CHRISTCHURCH CITY COUNCIL

PRK_ 3616_BLDG_002 EQ2
Duvauchelle Reserve and Campground Garage
Seafield Rd, Duvauchelle

QUALITATIVE ASSESSMENT REPORT

FINAL

- Rev C
- 27 November 2012

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Contents

Document history and status

Revision	Date issued	Reviewed by	Approved by	Date approved	Revision type
A	19 June 2012	C Paverd	N Calvert	19 June 2012	Draft for Client Approval
B	9 July 2012	C Paverd	N Calvert	9 July 2012	Draft for Client Approval
C	27 Nov. 2012	N Calvert	N Calvert	27 Nov. 2012	Final Issue

Distribution of copies

Revision	Copy no	Quantity	Issued to
A	1	1	Christchurch City Council
B	1	1	Christchurch City Council
C	1	1	Christchurch City Council

Printed:	27 November 2012
Last saved:	27 November 2012 02:40 PM
File name:	ZB01276.083.CCC_PRK_3616_BLDG_002_EQ2.Qualitative.Assmt.C.docx
Author:	Oliver Kingsnorth
Project manager:	Nick Calvert
Name of organisation:	Christchurch City Council
Name of project:	Christchurch City Council Structures Panel
Name of document:	PRK_3616_BLDG_002 EQ2 Qualitative Assessment Report
Document version:	B
Project number:	ZB01276.083

1. Executive Summary

1.1. Background

A Qualitative Assessment was carried out on PRK_3616_BLDG_002 EQ2 - Garage, located at the Duvauchelle Reserve and Campground. The building is a small timber framed vehicle garage. An aerial photograph illustrating the location of Building 2 is shown below in Figure 1. A detailed description outlining the building age and construction type is given in Section 5 of this report.

- **Figure 1: Aerial Photograph of PRK_3616_BLDG_002 EQ2 Duvauchelle Reserve and Campground showing the location of Building 2**

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 a visual inspection carried out on 24 April 2012 and fabrication specifications.

1.2. Key Damage Observed

Damage to the structure is minor and not expected to have altered the capacity of the building under lateral loading.

Damage observed to the building consists of cracking to the foundation slab.

1.3. Critical Structural Weaknesses

No critical structural weaknesses have been identified.

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

Based on the information available, and using the NZSEE Initial Evaluation Procedure, the building's original capacity has been assessed to be in the order of 81%NBS and due to the limited damage that has occurred as a result of the earthquake/s, the post earthquake capacity remains the same.

The building has been assessed to have a seismic capacity in the order of 81% NBS and is therefore not 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 building located at Seafield Rd, Duvauchelle 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 7.2.

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 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. Fabrication specifications were made available, and these have been considered in our evaluation of the building. The building description below is based on this information 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	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 2 is one of a number of buildings on the campsite grounds. The building is currently used as a vehicle and mower garage. It is a single storey timber framed structure with profile steel wall and roof cladding. The building has a concrete slab foundation. The roof is supported by timber A-frame trusses and timber purlins. Steel strap type bracing has been used to the external face of the timber framed walls and roof structure.

The building has no internal wall lining or ceiling.

The structure was built in 1996.

Photos of the structure can be found in Appendix 1 – Photos.

5.2. Gravity Load Resisting system

Our evaluation was based on the fabrication specifications dated March 1996 by Skyline Buildings Ltd. (Engineers). The specifications show basic dimensions, limited detailing and some materials used for construction.

Gravity load from the roof structure is transmitted down through the perimeter load bearing walls to the slab foundation.

5.3. Seismic Load Resisting system

Our evaluation was based on the fabrication specifications dated March 1996 by Skyline Buildings Ltd. (Engineers). The specifications show basic dimensions, limited detailing and some materials used for construction.

Lateral loads on the building will be resisted by the steel strap bracing attached to the timber framed walls and roof structure.

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 C (shallow soil sites). This is in part based on the based on the geomorphology of the area as well as nearby borehole investigation data.
- The liquefaction risk for the site is likely to be low.
- It is expected that the ultimate bearing capacity of a shallow pad footing on this site will be in the region of 300 kPa.

If future significant structure alterations or new structures are proposed which require building consent geotechnical investigations are recommended. This would include approximately two boreholes to 10m BGL with associated SPT geotechnical testing per building.

