Christchurch City Council
PRK_3035_BLDG_002
Greenwood Park Shed
450 Summit Road

QUANTITATIVE REPORT
FINAL

- Rev B
- 25 September 2013

Christchurch City Council
PRK_3035_BLDG_002
Greenwood Park Shed
450 Summit Road

QUANTITATIVE ASSESSMENT REPORT

FINAL

- Rev B
- 25 September 2013

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Contents

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Approval

	Signature	Date	Name	Title
Author		3/9/13	N Chan	Structural Engineer
Approver		3/9/13	A Martin	Project Manager

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1. Executive Summary

1.1. Background

A Quantitative Assessment was carried out on the building located at 450 Summit Road. The building located on this site is a timber framed 3 bay garage used to store fencing equipment and sits adjacent the Wool Shed (PRK_3035_BLDG_001). An aerial photograph illustrating these areas is shown below in Figure 1 Detailed descriptions outlining the buildings age and construction type is given in Section 5 of this report.

- **Figure 1: Aerial Photograph of 450 Summit Road**

This Quantitative report for the building structure is based on the Engineering Advisory Group's "Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings" (draft) July 2011, and visual inspections on 15th August 2013.

1.2. Key Damage Observed

No damage was observed.

1.3. Critical Structural Weaknesses

No potential critical structural weaknesses have been identified.

1.4. Indicative Building Strength

As described in the Engineering Advisory Group's "Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings" (draft) July 2011, we have assessed the capacity of the building as a percentage new building standard seismic resistance using the quantitative method. Our assessment included consideration of geotechnical conditions, existing earthquake damage to the building and structural engineering calculations to assess both strength and ductility/resilience.

The assessments were based on the following:

- On-site investigation to assess the extent of existing earthquake damage including limited intrusive investigation.
- No intrusive geotechnical investigation has been undertaken. We have based this report on our desktop geotechnical investigation of the site and the absence of liquefaction ejecta on the site.
- Assessment of the strength of the existing structures taking account of the current condition.

Any building that is found to have a seismic capacity less than 33% of the new building standard (NBS) is required to be strengthened up to a capacity of at least 67%NBS in order to comply with Christchurch City Council (CCC) policy - Earthquake-prone dangerous & insanitary buildings policy 2010.

Based on the Quantitative Assessment Procedure, the buildings original capacity has been assessed to be in the order of 100%NBS and post-earthquake capacity in the order of 100%NBS and is therefore not potentially earthquake prone.

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1.5. Conclusions and Recommendations

Based on the findings of this assessment indicating the building is in the order of 100%NBS, no strengthening is required in order to comply with Christchurch City Council (CCC) policy – Earthquake-prone dangerous & insanitary buildings policy 2010.

It is recommended that:

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

2. Introduction

Sinclair Knight Merz was engaged by Christchurch City Council to carry out a Quantitative Assessment of the seismic performance of Greenwood Park Wool Shed located at 450 Summit Road. An aerial view of the buildings location is found in Figure 1.

The scope of this quantitative analysis includes the following:

- Analysis of the seismic load carrying capacity of the building compared with current seismic loading requirements or New Buildings Standard (NBS). It should be noted that this analysis considers the building in its damaged state where appropriate.
- Identify any critical structural weaknesses which may exist in the building and include these in the assessed %NBS of the structure.
- Preparation of a summary report outlining the areas of concern in the building as well as identifying strengthening concepts to 67%NBS for any areas which have insufficient capacity if the building is found to be an earthquake prone building.

The recommendations from the Engineering Advisory Group[1] were followed to assess the likely performance of the structures 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[2].

At the time of this report, no intrusive site investigation had been carried out. Construction drawings were not made available, and assumptions have been made in our evaluation of the building. The building description in section 5 of this report is based on our visual inspections only.

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[1] EAG 2011, *Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings in Canterbury - Draft*, p 10

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

- **Table 1: %NBS compared to relative risk of failure**

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

5. Building Details

5.1. Building description

The building is a single storey timber framed three bay garage building. The buildings foot print is 9m x 6m. The roof and the walls of the building are clad in corrugated metal. The building sits on a slab on grade foundation, and has low lying retaining walls on the south and west ends of the building.

