CHRISTCHURCH CITY COUNCIL
BU 1662-006 EQ2
Templeton Pool – Covered BBQ Area
62 Kirk Road, Templeton

QUALITATIVE ASSESSMENT REPORT

FINAL

- Rev B
- 23 May 2013

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Contents

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Approval

	Signature	Date	Name	Title
Author		23/05/2013	Kimberley Wylie	Structural Engineer
Approver		23/05/2013	Nick Calvert	Senior Structural Engineer

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1. Executive Summary

1.1. Background

A Qualitative Assessment was carried out on building BU 1662-006 EQ2 located at 62 Kirk Road, Templeton. This building is a timber framed free roof structure that is used as a BBQ Area for the Templeton Pool. An aerial photograph illustrating the buildings location is shown below in Figure 1. Detailed descriptions outlining the buildings age and construction type is given in Section 5 of this report.

- **Figure 1 Aerial Photograph of Building BU 1662-006 EQ2 Located at 62 Kirk Road**

The qualitative assessment broadly includes a summary of the buildings 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 and our visual inspection carried out on the 27 April 2012.

1.2. Key Damage Observed

Key damage observed includes:-

- No damage was observed during our inspection.

1.3. Critical Structural Weaknesses

This structure contains no critical structural weaknesses.

1.4. Indicative Building Strength (from IEP and CSW assessment)

Based on the information available, and using the NZSEE Initial Evaluation Procedure, the buildings original capacity has been assessed to be at least 85%NBS. No damage was observed during our site investigation. Due to this the post earthquake capacity is also at least 85%NBS.

As noted above our analysis indicates that the current seismic capacity of the building is over 34% NBS and therefore is not a potentially earthquake prone building.

1.5. Recommendations

It is recommended that:

a) There is no damage to the building that would cause it to be unsafe to occupy.
b) We consider that barriers around the building are not necessary.

2. Introduction

Sinclair Knight Merz was engaged by the Christchurch City Council to prepare a qualitative assessment report for building BU 1662-006 EQ2 located at 62 Kirks 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 current likely Seismic Capacity compared with current seismic 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 7.2

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 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 structure have been carried out. No structural drawings were available for this structure and as a result the descriptions outlined in Section 5 are based only on our visual inspection carried out on the 27 April 2012.

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[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 33%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	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

Building BU 1662-006 EQ2 is a timber framed free roof structure that is used as a BBQ Area at Templeton Pool. The roof is constructed from timber rafters that support timber purlins and a light weight corrugated steel cladding. The roof is supported on timber columns that are fixed into the ground. The footprint of this structure is approximately 18.0m x3.2m and is 2.5m high on average. Due to a lack of structural drawings a post 1976 construction date has been assumed (which is conservative since a post-1992 construction date could probably be assumed based on the architecture and the condition of the structure and this would result in an increased %NBS).

5.2. Gravity Load Resisting System

Our evaluation was based on our site investigation conducted on the 27 April 2012.

As noted above the roof structure consists of timber rafters that support timber purlins and a light weight corrugated steel cladding. The roof is supported on timber columns that are fixed into the ground.

5.3. Seismic Load Resisting System

For the lateral analysis of this building the 'across direction' has been taken as north-south whereas the 'along direction' has been taken as east-west.

Lateral loads acting across and along the structure will be resisted by the roof bracing which consist of a combination of steel galvanised strap bracing and timber diagonal struts. The roof loads will then be transferred into the timber diagonal braces that are located on all sides of the structure as well as in some of the internal bays.

5.4. Geotechnical Conditions

A geotechnical desktop study was carried out for this site. The main conclusions from this report are:

- The site has been assessed as NZS 1170.5 Class D (soft or deep soil, including gravel exceeding 100 m in depth) using nearby borehole investigation data
- Liquefaction risk is low at this site.

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. The full geotechnical desktop study can be found in Appendix 4.

6. Damage Summary

SKM undertook inspections on the 27 April 2012. The following was observed during the time of inspection:

1) No external or internal damage was noted.
2) No visual evidence of settlement was noted at this site. Therefore a level survey is not required at this stage of assessment.

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	

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

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

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 27 April 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.
- No structural drawings were available for this building.

The assumptions and design criteria were used during our assessment:

- The building was built according to good practices at the time.
- Standard design assumptions as described in AS/NZS1170.0:2002
  - 50 year design life, which is the default NZ Building Code design life.
  - Structure Importance Level 2. This level of importance is described as 'normal' with medium or considerable consequence of failure.
- Ductility level of 1, based on our assessment and code requirements at the time of design.

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

- 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. 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 structure is zoned as TC1 on the CERA 'Technical Categories Map' for residential properties. Due to both these factors we do not recommend that any survey be undertaken at this stage of the assessment.

7.4. Critical Structural Weaknesses

No critical structural weaknesses for the building were observed during our visual inspection.

7.5. Qualitative Assessment Results

The structure has had its seismic capacity assessed using the Initial Evaluation Procedure based on the information available. The structures capacity is expressed as a percentage of new building standard (%NBS) and are in the order of that shown below in Table 3.

Table 3: Qualitative Assessment Summary

Item	%NBS
Buildings likely Seismic Capacity	85

Our qualitative assessment found that the structure is likely to be classed as a 'Low Risk Building' (capacity between 67% and 100% of NBS). The full IEP assessment form is detailed in Appendix 2 – IEP Report.

