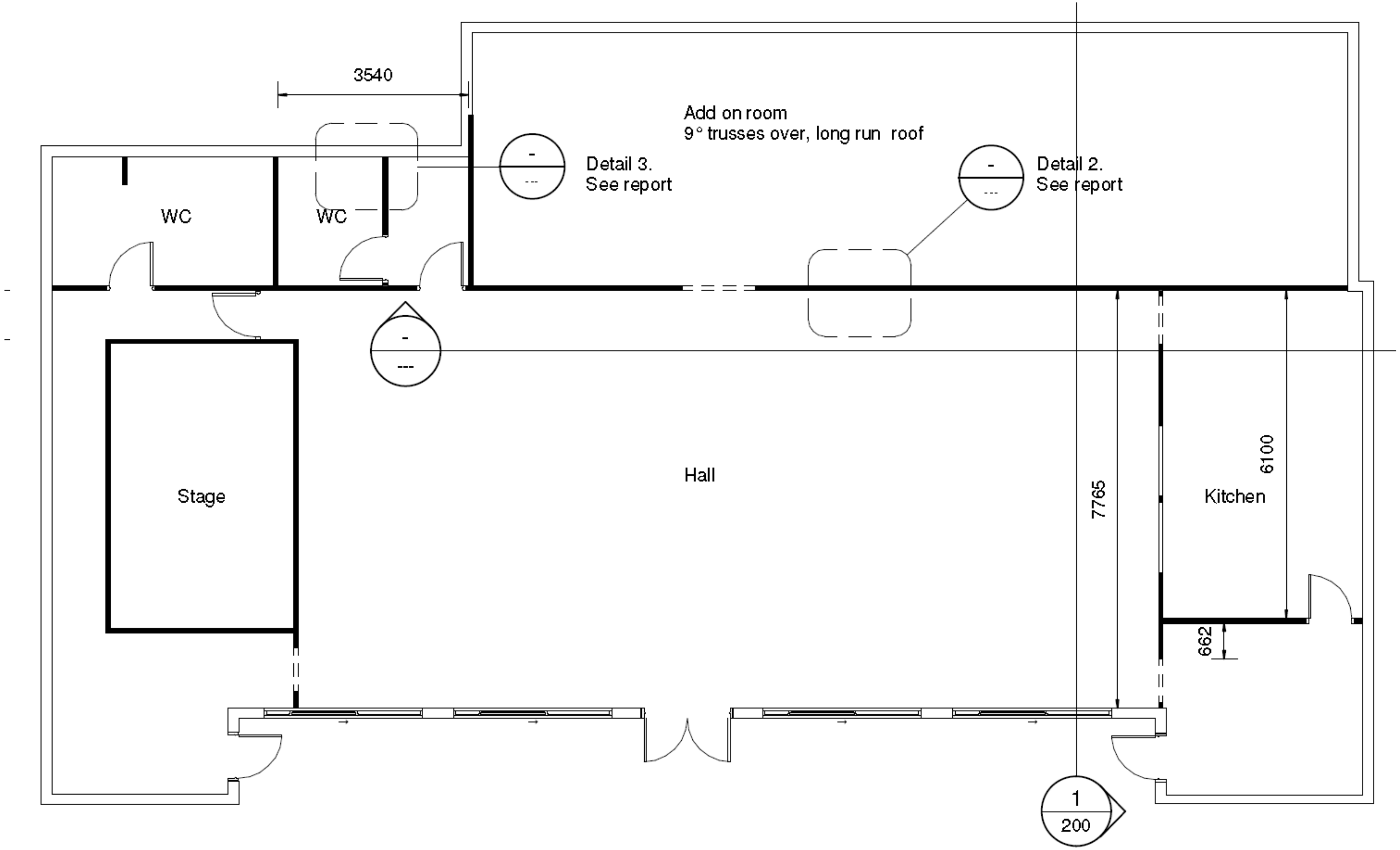
Photo 3: View of the sub floor and the failed pile

Photo 4: View of interior towards the west wall

Photo 5: View of interior towards the north and east walls

Photo 6: View of the large crack in the western wall

Appendix B – Floor Plan


3540
Add on room
9° trusses over, long run roof
Detail 3.
See report
Detail 2.
See report
WC
WC
Stage
Hall
Kitchen
7765
6100
662
1
200

Appendix C – Geotechnical Appraisal

10 April 2012

Christchurch City Council
C/O:- Michael Sheffield
Property Asset Manager

Dear Michael 6-QUCCC.88

Geotechnical Desktop Study – Centennial Hall, Somerfield

1. Introduction

Christchurch City Council has commissioned Opus International Consultants (Opus) to undertake a geotechnical desktop study and site walkover of the Centennial Hall, Somerfield, Christchurch. The purpose of this study is to collate existing subsoil information and undertake an appraisal of the potential geotechnical hazards at this site and to determine whether further investigations are required. The site walkover was completed by Opus on 26 March 2012.

This Geotechnical Desk Study has been prepared in accordance with the Engineering Advisory Group's Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings in Canterbury, Revision 5, 19 July 2011.

The Geotechnical Desk Study forms part of a Detailed Engineering Evaluation prepared by Opus. A level survey has not been undertaken. The Geotechnical Desk Study has been undertaken without the benefit of any site specific investigations and is therefore preliminary in nature.

2. Desktop Study

2.1 Site Description

The Centennial Hall building is bound by Sparks Road to the North-West, Lyttelton Road to the North-East and a Retirement Housing complex to the South. A stream is located 170m south west of the building. Refer to Site Walkover Plan Appendix B.

The Centennial Hall building is a one storey masonry building. Refer to the Opus Qualitative Structural Assessment Report for more detailed description of the building.

The ground profile is relatively flat and level with the carpark and playground, but gently slopes towards the adjacent roads. All surrounding areas are surfaced with asphalt, paving or bark.

2.2 Structural Drawings

Extracts from the Structural Drawings illustrating details of the foundation have not been available for review from CCC property files. Observations indicate that the building is founded on a timber suspended floor with a concrete perimeter strip footing and cylindrical concrete piles.

2.3 Regional Geology

The published geological map of the area, (Geology of the Christchurch Urban Area 1:25,000, Brown and Weeber, 1992) indicates the site is located on a Yaldhurst Member with dominantly alluvial sand and silt overbank deposits.

2.4 Expected Ground Conditions

A review of the Environmental Canterbury (ECan) wells database showed six wells located within approximately 130m of the property (refer to Site Location Plan in Appendix B). The locations of Boreholes and CPT's undertaken by Earthquake Commission have been reviewed. The nearest CPT is located 150m south west of the building. The CPT refused at a depth of approximately 2.8m indicating the presence of a possible dense sand or shallow gravel layer or an obstruction. Material logs available from ECan wells have been used to infer the ground conditions at the site as shown in Table 1 below.

Table 1: Inferred Ground Conditions

Stratigraphy	Thickness (m)	Depth Encountered From (m)
Fill	0.8-2.0m	Surface
Grey SILT	5.4m	Surface
Blue/grey sand and GRAVEL	7.3-8.6m	0.8-2.0m
Grey SAND	4.5m	9.4m
Sandy GRAVEL	5.3m	13.9m
Grey SILT with peat and trace organics	4.3m	19.2m
Sandy GRAVELS (Riccarton Formation)	-	22-23.5m

A groundwater depth of approximately 1m to 2m below ground level has been estimated from groundwater depth contour maps (Environment Canterbury (2003) and Elder et al. (1991)).

2.5 Liquefaction Hazard

A liquefaction hazard study was conducted by the Canterbury Regional Council (ECan) in 2004 to identify areas of Christchurch susceptible to liquefaction during an earthquake. This Spreydon site is located in an area identified as having 'moderate ground damage potential' for a low groundwater scenario. According to this study, the ground may be affected by 100mm to 300mm of subsidence.

Tonkin and Taylor Ltd (T&T Ltd) have been engaged as the Earthquake Commission's (EQC) geotechnical consultants and have prepared maps showing areas of liquefaction interpreted from high resolution aerial photos for the aftershock of February 2011 and December 2011. There is evidence from these aerial photos of moderate surface rupture liquefaction in the vicinity of the site after February 2011 seismic event.

CERA land zone map last updated 10 February, 2012 has classified the surrounding residential properties as Green Zone. This indicates that the repair and rebuilding process can begin. The maps that were released by the Department of Building and Housing (DBH) on 16 November 2011 indicate that the residential areas surrounding the site are classified as Technical Category 2 (yellow), which indicates that that minor to moderate land damage from liquefaction is possible in future significant earthquakes.

The University of Canterbury drive-through reconnaissance 23 February – 1 March (Cubrinovski & Taylor, 2011) indicated that there were areas of moderate to severe liquefaction to the north and east of the building, but no liquefaction to the west and south.

