

Christchurch City Council
PRK_1419_BLDG_002 EQ2
Pavilion/Toilet - McCormacks Bay
3 McCormacks Bay Rd



QUANTITATIVE REPORT
FINAL

- Rev C
- 08 March 2013



Christchurch City Council
PRK_1419_BLDG_002 EQ2
Pavilion/Toilet - McCormacks Bay
3 McCormacks Bay Rd

QUANTITATIVE ASSESSMENT REPORT

FINAL

- Rev C
- 08 March 2013

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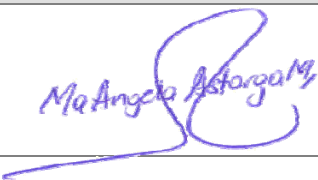

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1. Executive Summary

1.1. Background

A quantitative assessment was carried out on the building located at 3 Mc Cormacks Bay Rd. The building is single storey and is currently utilised as toilets and changing rooms. The structure of the building is reinforced masonry walls and timber-framed roof with lightweight cladding. An aerial photograph illustrating these areas is shown below in Figure1. Detailed descriptions outlining the buildings age and construction type is given in Section 5 of this report.



■ Figure 1 Aerial Photograph of 3 McCormacks Bay Rd

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, visual inspections on 1st February 2013, partial structural drawings and quantitative calculations.



1.2. Key Damage Observed

- Step cracking along mortar joints.
- Cracking through masonry elements.
- Cracking between timber doorframe and masonry wall.

A more detailed account of the damage can be found in section 5.

1.3. Critical Structural Weaknesses

No potential critical structural weaknesses have been identified for this building.

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 non intrusive investigation.
- Qualitative assessment of critical structural weaknesses (CSWs) based on review of available structural drawings and inspection where drawings were not available.
- A geotechnical desktop study of 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 information available, and using the Quantitative Assessment Procedure, the buildings original capacity has been assessed to be in the order of 67%NBS and post earthquake capacity in the order of 67%NBS. The buildings post earthquake capacity excluding critical structural weaknesses is in the order of 67%NBS.

The building has been assessed to have a seismic capacity in the order of 67% NBS and is therefore not potentially earthquake prone.



1.5. Recommendations

Based on the findings of this assessment indicating the building is in the order of 67%NBS, no strengthening is required since it is legally acceptable although its improvement may be desirable.

It is also recommended that:

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



2. Introduction

Sinclair Knight Merz were engaged by Christchurch City Council to carry out a Quantitative Assessment of the seismic performance of Pavilion/Toilet - McCormacks Bay located at 3 McCormacks Bay Rd. Building numbering is defined in Figure1.

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.

The recommendations from the Engineering Advisory Group¹ 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 0.3².

This assessment identified that the seismic capacity of the building was likely to be less than 33% of the new building standard (NBS). A quantitative assessment was recommended to confirm the initial assessment findings and to determine a more accurate seismic rating of the building.

Partial construction drawings were made available, and these have been considered in our evaluation of the building. The building description below is based on a review of the drawings and our visual inspections.

¹ 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 located at 3 McCormacks Bay Rd. There is only one building on this site. The building is single storey and is currently utilised as toilets and changing rooms. The structure of the building is reinforced masonry walls, timber framed walls above the masonry as separation between rooms, and a timber-framed roof with lightweight cladding.

Partial structural drawings were available, where it was observed that part of the structure (a new changing room) was added to the existing building. The construction of the new part of the building dates October 2000 on the drawings. Due to the similarity between the existing building and the new construction, it is considered that it could be similar in age of construction.

Our evaluation is based on our site non intrusive inspection conducted on the 1st February 2013 and the partial structural drawings available.

5.2. Gravity Load Resisting system

The weight of the roof is supported by the timber framed walls that in turn, transfer the loads to the reinforced masonry walls and the foundations. The foundations of the building are formed by a concrete strip and a concrete slab.

5.3. Seismic Load Resisting system

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

The seismic loads acting in both directions are resisted by the reinforced masonry walls as well as the timber framed walls above the masonry. The lateral forces are transferred to the concrete strip foundation.

5.4. Building Damage

SKM undertook an inspection on 21st May 2012 and 1st February 2013. The following areas of damage were observed during the time of inspection:

- 1) Step cracking along mortar joints on the south and west walls.
- 2) Vertical crack along mortar joint between perpendicular walls on the south side.
- 3) Hairline cracks in masonry blocks on the south and west walls.
- 4) Crack between concrete footing under masonry wall and concrete ground slab on south side.
- 5) Gaps opening up between timber elements in the southeast doorframe



- 6) Gap opening up between the timber doorframe in the centre of the south wall and the masonry wall.
- 7) Paint damage was noted on the south wall, but this is not earthquake-related damage.
- 8) Liquefaction was noted around the building.