6. Damage Summary

6.1. Damage Summary

SKM undertook inspection of the building from floor level on 24 April 2012. An employee at the site stated that the damage noted below is likely to have been present prior to the recent earthquakes. The damage found on site is minor and is not expected to alter the lateral capacity of the structure.

The following pre existing damage was observed at the time of the inspection:

1) Cracking was found in the slab foundation of the building. The cracks and their respective widths are listed below:
    a. A 1.5mm crack was found in the south west corner of the slab (see Photo 5 and Photo 6)
    b. A 2mm crack was found running north-south through the centre of the slab (see Photo 7)
    c. A 3mm crack was found south east corner of the slab (see Photo 8)

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	

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

[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

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 24 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. Please note no intrusive investigations were undertaken.
- Fabrication specifications were made available

The assumptions made in undertaking the assessment include:

- Standard design assumptions for typical office and factory buildings 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.

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

- Ductility level of 2, based on our assessment and code requirements at the time of design. The structure has a timber framed seismic resisting system therefore expected to have a high ductility.
- 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 fabrication specifications made available. 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 was there any significant ground movement issues around the building. The land at the site has been classified as green by CERA. 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 for the building were observed during our visual inspection.

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 is expressed as a percentage of new building standard (%NBS) and is in the order of that shown below in Table 3. This capacity is subject to confirmation by a quantitative analysis.

Table 3: Qualitative Assessment Summary

Item	%NBS
Building	81

Our qualitative assessment found that the building is likely to be classed as a ‘Low Risk Building’ (capacity greater than 67% of NBS). The full IEP assessment form is detailed in Appendix 2 – IEP Reports.

8. Further Investigation

No further investigation is deemed necessary for this building.

9. Conclusion

A qualitative assessment was carried out for Building 2 located at Duvauchelle Reserve and Campground. Minor cracking was observed in the floor slab which is believed to have been present prior to the recent earthquakes. The building has been assessed to have a seismic capacity in the order of 81% NBS and is therefore not earthquake prone and is likely to be classified as a 'Low Risk Building' (capacity greater than 67% of NBS).

No further investigation is deemed necessary.

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.

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: The west and south elevations on the garage

Photo 2: The south and east elevations of the garage

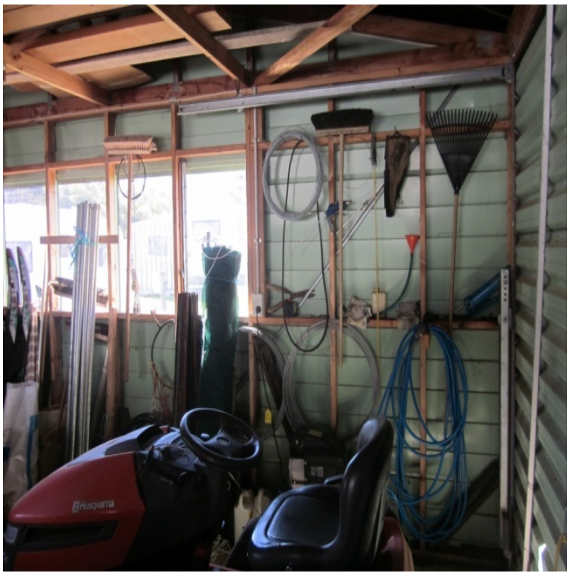


Photo 3: Elevation on an internal wall of the garage showing timber framing and steel strap bracing

Photo 4: The roof framing of the garage showing the timber A-frame trusses, timber purlins and steel strap bracing

Photo 5: The door at the south end of the west wall where one of the cracks in the foundation are located

Photo 6: The crack in the south west corner of the foundation slab

Photo 7: The crack through the centre of the foundation slab

Photo 8: The crack in the south east corner of the slab

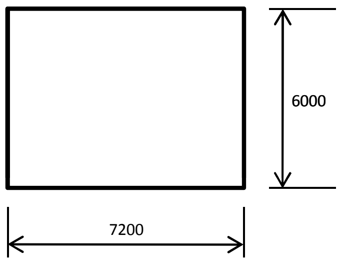
12. Appendix 2 – IEP Reports

Building Name:	**PRK_3616_BLDG_002 EQ2 Duvauchelle Reserve and Campground**	Ref.	**ZB01276.083**
Location:	Seafield Rd, Duvauchelle	By	OAK
		Date	9/07/2012

Step 1 - General Information

1.1 Photos (attach sufficient to describe building)


1.2 Sketch of building plan



1.3 List relevant features

Building 2 is one of a number of buildings on the campsite grounds. The building is currently used as a vehicle and mower garage. It is a single storey timber framed structure with profile steel wall and roof cladding. The building has a concrete slab foundation. The roof is supported by timber A-frame trusses and timber purlins. Steel strap type bracing has been used to the external face of the timber framed walls and roof structure.