3. *Site Walkover Inspection*

A walkover inspection of the exterior and adjacent areas was carried out by an Opus Geotechnical Engineer on 26 March 2012. The following observations were made (refer to the Walkover Inspection Plan and Site Photos attached to this report):

- An area of pavement, approximately $4m^2$, has been affected by up to 50mm of heave in the carpark north of the building.
- Multiple cracks up to 3mm wide were observed at several locations around the concrete perimeter strip footing (Photos 2, 5 and 6).
- Cracking (approximately 5mm wide) at the patio and down the steps on the north elevation of the building. One crack extends into the masonry wall (Photo 3).
- It appears there has been an extension of the original buildings footprint on the southern elevation. There is a 5mm wide crack at the join between the old and new perimeter strip footings (Photo 4).
- Minor surface rupture of liquefaction has occurred in the children’s area directly south of the building (Photo 9).
- Approximately 10mm of settlement appears to have occurred at the bus lay by area, 10m east of the Centennial Hall building (Photo 7).
- It appears that the retirement housing on the southern boundary has suffered from differential settlement estimated to be 50mm.

4. *Conclusions and Discussion*

Minor land damage has occurred to the Centennial Hall due to the Canterbury Earthquake Sequence following the 4 September 2010 earthquake. Moderate damage has occurred to the neighbouring retirement housing on the southern boundary.

Liquefaction appears to have occurred in the vicinity of the building, indicated by aerial photos, liquefaction deposits and up to 50mm of pavement heave. It is unclear whether the settlement in the bus stop is due to the recent seismic events, or due to the continued serviceability of buses.

The building is supported on concrete piles and a perimeter strip footing. The perimeter strip footings have performed well. Cracking on the perimeter footings generally less than 5mm has been observed, which may indicate that settlement of the structure has occurred during the earthquake events and recent aftershocks.

The seismic oscillations appear to have also caused the buildings southern extension foundations to separate from the original building foundations by 5mm. The cracking becomes wider as it goes up the wall, which suggests that settlement has occurred in the south west corner of the building. We recommend a detailed level survey is undertaken to more accurately assess the foundation performance.

The existing foundations of concrete piles with a concrete perimeter footing are consistent with the type of foundations recommended by the DBH for Technical Category 2 areas. Subject to a structural inspection, the existing foundations with repairs are considered suitable for this building.

GNS Science indicates an elevated risk of seismic activity is expected in the Canterbury region as a result of the earthquake sequence following the 4 September 2010 earthquake. Recent advice (Geonet) indicates there is currently a 15% probability of another Magnitude 6 or greater earthquake occurring in the next 12 months in the Canterbury region. Ground damage similar to what has been observed is anticipated in such an event, dependent on the location of the epicentre. It is expected that the probability of occurrence is likely to decrease with time, following periods of reduced seismic activity.

5. Recommendations

It is recommended that:

- A level survey of the Centennial Hall building should be undertaken to confirm settlement.
- An inspection of the subfloor area is undertaken to check the bearers are adequately tied to the concrete piles.
- Check there have been no voids from liquefaction created under the structure.
- Repairs completed to cracking in the perimeter strip footing.

6. Limitation

This report has been prepared solely for the benefit of Christchurch City Council as our client with respect to the particular brief given to us. Data or opinions in this desk study may not be used in other contexts, by any other party or for any other purpose.

It is recognised that the passage of time affects the information and assessment provided in this document. Opus's opinions are based upon information that existed at the time of the production of this Desk Study. It is understood that the Services provided allowed Opus to form no more than an opinion on the actual conditions of the site at the time the site was visited and cannot be used to assess the effect of any subsequent changes in the quality of the site, or its surroundings or any laws or regulations.

7. References:

Brown, LJ; Webber, JH 1992: Geology of the Christchurch Urban Area. Scale 1:25,000. Institute of Geological and Nuclear Sciences geological map, 1 sheet + 104p.

Environment Canterbury, Canterbury Regional Council (ECan) website:

ECan Well Card
http://ecan.govt.nz/services/online-services/tools-calculators/Pages/well-card.aspx

ECan 2004: The Soild Facts on Christchurch Liquefaction. Canterbury Regional Council, Christchurch, 1 sheet.

Project Orbit, 2011: interagency/organisation collaboration portal for Christchurch recovery effort. https://canterburyrecovery.projectorbit.com/SitePages/Home.aspx

GNS Science reporting on Geonet Website: http://www.geonet.org.nz/canterbury-quakes/aftershocks/ updated on 2 April 2012.

Appendices:
Appendix A: Site Photos
Appendix B: Site Location and Walkover Plans
Appendix C: Environment Canterbury Borehole Logs and EQC CPT logs

APPENDIX A:

Site Photos

Photo 1: North elevation of the Centennial Hall building.

Photo 2: 2mm cracks on the north elevation perimeter strip footing.

Photo 3: 3mm wide crack in patio, which continues as step cracking in the masonry blockwork.

Photo 4: Upto 5mm wide crack at the joint of adjacent footings.

Photo 5: Minor crack on the east elevation footing. Plaster is breaking off.

Photo 6: 3mm wide cracking on the north west corner foundations.

Photo 7: Bus lay by area appears to have settled by approximately 10mm.

Photo 8: Replaced pile.

Photo 9: Liquefaction on the south side of the building.

APPENDIX B:

Site Location and Walkover Plans

○ ECan Borehole Location

△ CPT Locations

BH	ECan Ref	CPT	Ref
1	M36/8824	7	CPT-HNH-28
2	M36/1619		
3	M36/0976		
4	M36/1210		
5	M36/1055		
6	M36/8288		

0 100m

Approximate Scale 1:1500 at A3

OPUS

Opus International Consultants Ltd
Christchurch Office
20 Moorhouse Ave
PO Box 1482
Christchurch, New Zealand
Tel: +64 3 363 5400 Fax: +64 3 365 7857

Project: Centenial Hall
Geotechnical Desk Study

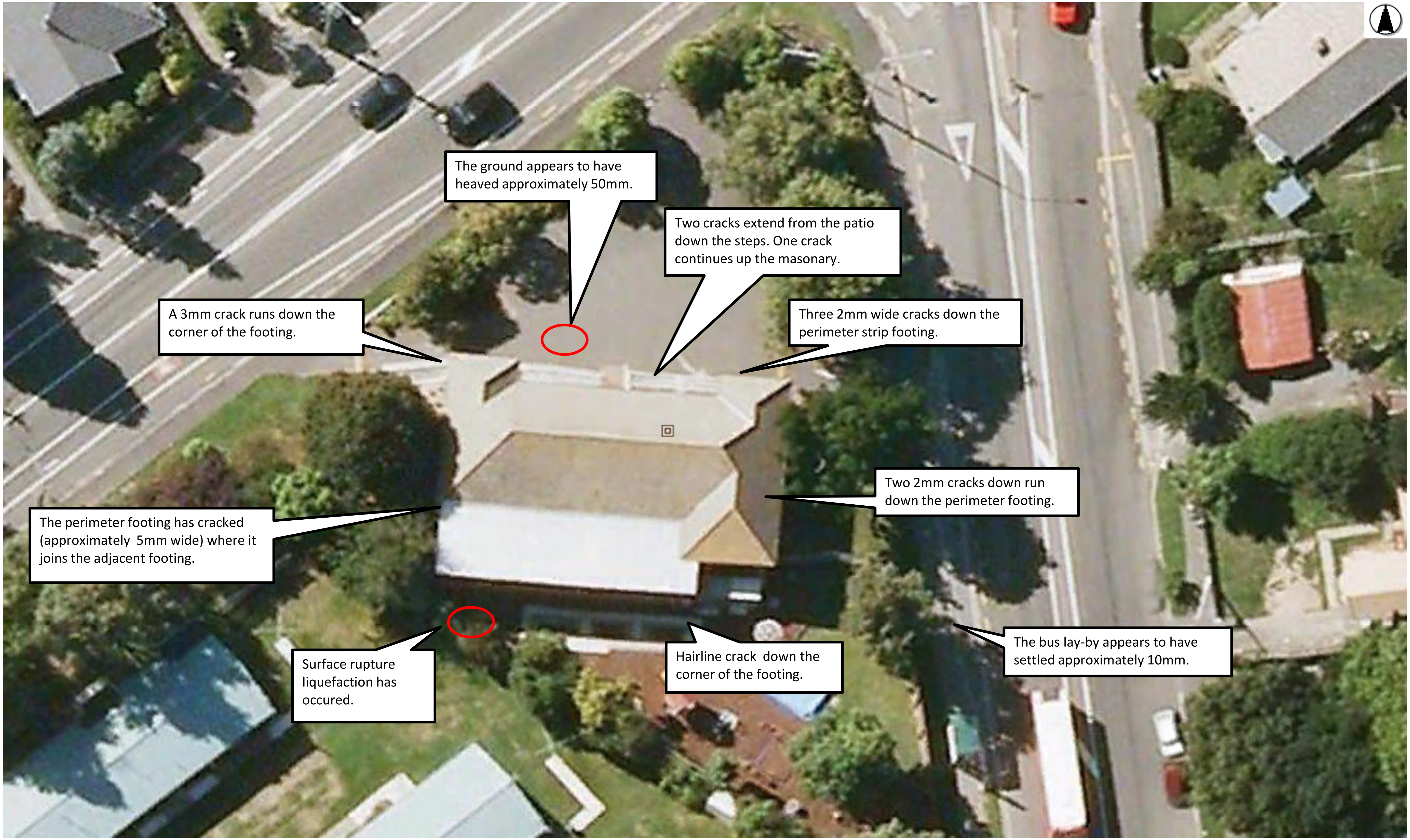
Project No.: 6-QUCCC.88

Client: Christchurch City Council

Site Location Plan

Drawn: Opus Geotechnical Engineer

Date: 23-Mar-12


The ground appears to have heaved approximately 50mm.