5.5. 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 NZS1170.5 Class D (deep or soft soil) from nearby borehole logs.
- Liquefaction risk appears to be severe at this site.
- It is also expected due to the short distance from the slope there is a possibility of rock fall at this site.
- The concrete slab foundation has performed well and as a result the structure appears to have only suffered minor structural damage. However, as there is no ground investigation in close proximity to the site, in order to perform a quantitative DEE additional investigations recommended are:
 - Minimum of one borehole on site to a depth of 20 metres. As the building footprint is fairly small, it is unlikely that the geology underlying the site would significantly change across the footprint and one borehole is likely to be adequate.
 - Two CPT tests should be used to evaluate the liquefaction potential of the site.
 - A field mapping above the slope to assess a risk of rock falling

The full geotechnical desktop study can be found in Appendix 3.

6. Available Information and Assumptions

6.1. Available Information

Following our inspection on the 1st February 2013, SKM carried out a seismic review on the structure. This review was undertaken using the available information which was as follows:

- Partial structural drawings of modifications of the building dated October 2000.
- SKM site measurements and non-intrusive inspection findings for the building.

6.2. Survey

No visual evidence of settlement was noted at this site; therefore a level survey is not required at this stage of assessment.

6.3. Assumptions

The assumptions made in undertaking the assessment include:

- The building was built according to the drawings and according to good practice at the time. We have reviewed the building and from our visual inspection the structure appears to be built in accordance with the drawings.
- Standard design assumptions for public 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 for loss of human life, or considerable economic, social or environmental consequence of failure.
- 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
- The following ductility criteria used in the building:
- **Table 2: Assumed Building Ductility**

Building	Ductility of Building in Current State	Ductility of Building in Strengthened State
Masonry structure	1.25	1.25

This nominal ductility has been assumed due that a design of the reinforced masonry walls according to ductile seismic requirements hasn't been confirmed.



- The following material properties were used in the analyses:

■ **Table 3: Material Properties**

Material	Nominal Strength	Structural Performance
Masonry (reinforced)	$f_m = 12\text{MPa}$	$S_p = 0.9$
Timber - Unknown	$f_b = 10\text{MPa}$ & $f_c = 15\text{MPa}$	$S_p = 1.0$

The detailed engineering analysis is a post construction evaluation. Since has not been completed 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 buildings³.

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)

³ <http://resources.ccc.govt.nz/files/EarthquakeProneDangerousAndInsanitaryBuildingsPolicy2010.pdf>



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 4. The building rank 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 20 times that of 100% NBS⁴. 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 prone⁵.

■ **Table 4: 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.

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>



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

7. Results and Discussions

7.1. Critical Structural Weaknesses

No critical structural weaknesses have been identified in this building.

7.2. Analysis Results

The equivalent static force method was used to analyse the seismic capacity of the building. The results of the analysis are reported in the following table as %NBS. The results below are calculated for the building in its damaged state. The building results have been broken down into their seismic resisting elements.

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

■ **Table 5: DEE Results**

Building	Seismic Resisting Element	Action	Seismic Rating %NBS
Mac Cormacks Bay Pavilion	Reinforced masonry walls	Out of plane bending	67%
	Reinforced masonry walls (along direction)	In- plane bending	95%
	Reinforced masonry walls (across direction)	In- plane bending	100%
	Reinforced masonry walls (along and across)	Shear	100%
	Gib lined timber framed walls (along direction)	Shear	84%
	Gib lined timber framed walls (across direction)	Shear	100%

8. Conclusion

SKM carried out a quantitative assessment on PRK_1419_BLDG_002 EQ2 located at 3 McCormacks Bay Rd. This assessment concluded that the building is classified as a low risk building.

■ **Table 6: Quantitative assessment summary**

Description	Grade	Risk	%NBS	Structural performance
Mc Cormacks Bay Pavilion	B	Low	80-67	Acceptable legally. Improvement may be desirable.

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: South elevation



Photo 2: East elevation



Photo 3: North elevation



Photo 4: West elevation



Photo 5: Ground in front of the south wall.



Photo 6: Entrance to changing rooms on the south side.



Photo 7: Timber roof rafter layout on the southwest corner.



Photo 8: Concrete strip footing directly under the masonry wall on the south side.



Photo 9: Crack between concrete strip footing and concrete ground slab.



Photo 10: Paint removal on south wall.



Photo 11: Connection between timber roof rafter and timber edge beam on top of masonry wall.



Photo 12: Timber roof rafter layout on south side.



Photo 13: Plasterboard ceiling cladding on soffit on south side.



Photo 14: Gaps opening up between timber elements on the changing room doorframe.