8. Further Investigation

Due to the likely seismic rating of this structure being greater than 67% and the lack of any structural damage no further investigation is recommended.

9. Conclusion

A qualitative assessment was carried out on the covered BBQ Area, BU 1662-006 EQ2, located at 62 Kirk Road, Templeton. This structure has been assessed to have a likely seismic capacity greater than 85% NBS and is therefore a 'Low Risk Building' (capacity greater than 67% of NBS).

Due to the likely seismic rating of this building and the lack of any structural damage no further investigation is required.

It is recommended that:

a) There is no damage to the building that would cause it to be unsafe to occupy.
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

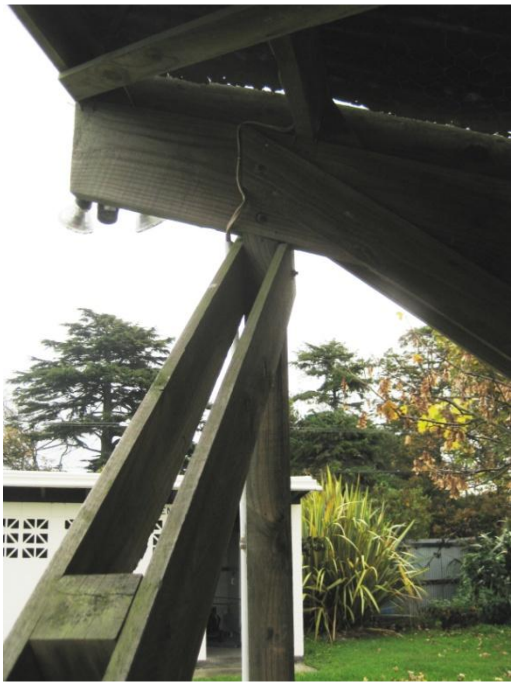
	
Photo 1: Front Elevation of Structure	Photo 2: Side Elevation of Structure
	
Photo 3: Typical Bracing	Photo 4: Bracing Connection

	
Photo 5: Close up of Bracing Connection	Photo 6: Roof structure

12. Appendix 2 – IEP Report

Table IEP-1 **Initial Evaluation Procedure – Step 1**

(Refer Table IEP - 2 for Step 2; Table IEP - 3 for Step 3, Table IEP - 4 for Steps 4, 5 and 6)

Building Name:	BU 1662-006 EQ2 - Covered BBQ Area	Ref.	ZB01276.55
Location:	Templeton Pool, 62 Kirk Road, Templeton	By	KW
		Date	27/04/2012

Step 1 - General Information

1.1 Photos (attach sufficient to describe building)

1.2 Sketch of building plan

1.3 List relevant features

Building BU 1662-006 EQ2 is a timber framed free roof structure that is used as a BBQ Area at Templeton Pool. The roof is constructed from timber rafters that support timber purlins and a light weight corrugated steel cladding. The roof is supported on timber columns that are fixed into the ground. The footprint of this structure is approximately 18.0m x3.2m and is 2.5m high on average. Due to a lack of structural drawings a post 1995 construction date has been assumed based on the architecture and the condition of the structure

Lateral loads acting across and along the structure will be resisted by the roof bracing which consist of a combination of steel galvanised strap bracing and timber diagonal struts. The roof loads will then be transferred into the timber diagonal braces that are located on all sides of the structure as well as in some of the internal bays.

1.4 Note information sources

Tick as appropriate

Visual Inspection of Exterior	☑
Visual Inspection of Interior	☑
Drawings (note type)	☐
Specifications	☐
Geotechical Reports	☐
Other (list)	☐

Inspection Date - 27/04/2012

Table IEP-2 Initial Evaluation Procedure – Step 2

(Refer Table IEP - 1 for Step 1; Table IEP - 3 for Step 3, Table IEP - 4 for Steps 4, 5 and 6)

Building Name:	BU 1662-006 EQ2 - Covered BBQ Area	Ref.	ZB01276.55
Location:	Templeton Pool, 62 Kirk Road, Templeton	By	KW
Direction Considered:	**Longitudinal & Transverse**	Date	27/04/2012

(Choose worse case if clear at start. Complete IEP-2 and IEP-3 for each if in doubt)

Step 2 - Determination of (%NBS)b

2.1 Determine nominal (%NBS) = (%NBS)nom

Pre 1935			○	See also notes 1, 3
1935-1965			○	
1965-1976	Seismic Zone;	A	○	
		B	○	
		C	○	See also note 2
1976-1992	Seismic Zone;	A	○	
		B	●	
		C	○	
1992-2004			○	

b) Soil Type

From NZS1170.5:2004, Cl 3.1.3

A or B Rock	○
C Shallow Soil	○
D Soft Soil	●
E Very Soft Soil	○

From NZS4203:1992, Cl 4.6.2.2
(for 1992 to 2004 only and only if known)

a) Rigid	●	N-A
b) Intermediate	○	

c) Estimate Period, T

building Ht = 3 meters

	Longitudinal	Transverse	
Ac =	18	3	m2

Can use following:

			Longitudinal	Transverse
$T = 0.09h_n^{0.75}$	for moment-resisting concrete frames	MRCF	○	○
$T = 0.14h_n^{0.75}$	for moment-resisting steel frames	MRSF	○	○
$T = 0.08h_n^{0.75}$	for eccentrically braced steel frames	EBSF	○	○
$T = 0.06h_n^{0.75}$	for all other frame structures	Others	●	●
$T = 0.09h_n^{0.75}/A_c^{0.5}$	for concrete shear walls	CSW	○	○
$T <= 0.4sec$	for masonry shear walls	MSW	○	○