Two cracks extend from the patio down the steps. One crack continues up the masonary.

A 3mm crack runs down the corner of the footing.

Three 2mm wide cracks down the perimeter strip footing.

Two 2mm cracks down run down the perimeter footing.

The perimeter footing has cracked (approximately 5mm wide) where it joins the adjacent footing.

Surface rupture liquefaction has occured.

Hairline crack down the corner of the footing.

The bus lay-by appears to have settled approximately 10mm.

Opus International Consultants Ltd
Christchurch Office
20 Moorhouse Ave
PO Box 1482
Christchurch, New Zealand
Tel: +64 3 363 5400 Fax: +64 3 365 7857

Project: Centenial Hall
Geotechnical Desk Study
Project No.: 6-QUCCC.88
Client: Christchurch City Council

Site Walkover Plan

Drawn: Opus Geotechnical Engineer

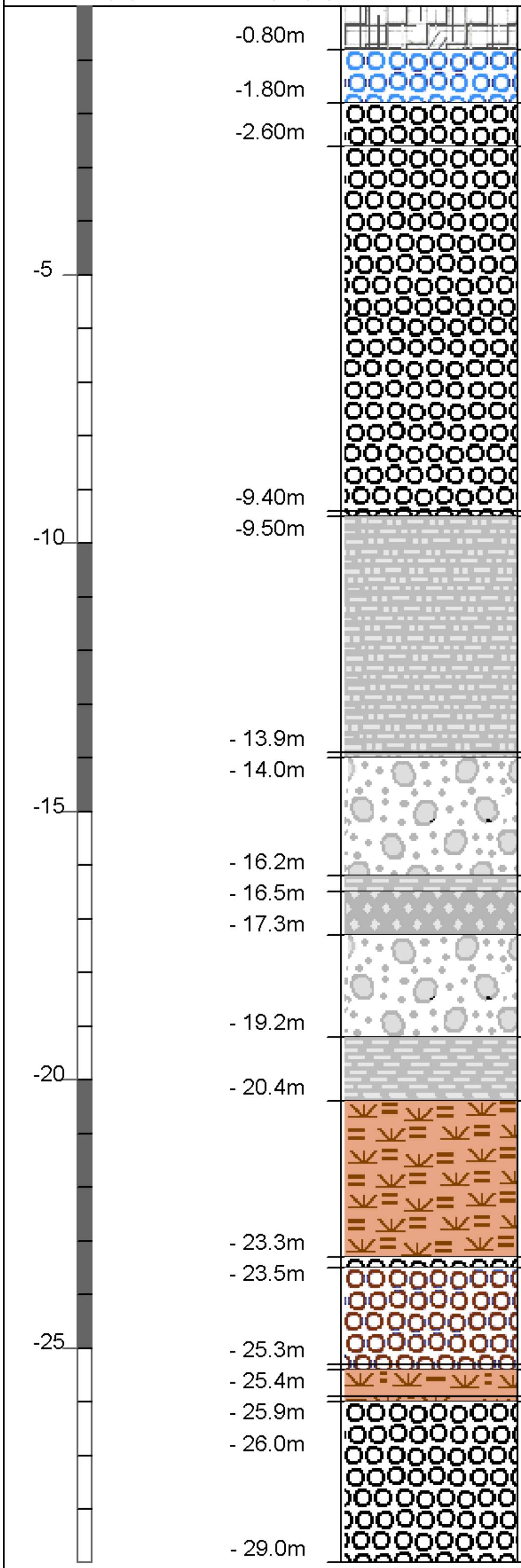
Date: 26-Mar-12

APPENDIX C:

Environment Canterbury Borehole Logs and EQC CPT Logs

Borelog for well M36/8288 page 1 of 2

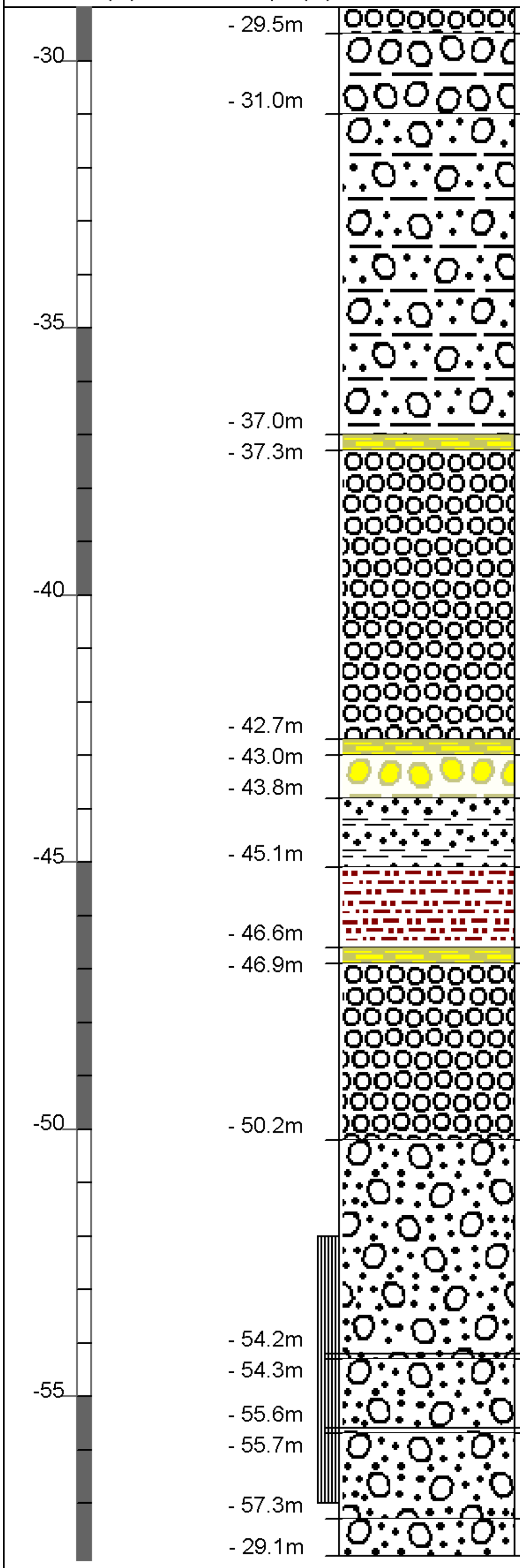
Gridref: M36:7882-3802 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 8 +MSD
Driller : Clemence Drilling Contractors
Drill Method : Rotary/Percussion
Drill Depth : -58m Drill Date : 13/11/2006



Water Level	Depth(m)	Full Drillers Description	Formation Code
	-0.80m	fill	
	-1.80m	blue gravel	
	-2.60m	grey/brown gravel	
	-9.40m	blue/grey gravel	
	-9.50m	grey pug	
	- 13.9m	puggy grey sand	
	- 14.0m	timber	
	- 16.2m	very sandy grey gravel	
	- 16.5m	grey pug	
	- 17.3m	grey sand	
	- 19.2m	very sandy grey gravel	
	- 20.4m	grey pug	
	- 23.3m	grey pug (timber & peat traces)	
	- 23.5m	blue/grey gravel	
	- 25.3m	loose brown gravel	
	- 25.4m	yellow clay	
	- 25.9m	puggy sand (timber & peat traces)	
	- 26.0m	yellow clay	
	- 29.0m	loose grey/brown gravel	