Photo 15: Gaps opening up between timber elements on the changing room doorframe.



Photo 16: Internal layout of changing room on the west side of the building.



Photo 17: Timber roof trusses in the changing room.



Photo 18: Shower area in changing room with internal masonry walls.



Photo 19: Roof layout inside changing room looking south at the entrance.



Photo 20: Crack in mortar joint at intersection of perpendicular walls on the south side.



Photo 21: Door layout of assumed storage areas on south side.



Photo 22: Roof cladding on the south side.



Photo 23: Gaps opening up between timber elements in the doorframe and the masonry wall on the south side



Photo 24: Cracking through masonry elements and mortar joints on the south side.



Photo 25: Entrance to women's toilets.



Photo 26: Timber roof rafter and timber edge beam on top of masonry wall over entrance to women's toilets



Photo 27: Timber roof rafter and timber edge beam on top of masonry wall over entrance to women's toilets



Photo 28: Lintel over entrance to women's toilets.



Photo 29: Internal layout of women's toilets.

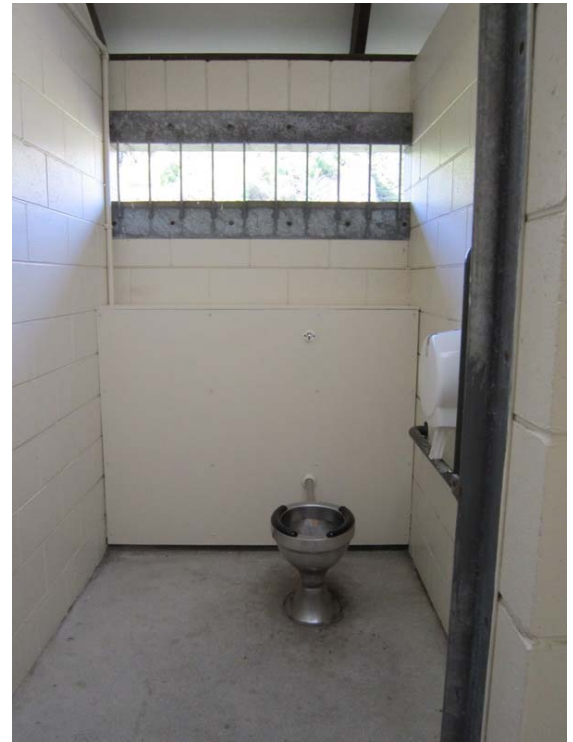


Photo 30: Internal layout of women's toilets.



Photo 31: Roof layout inside the women's toilets, with plasterboard cladding on the walls above the masonry blocks.



Photo 32: Roof layout inside the women's toilets over an internal masonry wall.



Photo 33: View of east wall.



Photo 34: View of east wall showing concrete footing.



Photo 35: View through ventilation gap in east wall showing roof rafters in the men's toilets.



Photo 36: Entrance to men's toilets on the north side.



Photo 37: Entrance to men's toilets on the north side.



Photo 38: Cracking in footpath on the east side of the building.



Photo 39: Cracking in footpath on the east side of the building.



Photo 40: Timber roof rafters and timber edge beam above the north wall.



Photo 41: Lightweight roof cladding.



Photo 42: Southwest elevation of building (sportsfield to the south of the building was cordoned off).



Photo 43: Crack through masonry elements and mortar joints on the west wall.



Photo 44: Crack through masonry elements and mortar joints on the west wall.



11. Appendix 2 – CERA Standardised Report Form

Location		Building Name: Pavilion/Toilet - McCormacks Bay	Unit No: Street	Reviewer: N Calvert
Building Address: _____		3 McCormacks Bay Rd		CPEng No: 242062
Legal Description: _____				Company: SKM
				Company project number: ZB01276.145
				Company phone number: 03 940 4900
GPS south: _____		Degrees	Min	Sec
GPS east: _____				
Building Unique Identifier (CCC): _____		Date of submission: 8-Mar		
		Inspection Date: 1/02/2013		
		Revision: C		
		Is there a full report with this summary? yes		

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

Building		No. of storeys above ground: 1	single storey = 1	Ground floor elevation (Absolute) (m): _____
Ground floor split? no		Storeys below ground: 0		Ground floor elevation above ground (m): _____
Foundation type: strip footings		Building height (m): 5.00	if Foundation type is other, describe: _____	
Floor footprint area (approx): 131		Age of Building (years): 20	height from ground to level of uppermost seismic mass (for IEP only) (m): _____	
Strengthening present? no		Date of design: 1976-1992		
Use (ground floor): public		If so, when (year)? _____		
Use (upper floors): _____		And what load level (%g)? _____		
Use notes (if required): _____		Brief strengthening description: _____		
Importance level (to NZS1170.5): IL2				