The building has no internal wall lining or ceiling.

The building was constructed in 1996.

1.4 Note information sources

	Tick as appropriate
Visual Inspection of Exterior	✓
Visual Inspection of Interior	✓
Drawings (note type)	☐
Specifications	✓
Geotechnical Reports	✓
Other (list)	☐

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:	**PRK_3616_BLDG_002 EQ2 Duvauchelle Reserve and Campgr**	Ref.	**ZB01276.083**
Location:	Seafield Rd, Duvauchelle	By	OAK
Direction Considered:	**Longitudinal & Transverse**	Date	9/07/2012

(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

Ac = (Longitudinal: , Transverse:) m2

Can use following:

		Longitudinal	Transverse
$T = 0.09h_n^{0.75}$	for moment-resisting concrete frames	○ MRCF	○ MRCF
$T = 0.14h_n^{0.75}$	for moment-resisting steel frames	○ MRSF	○ MRSF
$T = 0.08h_n^{0.75}$	for eccentrically braced steel frames	○ EBSF	○ EBSF
$T = 0.06h_n^{0.75}$	for all other frame structures	◉ Others	◉ Others
$T = 0.09h_n^{0.75}/A_c^{0.5}$	for concrete shear walls	○ CSW	○ CSW
$T <= 0.4sec$	for masonry shear walls	○ MSW	○ 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	19.2	$(\%NBS)_{nom}$
Transverse	19.2	$(\%NBS)_{nom}$

		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	19.2	$(\%NBS)_{nom}$
Transverse	19.2	$(\%NBS)_{nom}$

Continued over page

Building Name:	PRK_3616_BLDG_002 EQ2 Duvauchelle Reserve and Campgrc	Ref.	ZB01276.083
Location:	Seafield Rd, Duvauchelle	By	OAK
Direction Considered:	Longitudinal & Transverse	Date	9/07/2012

(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 = 0.6

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

b) Hazard Scaling Factor Type Z 1992 above

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 2.00

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 **Longitudinal** 2 μ Maximum = 6
(shall be less than maximum given in accompanying Table 3.2) **Transverse** 2 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 0.70

Transverse Sp 0.70

b) Structural Performance Scaling Factor

Longitudinal $1/S_p$ **Factor E** 1.43

Transverse $1/S_p$ **Factor E** 1.43

2.7 Baseline %NBS for Building, $(\%NBS)_b$
(equals $(\%NSB)_{nom}$ x A x B x C x D x E)

Longitudinal	54.9	(%NBS)b
Transverse	54.9	(%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:	PRK_3616_BLDG_002 EQ2 Duvauchelle Reserve and Campground	Ref.	ZB01276.083
Location:	Seafield Rd, Duvauchelle	By	OAK
Direction Considered:	a) Longitudinal	Date	9/07/2012

(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** 1.5

Record rationale for choice of Factor F:

The building is a lightweight structure with an expected capacity greater than that required to meet to the seismic loading of the time it was built

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

PAR 1.5

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:	**PRK_3616_BLDG_002 EQ2 Duvauchelle Reserve and Campg**	Ref.	**ZB01276.083**
Location:	Seafield Rd, Duvauchelle	By	OAK
Direction Considered:	**b) Transverse**	Date	9/07/2012

(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

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

3.2 Vertical Irregularity

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

3.3 Short Columns

	Severe	Significant	Insignificant	
Effect on Structural Performance	○	○	◉	**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)

	Severe	Significant	Insignificant	
Effect on Structural Performance	○ 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** 1.5

Record rationale for choice of Factor F:

The building is a lightweight structure with an expected capacity greater than that required to meet to the seismic loading of the time it was built

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

PAR 1.5

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:	**PRK_3616_BLDG_002 EQ2 Duvauchelle Reserve and Campground**	Ref.	**ZB01276.083**
Location:	Seafield Rd, Duvauchelle	By	OAK
Direction Considered:	**Longitudinal & Transverse**	Date	9/07/2012

(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)	54	54
4.2 Performance Achievement Ratio (PAR) (from Table IEP - 2)	1.50	1.50
4.3 PAR x Baseline (%NBS)$_b$	81	81