Borelog for well M36/8288 page 2 of 2

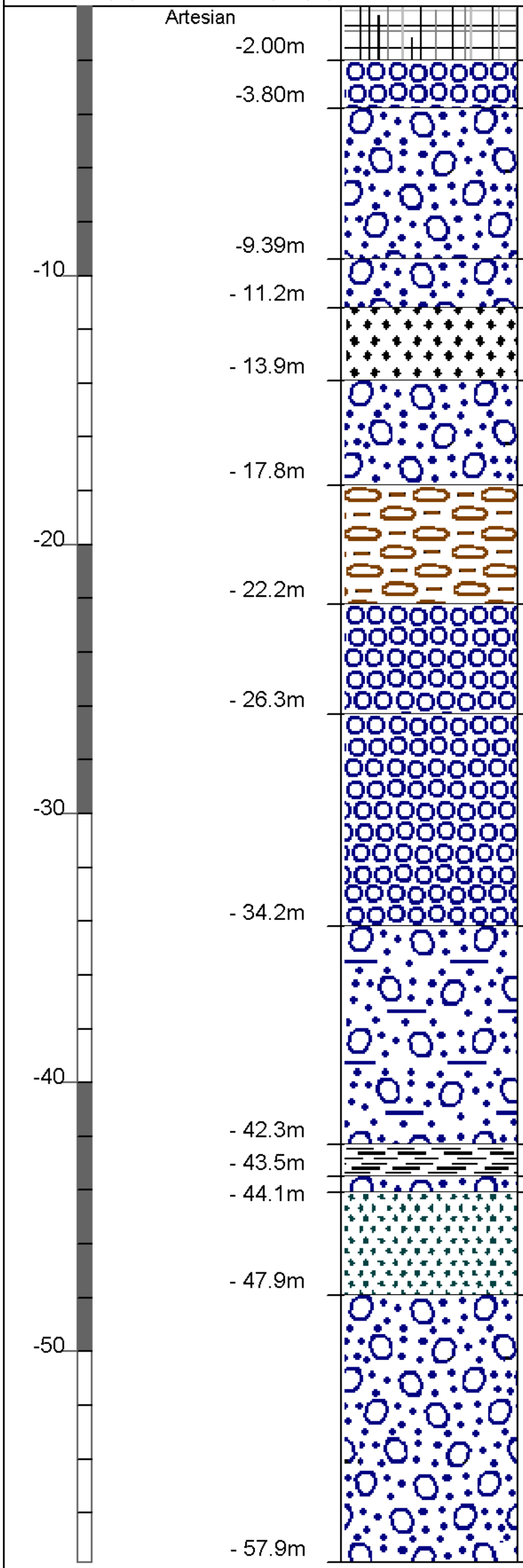
Gridref: M36:7882-3802 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 8 +MSD
Driller : Clemence Drilling Contractors
Drill Method : Rotary/Percussion
Drill Depth : -58m Drill Date : 13/11/2006



Depth(m)	Full Drillers Description	Formation Code
- 29.5m	loose grey/brown gravel	
	loose grey/brown gravel - clay trace	
- 31.0m	sandy grey/brown gravel - clay traces	
- 37.0m	soft yellow clay	
- 37.3m	grey/brown gravel	
- 42.7m	yellow clay (pale)	
- 43.0m	yellow clay (lenses of gravel)	
- 43.8m	sand (clay traces)	
- 45.1m	brown sand & grit	
- 46.6m	yellow clay	
- 46.9m	tight grey/brown gravel	
- 50.2m	loose sandy grey/brown gravel	
- 54.2m	clay seam	
- 54.3m	sandy grey/brown gravel	
- 55.6m	clay seam	
- 55.7m	sandy grey/brown gravel	
- 57.3m	tight sandy grey/brown gravel	
- 29.1m		

Borelog for well M36/1619   page 1 of 2

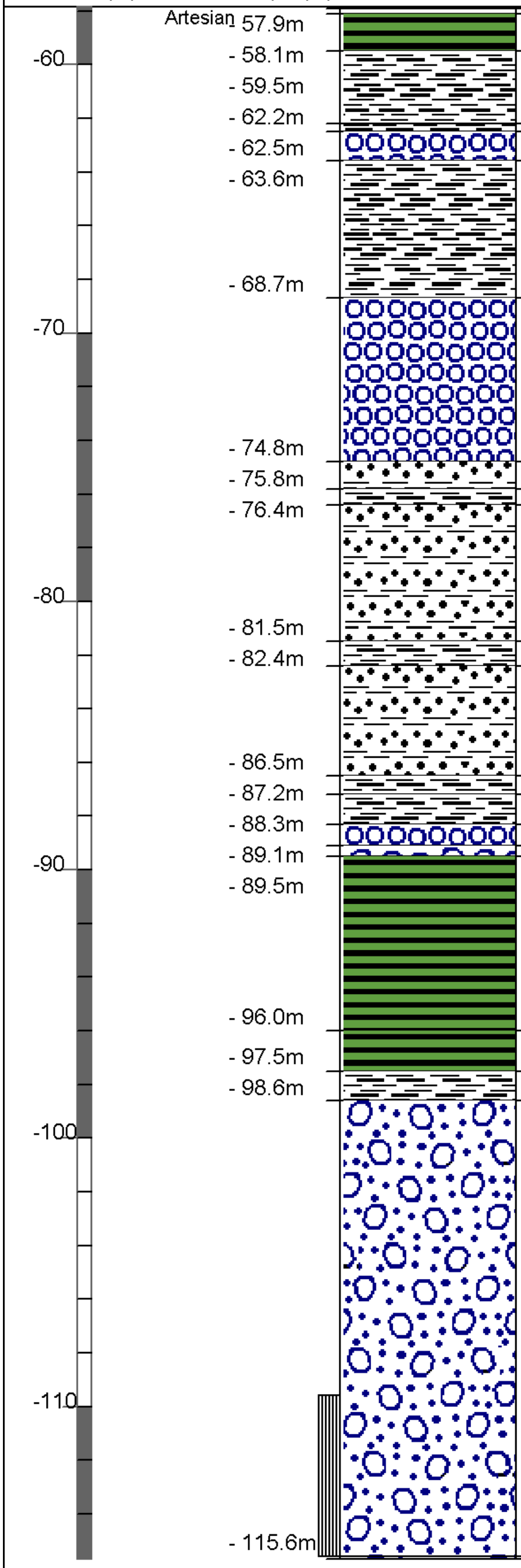
Gridref: M36:7880-3800 Accuracy : 3 (1=best, 4=worst)
Ground Level Altitude : 11.3 +MSD
Driller   : A M Bisley & Co
Drill Method : Cable Tool
Drill Depth   : -115.7m   Drill Date : 29/11/1983



Water Level	Depth(m)	Full Drillers Description	Formation Code
Artesian	-2.00m	Fill	fi
	-3.80m	Grey/Brown gravel	sp
	-9.39m	Blue gravel,sand	sp
	- 11.2m	Blue gravel,sand, wood	sp
	- 13.9m	Blue sand	sp
	- 17.8m	Blue sandy gravel	sp
	- 22.2m	Blue clay - wood	sp
	- 26.3m	Grey/Brown gravel	ri
	- 34.2m	Brown gravel	ri
	- 42.3m	Brown sandy gravel, some Yellow clay	ri
	- 43.5m	Yellow clay	br
	- 44.1m	Sandy Brown gravel	br
	- 47.9m	Fine Yellow sand	br
	- 57.9m	Sandy Brown gravel	li-1

Borelog for well M36/1619 page 2 of 2

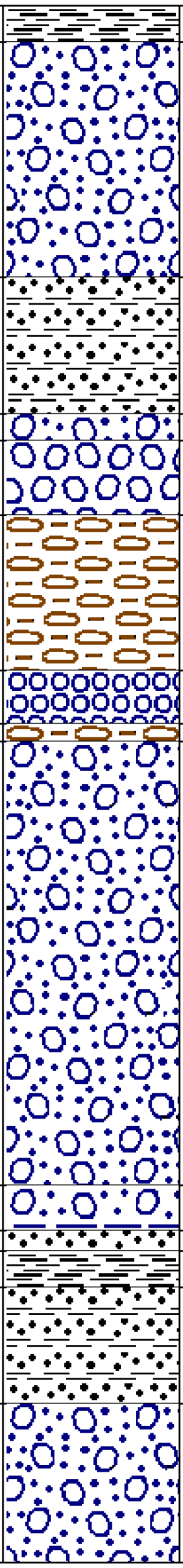
Gridref: M36:7880-3800 Accuracy : 3 (1=best, 4=worst)
Ground Level Altitude : 11.3 +MSD
Driller : A M Bisley & Co
Drill Method : Cable Tool
Drill Depth : -115.7m Drill Date : 29/11/1983



Water Level	Depth(m)	Full Drillers Description	Formation Code
Artesian	57.9m	Sandy Brown gravel	li-2
	- 58.1m	Yellow clay	li-2
	- 59.5m	Dark Brown peaty clay	
	- 62.2m	Blue clay	li-3 li-2
	- 62.5m	Brown gravel, Yellow clay	li-2
	- 63.6m	Brown gravel	
	- 68.7m	Yellow clay	li-2
	- 74.8m	Grey gravel	li-3
	- 75.8m	Brown sand, some Yellow clay	he
	- 76.4m	Yellow clay	he
	- 81.5m	Fine Brown sand, some Yellow clay	he
	- 82.4m	Yellow clay	he
	- 86.5m	Brown sand, Yellow clay trace	he
	- 87.2m	Brown clay	he
	- 88.3m	Yellow clay	he
	- 89.1m	Brown gravel	bu
	- 89.5m	Yellow clay, gravel	bu
	- 96.0m	Firm Blue peaty clay	sh
	- 97.5m	Brown clay & peat	sh
	- 98.6m	Yellow clay	sh
	- 115.6m	Brown gravel, sand	sh-wa
	- 115.7m	Yellow clay	wa