Gravity Structure		Gravity System: load bearing walls	
Roof: timber framed		rafter type, purlin type and cladding: steel cladding	Timber trusses & purlins and lightweight
Floors: concrete flat slab		slab thickness (mm): 100mm	
Beams: timber		type: 60mmx240mm	
Columns: none		typical dimensions (mm x mm): None	
Walls: fully filled concrete masonry		#N/A	190

Lateral load resisting structure		Lateral system along: fully filled CMU	Note: Define along and across in detailed report!	note total length of wall at ground (m): 16.8
Ductility assumed, μ : 1.25		Period along: 0.40	##### enter height above at H31	wall thickness (m): 0.2
Total deflection (ULS) (mm): 10				estimate or calculation? estimated
maximum interstorey deflection (ULS) (mm): _____				estimate or calculation? estimated
Lateral system across: fully filled CMU				note total length of wall at ground (m): 7.8
Ductility assumed, μ : 1.25		Period across: 0.40	##### enter height above at H31	wall thickness (m): 0.2
Total deflection (ULS) (mm): 10				estimate or calculation? estimated
maximum interstorey deflection (ULS) (mm): _____				estimate or calculation? estimated

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

Non-structural elements		Stairs: _____	
Wall cladding: exposed structure		describe: Masonry walls	
Roof Cladding: Metal		describe: Corrugated sheeting	
Glazing: _____			
Ceilings: none			
Services(list): Water, sewerage			

Available documentation		Architectural: none	original designer name/date: _____
Structural: partial		original designer name/date: modifications to structure/October2000	
Mechanical: none		original designer name/date: _____	
Electrical: none		original designer name/date: _____	
Geotech report: partial		original designer name/date: _____	

Damage		Site performance: _____	Describe damage: _____
Settlement: none observed		notes (if applicable): _____	
Differential settlement: none observed		notes (if applicable): _____	
Liquefaction: _____		notes (if applicable): Some observed. Refer to geotech	
Lateral Spread: none apparent		notes (if applicable): desktop study attached to report.	
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: Current damage noted will not diminish the capacity of the building	
Across	Damage ratio: 0%		
Diaphragms	Damage?: no	Describe: _____	
CSWs:	Damage?: no	Describe: _____	
Pounding:	Damage?: no	Describe: _____	
Non-structural:	Damage?: yes	Describe: Cracking in masonry and mortar, cracks between timber doorframes and masonry wall.	

Recommendations		Level of repair/strengthening required: minor non-structural	Describe: _____
Building Consent required: no		Describe: _____	
Interim occupancy recommendations: full occupancy		Describe: _____	
Along	Assessed %NBS before: 67%	%NBS from IEP below	Quantitative Assessment carried out (refer to SKM report).
	Assessed %NBS after: 67%		
Across	Assessed %NBS before: 67%	%NBS from IEP below	
	Assessed %NBS after: 67%		

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



12. Appendix 3 – Desktop Geotechnical Study



Christchurch City Council - Structural Engineering Service

Geotechnical Desk Study

SKM project number	ZB01276
SKM project site number	145
Address	McCormacks Reserve, McCormacks Bay Road
Report date	4 July 2012
Author	Chris Ritchie
Reviewer	Ross Kendrick
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