Where
hn = height in m from the base of the structure to the uppermost seismic weight or mass.
Ac = ΣAi(0.2 + Lwi/hn)2
Ai = cross-sectional shear area of shear wall i in the first storey of the building, in m2
lwi = length of shear wall i in the first storey in the direction parallel to the applied forces, in m
with the restriction that lwi/hn shall not exceed 0.9

Longitudinal	Transverse	
0.1	**0.1**	Seconds

d) (%NBS)nom determined from Figure 3.3

Longitudinal	16.5	$(\%NBS)_{nom}$
Transverse	16.5	$(\%NBS)_{nom}$

			Factor
Note 1:	For buildings designed prior to 1965 and known to be designed as public buildings in accordance with the code of the time, multiply (%NBS)nom by 1.25.	No	1
	For buildings designed 1965 - 1976 and known to be designed as public buildings in accordance with the code of the time, multiply (%NBS)nom by 1.33 - Zone A or 1.2 - Zone B	No	1
Note 2:	For reinforced concrete buildings designed between 1976 -1984 (%NBS)nom by 1.2	No	1
Note 3:	For buildings designed prior to 1935 multiply (%NBS)nom by 0.8 except for Wellington where the factor may be taken as 1.	No	1

Longitudinal	16.5	$(\%NBS)_{nom}$
Transverse	16.5	$(\%NBS)_{nom}$

Continued over page

Building Name:	BU 1662-006 EQ2 - Covered BBQ Area	Ref.	ZB01276.55
Location:	Templeton Pool, 62 Kirk Road, Templeton	By	KW
Direction Considered:	Longitudinal & Transverse	Date	27/04/2012

(Choose worse case if clear at start. Complete IEP-2 and IEP-3 for each if in doubt)

2.2 Near Fault Scaling Factor, Factor A

If T < 1.5sec, Factor A = 1

a) Near Fault Factor, N(T,D) 1

(from NZS1170.5:2004, Cl 3.1.6)

b) Near Fault Scaling Factor = 1/N(T,D) — **Factor A** 1.00

2.3 Hazard Scaling Factor, Factor B

Select Location: Christchurch

a) Hazard Factor, Z, for site

(from NZS1170.5:2004, Table 3.3)

Z = 0.3

Z 1992 = 0.8

Auckland	0.6	Palm Nth	1.2
Wellington	1.2	Dunedin	0.6
Christchurch	0.8	Hamilton	0.67

b) Hazard Scaling Factor

For pre 1992 = 1/Z

\# For 1992 onwards = Z 1992/Z

(Where Z 1992 is the NZS4203:1992 Zone Factor from accompanying Figure 3.5(b))

Factor B 3.33

2.4 Return Period Scaling Factor, Factor C

a) Building Importance Level 2

(from NZS1170.0:2004, Table 3.1 and 3.2)

b) Return Period Scaling Factor from accompanying Table 3.1 — **Factor C** 1.00

2.5 Ductility Scaling Factor, D

a) Assessed Ductility of Existing Structure, μ

(shall be less than maximum given in accompanying Table 3.2)

	μ	
Longitudinal	1	μ Maximum = 6
Transverse	1	μ Maximum = 6

b) Ductility Scaling Factor

For pre 1976 = k_μ

For 1976 onwards = 1

(where k_μ is NZS1170.5:2005 Ductility Factor, from accompanying Table 3.3)

Longitudinal	**Factor D**	1.00
Transverse	**Factor D**	1.00

2.6 Structural Performance Scaling Factor, Factor E

Select Material of Lateral Load Resisting System

Longitudinal Timber

Transverse Timber

a) Structural Performance Factor, S_p

from accompanying Figure 3.4

Longitudinal	Sp	1.00
Transverse	Sp	1.00

b) Structural Performance Scaling Factor

Longitudinal	$1/S_p$	**Factor E**	1.00
Transverse	$1/S_p$	**Factor E**	1.00

2.7 Baseline %NBS for Building, $(\%NBS)_b$

(equals $(\%NSB)_{nom}$ x A x B x C x D x E)

Longitudinal	55.0	$(\%NBS)_b$
Transverse	55.0	$(\%NBS)_b$

Table IEP-3 Initial Evaluation Procedure – Step 3

(Refer Table IEP - 1 for Step 1; Table IEP - 2 for Step 2, Table IEP - 4 for Steps 4, 5 and 6)

Building Name:	BU 1662-006 EQ2 - Covered BBQ Area	Ref.	ZB01276.55
Location:	Templeton Pool, 62 Kirk Road, Templeton	By	KW
Direction Considered:	**a) Longitudinal**	Date	27/04/2012

(Choose worse case if clear at start. Complete IEP-2 and IEP-3 for each if in doubt)

Step 3 - Assessment of Performance Achievement Ratio (PAR)

(Refer Appendix B - Section B3.2)

Critical Structural Weakness — **Effect on Structural Performance** (Choose a value - Do not interpolate) — **Building Score**

3.1 Plan Irregularity

Effect on Structural Performance	Severe	Significant	Insignificant		
	○	○	◉	**Factor A**	1
Comment					

3.2 Vertical Irregularity

Effect on Structural Performance	Severe	Significant	Insignificant		
	○	○	◉	**Factor B**	1
Comment					

3.3 Short Columns

Effect on Structural Performance	Severe	Significant	Insignificant		
	○	○	◉	**Factor C**	1
Comment					

3.4 Pounding Potential

(Estimate D1 and D2 and set D = the lower of the two, or =1.0 if no potential for pounding)

a) Factor D1: - Pounding Effect

Select appropriate value from Table

Note:
Values given assume the building has a frame structure. For stiff buildings (eg with shear walls), the effect of pounding may be reduced by taking the co-efficient to the right of the value applicable to frame buildings.