Borelog for well M36/1210 page 1 of 2

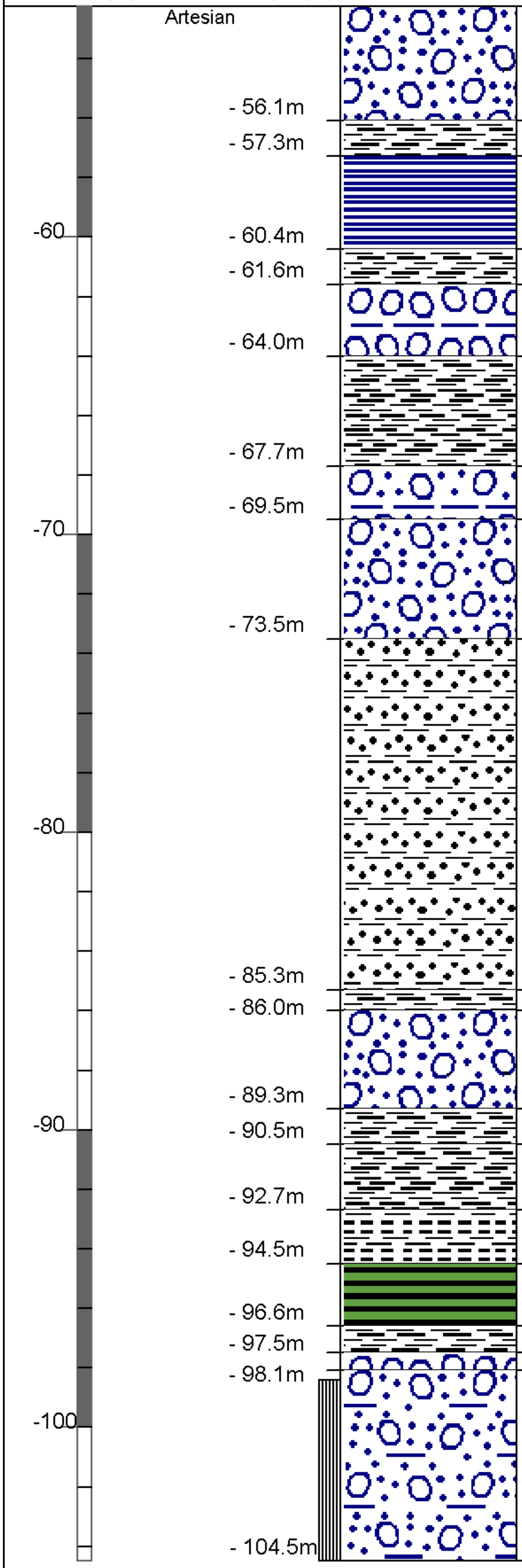
Gridref: M36:7880-3796 Accuracy : 3 (1=best, 4=worst)
Ground Level Altitude : 11.4 +MSD
Driller : Owner
Drill Method : Cable Tool
Drill Depth : -104.5m Drill Date : 28/09/1951



Scale(m)	Water Level	Depth(m)	Full Drillers Description	Formation Code
	Artesian	-1.20m	Fill & clay	fi
		-9.10m	Blue gravel & sand	sp
-10		- 13.7m	Blue sand, some timber & clay	sp
		- 14.6m	Blue sand & gravel (Tight)	sp
		- 17.1m	Blue gravel (Coarse)	sp
-20		- 22.3m	Blue clay (Timber from 21.4m)	sp
		- 24.1m	Brown gravel & some timber	sp
		- 24.7m	Blue clay & timber	sp
-30		- 39.6m	Brown gravel & sand	ri
-40		- 41.1m	Brown sand, some gravel & clay	br
		- 41.8m	Brown sand & clay	br
		- 43.0m	Yellow clay	br
		- 46.9m	Yellow clay, some sand & grit	br
-50		- 56.1m	Brown gravel & sand (Some water)	li-1

Borelog for well M36/1210 page 2 of 2

Gridref: M36:7880-3796 Accuracy : 3 (1=best, 4=worst)
Ground Level Altitude : 11.4 +MSD
Driller : Owner
Drill Method : Cable Tool
Drill Depth : -104.5m Drill Date : 28/09/1951

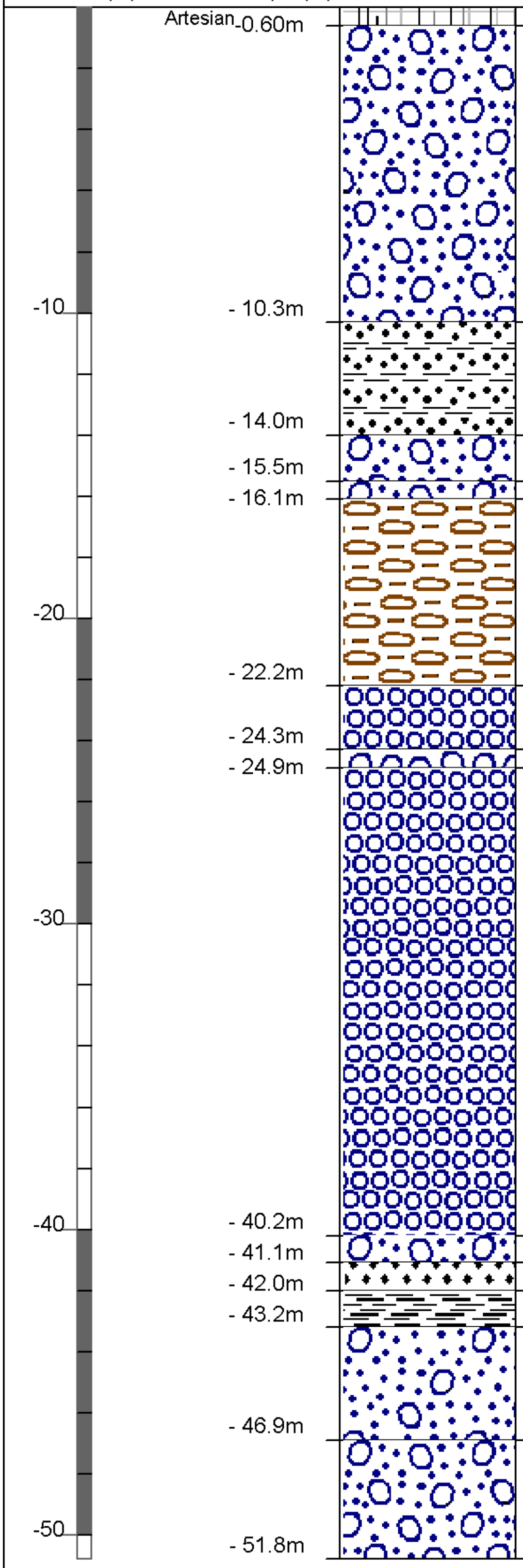


Water Level	Depth(m)	Full Drillers Description	Formation Code
Artesian	- 56.1m	Brown gravel & sand (Some water)	li-1
	- 57.3m	Yellow clay	li-2
	- 60.4m	'papa' clay	li-2
	- 61.6m	Yellow clay	li-2
	- 64.0m	Brown gravel & clay	li-2
	- 67.7m	Yellow clay	li-2
	- 69.5m	Yellow clay with gravel & sand	li-3
	- 73.5m	Brown gravel & sand (Tight)	li-3
	- 85.3m	Yellow clay & Brown sand	he
	- 86.0m	Yellow clay	he
	- 89.3m	Brown gravel & sand (Some water)	bu
	- 90.5m	Yellow clay	sh
	- 92.7m	Blue clay	sh
	- 94.5m	Blue silty clay & some timber	sh
	- 96.6m	Blue clay, some peat & timber	sh
	- 97.5m	Yellow clay	sh
	- 98.1m	Gravel & clay	sh
	- 104.5m	Brown gravel & sand with some clay	sh

Borelog for well M36/1055 page 1 of 3

Gridref: M36:7879-3797 Accuracy : 3 (1=best, 4=worst)
Ground Level Altitude : 11.34 +MSD
Driller : A M Bisley & Co
Drill Method : Cable Tool
Drill Depth : -152.39m Drill Date : 22/09/1965

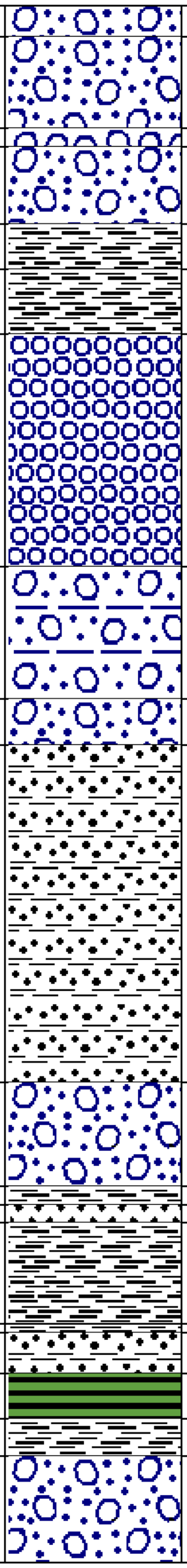
Environment Canterbury
Your regional council



