Christchurch City Council
PRK_1673_BLDG_001 EQ2
Templeton Domain Toilet
Kirk Road, Templeton

QUALITATIVE ASSESSMENT REPORT

FINAL

- Rev B
- 21 November 2012

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Contents

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1. Executive Summary

1.1. Background

A Qualitative Assessment was carried out on the Toilet building located at Templeton Domain on Kirk Road, Templeton. The building was built in around 1964 and is constructed from unreinforced masonry with reinforced bond beams and columns. The building has a timber framed roof with metal roof cladding. An aerial photograph illustrating these areas is shown below in Figure 1. Detailed descriptions outlining the buildings age and construction type is given in Section 2 of this report.

■ **Figure 1 Aerial Photograph of the site**

The qualitative assessment broadly includes a summary of the building damage as well as an initial assessment of the current Seismic Capacity compared with current seismic code loads using the Initial Evaluation Procedure (IEP).

This Qualitative report for the building structure is based on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011, our visual inspection on 16/04/2012, one building drawing and the SKM calculations contained in Appendix 2.

1.2. Key Damage Observed

Key damage observed includes:-

- Minor cracking of the unreinforced masonry bed joint.

1.3. Critical Structural Weaknesses

No critical structural weaknesses have been identified.

1.4. Indicative Building Strength

Based on the information available, and from our conceptual calculations, the buildings original capacity has been assessed to be in the order of 94%NBS and post earthquake capacity in the order of 94%NBS. The buildings post earthquake capacity excluding critical structural weaknesses is in the order of 94%NBS. This assessment has been made with only limited structural drawings and is accordingly limited.

The building has been assessed to have a seismic capacity in the order of 94% NBS and is therefore not potentially earthquake prone.

1.5. Recommendations

It is recommended that:

a) The current placard status of the building of green 1 remain as is.

b) We consider that barriers around the building are not necessary.

2. Introduction

Sinclair Knight Merz was engaged by Christchurch City Council to prepare a qualitative assessment report for the Templeton Domain Toilet building located at Templeton Domain on Kirk Road, Templeton, following the magnitude 6.3 earthquake which occurred in the afternoon of the 22nd of February 2011 and the subsequent aftershocks.

The Qualitative Assessment uses the methodology recommended in the Engineering Advisory Group document "Guidance on Detailed Engineering Evaluation of Earthquake affected Non-residential Buildings in Canterbury". The qualitative assessment broadly includes a summary of the building damage as well as an initial assessment of the likely current Seismic Capacity compared with current seismic code requirements.

A qualitative assessment involves inspections of the building and a desktop review of existing structural and geotechnical information, including existing drawings and calculations, if available.

The purpose of the assessment is to determine the likely building performance and damage patterns, to identify any potential critical structural weaknesses or collapse hazards, and to make an initial assessment of the likely building strength in terms of percentage of new building standard (%NBS).

This report describes the structural damage observed during our inspection and indicates suggested remediation measures. The inspection was undertaken from floor levels and was a visual inspection only. Our report reflects the situation at the time of the inspection and does not take account of changes caused by any events following our inspection. A full description of the basis on which we have undertaken our visual inspection is set out in Section 7.

The NZ Society for Earthquake Engineering (NZSEE) Initial Evaluation Procedure (IEP) was used to assess the likely performance of the building in a seismic event relative to the New Building Standard (NBS). 100% NBS is equivalent to the strength of a building that fully complies with current codes. This includes a recent increase of the Christchurch seismic hazard factor from 0.22 to 0.3[1].

At the time of this report, no intrusive site investigation, detailed analysis, or modelling of the building structure had been carried out. Construction drawings were made available, and these have been considered in our evaluation of the building. The building description below is based on a review of the drawings and our visual inspections.

[1] http://www.dbh.govt.nz/seismicity-info

3. 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.

3.1. 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 carry out a full structural survey before the building is re-occupied.

We understand that CERA will 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). It is anticipated that CERA will adopt the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011. This document sets out a methodology for both qualitative and quantitative assessments.

The qualitative assessment is a desk-top and site inspection assessment. It is based on a thorough visual inspection of the building coupled with a review of available documentation such as drawings and specifications. The quantitative assessment involves analytical calculation of the buildings strength and may require non-destructive or destructive material testing, geotechnical testing and intrusive investigation.

It is anticipated that factors determining the extent of evaluation and strengthening level required will include:

- The importance level and occupancy of the building
- The placard status and amount of damage
- The age and structural type of the building
- Consideration of any critical structural weaknesses

- The extent of any earthquake damage

3.2. Building Act

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

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

3.2.2. Section 115 – Change of Use

This section requires that the territorial authority (in this case Christchurch City Council (CCC)) be satisfied that the building with a new use complies with the relevant sections of the Building Code 'as near as is reasonably practicable'. Regarding seismic capacity 'as near as reasonably practicable' has previously been interpreted by CCC as achieving a minimum of 67%NBS however where practical achieving 100%NBS is desirable. The New Zealand Society for Earthquake Engineering (NZSEE) recommend a minimum of 67%NBS.

3.2.3. Section 121 – Dangerous Buildings

The definition of dangerous building in the Act was extended by the Canterbury Earthquake (Building Act) Order 2010, and it now defines a building as dangerous if:

- 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
- 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
- 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
- there is a risk that that other property could collapse or otherwise cause injury or death; or
- A territorial authority has not been able to undertake an inspection to determine whether the building is dangerous.

3.2.4. Section 122 – Earthquake Prone Buildings

This section defines a building as earthquake prone 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 ground shaking 33% of the shaking used to design an equivalent new building.

3.2.5. 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.

3.2.6. Section 131 – Earthquake Prone Building Policy

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

3.3. 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 of the 4th September 2010.

The 2010 amendment includes the following:

- A process for identifying, categorising and prioritising Earthquake Prone Buildings, commencing on 1 July 2012;
- A strengthening target level of 67% of a new building for buildings that are Earthquake Prone. Council recognises that it may not be practicable for some repairs to meet that target. The council will work closely with building owners to achieve sensible, safe outcomes;
- A timeframe of 15-30 years for Earthquake Prone Buildings to be strengthened; and,
- 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.

We anticipate that any building with a capacity of less than 34%NBS (including consideration of critical structural weaknesses) will need to be strengthened to a target of 67%NBS of new building standard as recommended by the Policy.

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.

3.4. 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.