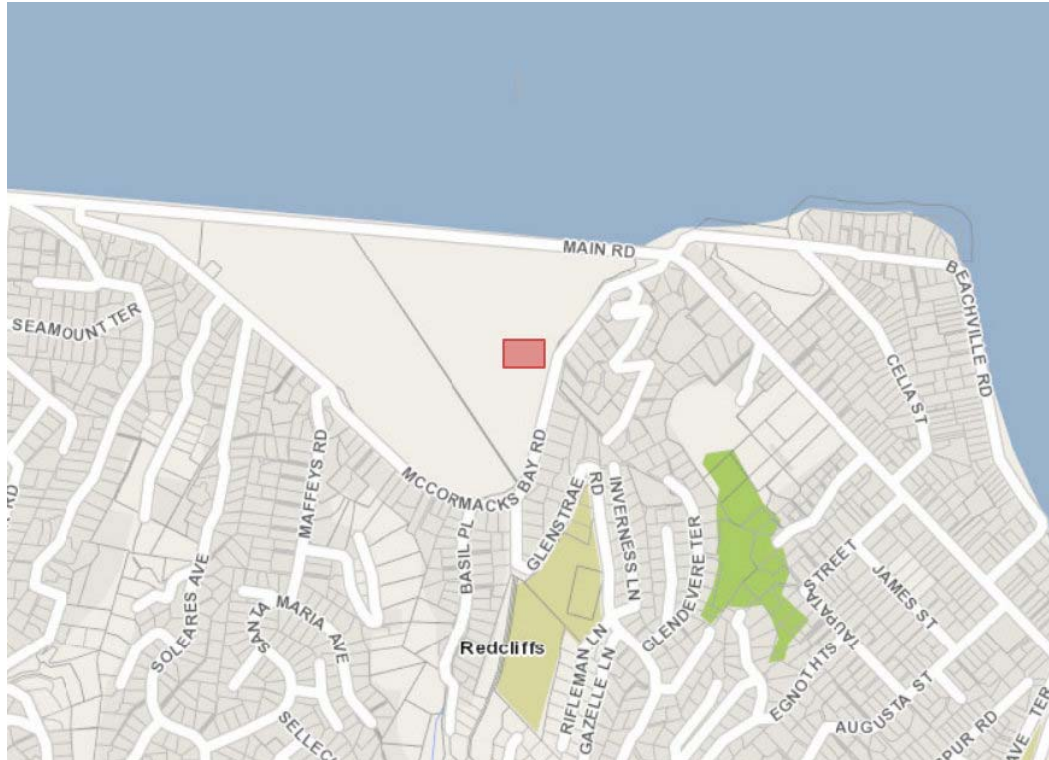
This report was prepared to address geotechnical issues relating to the specific site in accordance with the scope of works as defined in the contract between SKM and our Client. This report has been prepared on behalf of, and for the exclusive use of, our Client, and is subject to, and issued in accordance 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

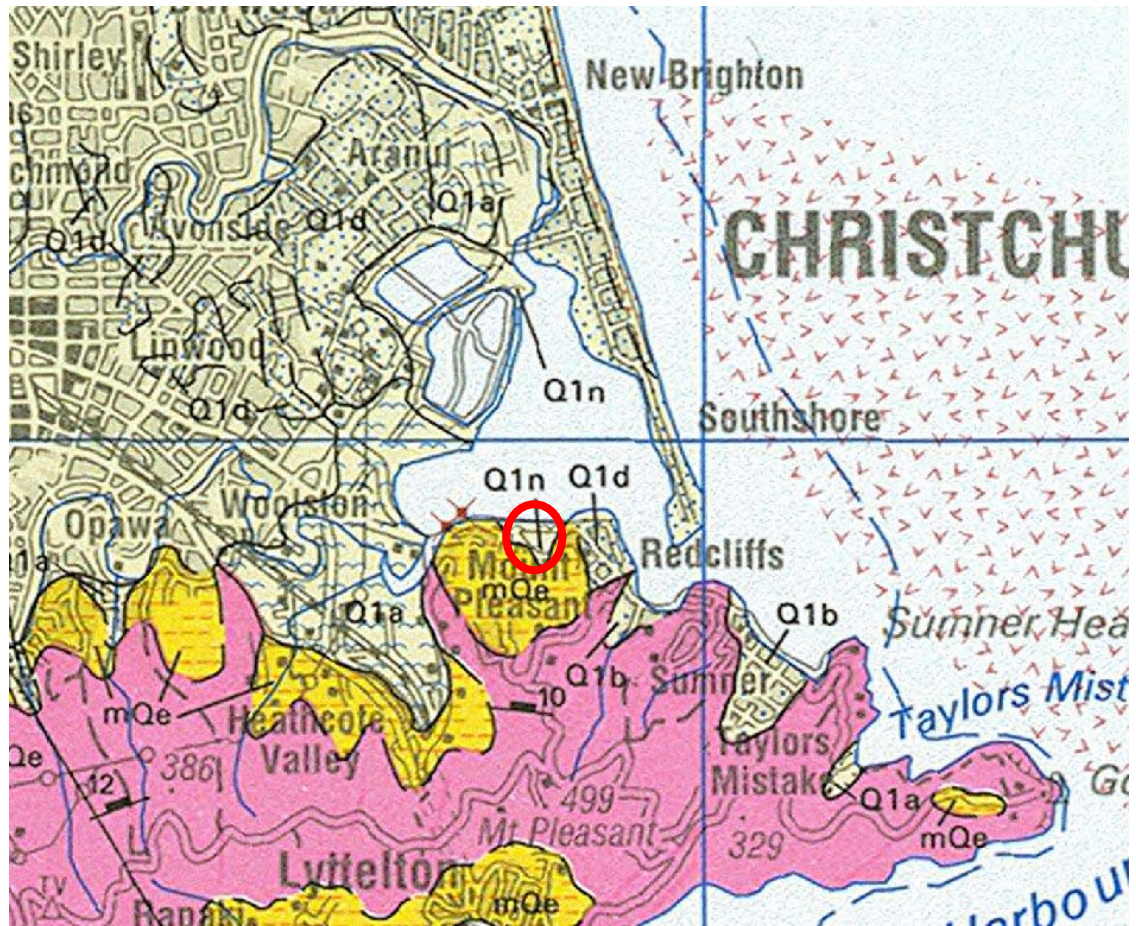


■ **Figure 1 – Site location (courtesy of LINZ <http://viewers.geospatial.govt.nz>)**