4.4 Percentage New Building Standard (%NBS) (Use lower of two values from Step 4.3) — **81**

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

NICK CALVERT Name

242062 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

Location

Building Name:	PRK_3616_BLDG_002 EQ2	Reviewer:	NICK CALVERT
	Unit / No: / Street	CPEng No:	242062
Building Address:	Building 2 - Garage / Seafield Rd, Duvauchelle	Company:	SKM
Legal Description:		Company project number:	ZB01276.083
		Company phone number:	
	Degrees / Min / Sec		
GPS south:		Date of submission:	
GPS east:		Inspection Date:	24/04/2012
		Revision:	
Building Unique Identifier (CCC):		Is there a full report with this summary?	

Site

Site slope:	flat	Max retaining height (m):	
Soil type:		Soil Profile (if available):	
Site Class (to NZS1170.5):	C		
Proximity to waterway (m, if <100m):		If Ground improvement on site, describe:	
Proximity to clifftop (m, if < 100m):			
Proximity to cliff base (m,if <100m):		Approx site elevation (m):	

Building

No. of storeys above ground:	1	single storey = 1	Ground floor elevation (Absolute) (m):	
Ground floor split?	no		Ground floor elevation above ground (m):	
Storeys below ground	0			
Foundation type:	raft slab		if Foundation type is other, describe:	
Building height (m):	3.00		height from ground to level of uppermost seismic mass (for IEP only) (m):	3
Floor footprint area (approx):				
Age of Building (years):	16		Date of design:	1992-2004
Strengthening present?	no		If so, when (year)?	
			And what load level (%g)?	
Use (ground floor):	parking		Brief strengthening description:	
Use (upper floors):				
Use notes (if required):				
Importance level (to NZS1170.5):	IL2			

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber truss	truss depth, purlin type and cladding	A-frame roof truss with timber purlins and profile steel roof sheeting
Floors:			
Beams:			
Columns:			
Walls:			

Lateral load resisting structure

Note: Define along and across in detailed report!

Lateral system along:	other (note)		describe system	Timber framed walls braced with steel strapping
Ductility assumed, μ:	2.00			
Period along:		0.00	estimate or calculation?	
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	
Lateral system across:	other (note)		describe system	Timber framed walls braced with steel strapping
Ductility assumed, μ:	2.00			
Period across:		0.00	estimate or calculation?	
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	

Separations:

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

Non-structural elements

Stairs:			
Wall cladding:	profiled metal	describe	Light weight profiled steel sheeting
Roof Cladding:	Metal	describe	Light weight profiled steel sheeting
Glazing:			
Ceilings:			
Services(list):			

Available documentation

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

Damage

Site: (refer DEE Table 4-2)

Site performance:	1	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:	
	Describe (summary):	Damage to building is pre-existing		
Across	Damage ratio:	0%		
	Describe (summary):	Damage to building is pre-existing		
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:	minor non-structural	Describe:	Repairs to cracks in foundation
Building Consent required:	no	Describe:	
Interim occupancy recommendations:	full occupancy	Describe:	

Along	Assessed %NBS before:	81%	%NBS from IEP below	If IEP not used, please detail assessment methodology:	Qualitative Assessment carried out includes NZSEE IEP (refer to SKM report)
	Assessed %NBS after:	81%			
Across	Assessed %NBS before:	81%	%NBS from IEP below		
	Assessed %NBS after:	81%			

14. Appendix 4 – Geotechnical Desktop Study

Christchurch City Council - Structural Engineering Service

Geotechnical Desk Study

SKM project number	ZB01276
SKM project site number	83 to 88 inclusive
Address	Duvauchelle Reserve and Campground, Seafield Road
Report date	28 May 2012
Author	Dominic Hollands
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 at Devauchelle Reserve and Campground, 17 Sealand Road, Devauchelle at grid reference 1595440 E, 5155483 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 to brown alluvium, comprising gravel and sand forming alluvial fan.

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 Devauchelle.