After the February Earthquake, on 19 May 2011, Compliance Document B1: Structure was amended to include increased seismic design requirements for Canterbury as follows:

a) Hazard Factor increased from 0.22 to 0.3 (36% increase in the basic seismic design load)

b) Serviceability Return Period Factor increased from 0.25 to 0.33 (80% increase in the serviceability design loads when combined with the Hazard Factor increase)

The increase in the above factors has resulted in a reduction in the level of compliance of an existing building relative to a new building despite the capacity of the existing building not changing.

4. 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 new building standard load requirements have been determined in accordance with the current earthquake loading standard (NZS 1170.5:2004 Structural design actions - Earthquake actions - New Zealand).

The likely capacity of this building has been derived in accordance with the New Zealand Society for Earthquake Engineering (NZSEE) guidelines 'Assessment and Improvement of the Structural Performance of Buildings in Earthquakes' (AISPBE), 2006. These guidelines provide an Initial Evaluation Procedure that assesses a buildings capacity based on a comparison of loading codes from when the building was designed and currently. It is a quick high-level procedure that can be used when undertaking a Qualitative analysis of a building. The guidelines also provide guidance on calculating a modified Ultimate Limit State capacity of the building which is much more accurate and can be used when undertaking a Quantitative analysis.

The New Zealand Society for Earthquake Engineering has proposed a way for classifying earthquake risk for existing buildings in terms of %NBS and this is shown in Figure 2 below.

Description	Grade	Risk	%NBS	Existing Building Structural Performance	Improvement of Structural Performance: Legal Requirement	Improvement of Structural Performance: 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	Unacceptable	Unacceptable

- **Figure 2: NZSEE Risk Classifications Extracted from table 2.2 of the NZSEE 2006 AISPBE Guidelines**

Table 1 below provides an indication of the risk of failure for an existing building with a given percentage NBS, relative to the risk of failure for a new building that has been designed to meet current Building Code criteria (the annual probability of exceedance specified by current earthquake design standards for a building of 'normal' importance is 1/500, or 0.2% in the next year, which is equivalent to 10% probability of exceedance in the next 50 years).

- **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

5. Building Details

5.1. Building description

The Toilet building is located at the Templeton Domain on Kirk Road, Templeton. The building has one occupied storey. The building is used as a public toilet. The building is constructed from partially reinforced concrete block. The building is supported on concrete strip foundations and has a concrete slab on grade. The building was constructed in approximately 1964.

5.2. Gravity Load Resisting system

The building is a single story building constructed from concrete block load bearing walls with a timber framed roof with metal cladding. The foundations of the building are constructed from concrete ground beams.

5.3. Seismic Load Resisting system

Lateral loads on the building are resisted by the concrete block walls. The block walls resist shear in-plane and face loading out of plane by perpendicular walls and a reinforced ring beam providing support.

5.4. Geotechnical Conditions

The site has been assessed as being NZS 1170.5 Class D (soft or deep soil, including gravel exceeding a depth of 100m) using nearby borehole investigation data.

For the purposes of carrying out a Quantitative Detailed Engineering Evaluation the engineer can assume this site is 'good ground' (as defined in NZS3604:2011) and therefore the following parameters are recommended for the shallow materials:

Parameter	Estimated value
Effective angle of friction	35 degrees
Apparent cohesion	0 kPa
Unit weight	18 kPa
Ultimate bearing capacity of a shallow square pad footing	300 kPa

NOTE: These figures are based on historical geotechnical data from outside the site for the purposes of preliminary structural assessment. These parameters should not be relied upon for any design work. Site specific investigations are required to confirm that these assumed values are correct. Additionally, further geotechnical investigation could potentially increase the ultimate bearing capacity stated above. The full geotechnical desktop study can be found in Appendix 4.

6. Damage Summary

SKM undertook inspections on 16/04/2012. The following areas of damage were observed during the time of inspection:

1) Cracking less than 0.5mm in the concrete block bed joints. Note that the damage may not have been caused by the earthquake, however is of a type consistent with earthquake damage and there was no other evidence which would lead us to believe that the damage existed prior to the earthquakes.

Photos of the above damage can be found in Appendix 1 – Photos.

7. Initial Seismic Evaluation

7.1. The Initial Evaluation Procedure Process

This section covers the initial seismic evaluation of the building as detailed in the NZSEE 'Assessment and Improvement of the Structural Performance of Buildings in Earthquakes'. The IEP grades buildings according to their likely performance in a seismic event. The procedure is not yet recognised by the NZ Building Code but is widely used and recognised by the Christchurch City Council as the preferred method for preliminary seismic investigations of buildings[2].

The IEP is a coarse screening process designed to identify buildings that are likely to be earthquake prone. The IEP process ranks buildings according to how well they are likely to perform relative to a new building designed to current earthquake standards, as shown in Table 2. The building grade is indicated by the percent of the required New Building Standard (%NBS) strength that the building is considered to have. Earthquake prone buildings are defined as having less than 33 %NBS strength which correlates to an increased risk of approximately 10 times that of 100% NBS (refer Table 1)[3]. Buildings in Christchurch City that are identified as being earthquake prone are required by law to be followed up with a detailed assessment and strengthening work within 30 years of the owner being notified that the building is potentially earthquake prone[4].Table 2: IEP Risk classifications

Description	Grade	Risk	%NBS	Structural performance
Low risk building	A+	Low	> 100	Acceptable. Improvement may be desirable.
	A		100 to 80	
	B		80 to 67	
Moderate risk building	C	Moderate	67 to 33	Acceptable legally. Improvement recommended.
High risk building	D	High	33 to 20	Unacceptable. Improvement required.
	E		< 20	

[2] http://resources.ccc.govt.nz/files/EarthquakeProneDangerousAndInsanitaryBuildingsPolicy2010.pdf
[3] NZSEE 2006, *Assessment and Improvement of the Structural Performance of Buildings in Earthquakes,* p 2-2
[4] http://resources.ccc.govt.nz/files/EarthquakeProneDangerousAndInsanitaryBuildingsPolicy2010.pdf

The IEP is a simple desktop study that is useful for risk management. No detailed calculations are done and so it relies on an inspection of the building and its plans to identify the structural members and describe the likely performance of the building in a seismic event. A review of the plans is also likely to identify any critical structural weaknesses. The IEP assumes that the building was properly designed and built according to the relevant codes at the time of construction. The IEP method rates buildings based on the code used at the time of construction and some more subjective parameters associated with how the building is detailed and so it is possible that %NBS derived from different engineers may differ.