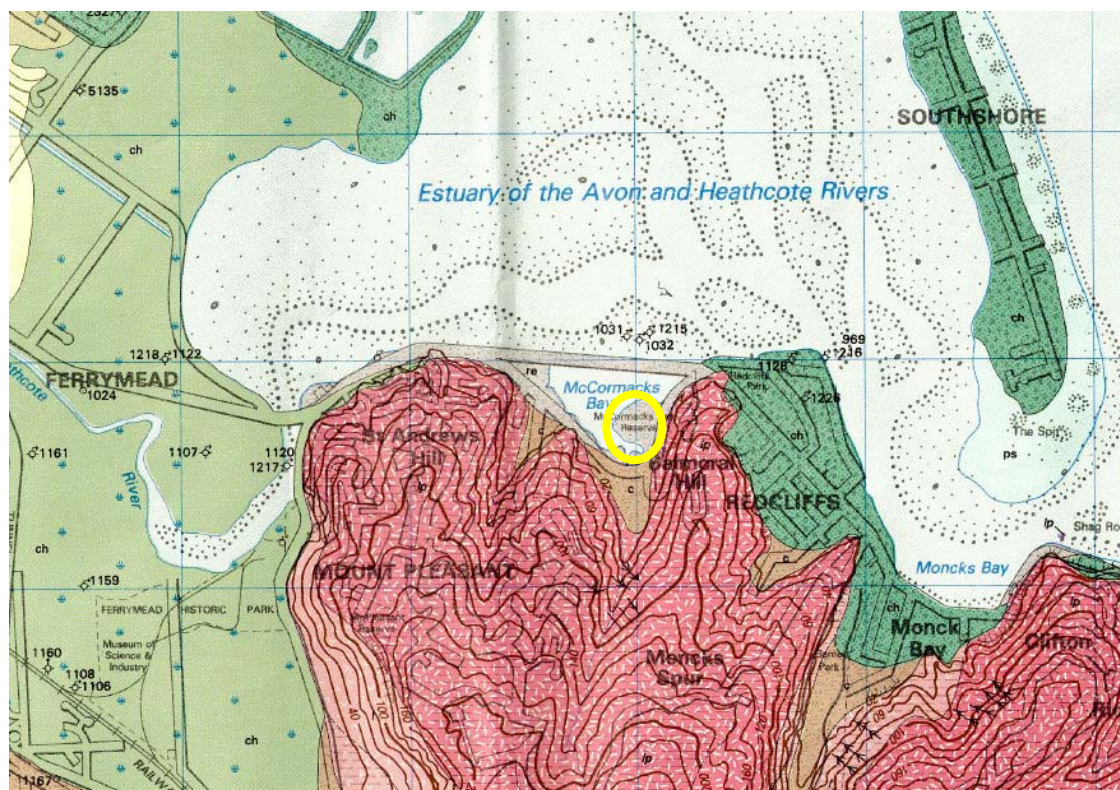
The structure is located within McCormacks Bay reserve off McCormacks Bay Road (1570850 E, 5183080 N (NZTM)).

5. Review of available information

5.1 Geological maps



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



■ Figure 3 – Local geological map (Brown et al, 1992). Site marked in yellow.

The site is shown to be underlain by Holocene deposits comprising of reclaimed land.

5.2 Aerial photography



- **Figure 4 – Aerial photography from 24 Feb 2011 (<http://viewers.geospatial.govt.nz/>)**

Aerial photography shows significant liquefaction after the 22 Feb 2011 event.