Factor D1 1

Table for Selection of Factor D1

Separation	Severe 0<Sep<.005H	Significant .005<Sep<.01H	Insignificant Sep>.01H
Alignment of Floors within 20% of Storey Height	○ 0.7	○ 0.8	◉ 1
Alignment of Floors not within 20% of Storey Height	○ 0.4	○ 0.7	○ 0.8

b) Factor D2: - Height Difference Effect

Select appropriate value from Table

Factor D2 1

Table for Selection of Factor D2

Separation	Severe 0<Sep<.005H	Significant .005<Sep<.01H	Insignificant 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

Factor D 1

(Set D = lesser of D1 and D2 or..
set D = 1.0 if no prospect of pounding)

3.5 Site Characteristics - (Stability, landslide threat, liquefaction etc)

Effect on Structural Performance	Severe	Significant	Insignificant		
	○ 0.5	○ 0.7	◉ 1	**Factor E**	1

3.6 Other Factors

For < 3 storeys - Maximum value 2.5,

otherwise - Maximum value 1.5. No minimum. **Factor F** 1.55

Record rationale for choice of Factor F:

The structure is lightweight, has clear load paths for bracing against racking loads, and is likely to be governed by wind loads.

Conservatively estimate F factor as: [1.05kPa perpendicular wind load x sin(20)] / [0.3kPa gravity load x 0.9g x 85%NBS] ≈ 1.55

3.7 Performance Achievement Ratio (PAR)
(equals A x B x C x D x E x F)

PAR 1.55

(Refer Table IEP - 1 for Step 1; Table IEP - 2 for Step 2, Table IEP - 4 for Steps 4, 5 and 6)

Building Name:	BU 1662-006 EQ2 - Covered BBQ Area	Ref.	ZB01276.55
Location:	Templeton Pool, 62 Kirk Road, Templeton	By	KW
Direction Considered:	**b) Transverse**	Date	27/04/2012

(Choose worse case if clear at start. Complete IEP-2 and IEP-3 for each if in doubt)

Step 3 - Assessment of Performance Achievement Ratio (PAR)

(Refer Appendix B - Section B3.2)

Critical Structural Weakness — **Effect on Structural Performance** (Choose a value - Do not interpolate) — **Building Score**

3.1 Plan Irregularity

Effect on Structural Performance	Severe	Significant	Insignificant	
	○	○	◉	**Factor A** 1
Comment				

3.2 Vertical Irregularity

Effect on Structural Performance	Severe	Significant	Insignificant	
	○	○	◉	**Factor B** 1
Comment				

3.3 Short Columns

Effect on Structural Performance	Severe	Significant	Insignificant	
	○	○	◉	**Factor C** 1
Comment				

3.4 Pounding Potential

(Estimate D1 and D2 and set D = the lower of the two, or =1.0 if no potential for pounding)

a) Factor D1: - Pounding Effect

Select appropriate value from Table

Note:
Values given assume the building has a frame structure. For stiff buildings (eg with shear walls), the effect of pounding may be reduced by taking the co-efficient to the right of the value applicable to frame buildings.

Factor D1 1

Table for Selection of Factor D1

	Severe	Significant	Insignificant
Separation	0<Sep<.005H	.005<Sep<.01H	Sep>.01H
Alignment of Floors within 20% of Storey Height	○ 0.7	○ 0.8	◉ 1
Alignment of Floors not within 20% of Storey Height	○ 0.4	○ 0.7	○ 0.8

b) Factor D2: - Height Difference Effect

Select appropriate value from Table

Factor D2 1

Table for Selection of Factor D2

	Severe	Significant	Insignificant
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

Factor D 1

(Set D = lesser of D1 and D2 or..
set D = 1.0 if no prospect of pounding)

3.5 Site Characteristics - (Stability, landslide threat, liquefaction etc)

Effect on Structural Performance	Severe	Significant	Insignificant	
	○ 0.5	○ 0.7	◉ 1	**Factor E** 1

3.6 Other Factors

For < 3 storeys - Maximum value 2.5,

otherwise - Maximum value 1.5. No minimum. **Factor F** 1.55

Record rationale for choice of Factor F:

The structure is lightweight, has clear load paths for bracing against racking loads, and is likely to be governed by wind loads.