This assessment describes only the likely seismic Ultimate Limit State (ULS) performance of the building. The ULS is the level of earthquake that can be resisted by the building without catastrophic failure. The IEP does not attempt to estimate Serviceability Limit State (SLS) performance of the building, or the level of earthquake that would start to cause damage to the building[5]. This assessment concentrates on matters relating to life safety as damage to the building is a secondary consideration. SLS performance of the building can be estimated by scaling the current code levels if required.

The NZ Building Code describes that the relevant codes for NBS are primarily:

- AS/NZS 1170 Structural Design Actions
- NZS 3101:2006 Concrete Structures Standard
- NZS 3404:1997 Steel Structures Standard
- NZS4230:2004 Design of Reinforced Concrete Masonry Structures
- NZS 3603:1993 Timber Structures Standard
- NZS 3604:2011 Timber Framed Buildings

7.2. Available Information, Assumptions and Limitations

Following our inspection on the 16/04/2012, SKM carried out a preliminary structural review. The structural review was undertaken using the available information which was as follows:

- SKM site measurements and inspection findings of the building. Please note no intrusive investigations were undertaken.
- One structural drawing was available

The assumptions made in undertaking the assessment include:

- Standard design assumptions for typical buildings as described in AS/NZS1170.0:2002
  - 50 year design life, which is the default NZ Building Code design life.

[5] NZSEE 2006, *Assessment and Improvement of the Structural Performance of Buildings in Earthquakes,* p2-9

- Structure importance level 1 since the total floor area is <30m² and represents structures presenting a low degree of hazard to life and other property.
- Ductility level of 1, based on our assessment and code requirements at the time of design..
- Site hazard factor, Z = 0.3, NZBC, Clause B1 Structure, Amendment 11 effective from 1 August 2011

This IEP was based on our visual inspection of the building and a review of the available structural drawings. Since it is not a full design and construction review, it has the following limitations:

- It is not likely to pick up on any original design or construction errors (if they exist)
- Other possible issues that could affect the performance of the building such as corrosion and modifications to the building will not be identified
- The IEP deals only with the structural aspects of the building. Other aspects such as building services are not covered.
- The IEP does not involve a detailed analysis or an element by element code compliance check.

7.3. Survey

There was no visible settlement of the structure, nor were there any significant ground movement issues around the building. The building is adjacent to land that is zoned TC1 under the CERA Residential Green Zone Mapping exercise. The combination of these factors means that we do not recommend that any survey be undertaken at this point.

7.4. Critical Structural Weaknesses

No critical structural weaknesses were discovered within the building.

7.5. Qualitative Assessment Results

The building has had its capacity assessed using the Initial Evaluation Procedure based on the information available. The buildings capacity excluding critical structural weaknesses and the capacity of any identified weaknesses are expressed as a percentage of new building standard (%NBS) and are in the order of that shown below in Table 3. These capacities are subject to confirmation by a quantitative analysis.

Table 3: Qualitative Assessment Summary

Item	%NBS
Building excluding CSW's	94

Our qualitative assessment found that the building is likely to be classed as a 'Low Risk Building' (capacity greater than 67% of NBS)..

8. Further investigation

No further investigation is required for this building is required to confirm our initial findings and establish possible strengthening concepts.

9. Conclusion

A qualitative assessment was carried out on the Toilet building located at Templeton Domain on Kirk Road, Templeton. The building has sustained minor bed joint cracking damage to the unreinforced masonry walls. The building has been assessed to have a seismic capacity in the order of 94% NBS and is therefore not potentially earthquake prone and is likely to be classified as a 'Low Risk Building' (capacity greater than 67% of NBS).

No Critical Structural Weaknesses were identified. No further investigation is required.

Since the building has sustained only minor damage and is not earthquake prone, the building can continue to operate.

It is recommended that:

a) The current placard status of the building of green1 remain as is.

b) We consider that barriers around the building are not necessary.

10. Limitation Statement

This report has been prepared on behalf of, and for the exclusive use of, SKM's client, and is subject to, and issued in accordance with, the provisions of the contract between SKM and the Client. It is not possible to make a proper assessment of this report without a clear understanding of the terms of engagement under which it has been prepared, including the scope of the instructions and directions given to, and the assumptions made by, SKM. The report may not address issues which would need to be considered for another party if that party's particular circumstances, requirements and experience were known and, further, may make assumptions about matters of which a third party is not aware. No responsibility or liability to any third party is accepted for any loss or damage whatsoever arising out of the use of or reliance on this report by any third party.

Without limiting any of the above, in the event of any liability, SKM's liability, whether under the law of contract, tort, statute, equity or otherwise, is limited in as set out in the terms of the engagement with the Client.

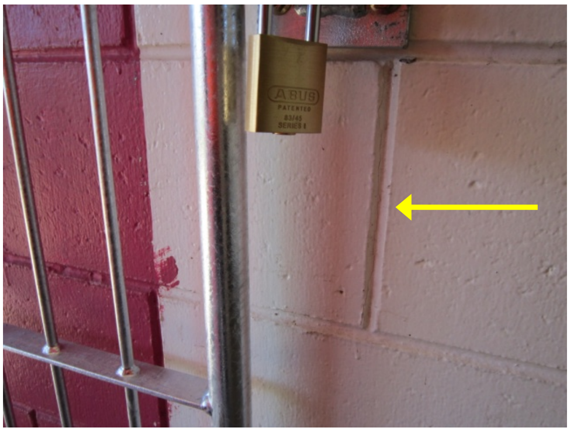
It is not within SKM's scope or responsibility to identify the presence of asbestos, nor the responsibility of SKM to identify possible sources of asbestos. Therefore for any property pre-dating 1989, the presence of asbestos materials should be considered when costing remedial measures or possible demolition.

There is a risk of further movement and increased cracking due to subsequent aftershocks or settlement.

Should there be any further significant earthquake event, of a magnitude 5 or greater, it will be necessary to conduct a follow-up investigation, as the observations, conclusions and recommendations of this report may no longer apply Earthquake of a lower magnitude may also cause damage, and SKM should be advised immediately if further damage is visible or suspected.

11. Appendix 1 – Photos

	
Photo 1: View of the building looking south	Photo 2: View of the building looking east
	
Photo 3: View of the building looking north	Photo 4: View of the mens toilet entrance block walls at either side of the opening

	
Photo 5: View of the block walls within the mens toilet area.	Photo 6: Minor bed joint cracking.