Water Level	Depth(m)	Full Drillers Description	Formation Code
Artesian	0.60m	Filling	fi
	- 10.3m	Blue gravel & sand	sp
	- 14.0m	Blue sand, some clay & timber	sp
	- 15.5m	Blue sand & gravel	sp
	- 16.1m	Grey gravel & sand	sp
	- 22.2m	Soft Blue clay & timber	sp
	- 24.3m	Grey gravel & some timber	sp
	- 24.9m	Grey gravel & Blue clay	ri
	- 40.2m	Brown gravel	ri
	- 41.1m	Brown sandy gravels	ri
	- 42.0m	Brown sand	br
	- 43.2m	Yellow clay	br
	- 46.9m	Yellow sand & some gravel	br
	- 51.8m	Sandy Brown gravel	br

Borelog for well M36/1055 page 2 of 3

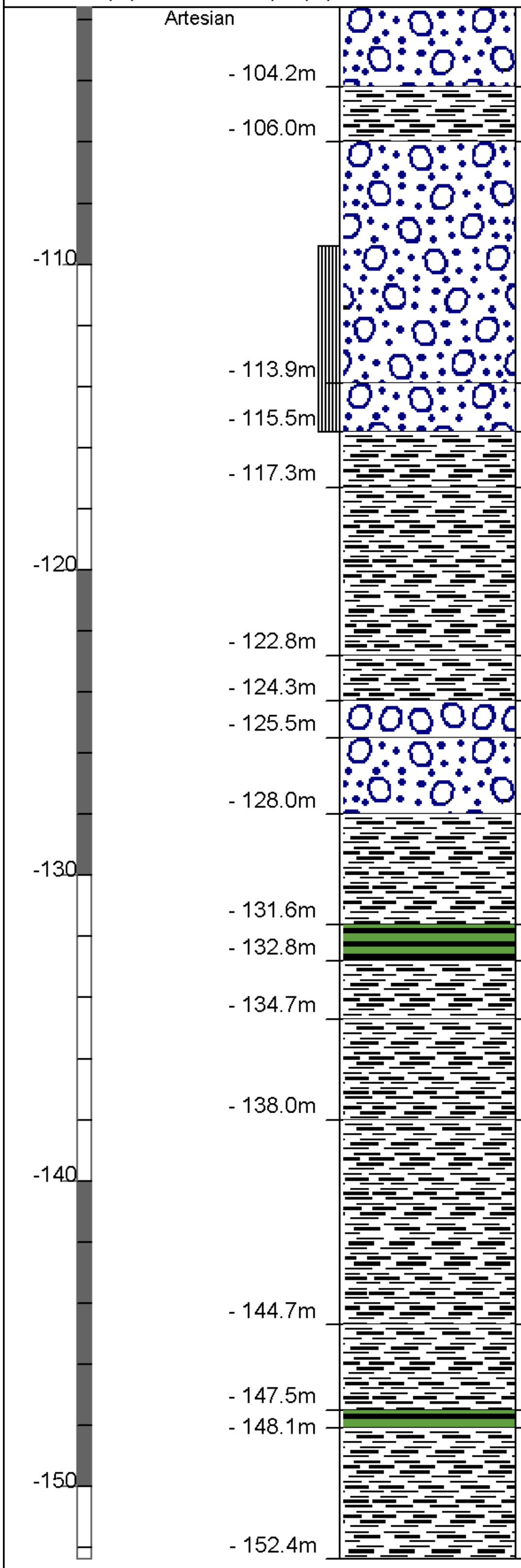
Gridref: M36:7879-3797 Accuracy : 3 (1=best, 4=worst)
Ground Level Altitude : 11.34 +MSD
Driller : A M Bisley & Co
Drill Method : Cable Tool
Drill Depth : -152.39m Drill Date : 22/09/1965



Scale(m)	Water Level	Depth(m)	Full Drillers Description	Formation Code
	Artesian	51.8m	Sandy Brown gravel	br
		- 54.8m	Brown gravel & sand	br
		- 55.4m	Brown gravel & Yellow clay	br
		- 57.9m	Brown gravel & sand	li-1
		- 59.4m	Dark Brown clay	li-2
-60		- 61.5m	Blue clay	li-2
		- 69.1m	Brown gravel & some timber	li-2
-70		- 73.4m	Brown sand, some gravel & lenses of Yellow clay	li-2
		- 74.9m	Grey gravel & sand (Tight)	li-3
-80		- 85.9m	Brown sand & lenses of Yellow clay	he
		- 89.3m	Brown gravel & fine sand	bu
-90		- 89.9m	Yellow clay	sh
		- 90.5m	Blue sand	sh
		- 93.8m	Firm Blue clay	sh
		- 94.1m	Fine Brown sand	sh
		- 95.4m	Sandy Yellow clay	sh
		- 96.9m	Brown clay & peat	sh
		- 98.1m	Hard Yellow clay	sh
-100		- 104.2m	Brown gravel & sand	sh

Borelog for well M36/1055 page 3 of 3

Gridref: M36:7879-3797 Accuracy : 3 (1=best, 4=worst)
Ground Level Altitude : 11.34 +MSD
Driller : A M Bisley & Co
Drill Method : Cable Tool
Drill Depth : -152.39m Drill Date : 22/09/1965



Water Level	Depth(m)	Full Drillers Description	Formation Code
Artesian	- 104.2m	Brown gravel & sand	sh
	- 106.0m	Yellow clay	sh
	- 113.9m	Brown gravel & sand	wa
	- 115.5m	Loose Brown gravel & sand	wa
	- 117.3m	Yellow clay	wa
	- 122.8m	Blue clay	wa
	- 124.3m	Yellow clay	wa
	- 125.5m	Yellow clay & gravel	wa
	- 128.0m	Brown gravel & sand	wa
	- 131.6m	Soft Blue clay	aq5
	- 132.8m	Brown peaty clay & some grit	aq5
	- 134.7m	Soft Blue clay	aq5
	- 138.0m	Firm Blue clay	aq5
	- 144.7m	Hard Yellow clay	aq5
	- 147.5m	Hard Blue clay	aq5
	- 148.1m	Dark Brown peaty clay	aq5
	- 152.4m	Hard Blue clay	aq5

Borelog for well M36/0976 page 1 of 2

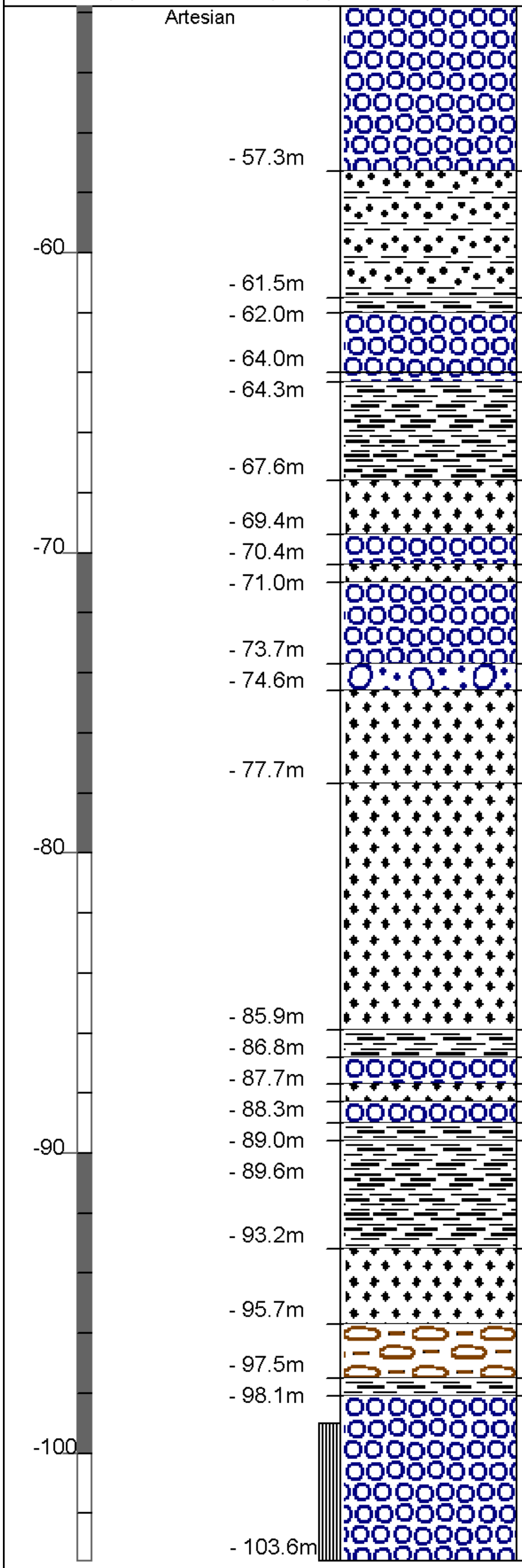
Gridref: M36:7882-3801 Accuracy : 3 (1=best, 4=worst)
Ground Level Altitude : 11.45 +MSD
Driller : J W Horne (& Co)
Drill Method : Cable Tool
Drill Depth : -103.6m Drill Date : 1/07/1940