Conservatively estimate F factor as: [1.05kPa perpendicular wind load x sin(20)] / [0.3kPa gravity load x 0.9g x 85%NBS] ≈ 1.55

3.7 Performance Achievement Ratio (PAR)
(equals A x B x C x D x E x F) **PAR** 1.55

Table IEP-4 **Initial Evaluation Procedure – Steps 4, 5 and 6**

(Refer Table IEP - 1 for Step 1; Table IEP - 2 for Step 2, Table IEP - 3 for Step 3)

Building Name:	BU 1662-006 EQ2 - Covered BBQ Area	Ref.	ZB01276.55
Location:	Templeton Pool, 62 Kirk Road, Templeton	By	KW
Direction Considered:	**Longitudinal & Transverse**	Date	27/04/2012

(Choose worse case if clear at start. Complete IEP-2 and IEP-3 for each if in doubt)

Step 4 - Percentage of New Building Standard (%NBS)

	Longitudinal	Transverse
4.1 Assessed Baseline $(\%NBS)_b$ (from Table IEP - 1)	55	55
4.2 Performance Achievement Ratio (PAR) (from Table IEP - 2)	1.55	1.55
4.3 PAR x Baseline $(\%NBS)_b$	85	85

4.4 Percentage New Building Standard (%NBS)
(Use lower of two values from Step 4.3) — **85**

Step 5 - Potentially Earthquake Prone?
(Mark as appropriate)

%NBS ≤ 33 — NO

Step 6 - Potentially Earthquake Risk?

%NBS < 67 — NO

Step 7 - Provisional Grading for Seismic Risk based on IEP

Seismic Grade — **A**

Evaluation Confirmed by

Signature

BRENDAN DONNELL — Name

246971 — CPEng. No

Relationship between Seismic Grade and % NBS :

Grade:	A+	A	B	C	D	E
%NBS:	> 100	100 to 80	80 to 67	67 to 33	33 to 20	< 20

13. Appendix 3 – CERA Standardised Report Form

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Templeton Pool Covered BBQ Area
Building Address: (Unit / No: / Street)	62 Kirk Road, Templeton
Legal Description:	
GPS south: (Degrees / Min / Sec)	
GPS east:	
Building Unique Identifier (CCC):	PRO 1662-006
Reviewer:	B. Donnell
CPEng No:	246971
Company:	SKM
Company project number:	ZB01276.55
Company phone number:	03 940 4900
Date of submission:	24-May
Inspection Date:	27/04/2012
Revision:	B
Is there a full report with this summary?	yes

Site

Site slope:	flat
Soil type:	silty sand
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):	The regional geological map shows the area to be underlain by grey river alluvium, comprising gravel, sand and silt, in active flood plains.
If Ground improvement on site, describe:	n/a
Approx site elevation (m):	

Building

No. of storeys above ground:	1 (single storey = 1)
Ground floor split?	no
Storeys below ground	0
Foundation type:	timber piles
Building height (m):	2.50
Floor footprint area (approx):	58
Age of Building (years):	25 (max)
Ground floor elevation (Absolute) (m):	
Ground floor elevation above ground (m):	
if Foundation type is other, describe:	assumed
height from ground to level of uppermost seismic mass (for IEP only) (m):	3.1
Date of design:	1976-1992
Strengthening present?	no
If so, when (year)?	
And what load level (%g)?	
Brief strengthening description:	
Use (ground floor):	other (specify)
Use (upper floors):	
Use notes (if required):	covered BBQ area at Templeton Pool
Importance level (to NZS1170.5):	IL2

Gravity Structure

Gravity System:	frame system
Roof:	timber framed
rafter type, purlin type and cladding	timber rafters supporting timber purlins and light weight corrugated steel cladding.
Floors:	
Beams:	
Columns:	timber
typical dimensions (mm x mm)	Approx 100x100
Walls:	

Lateral load resisting structure

Note: Define along and across in detailed report!

Lateral system along:	other (note)
describe system	timber compression braces
Ductility assumed, μ:	1.00
Period along:	0.10 (0.00)
estimate or calculation?	estimated
Total deflection (ULS) (mm):	10
estimate or calculation?	estimated
maximum interstorey deflection (ULS) (mm):	
estimate or calculation?	
Lateral system across:	other (note)
describe system	timber compression braces
Ductility assumed, μ:	1.00
Period across:	0.10 (0.00)
estimate or calculation?	estimated
Total deflection (ULS) (mm):	10
estimate or calculation?	estimated
maximum interstorey deflection (ULS) (mm):	
estimate or calculation?	

Separations:

leave blank if not relevant

north (mm):	
east (mm):	
south (mm):	
west (mm):	

Non-structural elements

		describe
Stairs:		na
Wall cladding:		structure is a free roof structure and therefore has no walls
Roof Cladding:	Metal	light weight corrigated steel
Glazing:		n/a
Ceilings:		n/a
Services(list):	none	

Available documentation

		original designer name/date
Architectural	none	
Structural	none	
Mechanical	none	
Electrical	none	
Geotech report	none	

Damage

Site: (refer DEE Table 4-2)

		notes (if applicable):
Site performance:	1	Describe damage: no damage observed
Settlement:	none observed	
Differential settlement:	none observed	
Liquefaction:	none apparent	
Lateral Spread:	none apparent	
Differential lateral spread:	none apparent	
Ground cracks:	none apparent	
Damage to area:	none apparent	

Building:

	Current Placard Status:	green
Along	Damage ratio:	0%
	Describe (summary):	
	Describe how damage ratio arrived at:	no damage observed
Across	Damage ratio:	0%
	Describe (summary):	
Diaphragms	Damage?:	no
	Describe:	
CSWs:	Damage?:	no
	Describe:	
Pounding:	Damage?:	no
	Describe:	
Non-structural:	Damage?:	no
	Describe:	