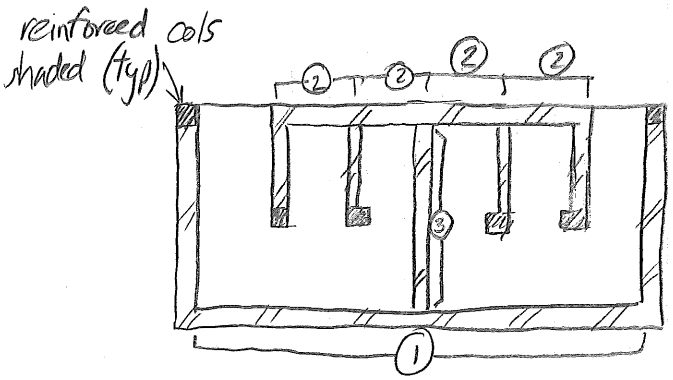
12. Appendix 2 – SKM Calculations

SKM

Client: Christchurch City Council	Job No. 2801276.082
Job Name: Templeton Domain Toilets	Calc. Series: F
Calcs Title: F Factor Calculation	Page: 1
	By: NMC
	Date: 26/04/12

- Assumption: Unreinforced Masonry in out of plane bending is the governing factor in the building design.

- Loading: Light weight roof 0.15kPa
  Filled Block walls 3.8 kPa (on elevation)
  Seismic coefficient 0.45 as attached using IL=1 since the building floor area < 30m²



Note: Unsure of presence of ties between adjacent walls so will assume none exist,

Walls have ring beams as per drawings which are all tied together

check wall ①

Size 2.2(h) x 7.0 (w) → use one way vertical bending since it spans between floor and ring beam.

Use AS3700-2011 and Assessment & Improvement of unreinforced masonry buildings for earthquake resistance, draft Feb 2011

20 series block 190x190x390 units

$Z_d = 190^2 \times 1000/6 = 6.02 \times 10^6 mm^3/m$

$\phi = 1.0$ (for Probable strength)

$f_{mt} = 0.025 f_j'$ $f_j' = 5.5$ for medium hardness
$= 0.138$ MPa

$f_d = (1.1 \times 3.8 + 0.15 \times 1.5)/190 = 0.023$MPa

$M_{cv} = \min \begin{cases} \phi f_{mt} Z_d + f_d Z_d = (1.0 \times 0.138 + 0.023) \times 6.02 = 0.97 \\ 3.0 \phi f_{mt} Z_d = 3.0 \times 1.0 \times 0.138 \times 6.02 = 2.49 kNm/m \end{cases} = 0.97 kNm/m$

demand = $0.45 \times 3.8 \times 2.2^2/8 = 1.03$ kNm/m ✗ FAILS 94%

CALCULATIONS

SINCLAIR KNIGHT MERZ

PROJECT	Templeton Domain Toilets		
PART OF STRUCTURE	Structure Seismic Coefficient	PROJECT No. Z801276.082	REVISION A
		DATE 26 Apr 12	BY NMC

Earthquake Loading to NZS 1170.5:2002

This spreadsheet is for the calculation of equivalent static earthquake loads on structures. All references are to NZS 1170.5:2004 except where noted. As per NZS 1170.5 this spreadsheet is not applicable to bridges, tanks containing liquids, civil structures (dams and bunds etc) off-shore structures and soil retaining structures. It is recommended that the structure period is calculated but if not 0 seconds should be input to acheive conservative results. This spreadsheet is not applicable to parts of structures - see section 8 for design of parts.

INPUT

	Site location	Christchurch
3.1.3	Site Subsoil class	D
AS/NZS1170.0	Importance level	1
AS/NZS1170.0	Design life	50 years
AS/NZS1170.0	ULS Earthquake Annual probability of exceedance	1/100
AS/NZS1170.0	SLS Earthquake Annual probability of exceedance	1/25

CALCULATION

Structure period, T	0.5 s
Structural Ductility Factor, μ	1.0
ULS Structural Performance Factor from material code, S_p	1.0

Note: Leave these S_p blank to use the values in NZS1170.5

Spectral shape factor, $C_h(T)$	3.00
Spectral shape factor, $C_h(0)$	3.00
Hazard factor, Z	0.3
ULS Return Period, R_u	0.50
SLS Return Period, R_s	0.25
ULS Near fault factor, N(T,D)	1.00
SLS Near fault factor, N(T,D)	1.00
ULS Elastic site hazard spectrum for horizontal loading, C(T)	0.45
SLS Elastic site hazard spectrum for horizontal loading, C(T)	0.23
ULS Elastic site hazard spectrum for vertical loading, $C_v(T)$	0.32
SLS Elastic site hazard spectrum for vertical loading, $C_v(T)$	0.16
ULS Structural Performance Factor, S_p	1.0
ULS Structural Performance Factor for sliding or toppling, S_p	1.0
SLS Structural Performance Factor, S_p	0.7
k_μ	1.00

ULS horizontal design action coefficient, $C_d(T_1)$	**0.45**
ULS horizontal design coefficient sliding or toppling, $C_d(T_1)$	**0.45**
ULS vertical design action coefficient, $C_{vd}(T_1)$	**0.32**

SLS horizontal design action coefficient, $C_d(T_1)$	**0.16**
SLS vertical design action coefficient, $C_{vd}(T_1)$	**0.11**

$$M_{ch} = \min \begin{cases} 2 \times 1.0 \times 1.0 \times \sqrt{0.2}\ \left(\sqrt{N/mm^2}\right) \times \left(1 + \dfrac{0.023}{0.2}\right) \times 6.02 \times 10^6\ (mm^3/m) = 6.0\ kNm/m \\ 4 \times 1.0 \times 1.0 \times \sqrt{0.2} \times 6.02 \times 10^6 = 10.77\ kNm/m \\ 1.0 \times (0.44 \times 0.8 \times 12.35 \times 10^6 + 0.56 \times 0.2 \times 6.02 \times 10^6) = 5.02\ kNm/m \end{cases}$$

$$M_{cd} = \phi f_t' Z_t$$

$$Z_t = \frac{\dfrac{2B^2 t_u^2}{3B + 1.8 t_u}}{\left[(l_u + t_j)\sqrt{1 + G^2}\right]} = \frac{\dfrac{2 \times 1000^2 \times 190^2}{3 \times 1000 + 1.8 \times 190}}{\left[(390 + 10)\sqrt{1 + 1.0^2}\right]} = 38200\ mm^3/m$$

$$f_t' = 2.25 \times \sqrt{0.2} + 0.15 \times 0.023 = 1.0097\ MPa$$

$$M_{cd} = 1.0 \times 1.0097 \times 38200 = 0.039\ kNm/m$$

$$\therefore w = \frac{2 \times 2.01}{1.75^2} \times (1 \times 5.02 + 2 \times 0.039) = 6.7\ kPa > 1.71\ kPa$$