Water Level	Depth(m)	Full Drillers Description	Formation Code
Artesian	0.60m	Clay & soil	sp
	- 16.7m	Blue shingle (Timber at 3.6m)	sp
	- 21.3m	Blue clay	sp
	- 21.9m	Yellow clay	sp
	- 28.9m	Loose Brown shingle. Water rose to within 0.9m. On pumping fell 1.5m 157.2m3/d	ri
	- 29.2m	Brown sand	
	- 41.4m	Tight Brown shingle	ri
	- 47.5m	Brown sand	br
	- 57.3m	Brown shingle wl 0.76m from surface	li-1

Scale(m): -10, -20, -30, -40, -50

Borelog for well M36/0976 page 2 of 2

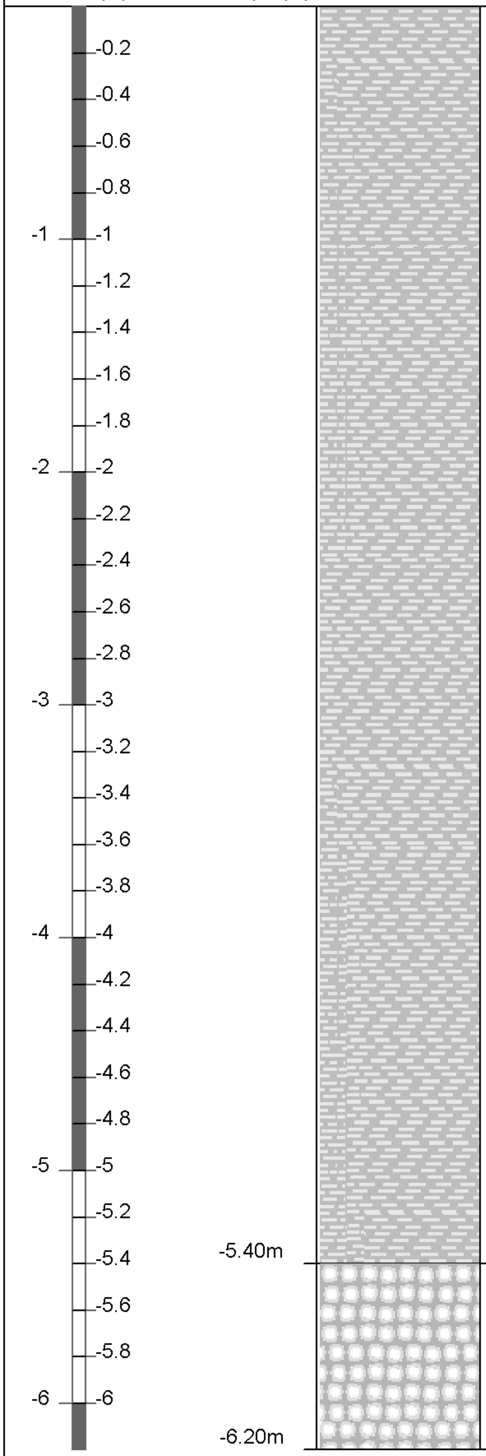
Gridref: M36:7882-3801 Accuracy : 3 (1=best, 4=worst)
Ground Level Altitude : 11.45 +MSD
Driller : J W Horne (& Co)
Drill Method : Cable Tool
Drill Depth : -103.6m Drill Date : 1/07/1940



Water Level	Depth(m)	Full Drillers Description	Formation Code
Artesian	- 57.3m	Brown shingle wl 0.76m from surface	li-1
	- 61.5m	Blue clay & sand	li-2
	- 62.0m	Yellow clay	li-2
	- 64.0m	Brown shingle, water 1.8m from surface	li-2
	- 64.3m	Yellow sand	li-2
	- 67.6m	Yellow clay	li-2
	- 69.4m	Yellow sand	li-2
	- 70.4m	Brown shingle, water 0.3m from surface	li-3
	- 71.0m	Sand	li-3
	- 73.7m	Shingle water 0.3m rise	li-3
	- 74.6m	Brown sand & shingle	li-3
	- 77.7m	Brown sand	he
	- 85.9m	Yellow sand	he
	- 86.8m	Yellow clay	he
	- 87.7m	Brown shingle	bu
	- 88.3m	Yellow sand	bu
	- 89.0m	Brown shingle	bu
	- 89.6m	Yellow clay	sh
	- 93.2m	Blue clay	sh
	- 95.7m	Blue sand	sh
	- 97.5m	Blue clay (Timber @ 97.5m)	sh
	- 98.1m	Yellow clay	sh
	- 103.6m	Brown shingle	sh

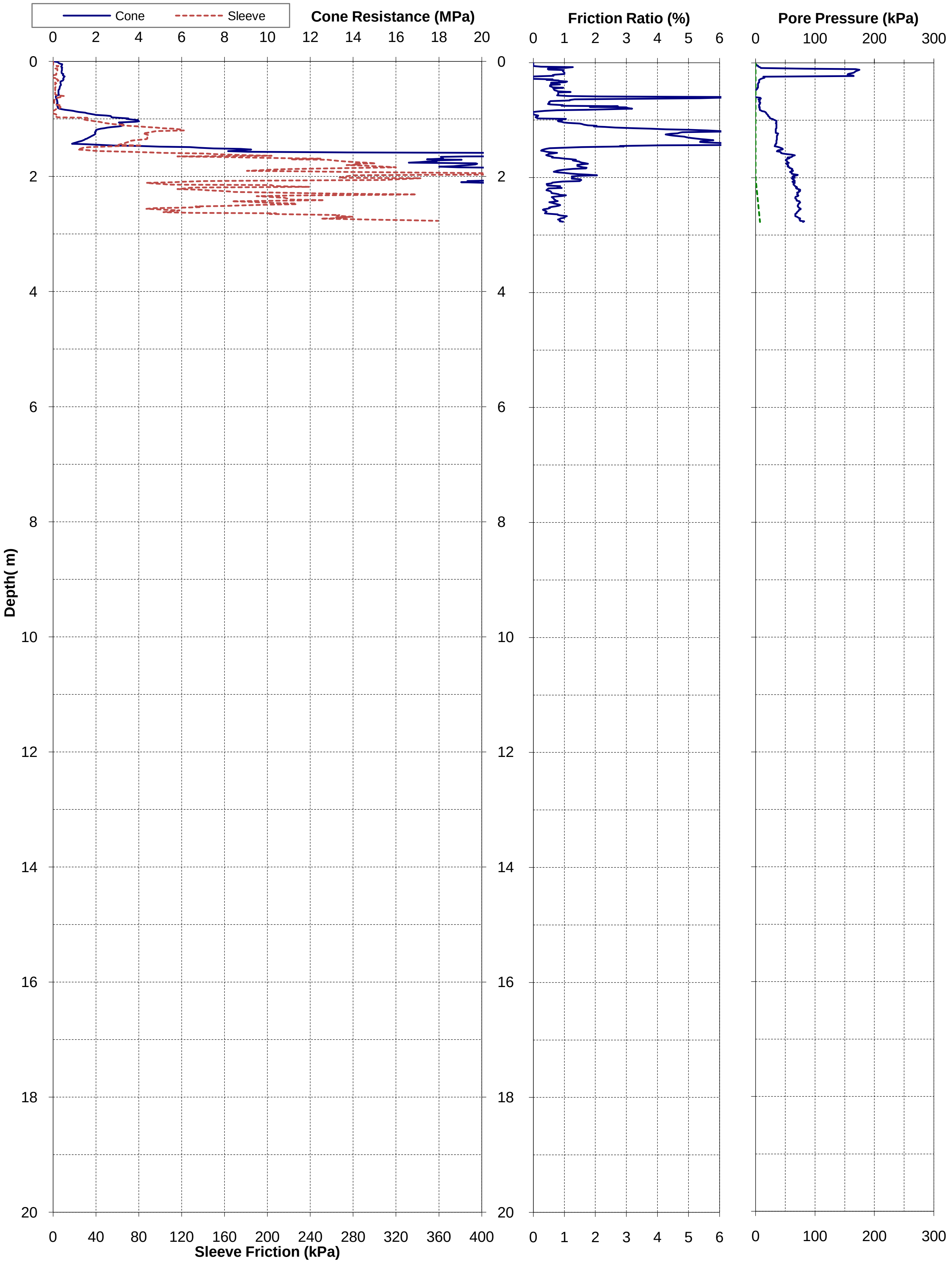
Borelog for well M36/8824

Gridref: M36:78875-38221 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 9 +MSD
Well name : CCC BorelogID 754
Drill Method : Not Recorded
Drill Depth : -6.2m Drill Date :



Water Level	Depth(m)	Full Drillers Description	Formation Code
	-5.40m	grey saturated silt	
	-6.20m	grey dense wet gravel	

Project:	Christchurch 2011 Earthquake - EQC Ground Investigations			**Page:** 1 of 1		**CPT-HNH-28**
Test Date:	16-May-2011	**Location:**	Hoon Hay	**Operator:**	McMillan	
Pre-Drill:	1.2m	**Assumed GWL:**	2mBGL	**Located By:**	Survey GPS	
Position:	2478683.6mE	5738101.2mN	11.201mRL	**Coord. System:**	NZMG & MSL	
Other Tests:				**Comments:**		



T+T Ref: 52000.3000

Printed: 18/08/2011 4:18 p.m.