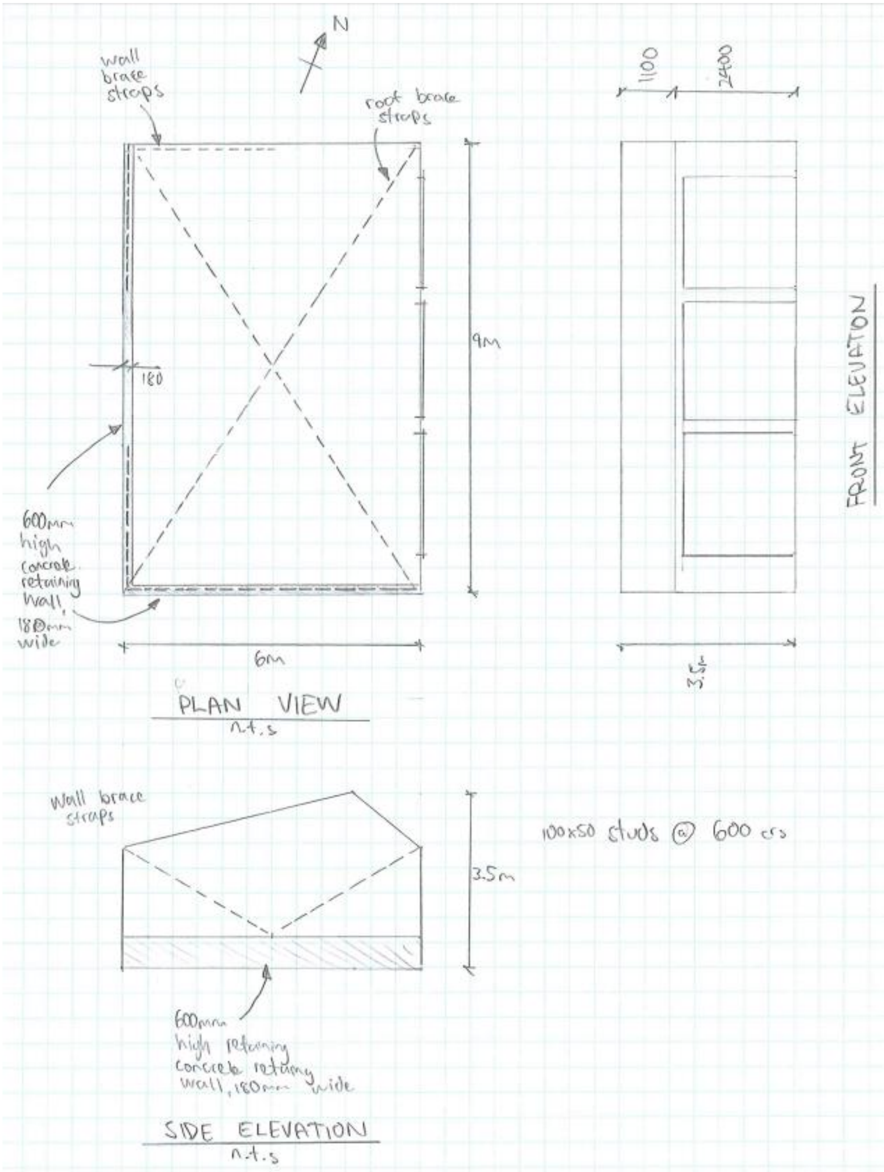

Figure 3: Sketch of plan view of Wool Shed from site measurements

5.2. Gravity Load Resisting system

The building's roof weight is transferred to perimeter walls through timber trusses spanning transversely and supported by the perimeter walls, the walls are then supported by the slab on grade foundation.

5.3. Seismic Load Resisting system

Seismic loads from the roof are transferred to the walls through the roof brace straps. The loads are then resisted by the angle brace straps along the North, South and West walls, which is then transferred to the slab on grade foundation.

5.4. Building Damage

No damage was observed.

6. Available Information and Assumptions

6.1. Available Information

Following our inspections on 15th August 2013, SKM carried out a seismic review on the structure. This review was undertaken using the available information which was as follows:

- SKM desktop geotechnical investigation dated August 2013, see Appendix 3 – Desktop Geotechnical Investigation
- SKM site measurements and findings from the inspection

6.2. Survey

The building has not been surveyed

6.3. Assumptions

The assumptions made in undertaking the assessment include:

- The building was built according to good practice at the time.
- The soil on site is class C as described in AS/NZS1170.5:2004, Clause 3.1.3, Shallow Soil. This is a conservative assumption based on existing data from nearby areas. The ultimate bearing capacity on site is 220kPa, we believe that this assumption is reasonable. Liquefaction does not need to be accounted for in the foundation design. See Appendix 3 – Desktop Geotechnical Investigation.
- Standard design assumptions for farm building as described in AS/NZS1170.0:2002:
  - 50 year design life, which is the default NZ Building Code design life.
  - Structure importance level 1. This level of importance is described as structures presenting a low degree of hazard to life and other property with low consequence for loss of human life, or small or moderate economic, social or environmental consequences.
- The building has a short period less than 0.4 seconds.
- Site hazard factor, Z = 0.3, NZBC, Clause B1 Structure, Amendment 11 effective from 1 August 2011
- A ductility of, μ=2.5 was used in the building for both directions. This is appropriate due to the typical inherent strength and ductility timber framed buildings possess.
- The bracing elements in the wall and ceiling are Lumberlok angle brace and Lumberlok strip brace respectively. It has been assumed they have been installed according to the manufacturer's specifications.
- Concrete unit weight = 24kN/m^3, timber unit weight = 4.6kN/m^3

The detailed engineering analysis is a post construction evaluation. Since it is not a full design and construction monitoring, it has the following limitations:

- It is not likely to pick up on any concealed construction errors (if they exist)
- Other possible issues that could affect the performance of the building such as corrosion and modifications to the structure will not be identified unless they are visible and have been specifically mentioned in this report.
- The detailed engineering evaluation deals only with the structural aspects of the structure. Other aspects such as building services are not covered.