✓ ok

S/S

Check ring beam support

$$M^* = 1.71 \times 1.1 \times 3.5^2/10$$

$$= 2.304\ kNm$$

2 – 12ø rods

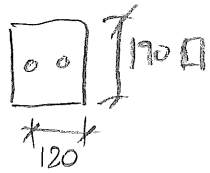
$$\phi M = 1.0 \times 2 \times 113 \times 250 \times \left(90 - 0.59 \times \frac{113 \times 250 \times 2}{4.0 \times 0.19}\right) = 2.61\ kNm > 2.30\ kNm$$

✓ ok

Check perimeter columns

$$M^* = 1.71 \times 1.5 \times 2.2^2/8 = 1.55\ kNm$$

2 – 10ø rods



$$\phi M_s = 1.0 \times 250 \times 78.5 \times \left(120 - 0.59 \times \frac{250 \times 78.5}{4 \times 190}\right)$$

$$= 2.06\ kNm$$

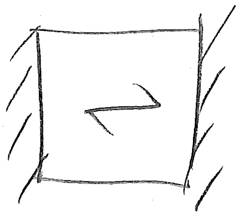
✓ ok

100%

SKM

Client	
Job Name	
Calcs Title	
Job No.	ZB01276.082
Calc. Series	F
Page	4
By	NMC
Date	27/04/12

Design Rear wall panels



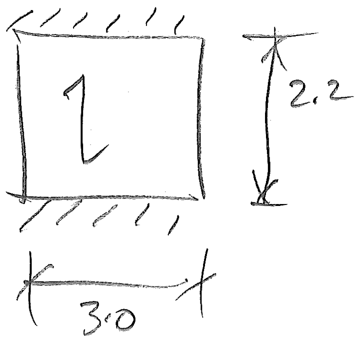
horizontal spanning to AS 3700

$$M^* = 1.71 \times 0.9^2/8 = 0.17\,kNm/m$$

$$M_{ch} = \min \begin{cases} 2 \times 1.0 \times 1.0 \times \sqrt{0.2} \times \left(1 + \frac{0.9 \times 20}{1000 \times 0.2}\right) \times 6.017 \times 10^6\,mm^3/m = 5.87\,kNm/m \\ 4 \times 1.0 \times 1.0 \times \sqrt{0.2} \times 6.017 = 10.7\,kNm/m \\ 1.0 \times (0.44 \times 0.52 + 0.56 \times 0.2) \times 6.017 = 2.05\,kNm/m \end{cases}$$

$> 0.17\,kNm/m$ ✓ OK

check central wall



vertical bending to AS3700

$$M^* = 1.71 \times 2.2^2/8 = 1.03\,kNm/m$$

$$M_{cv} = \min \begin{cases} \left(1.0 \times 0.2 + \frac{1.1 \times 20}{1000}\right) \times 6.017 = 1.34\,kNm/m \\ 3.0 \times 1.0 \times 0.2 \times 6.017 = 3.61 \end{cases}$$

$> 1.03\,kNm/m$

13. Appendix 3 – CERA Standardised Report Form

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name: PRK_1673_BLDG_001 EQ2

	Unit	No:	Street
Building Address:	Templeton Domain Toilet		Kirk Road, Templeton
Legal Description:	Lot 3, DP11243		

	Degrees	Min	Sec
GPS south:			
GPS east:			

Building Unique Identifier (CCC):

Reviewer: Nick Calvert
CPEng No: 242062
Company: Sinclair Knight Merz
Company project number: ZB01276.082
Company phone number: 03 940 4900

Date of submission:
Inspection Date: 16/04/2012
Revision: A
Is there a full report with this summary? yes

Site

Site slope: flat
Soil type:
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): 0
Soil Profile (if available):
If Ground improvement on site, describe: None
Approx site elevation (m): 41.00

Building

No. of storeys above ground: 1 — single storey = 1
Ground floor split? no
Storeys below ground: 0
Foundation type: strip footings
Building height (m): 3.20
Floor footprint area (approx): 21
Age of Building (years): 48

Ground floor elevation (Absolute) (m): 41.00
Ground floor elevation above ground (m): 0.00
if Foundation type is other, describe:
height from ground to level of uppermost seismic mass (for IEP only) (m): 3.5
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): IL1

Gravity Structure

Gravity System: load bearing walls
Roof: timber truss — truss depth, purlin type and cladding: Truss depth approx 600, corrugated iron cladding, 75x50 timber purlins
Floors: concrete flat slab — slab thickness (mm): 100
Beams:
Columns:
Walls: fully filled concrete masonry — thickness (mm): 190

Lateral load resisting structure

Lateral system along: fully filled CMU — note total length of wall at ground (m): 14
Ductility assumed, μ: 1.00 — wall thickness (m): 0.19
Period along: 0.40 — 0.03 from parameters in sheet — estimate or calculation? estimated
Total deflection (ULS) (mm): 5 — estimate or calculation? estimated
maximum interstorey deflection (ULS) (mm): 5 — estimate or calculation? estimated

Note: Define along and across in detailed report!

Lateral system across: fully filled CMU — note total length of wall at ground (m): 11.6
Ductility assumed, μ: 1.00 — wall thickness (m): 0.19
Period across: 0.40 — 0.04 from parameters in sheet — estimate or calculation? estimated
Total deflection (ULS) (mm): 5 — estimate or calculation? estimated
maximum interstorey deflection (ULS) (mm): 5 — estimate or calculation? estimated

Separations:

north (mm): — leave blank if not relevant
east (mm):
south (mm):
west (mm):

Non-structural elements

Stairs:
Wall cladding:
Roof Cladding:
Glazing:
Ceilings: fibrous plaster, fixed
Services(list):

Available documentation

Architectural	none	original designer name/date:
Structural	partial	original designer name/date: Unsure
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:	none observed	notes (if applicable):
Liquefaction:	none apparent	notes (if applicable):
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:	none apparent	notes (if applicable):

Building:

Current Placard Status: green

Along — Damage ratio: 0% — Describe how damage ratio arrived at: Engineering judgement of level of damage
Describe (summary): Damage insignificant in building capacity

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

Across — Damage ratio: 0%
Describe (summary): Damage insignificant in building capacity

Diaphragms — Damage?: no — Describe:
CSWs: — Damage?: no — Describe:
Pounding: — Damage?: no — Describe:
Non-structural: — Damage?: no — Describe:

Recommendations

Level of repair/strengthening required: minor structural — Describe: Cracking repairs to blockwork
Building Consent required: no — Describe: Like for like repair
Interim occupancy recommendations: full occupancy — Describe: No restrictions required