5.3 CERA classification

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

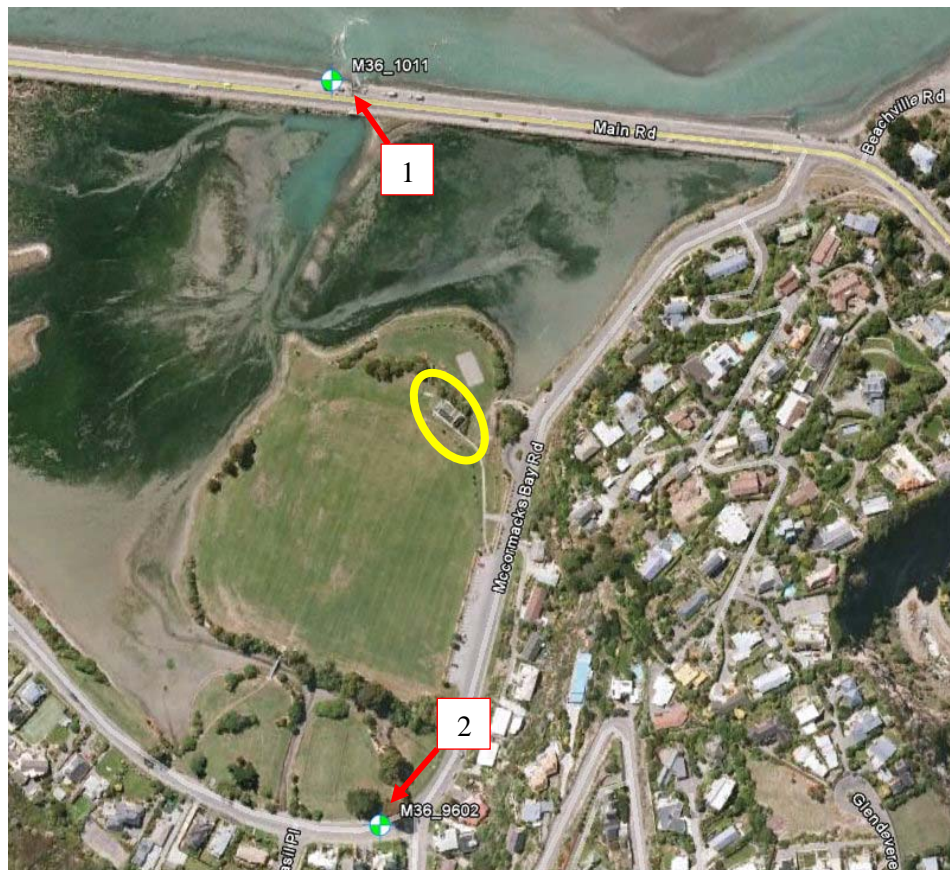
- Zone: Green
- DBH Technical Category NA/non residential.



5.4 Historical land use

Reference to historical documents (e.g. Appendix A) shows that the site was situated in a marshland or swamp in 1856.

5.5 Existing ground investigation data



- **Figure 5 – Local boreholes from Project Orbit and SKM files**
(<https://canterburyrecovery.projectorbit.com/>)

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



5.6 Council property files

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

5.7 Site walkover

An external site walkover was conducted by an SKM engineer on 26 June 2012.

The building was noted to be a masonry block building with a sheet metal roof and slab on grade foundation. Some cracking in the masonry wall and concrete ground slab was noted during the external site inspection. There was significant damage to the asphalt surface in front of the southern wall.

The site had significant liquefaction during the February 2011 earthquake, as there was obvious evidence of liquefaction and land damage noted during the external site walkover. There were remaining sand ejecta on the site and significant ground bulges in the external footpath where silt or sand ejecta domes had been trapped beneath the asphalt. Some cracking and differential settlement of the asphalt footpath was noted. The site was located close to a waterway to the north; however, no visual evidence of lateral spreading or settlement of the structure was observed during the site walkover. It was noted that a new lawn had been planted to the south of the building where significant liquefaction occurred during the Feb 2011 earthquake.





■ **Figure 6 Overview of structures**



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 (mBLG)	Soil type
0 – 6	Interbedded sand and silt
6 - 23	Sand
23+	Gravel

6.2 Seismic site subsoil class

The site has been assessed as NZS1170.5 Class D (deep or soft soil).

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.

In this case the absence of deep boreholes near the site has resulted in the use of the least preferred method. It is therefore possible that site specific investigation could revise the site class.

6.3 Building Performance

Although detailed records of the existing foundations are not available, the performance to date suggests that they are adequate for their current purpose.

6.4 Ground performance and properties

Liquefaction risk is severe at this site. The existing investigation data from the boreholes suggest sand and silt layers to at least 23m. However the geology maps indicate that this sites on reclaimed land. The area is in a low lying estuarine environment, groundwater levels are expected to be very high.

It is also expected due to the short distance from the slope there is a possibility of rock fall at this site.

As all available ground investigation data was greater than 200m away from the site, an estimation of the ground properties has not been provided in this desk study. Additional, investigations closer to the site would be required to perform a full quantitative DEE.