6.4. The Detailed Engineering Evaluation (DEE) process

The DEE is a procedure written by the Department of Building and Housing's Engineering Advisory Group and 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[3].

The procedure of the DEE is as follows:

1) Qualitative assessment procedure
    a. Determine the building's status following any rapid assessment that have been done
    b. Review any existing documentation that is available. This will give the engineer an understanding of how the building is expected to behave. If no documentation is available, site measurements may be required
    c. Review the foundations and any geotechnical information available. This will include determining the zoning of the land and the likely soil behaviour, a site investigation may be required
    d. Investigate possible Critical Structural Weaknesses (CSW) or collapse hazards
    e. Assess the original and post earthquake strength of the building (this assessment is subsequently superseded by the quantitative assessment)
2) Quantitative procedure
    a. Carry out a geotechnical investigation if required by the qualitative assessment
    b. Analyse the building according to current building codes and standards. Analysis accounts for damage to the building.

The DEE assessment 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 rank is

[3] http://resources.ccc.govt.nz/files/EarthquakeProneDangerousAndInsanitaryBuildingsPolicy2010.pdf

indicated by the per cent 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 20 times that of 100% NBS[4]. Buildings that are identified to be earthquake prone are required by law to be strengthened within 30 years of the owner being notified that the building is potentially earthquake prone[5].

Table 2: DEE 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 DEE method rates buildings based on the plans (if available) and other information known about the building 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 DEE does also consider Serviceability Limit State (SLS) performance of the building and or the level of earthquake that would start to cause damage to the building but this result is secondary to the ULS performance.

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

- AS/NZS 1170 parts 0, 1 and 5 Structural Design Actions
- NZS 3101:2006 Concrete Structures Standard
- NZS 3404:1997 Steel Structures Standard
- NZS 2606:1993 Timber Structures Standard
- NZS 4230:1990 Design of Reinforced Concrete Masonry Structures

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[4] NZSEE 2006, *Assessment and Improvement of the Structural Performance of Buildings in Earthquakes*, p 2-2

[5] http://resources.ccc.govt.nz/files/EarthquakeProneDangerousAndInsanitaryBuildingsPolicy2010.pdf

7. Results and Recommendations

7.1. Critical Structural Weaknesses

This building has no critical structural weaknesses.

7.2. Analysis Results

The equivalent static force method was used to analyse the demands or loads applied to the building. These were then compared to the capacities of the structural elements to assess the seismic capacity of the building. The results of the analysis are reported in the following table as %NBS.

(%NBS = the reliable strength / new building standards)

- **Table 3: DEE Results**

Seismic Resisting Element	Action	Seismic Rating %NBS
Roof bracing	tension capacity of strip bracing	>100%
Earthquake loads in north-south direction	tension and compression capacity of angle braces	>100%
Earthquake loads in east-west direction	tension and compression of angle braces	>100%
Foundation	Overturning	>100%

7.3. Recommendations

The quantitative assessment carried out on the Greenwood Park Wool Shed indicates that the building has a seismic capacity of 100% of NBS and is therefore classed as being in the category of ‘Low risk’.

No strengthening is required to comply with the Christchurch City Council Earthquake Prone, Dangerous and Insanitary Building Policy 2010.

8. Conclusion

SKM carried out a quantitative assessment on PRK_3035_BLDG_002 located at 450 Summit Road. This assessment concluded that the building is classified as low risk.

The building is considered "low risk" having a capacity over 67% NBS.

Table 4: Quantitative assessment summary

Description	Grade	Risk	%NBS	Structural performance
Wool Shed	A	Low	100	Acceptable.

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.

9. 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.

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.

10. Appendix 1 – Photos

	
Photo 1: East elevation	Photo 2: South elevation
	
Photo 3: West elevation	Photo 4: North elevation
	
Photo 5: Interior view of north wall	Photo 6: Interior view looking along west wall

Photo 7: Interior view of south wall

Photo 8: Interior view of west wall

Photo 9: Close up view of the angle brace on south wall.