Along — Assessed %NBS before: 94% — %NBS from IEP below — If IEP not used, please detail assessment methodology: SKM conceptual calculations
Assessed %NBS after: 94%

Across — Assessed %NBS before: 94% — %NBS from IEP below
Assessed %NBS after: 94%

14. Appendix 4 – Geotechnical Desktop Study

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Christchurch City Council - Structural Engineering Service

Geotechnical Desk Study

SKM project number	ZB01276
SKM project site number	081 to 082
Address	Templeton Domain,39 Kirk Road
Report date	16 April 2012
Author	Ross Roberts / Ananth Balachandra
Reviewer	Leah Bateman
Approved for issue	Yes

1. Introduction

This report outlines the geotechnical information that Sinclair Knight Merz (SKM) has been able to source from our database and other sources in relation to the property listed above. We understand that this information will be used as part of an initial qualitative Detailed Engineering Evaluation (DEE), and will be supplemented by more detailed information and investigations to allow detailed scoping of the repair or rebuild of the building.

2. Scope

This geotechnical desk top study incorporates information sourced from:

- Published geology
- Publically available borehole records
- Liquefaction records
- Aerial photography
- Council files
- A preliminary site walkover

3. Limitations

This report was prepared to address geotechnical issues relating to the specific site in accordance with the scope of works as defined in the contract between SKM and our Client. This report has been prepared on behalf of, and for the exclusive use of, our Client, and is subject to, and issued in accordance with, the provisions of the contract between SKM and our Client. The findings presented in this report should not be applied to another site or another development within the same site without consulting SKM.

The assessment undertaken by SKM was limited to a desktop review of the data described in this report. SKM has not undertaken any subsurface investigations, measurement or testing of materials from the site. In preparing this report, SKM has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by our Client, and from other sources as described in the report. Except as otherwise stated in this report, SKM has not attempted to verify the accuracy or completeness of any such information.

This report should be read in full and no excerpts are to be taken as representative of the findings. It must not be copied in parts, have parts removed, redrawn or otherwise altered without the written consent of SKM.

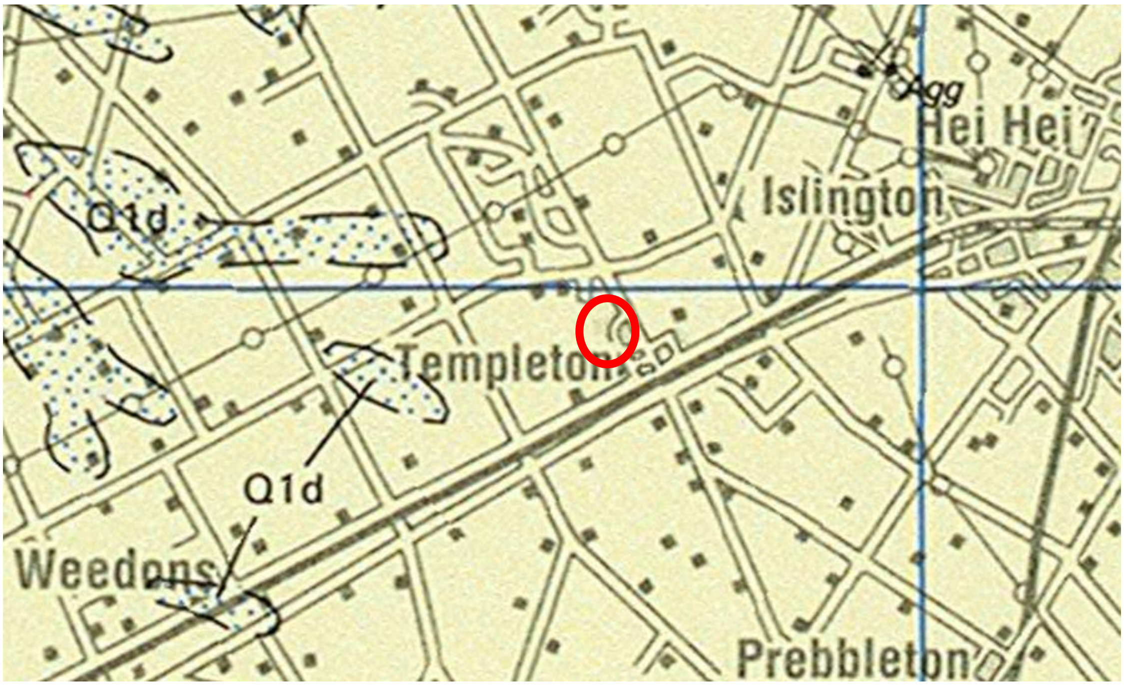
4. Site location

- **Figure 1 – Site location (courtesy of LINZ http://viewers.geospatial.govt.nz)**

These structures are located on 39 Kirk Road at grid reference 1557164E, 5177870 N (NZTM).

5. Review of available information

5.1 Geological maps



- **Figure 2 – Regional geological map (Forsyth et al, 2008). Site marked in red.**

The local geological map for Christchurch did not extend to the location of the site.

From the local geology map the site is shown to be generally underlain by grey river alluvium, comprising gravel, sand and silt, in active flood plains.

5.2 Liquefaction map

Following the 22 February 2011 earthquake event a drive through reconnaissance of the general Christchurch area was undertaken from 23 February until 1 March by M Cubrinovsko and M Taylor of Canterbury University.

However, this reconnaissance did not extend to Templeton.

5.3 Aerial photography

Aerial photography of Christchurch from 24th February 2011, availalbe on http://viewers.geospatial.govt.nz/ did not extend to this area.