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

Recommendations

	Level of repair/strengthening required:	none
	Describe:	
	Building Consent required:	no
	Describe:	
	Interim occupancy recommendations:	full occupancy
	Describe:	
Along	Assessed %NBS before:	85% (##### %NBS from IEP)
	Assessed %NBS after:	85%
Across	Assessed %NBS before:	85% (##### %NBS from IEP)
	Assessed %NBS after:	85%

If IEP not used, please detail assessment methodology: NZSEE IEP used, refer to SKM qualitative report

14. Appendix 4 – Geotechnical Desk Study

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Web: www.globalskm.com

Christchurch City Council - Structural Engineering Service

Geotechnical Desk Study

SKM project number	ZB01276
SKM project site number	053 to 055 inclusive
Address	Templeton Pool, 62 Kirk Road
Report date	13 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

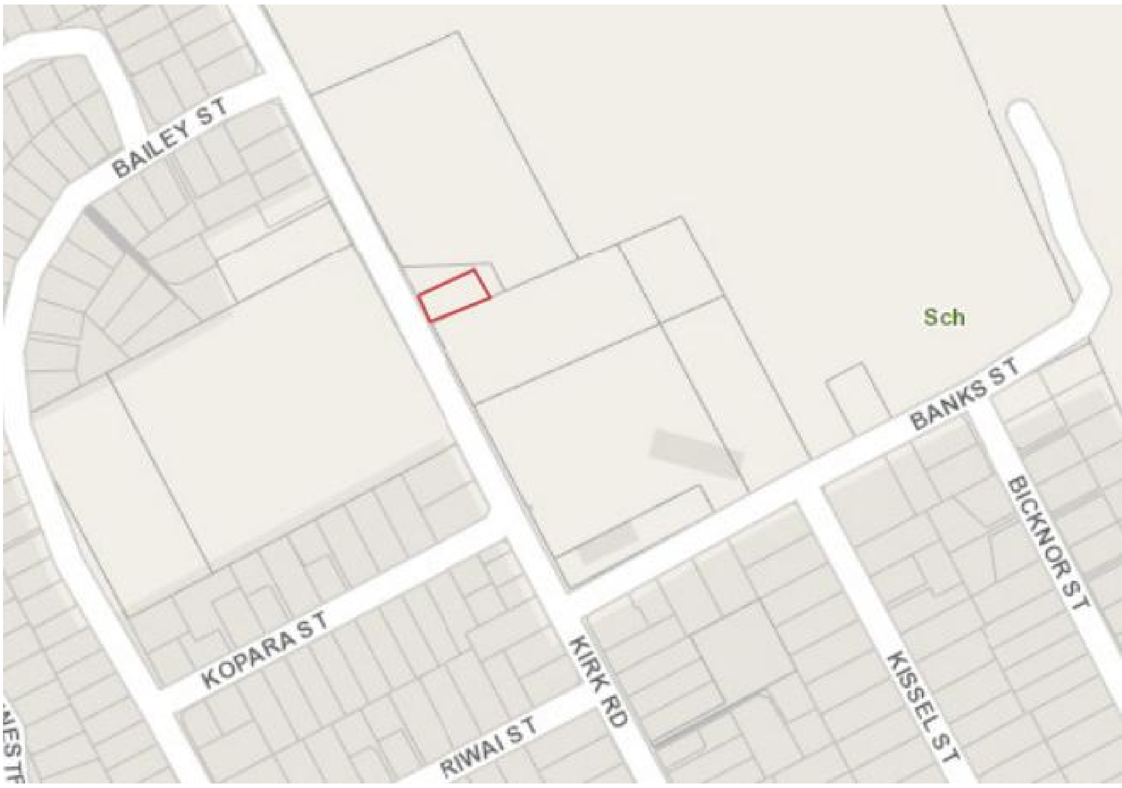
3. Limitations

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

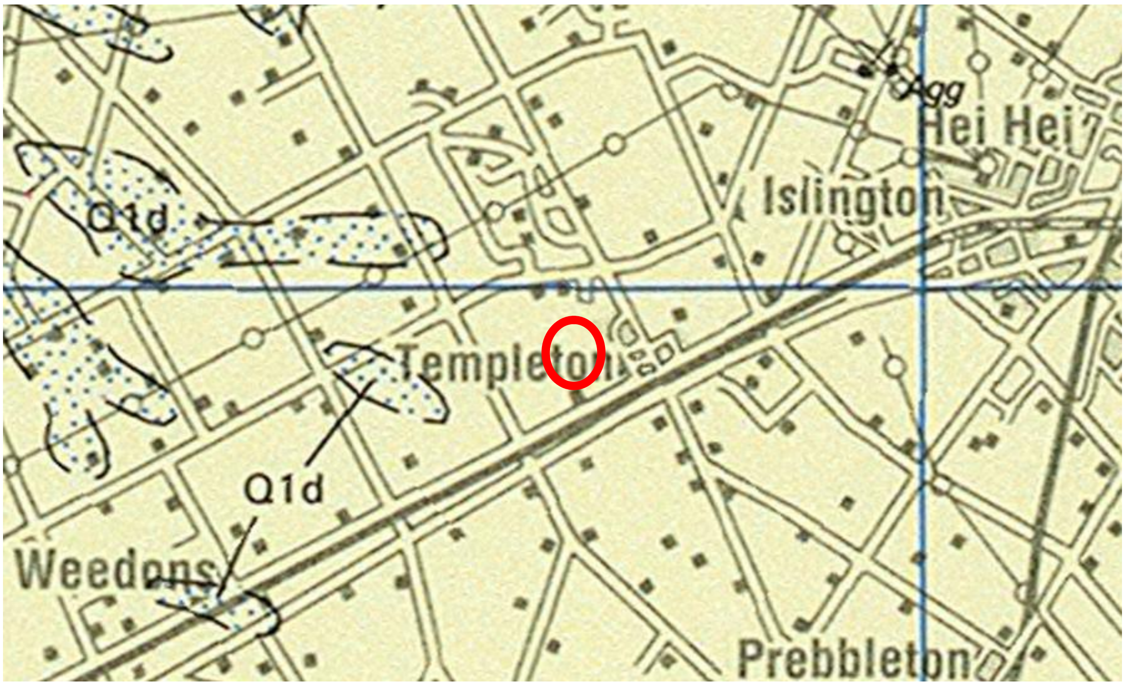


- **Figure 1 – Site location (courtesy of LINZ http://viewers.geospatial.govt.nz)**

These structures are located on 62 Kirk road at grid reference 1557295 E, 5177988 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.

The regional geological map shows the area to be 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

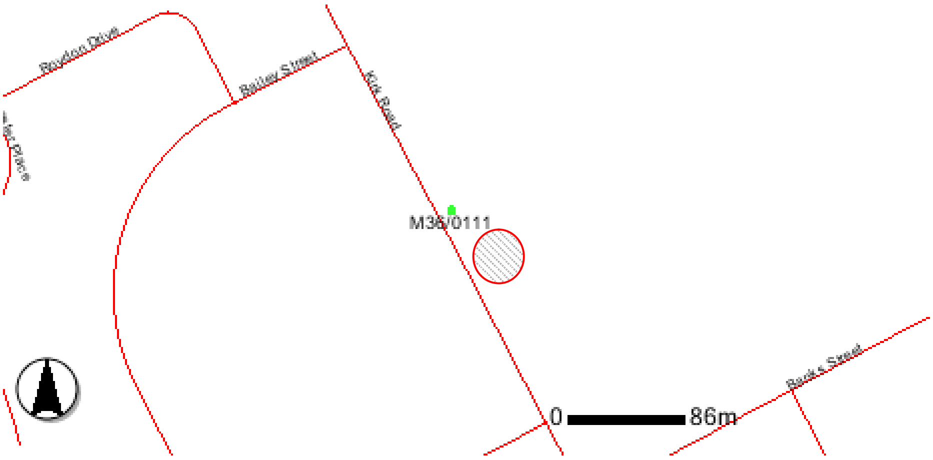
A review of the LINZ website (http://viewers.geospatial.govt.nz/) shows that the site is:

- Zone: Green
- DBH Technical Category: N/A (Rural & Unmapped) – adjacent properties are classified as TC1 with the exception of the site directly oppose to the structure, which is classified as N/A (Urban Non-residential)

5.5 Historical land use

Available historical reference document is shown in Appendix A. However, no record for historical land use of this 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 ground condition