11. Appendix 2 – CERA Standardised Report Form

Detailed Engineering Evaluation Summary Data V1.14

Location

Building Name:	Greenwood Park Shed	Reviewer:	Kelly Sutherland
	Unit / No: 450 / Street: Summit Road	CPEng No:	258029
Building Address:	450 Summit Road	Company:	Sinclair Knight Merz
Legal Description:		Company project number:	ZB01276.250
		Company phone number:	03 940 4900
	Degrees / Min / Sec		
GPS south:		Date of submission:	25/09/2013
GPS east:		Inspection Date:	15/08/2013
		Revision:	B
Building Unique Identifier (CCC):	PRK_3035_BLDG_002	Is there a full report with this summary?	yes

Site

Site slope:	slope < 1in 10	Max retaining height (m):	0.6
Soil type:	silt	Soil Profile (if available):	0-3.5m Clay/Silt, 3.5m - 20m Scoria silt and pyroclastic material
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):	311.00
Ground floor split?	no	Ground floor elevation above ground (m):	0.00
Storeys below ground			
Foundation type:	mat slab	if Foundation type is other, describe:	
Building height (m):	3.50	height from ground to level of uppermost seismic mass (for IEP only) (m):	3.5
Floor footprint area (approx):	54		
Age of Building (years):	20	Date of design:	1992-2004
Strengthening present?	no	If so, when (year)?	
		And what load level (%g)?	
Use (ground floor):	other (specify)	Brief strengthening description:	
Use (upper floors):			
Use notes (if required):	storage		
Importance level (to NZS1170.5):	IL1		

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber truss	truss depth, purlin type and cladding	100mm, timber, corrugated metal
Floors:	concrete flat slab	slab thickness (mm)	
Beams:	none	overall depth x width (mm x mm)	
Columns:	load bearing walls	typical dimensions (mm x mm)	timber framed walls
Walls:			

Lateral load resisting structure

Lateral system along:	lightweight timber framed walls	Note: Define along and across in detailed report! note typical wall length (m)	9
Ductility assumed, μ:	2.50		
Period along:	0.40 0.00	estimate or calculation?	estimated
Total deflection (ULS) (mm):		estimate or calculation?	
maximum interstorey deflection (ULS) (mm):		estimate or calculation?	
Lateral system across:	lightweight timber framed walls	note typical wall length (m)	6
Ductility assumed, μ:	2.50		
Period across:	0.40 0.00	estimate or calculation?	estimated
Total deflection (ULS) (mm):		estimate or calculation?	
maximum interstorey deflection (ULS) (mm):		estimate or calculation?	

Separations:

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

Non-structural elements

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

Available documentation

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

Damage

Site: (refer DEE Table 4-2)

Site performance:		Describe damage:	
Settlement:	none observed	notes (if applicable):	
Differential settlement:	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):	no damage observed		
Across	Damage ratio:	0%		
	Describe (summary):	no damage observed		
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 e'quakes:	100% ##### %NBS from IEP below	If IEP not used, please detail assessment methodology:	Quantitative DEE calculations
	Assessed %NBS after e'quakes:	100%		
Across	Assessed %NBS before e'quakes:	100% ##### %NBS from IEP below		
	Assessed %NBS after e'quakes:	100%		

12. Appendix 3 – Desktop Geotechnical Investigation

Christchurch City Council - Structural Engineering Service

Geotechnical Desk Study

SKM project number	ZB01276
SKM project site number	250-251
Address	450 Summit Road – Greenwood Park Shed
Report date	August 2013
Author	David Bae
Reviewer	Leah King
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 a quantitative 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
- A preliminary site walkover