5.4 CERA classification

A review of the LINZ website (http://viewers.geospatial.govt.nz/) shows that the site is:

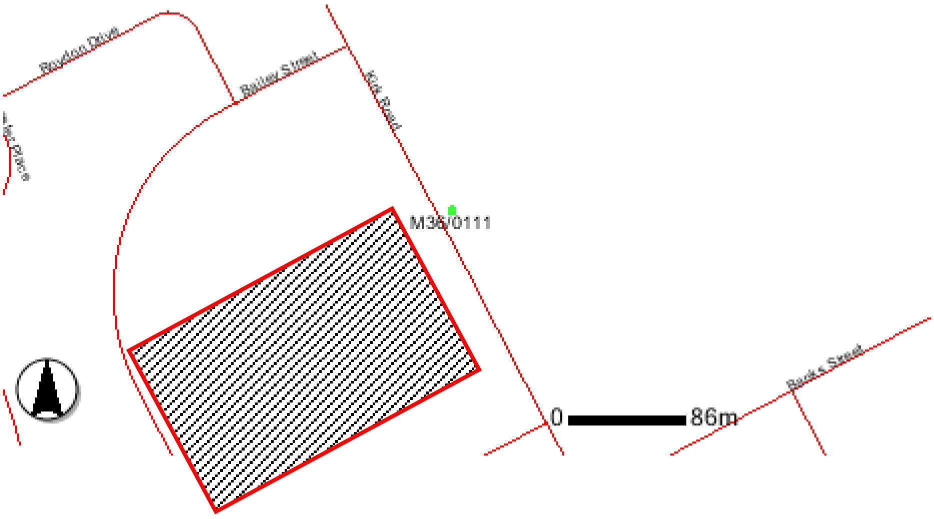
- Zone: Green

- DBH Technical Category: N/A (Urban Non-residential) – the site immediately east is classified as N/A (Rural & Unmapped) while the remaining properties adjacent to the site are classified as TC1

5.5 Historical land use

Available historical reference document is shown in Appendix A. However, no record for historical land use of this site was available.

5.6 Existing ground investigation data



- **Figure 3 - Local Borehole from environment Canterbury online GIS (http://arcims.ecan.govt.nz/ecanmapping/)**

Where available logs from these investigation locations are attached to this report (Appendix B), and the results are summarised in Section 6.1 and Appendix C.

Only investigations within 300m have been summarised however our existing knowledge of the area and wider boreholes have been used to draw conclusions regarding the ground conditions.

5.7 Council property files

Available council property files are documents and drawings relating to the construction of the public toilet structure at Templeton Domain. The documents were drawn up in 1964.

The drawings for the proposed toilet block shows that a reinforced concrete slab approximately 100mm in thickness was used as the floor for the structure. A thickened reinforced concrete slab measuring approximately 225mm is shown to be present beneath the “internal block walls”. The drawings show that the thickened slabs were reinforced with two 12.5mm rods.

No information regarding the underlying ground conditions or any earthworks performed during the construction of the toilet block is available in the council property files for Templeton Domain.

5.8 Site walkover

A site walkover was conducted by a SKM engineer on 16 April 2012.

The Changing Shed and public toilets are both masonry block buildings, with sheet metal roof and slab on grade foundations.

Very minor separation of an extension building from the main block of the changing shed (approx 2mm) was observed; otherwise no damage was noted from the external site inspection. Additionally, there was no evidence of any land damage around the site.

- **Figure 4 Overview of changing sheds**

- **Figure 5 Observed separation of changing shed from main block**

6. Conclusions and recommendations

6.1 Site geology

An interpretation of the most relevant geotechnical investigation data suggests that the site is underlain by:

Depth range (mBGL)	Soil type
0 - 1	Top soil
1 - 5.5	Dense Gravels of the Springston formation
5.5 - 13	Medium to course Riccarton gravels
13 +	Fine to medium sandy gravels of the Riccarton formation

A calculated minimum water table of 17.7m below ground level is shown in the available investigation data. This is a relatively deep water table for the general area and if further information is required regarding this it would need to be confirmed with additional investigations.

6.2 Seismic site subsoil class

The site has been assessed as being NZS 1170.5 Class D (soft or deep soil, including gravel exceeding a depth of 100m) using nearby borehole investigation data.

As described in NZS1170, the preferred site classification method is from site periods based on four times the shear wave travel time through material from the surface to the underlying rock. The next preferred methods are from borelogs including measurement of geotechnical properties or by evaluation of site periods from Nakamura ratios or from recorded earthquake motions. Lacking this information, classification may be based on boreholes with descriptors but no geotechnical measurements. The least preferred method is from surface geology and estimates of the depth to underlying rock.

The third preferred method has been used in the assessment of site subsoil class. It should be noted that only one borehole sufficient near the site was available however we are relatively confident of ground conditions in this area.

6.3 Building Performance

The performance to date suggests that the existing foundations are adequate for their current purpose.

6.4 Ground performance and properties

The liquefaction risk for the site is likely to be low. The gravel layers inferred to be underlying the site are not liquefiable. However, there may be lenses of sand that are potentially liquefiable.

Although there is limited ground investigation data within the direct area of the site, the ground conditions in the Templeton region are relatively consistent, with interbedded gravels and sand from a depth of one metre.

For the purposes of carrying out a Quantitative Detailed Engineering Evaluation the engineer can assume this site is 'good ground' (as defined in NZS3604:2011) and therefore the following parameters are recommended for the shallow materials:

Parameter	Estimated value
Effective angle of friction	35 degrees
Apparent cohesion	0 kPa
Unit weight	18 kPa
Ultimate bearing capacity of a shallow square pad footing	300 kPa

NOTE: These figures are based on historical geotechnical data from outside the site for the purposes of preliminary structural assessment. These parameters should not be relied upon for any design work. Site specific investigations are required to confirm that these assumed values are correct. Additionally, further geotechnical investigation could potentially increase the ultimate bearing capacity stated above.

6.5 Further investigations

Unless a change of use is intended for the site we do not believe that any further geotechnical investigations are required. Specific ground investigation should be undertaken if significant alterations or new structures are proposed.

7. References

Brown LJ, Weeber JH, 1992. Geology of the Christchurch urban area. Scale 1:25,000. Institute of Geological & Nuclear Sciences geological map 1.