5.7 Council property files

The available council property files for the site relate to the building consent documents drawn up in 1974 and warrant of fitness documents for the Templeton pool.

No relevant information for this desk study was evident from the review of available council property files.

5.8 Site walkover

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

The toilets, changing rooms and other structures are all masonry block buildings with constructed slab on grade foundations and sheet metal roof. There are two shaded BBQ areas, one a canvas construction suspended on timber poles, the other a timber framed construction on slab. The plant shed appears to be corrugated iron on timber frame on slab. The pool looks to be poured in-situ cement with cement seating/bleachers on the southern side. The site is surrounded by a masonry block fence to on the western and southern sides and sheet metal on the northern and eastern sides.

There is no evidence of damage to any of the structures /fences from the external inspection. There is no evidence of any land damage.

- **Figure 4 Overview of the pool**

- **Figure 5 Overview of Toilet block and changing rooms**

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 (mBLG)	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 NZS 1170.5 Class D (soft or deep soil, including gravel exceeding 100 m in depth) using nearby borehole investigation data. As no information regarding the composition of the top soil layer is available, Class D is recommended as a conservative estimate of the seismic site subsoil class.

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 they 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 and no evidence of land damage or liquefaction was observed during the external inspection of the site. However, there may be lenses of sand present in the sandy gravel layers 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.