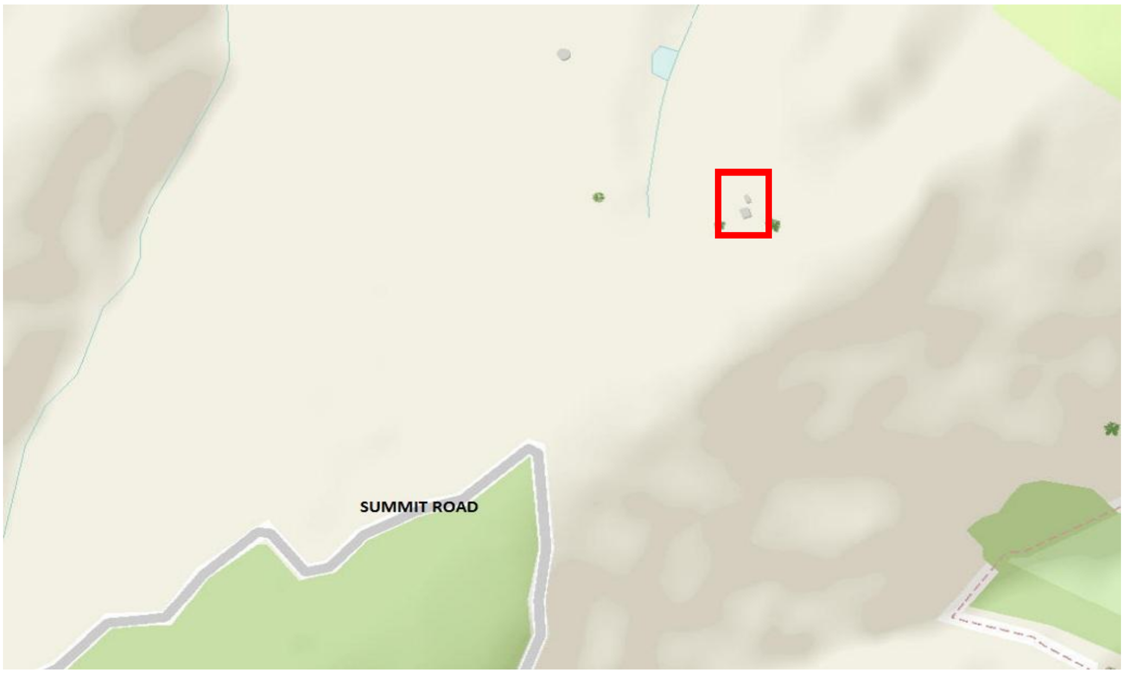
3. Limitations

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

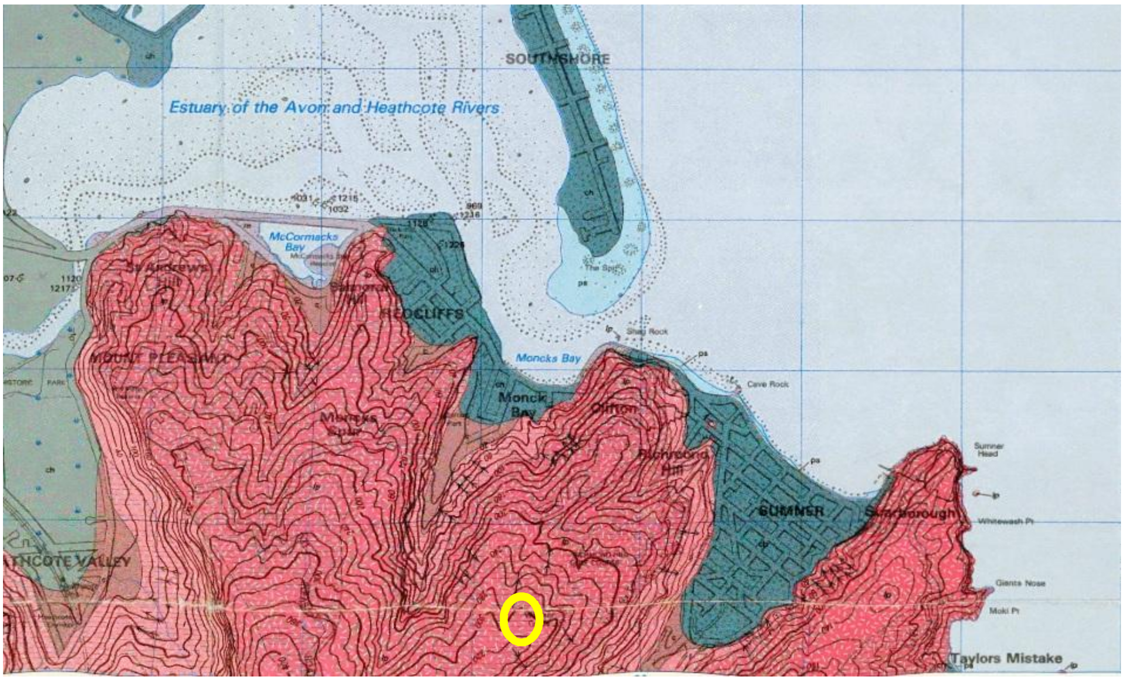


- **Figure 1 – Site location (courtesy of CERA http://maps.cera.govt.nz/advanced-viewer/?Viewer=CERA__Public)**