Template: CPT Graph Template v0.41.xls

Appendix D – CERA DEEP Data Sheet

Detailed Engineering Evaluation Summary Data

V1.11

Location

Building Name: Centennial Hall

Unit No: Street

Building Address: Centennial Park, Spreydon

Legal Description:

Degrees Min Sec

GPS south:

GPS east:

Building Unique Identifier (CCC): BU 1098-001

Reviewer: Dave Dekker

CPEng No: 1003026

Company: Opus International Consultants

Company project number: 6QUCCC.88

Company phone number: 03 363 5400

Date of submission: 13-Sep-12

Inspection Date: 22-Mar-12

Revision: Final

Is there a full report with this summary? yes

Site

Site slope: flat

Soil type: silt

Site Class (to NZS1170.5): D

Proximity to waterway (m, if <100m):

Proximity to clifftop (m, if < 100m):

Proximity to cliff base (m,if <100m):

Max retaining height (m):

Soil Profile (if available):

If Ground improvement on site, describe:

Approx site elevation (m): 5.00

Building

No. of storeys above ground: 1 single storey = 1

Ground floor split? no

Storeys below ground 0

Foundation type: other (describe)

Building height (m): 6.00

Floor footprint area (approx): 315

Age of Building (years): 57

Ground floor elevation (Absolute) (m): 5.40

Ground floor elevation above ground (m): 0.40

if Foundation type is other, describe: Cast-insitu concrete piles and a concrete perimeter wall

height from ground to level of uppermost seismic mass (for IEP only) (m):

Date of design: 1935-1965

Strengthening present? no

If so, when (year)?

And what load level (%g)?

Brief strengthening description:

Use (ground floor): public

Use (upper floors):

Use notes (if required):

Importance level (to NZS1170.5): IL2

Gravity Structure

Gravity System: load bearing walls

Roof: timber truss

truss depth, purlin type and cladding: 2.5m deep, wooden purlins, clay tile cladding

Floors: timber

joist depth and spacing (mm):

Beams: none

overall depth x width (mm x mm):

Columns: load bearing walls

typical dimensions (mm x mm):

Walls:

Lateral load resisting structure

Lateral system along: lightweight timber framed walls

Note: Define along and across in detailed report!

note typical wall length (m):

Ductility assumed, μ: 1.25

Period along: 0.40 0.00

estimate or calculation? estimated

Total deflection (ULS) (mm):

estimate or calculation?

maximum interstorey deflection (ULS) (mm):

estimate or calculation?

Lateral system across: lightweight timber framed walls

note typical wall length (m):

Ductility assumed, μ: 1.25

Period across: 0.40 0.00

estimate or calculation? estimated

Total deflection (ULS) (mm):

estimate or calculation?

maximum interstorey deflection (ULS) (mm):

estimate or calculation?

Separations:

north (mm): leave blank if not relevant

east (mm):

south (mm):

west (mm):

Non-structural elements

Stairs:

Wall cladding: brick or tile

describe (note cavity if exists) Single layer of bricks seperated from the timber walls by a ca

Roof Cladding: Heavy tiles

describe Clay tiles

Glazing: timber frames

Ceilings: light tiles

Services(list):

Available documentation

Architectural none — original designer name/date

Structural none — original designer name/date

Mechanical none — original designer name/date

Electrical none — original designer name/date

Geotech report none — original designer name/date

Damage

Site:

(refer DEE Table 4-2)

Site performance:

Describe damage:

Settlement: none observed

notes (if applicable):

Differential settlement: 0-1:350

notes (if applicable): Minor settlement at south western corner

Liquefaction: 0-2 m²/100m³

notes (if applicable): A couple of small sand boils around building

Lateral Spread: none apparent

notes (if applicable):

Differential lateral spread: none apparent

notes (if applicable):

Ground cracks: none apparent

notes (if applicable):

Damage to area: slight

notes (if applicable):

Building:

Current Placard Status: yellow

Along

Damage ratio: 100%

Describe how damage ratio arrived at:

Describe (summary): Large number of cracks in the brick veneer, cracks in the foundation wall and piles, one visibly failed pile

Across

Damage ratio:

$$Damage\_Ratio = \frac{(\%NBS\ (before) - \%NBS\ (after))}{\%NBS\ (before)}$$

Describe (summary): Large number of cracks in the brick veneer, cracks in the foundation wall and piles, one visibly failed pile

Diaphragms Damage?: no Describe:

CSWs: Damage?: no Describe:

Pounding: Damage?: no Describe:

Non-structural: Damage?: no Describe:

Recommendations

Level of repair/strengthening required: significant structural and strengthening

Describe:

Building Consent required: yes

Describe:

Interim occupancy recommendations: do not occupy

Describe:

Along

Assessed %NBS before: 25% ##### %NBS from IEP below

Assessed %NBS after:

If IEP not used, please detail assessment methodology:

Across

Assessed %NBS before: 20% ##### %NBS from IEP below

Assessed %NBS after:

IEP

Use of this method is not mandatory - more detailed analysis may give a different answer, which would take precedence. Do not fill in fields if not using IEP.

Period of design of building (from above): 1935-1965

h_n from above: m

Seismic Zone, if designed between 1965 and 1992:

not required for this age of building

not required for this age of building

	along	across
Period (from above):	0.4	0.4
(%NBS)nom from Fig 3.3:		

Note:1 for specifically design public buildings, to the code of the day: pre-1965 = 1.25; 1965-1976, Zone A =1.33; 1965-1976, Zone B = 1.2; all else 1.0

Note 2: for RC buildings designed between 1976-1984, use 1.2

Note 3: for buildngs designed prior to 1935 use 0.8, except in Wellington (1.0)

	along	across
Final $(\%NBS)_{nom}$:	**0%**	**0%**

2.2 Near Fault Scaling Factor

Near Fault scaling factor, from NZS1170.5, cl 3.1.6:

	along	across
Near Fault scaling factor (1/N(T,D), **Factor A**:	#DIV/0!	#DIV/0!

2.3 Hazard Scaling Factor

Hazard factor Z for site from AS1170.5, Table 3.3:

Z_{1992}, from NZS4203:1992

Hazard scaling factor, **Factor B:** #DIV/0!

2.4 Return Period Scaling Factor

Building Importance level (from above): 2

Return Period Scaling factor from Table 3.1, **Factor C**: 1.00

2.5 Ductility Scaling Factor

	along	across
Assessed ductility (less than max in Table 3.2)		
Ductility scaling factor: =1 from 1976 onwards; or =kμ, if pre-1976, fromTable 3.3:		
Ductiity Scaling Factor, **Factor D**:	0.00	0.00

2.6 Structural Performance Scaling Factor:

Sp:		
Structural Performance Scaling Factor **Factor E**:	#DIV/0!	#DIV/0!

2.7 Baseline %NBS, $(NBS\%)_b = (\%NBS)_{nom} \times A \times B \times C \times D \times E$

$\%NBS_b$:	**#DIV/0!**	**#DIV/0!**

Global Critical Structural Weaknesses: (refer to NZSEE IEP Table 3.4)

3.1. Plan Irregularity, factor A: insignificant 1

3.2. Vertical irregularity, Factor B: insignificant 1

3.3. Short columns, Factor C: insignificant 1

3.4. Pounding potential

Pounding effect D1, from Table to right 1.0

Height Difference effect D2, from Table to right 1.0

Therefore, Factor D: 1

3.5. Site Characteristics insignificant 1

Table for selection of D1	Severe	Significant	Insignificant/none
Separation	0<sep<.005H	.005<sep<.01H	Sep>.01H
Alignment of floors within 20% of H	**0.7**	**0.8**	**1**
Alignment of floors not within 20% of H	**0.4**	**0.7**	**0.8**

Table for Selection of D2	Severe	Significant	Insignificant/none
Separation	0<sep<.005H	.005<sep<.01H	Sep>.01H
Height difference > 4 storeys	0.4	0.7	1
Height difference 2 to 4 storeys	0.7	0.9	1
Height difference < 2 storeys	1	1	1

3.6. Other factors, Factor F

	Along	Across
For ≤ 3 storeys, max value =2.5, otherwise max valule =1.5, no minimum	1.0	1.0
Rationale for choice of F factor, if not 1		

Detail Critical Structural Weaknesses: (refer to DEE Procedure section 6)

List any: Refer also section 6.3.1 of DEE for discussion of F factor modification for other critical structural weaknesses

3.7. Overall Performance Achievement ratio (PAR) **1.00** **1.00**

4.3 PAR x (%NBS)b: PAR x Baselline %NBS: **#DIV/0!** **#DIV/0!**

4.4 Percentage New Building Standard (%NBS), (before) **#DIV/0!**

OPUS