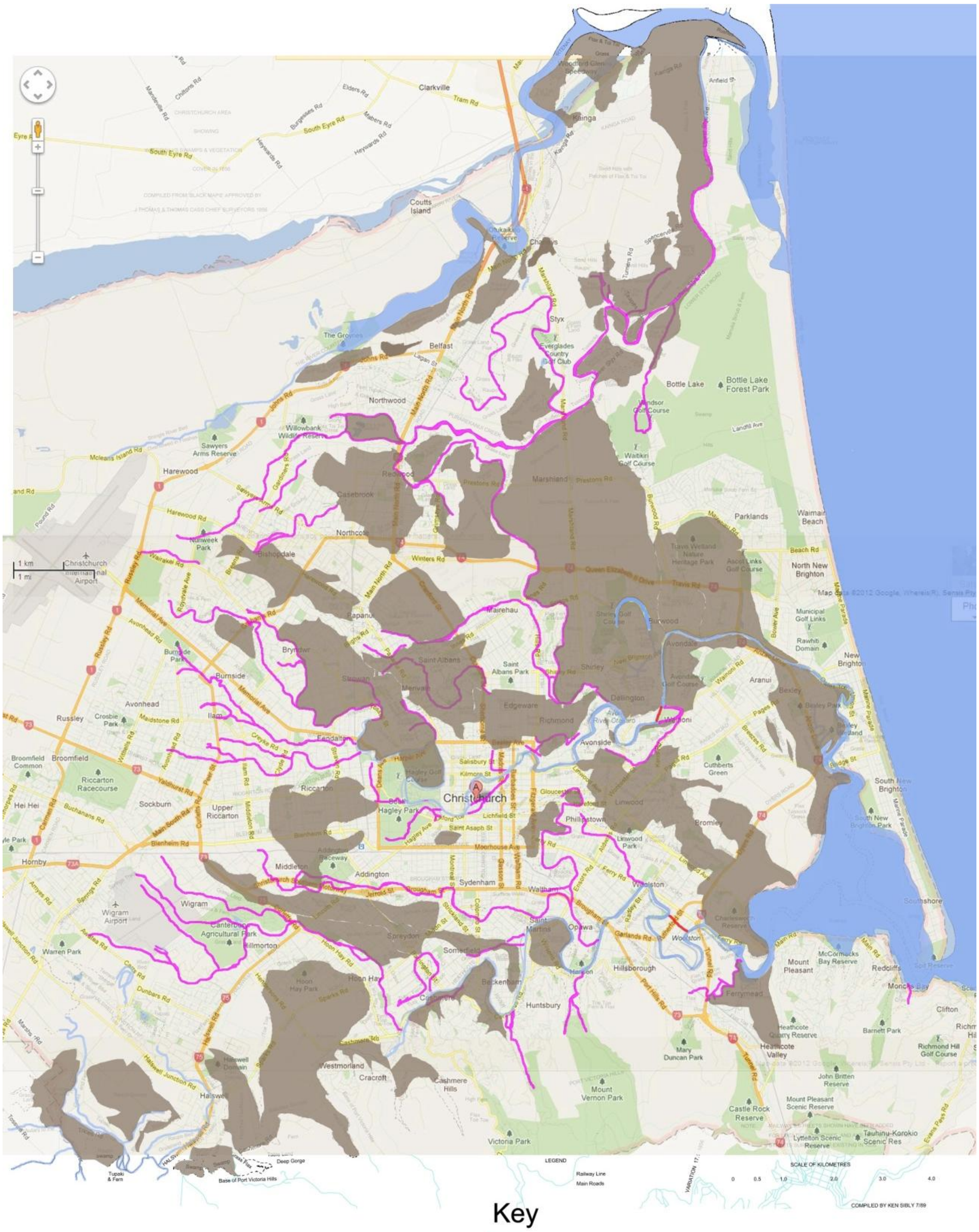
Cubrinovski & Taylor, 2011. Liquefaction map summarising preliminary assessment of liquefaction in urban areas following the 2010 Darfield Earthquake.

Forsyth PJ, Barrell DJA, Jongens R, 2008. Geology of the Christchurch area. Institute of Geological & Nuclear Sciences geological map 16.

Land Information New Zealand (LINZ) geospatial viewer (http://viewers.geospatial.govt.nz/)

EQC Project Orbit geotechnical viewer (https://canterburyrecovery.projectorbit.com/)

Appendix A – Christchurch 1856 land use



Key

- Previous creeks/rivers
- Existing creeks/rivers
- New creeks/rivers
- Swamp/Marshland

The swamps and previous creeks/rivers from 1856 have been overlayed onto a map of Christchurch in 2012

Appendix B – Existing ground investigation logs

Borelog for well M36/0111 page 1 of 2

Gridref: M36:67260-39620 Accuracy : 2 (1=best, 4=worst)
Ground Level Altitude : 41.4 +MSD
Driller : A M Bisley & Co
Drill Method : Cable Tool
Drill Depth : -61m Drill Date : 4/02/1965

Water Level: -17.7CalcMin

Depth(m)	Full Drillers Description	Formation Code
-0.89m	Topsoil	sp
-5.50m	Tight Grey gravels	sp
- 13.1m	Medium to coarse Grey and Brown gravels	ri
- 14.9m	Fine to medium Grey gravels, and sand	ri
- 16.2m	Fine Grey gravels, Water-bearing	ri
- 20.1m	Cemented gravels	ri
- 20.4m	Fine to medium Grey gravels, Water-bearing	ri
- 23.5m	Cemented gravels	ri
- 25.3m	Fine to medium Grey claybound Water-bearing gravels	ri
- 35.4m	Fine to medium Grey gravels and sand, screened	ri

Scale(m): -5, -10, -15, -20, -25, -30

Borelog for well M36/0111 page 2 of 2

Gridref: M36:67260-39620 Accuracy : 2 (1=best, 4=worst)
Ground Level Altitude : 41.4 +MSD
Driller : A M Bisley & Co
Drill Method : Cable Tool
Drill Depth : -61m Drill Date : 4/02/1965

Environment Canterbury
Your regional council

Depth(m)	Full Drillers Description	Formation Code
- 35.4m	Fine to medium Grey gravels and sand, screened	ri
- 38.1m	Cemented gravels	br?
- 41.1m	Medium to coarse Grey gravels and sand	br?
- 42.7m	Cemented gravels and Yellow clay	br?
- 48.8m	Fine to medium Grey and Brown gravels	li
- 50.3m	Sand and Grey gravels	li
- 55.5m	Fine to medium Grey gravel and sand	li
- 58.5m	Fine to medium Brown gravels	li
- 61.0m	Medium to coarse Brown gravels and sand	li

Scale(m): -35, -40, -45, -50, -55, -60

Appendix C – Geotechnical Investigation Summary

- **Table 1 Summary of most relevant investigation data**

ID		**1**
Type *		BH
Ref		M36 - 0111
Depth (m)		61
Distance from site (m)		100
Ground water level (mBGL)		17.7
Simplified recorded geological profile (depth below ground level to top of stratum, m)	0	
	1	
	2	
	3	
	4	
	5	
	6	
	7	
	8	
	9	
	10	
	11	
	12	
	13	
	14	
	15	
	16	
	17	
	18	
	19	
	20	
	21	
	22	
	23	
	24	
	25	
Greater depths		

*BH: Borehole, HA: Hand Auger, WW: Water Well, CPT: Cone Penetration Test

Sensitive or organic clay/silt | Clay to silty clay | Clayey silt to silt | Silty sand to silt

Clayey sand | Sand | Gravelly sand or gravel

VL = very loose, L = loose, MD = medium dense, D = dense, VD = very dense

VS = very soft, So = soft, F = firm, St = stiff, VS = very stiff, H = hard