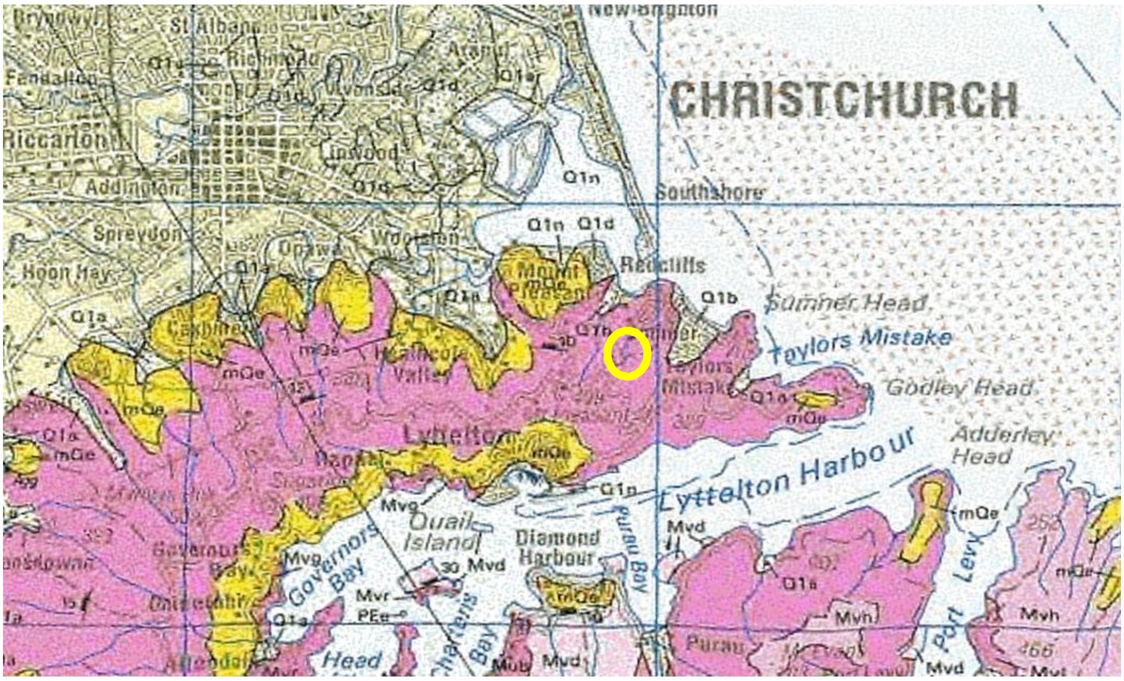
The structure is located off Summit Road at grid reference 1579279 E, 5174756 N (NZTM).

5. Review of available information

5.1 Geological maps



- **Figure 2 – Local geological map (Brown et al, 1992). Site marked in yellow.**



- **Figure 3 – Regional geological map (Forsyth et al, 2008). Site marked in yellow.**

The site is shown to be underlain by basaltic to trachytic lava flows interbedded with breccias and tuff. Additionally, there is presence of numerous dikes and minor domes.

5.2 Liquefaction

The site is located on the Port Hills, liquefaction is not a risk in this area.

5.3 Aerial photography

- **Figure 4 – Aerial photography from 24 Feb 2011 (http://maps.cera.govt.nz/advanced-viewer/?Viewer=CERA__Public)**

Aerial photography taken after the 22 February 2011 event shows no evidence of land damage in the vicinity of the site. There is a rock bluff located to the east of the site; however rockfall would travel to the east away from the site.

5.4 CERA classification

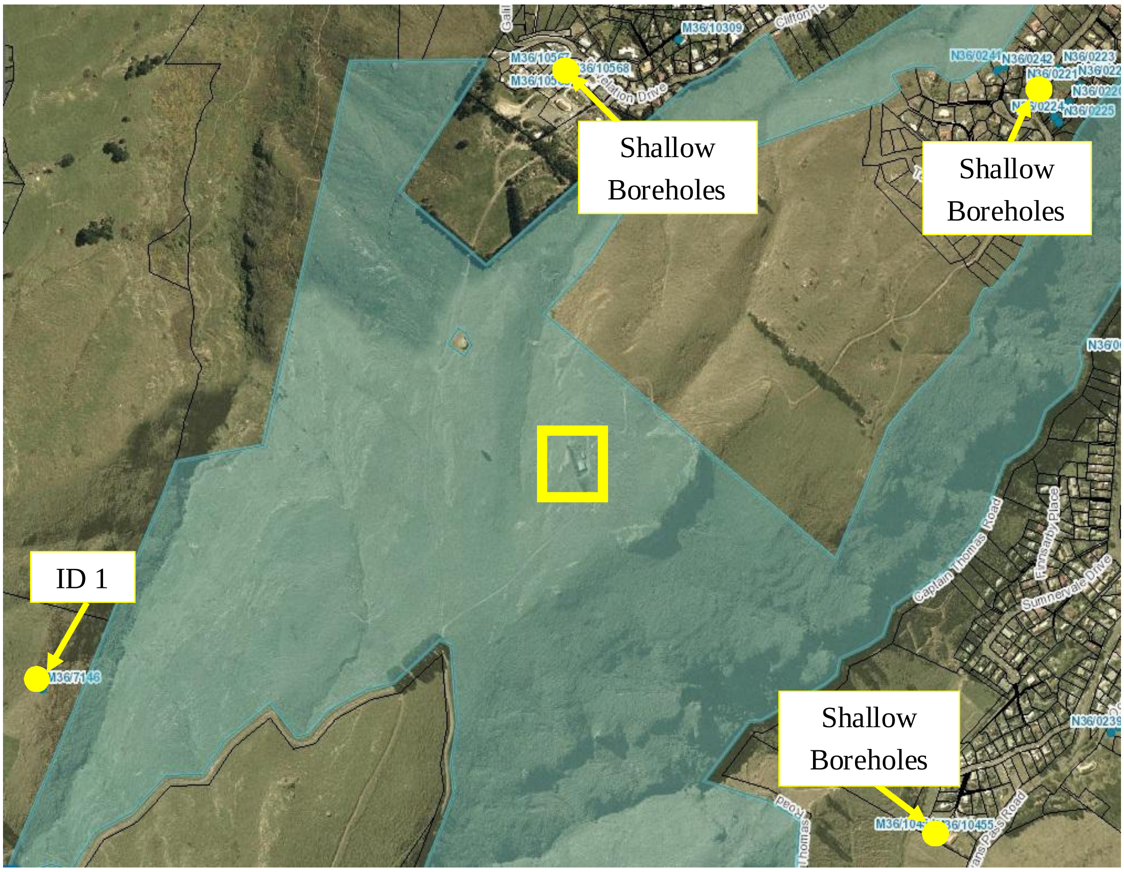
A review of the CERA website (http://maps.cera.govt.nz/advanced-viewer/?Viewer=CERA__Public) shows that the site is:

- Zone: Green
- DBH Technical Category: N/A – Port Hills & Banks Peninsula

5.5 Historical land use

The site is outside the area covered by available historical documents.

5.6 Existing ground investigation data



- **Figure 5 - Location of local ground investigations from ECan GIS (http://canterburymaps.govt.nz/Viewer/)**

The borehole log for ID: 1 is attached to this report (Appendix A), and the results are summarised in Appendix B.

5.7 Council property files

Council files were not available at the time of writing this report.

5.8 Site walkover

An experienced SKM structural engineer visited the site on 15 August 2013.

The sheds were noted to be timber framed structure with iron cladding. The main wool shed was noted to be supported on timber piles approximately 180 mm in diameter founded in 600mm diameter encased concrete and the adjacent shed on slab on grade foundation. During the external site walkover, no evidence of land damage was observed on site.

6. Conclusions and recommendations

6.1 Site geology

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

Depth range (mBGL)	Soil type
0 – 3.5 3.5 – 20	Clay / Silt Scoria silt and pyroclastic material

The ground water table is inferred to be greater than 15 m below the surface.

6.2 Seismic site subsoil class

The site has been assessed as being either Class B (rock) or Class C (shallow soil) as described in NZS1170.5. Further, investigation would be needed to confirm the depth of the surface soil. Until such investigations have been undertaken, Class C should be used as a conservative parameter.

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.

As no borehole information was available near site, the least preferred method of using surface geology to classify the site was performed. The site was inferred to be underlain by basaltic lava flows using the local and regional maps.

6.3 Building Performance

Although a detailed record of the existing foundation is not available, the performance to date suggests that it is adequate for its current purpose.

6.4 Ground performance and properties

There is no risk of liquefaction at this site. The underlying loess/clay and volcanic deposits are not susceptible to liquefaction.

Investigations with geotechnical parameters near the site were not available, however we are reasonably confident of the underlying geology, with the site underlain by loess, which in turn is underlain by volcanic deposits. Additionally, no land damage as a result of the earthquake is expected to have occurred on site. Therefore, following parameters are recommended for the shallow ground layer:

Parameter	Estimated Value
Friction angle	28
Effective Cohesion	5 kPa
Unit Weight	17 kN / m^3
Ultimate Bearing Capacity[1]	220 kPa

[1] Estimated for a 1 m wide strip footing bearing on undisturbed loess deposit.

It should be noted that the above parameters were estimated using borehole undertaken for non-geotechnical purposes and investigation located a significant distance away from the site. Therefore, these parameters should not be used for consent or design purposes without additional site specific investigations to confirm the recommended values

6.5 Geohazards

The site is located on the ridgeline and therefore there is no risk of rockfall to these structures. There is no evidence of slope instability at the site.

6.6 Further investigations

No further investigations are required to undertake a quantitative DEE for the structure on site. However, if significant alterations or a new structure on site are proposed requiring consent, additional site specific investigation would be required in order to provide a more reliable assessment of the geology and ground properties.

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.

Canterbury Earthquake Recovery Authority (CERA) geospatial viewer (http://maps.cera.govt.nz/advanced-viewer/?Viewer=CERA__Public)