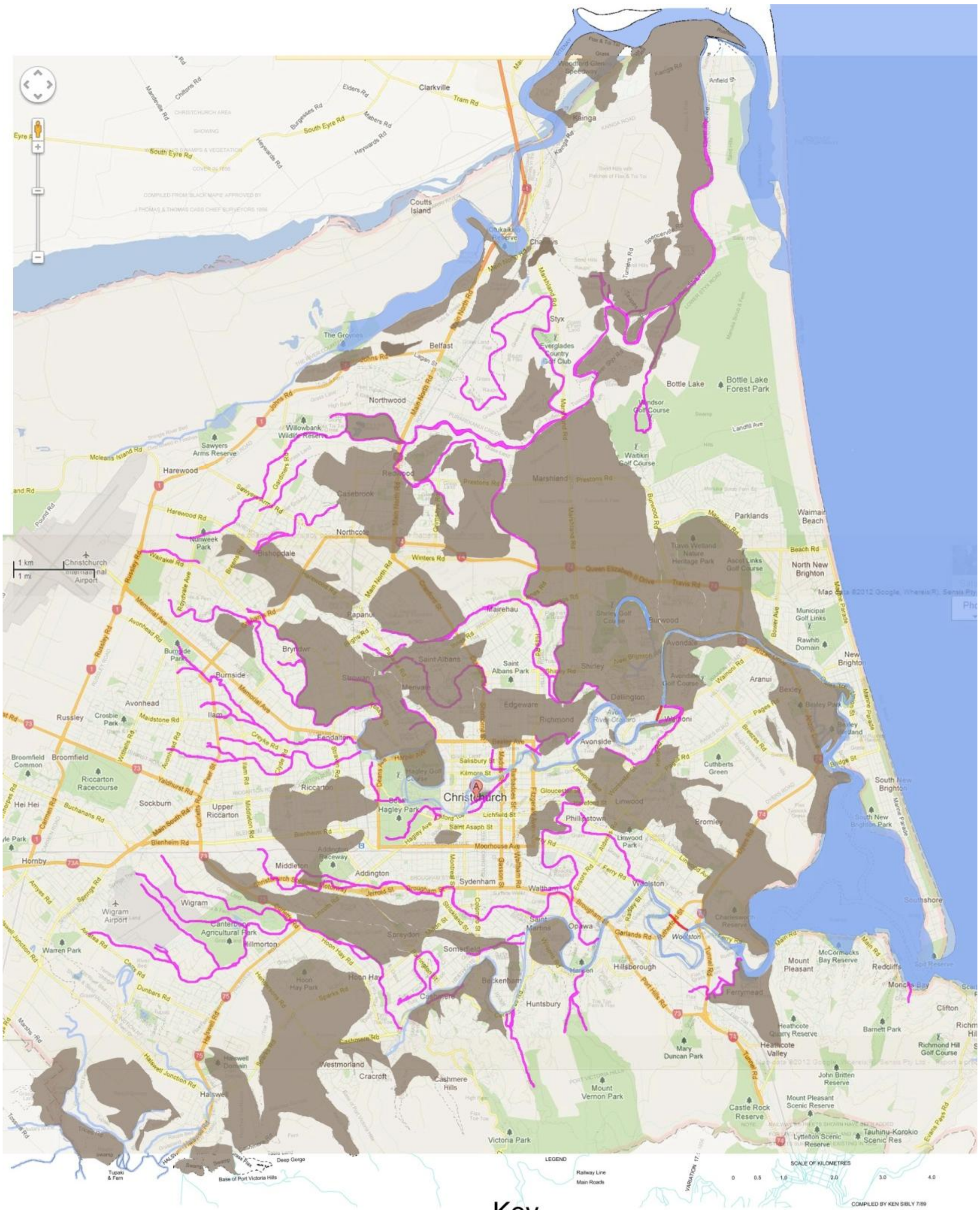
Cubrinovski & Taylor, 2011. Liquefaction map summarising preliminary assessment of liquefaction in urban areas following the 2010 Darfield Earthquake.

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



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

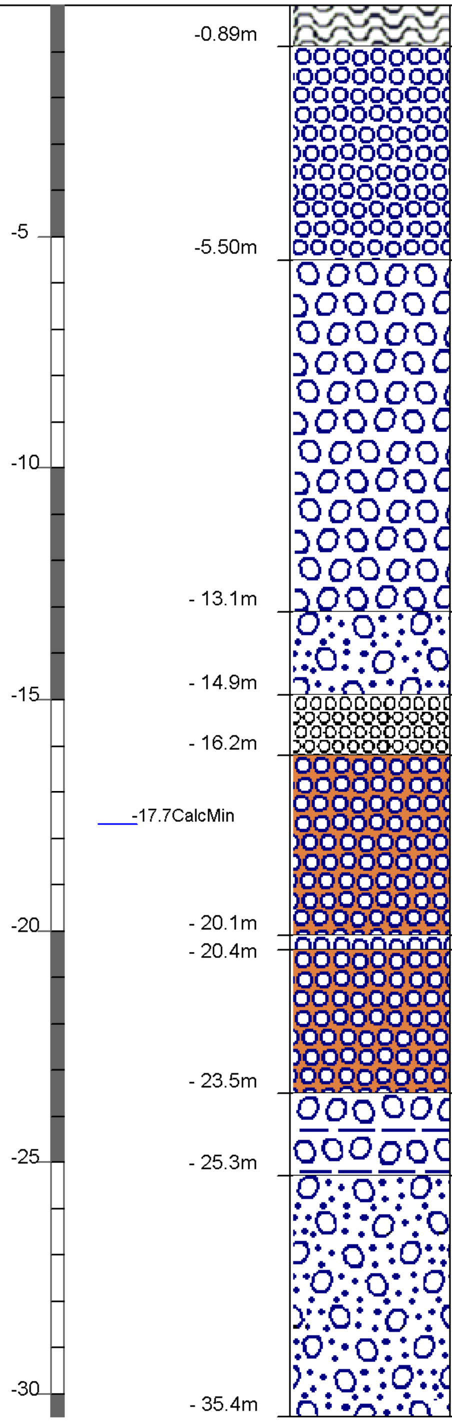
Key

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

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



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

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

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)		30
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