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

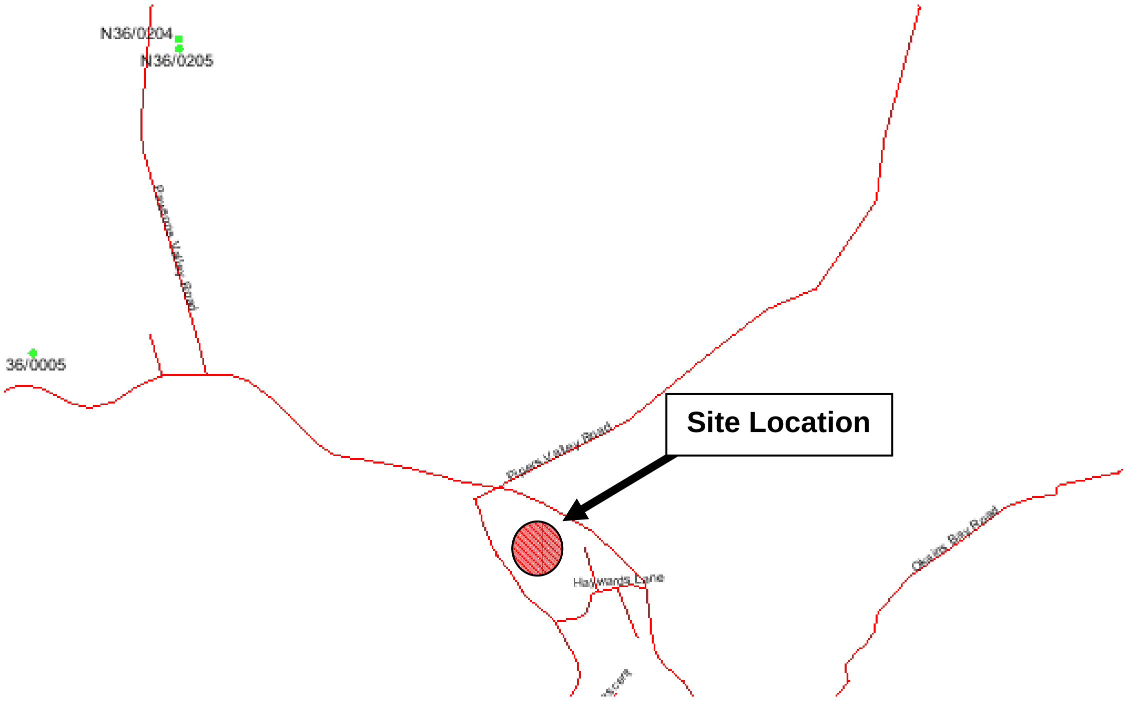
A review of the LINZ website (http://viewers.geospatial.govt.nz/) shows that the site is:

- Zone: Green
- DBH Technical Category: N/A (Rural & Unmapped).

5.5 Historical land use

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 A), and the results are summarised in Section 6.1 and Appendix B. Although the closest investigation is approximately 1 km west of the site this information and our existing knowledge of the area have been used to draw conclusions regarding the site's ground condition.

5.7 Council property files

The available council property files for the site consist of building consent documents and building inspection reports for structures located on 17 Seafield Road, Devauchelle Reserve and Campground.

Drawings for the proposed "office structure with shop" occupying a footprint of approximately 54 square metres shows the foundation solution to be a 100mm thick concrete on grade floor slab with thickened concrete footing around the perimeter of the structure. Steel reinforcing consisting of 1-100/1-120 rods is described to be present around the perimeter of the structure.

Likewise, drawings for the new "cabin" structure shows that a 100mm thick concrete floor slab supported on a 125mm thick fill layer above grade and 425mm deep and 200mm wide reinforced concrete footing around the perimeter of the structure was as the foundation solution. From available information it is not clear, where the "cabin" structure is located.

Additionally, the foundation for the garage was inferred to be a concrete slab on grade footing with thickened concrete around the perimeter of the structure. However, this was inferred from the description of the foundation as detailed drawings of the footing were not available.

No detailed ground investigation records were available. However, reports prepared by Ross Maguire Architects Ltd for the “new proposed residential dwelling” state that they “believe the proposed building site at Camp Road is of good ground as per definition of NZS3604:1999 section 3”. These documents and reports were drawn up in August 2009. This information was taken into account in assessing the general geology of the site.

Additionally, the area is classified as sea spray zone.

5.8 Site walkover

A site walkover was conducted by an SKM engineer on the 26 April 2012.

The garage, community hall, office and shed buildings are timber clad construct with slab on grade foundations. The two toilet blocks onsite are masonry clad on slab and prefabricated on piles respectively.

The only evidence of earthquake damage to the onsite structures was shear cracking to the masonry clad toilet. There is no evidence of any land damage.