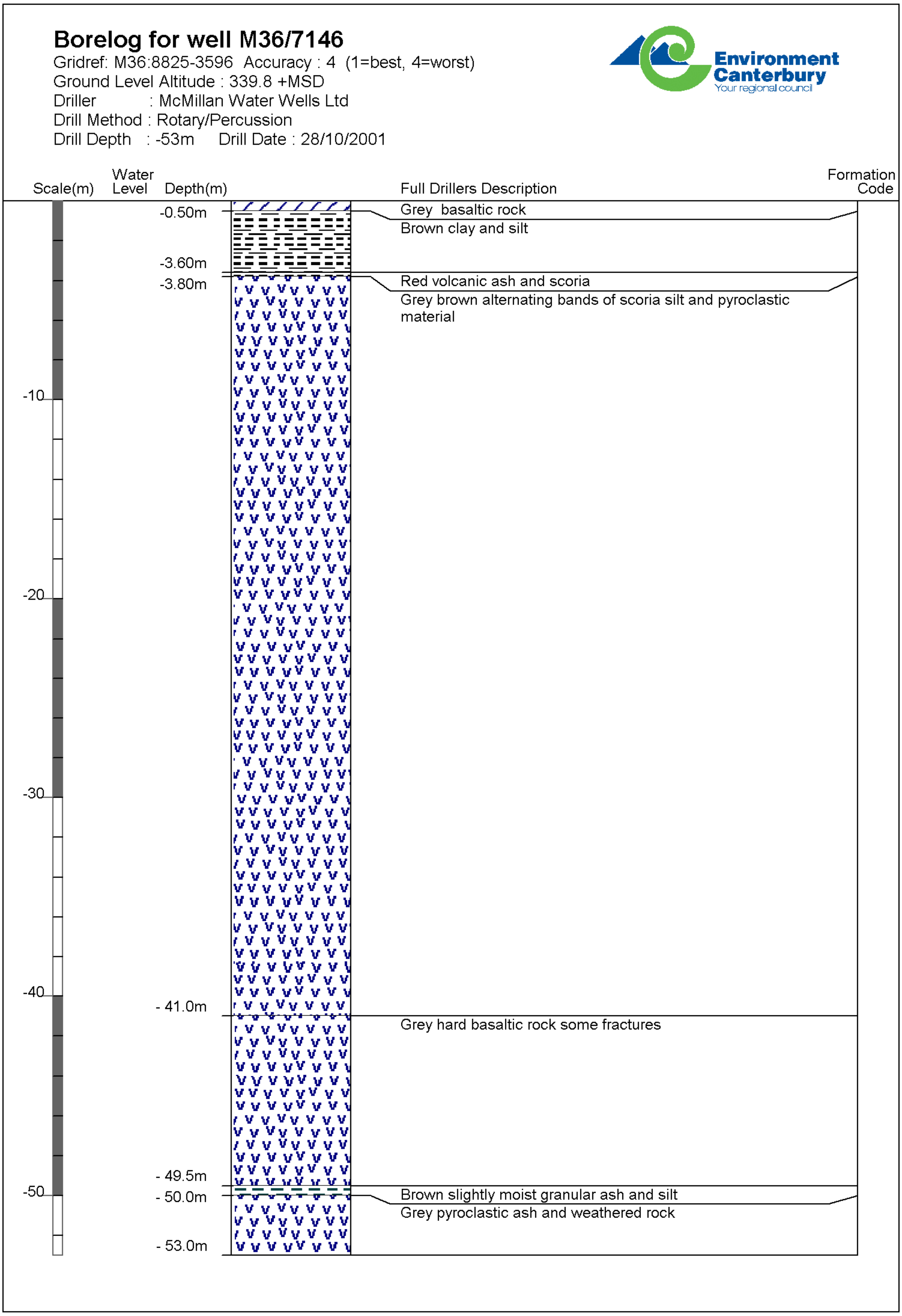
Cubrinovski & Taylor, 2011. Liquefaction map summarising preliminary assessment of liquefaction in urban areas following the 2010 Darfield Earthquake.

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

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

Environment Canterbury geographic information systems (http://canterburymaps.govt.nz/Viewer/)

Appendix A – Existing ground investigation logs


Borelog for well M36/7146
Gridref: M36:8825-3596 Accuracy : 4 (1=best, 4=worst)
Ground Level Altitude : 339.8 +MSD
Driller : McMillan Water Wells Ltd
Drill Method : Rotary/Percussion
Drill Depth : -53m Drill Date : 28/10/2001
Environment Canterbury
Your regional council
Scale(m)
Water Level
Depth(m)
Full Drillers Description
Formation Code
-0.50m
Grey basaltic rock
Brown clay and silt
-3.60m
-3.80m
Red volcanic ash and scoria
Grey brown alternating bands of scoria silt and pyroclastic material
-10
-20
-30
-40
- 41.0m
Grey hard basaltic rock some fractures
- 49.5m
- 50.0m
-50
Brown slightly moist granular ash and silt
Grey pyroclastic ash and weathered rock
- 53.0m

Appendix B – Geotechnical Investigation Summary

Table 1 Summary of most relevant investigation data

ID		1	2	3	4
Type *		WW			
Ref		M36/7146			
Depth (m)		53			
Distance from site (m)		~1,110			
Ground water level (mBGL)		N/A			
Simplified recorded geological profile (depth below ground level to top of stratum, m)	0				
	1				
	2				
	3				
	4				
	5				
	5.5				
	6				
	7				
	8				
	9				
	10				
	11				
	12				
	13				
	14				
	15				
	16				
	17				
	18				
	19				
	20				
	21				
	22				
	23				
	24				
	24.5				
	25				
Greater depths					

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

Clay/Silt

Scoria silt and pyroclastic material