- **Figure 4 Overview of the site looking north east.**

- **Figure 5 Overview of the Community Hall**

6. Conclusions and recommendations

6.1 Site geology

No geological or geotechnical borehole information is available for the site. The closest borehole record is located approximately 1 km to the west of the site and indicates interbedding of clays, gravels and clay/gravels of volcanic origin. The historical depositional environment can be assumed as being similar to that of this site that is alluvial fan or colluvium deposits with lenses of clay alluvium. The site was once a football field and a road intersects the shoreline and the site. It is therefore likely that fill is probably present at site due to the presence of these features. The probable geological profile of the site is:

Approximate depth range (mBLG)	Soil type
0 – 0.5	Top soil
0.5 – 1.0	Fill (possible gravel)
-	Gravel
-	Basalt gravel and clay

Although no groundwater data was available for the site its proximity to the shoreline means that groundwater depth at this location can be estimated at 1 to 2m below ground level.

6.2 Seismic site subsoil class

The site has been assessed as NZS 1170.5 Class C (shallow soil sites). This is in part based on the based on the geomorphology of the area as well as nearby borehole investigation data. The site is located adjacent to a volcanic slope and the borehole log indicated volcanic gravel cobble material which has most likely originated from the slope ground area nearby.

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 bore logs 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 and fourth preferred method has been used in the assessment of site subsoil class. Although these are the least preferred methods of classification 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 fill and gravel/clay 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.

There is very limited ground investigation data within the direct area of the site however ground data from a similar geological setting 1 km away suggest gravel and gravel/clay ground conditions below possibly 1 to 2m of top soil and fill. Additionally, information available in council files suggest that the soil conditions in the area were generally assessed as good soil as defined in NZS3604:1999 and the structures on site were supported using shallow concrete slab on grade foundations.

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	34 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 geological properties from outside the site for the purposes of preliminary structural assessment. These parameters should not be relied upon for any design work or if consent is required for the site. 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

If future significant structure alterations or new structures are proposed which require building consent geotechnical investigations are recommended. This would include approximately two boreholes to 10m BGL with associated SPT geotechnical testing per building.

7. References

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.

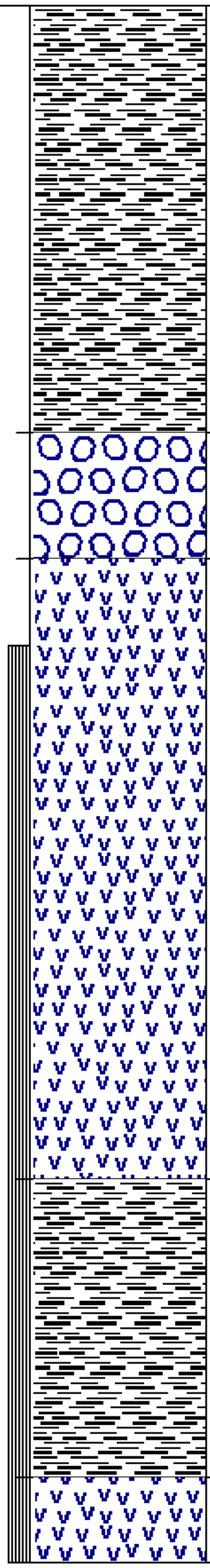
Land Information New Zealand (LINZ) geospatial viewer (http://viewers.geospatial.govt.nz/)

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

Appendix A – Borehole Log

Borelog for well N36/0005

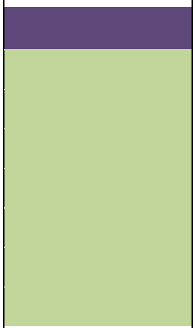
Gridref: N36:043-175 Accuracy : 4 (1=best, 4=worst)
Driller : McMillan Water Wells Ltd
Drill Method : Unknown
Drill Depth : -7.3m Drill Date :



Scale(m)	Water Level	Depth(m)	Full Drillers Description	Formation Code
		-2.00m	Clay	
		-2.59m	Large stones and rocks	
-5		-5.50m	Claybound volcanic rocks	
		-6.90m	Blue and Brown clay	
		-7.30m	Hard claybound volcanic rock	

Appendix B – Geotechnical Investigation Summary

Table 1 Summary of most relevant investigation data

ID		1
Type *		BH
Ref		N36 - 0005
Depth (m)		7.3
Distance from site (m)		1000
Ground water level (mBGL)		-
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	
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
Gravel and clay | Sand | Gravelly sand or gravel | Fill

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