6.5 Further investigations

The structure is one storey, masonry block with timber frame construction with a concrete slab foundation and sheet metal roof. The concrete slab foundation has performed well and as a result the structure appears to have only suffered minor structural damage. However, as there is no ground investigation in close proximity to the site, in order to perform a quantitative DEE additional investigations recommended are:



- Minimum of one borehole on site to a depth of 20 metres. As the building footprint is fairly small, it is unlikely that the geology underlying the site would significantly change across the footprint and one borehole is likely to be adequate.
- Two CPT tests should be used to evaluate the liquefaction potential of the site.
- A field mapping above the slope to assess a risk of rock falling

7. References

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

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

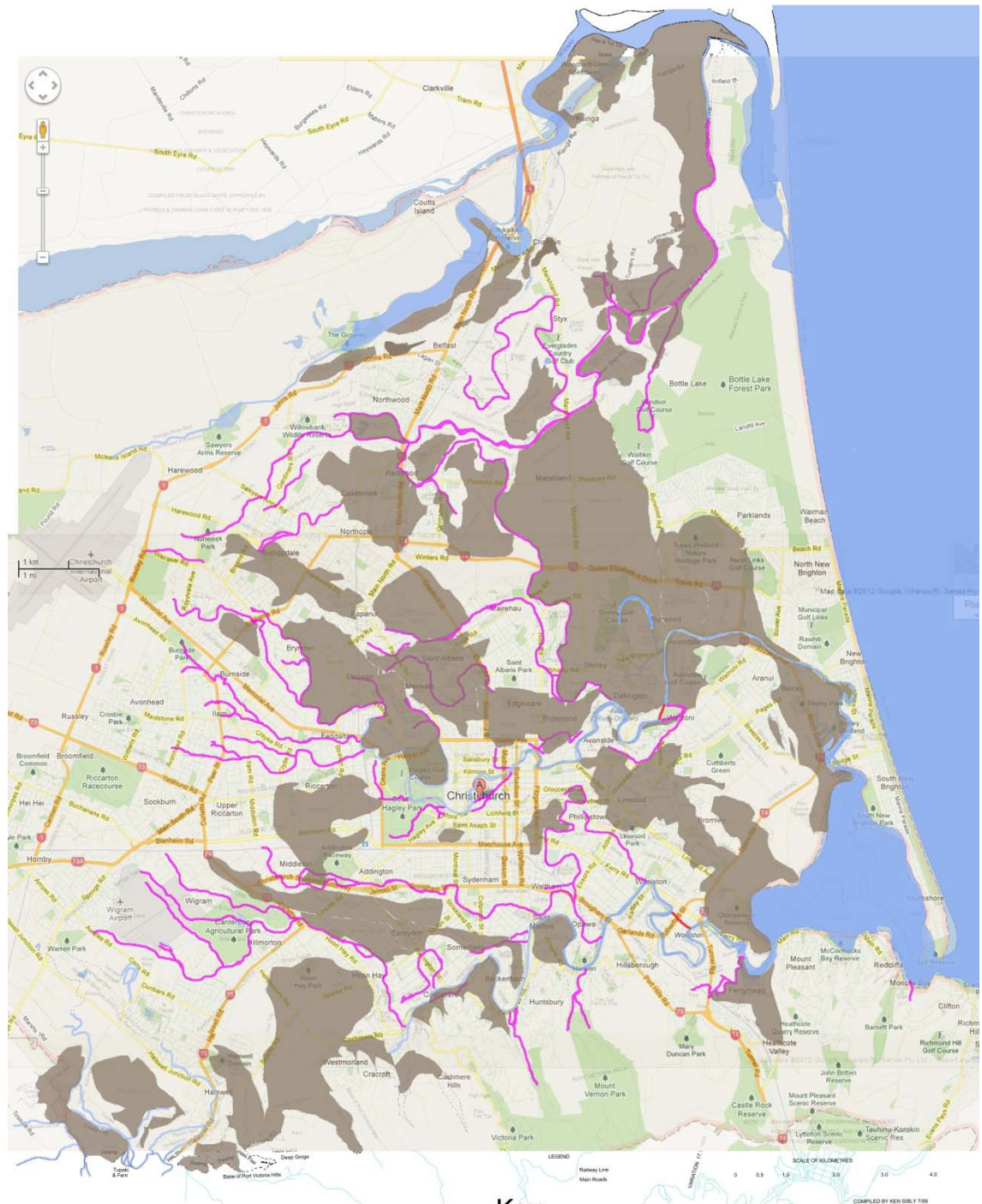
Forsyth PJ, Barrell DJA, Jongens R, 2008. Geology of the Christchurch area. Institute of Geological & Nuclear Sciences geological map 16.

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

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



Appendix A – Christchurch 1856 land use



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

- Key**
- Previous creeks/ivers
 - Existing creeks/ivers
 - New creeks/ivers
 - Swamp/Marshland



Appendix B – Existing ground investigation logs

Borelog for well M36/1011 page 1 of 2

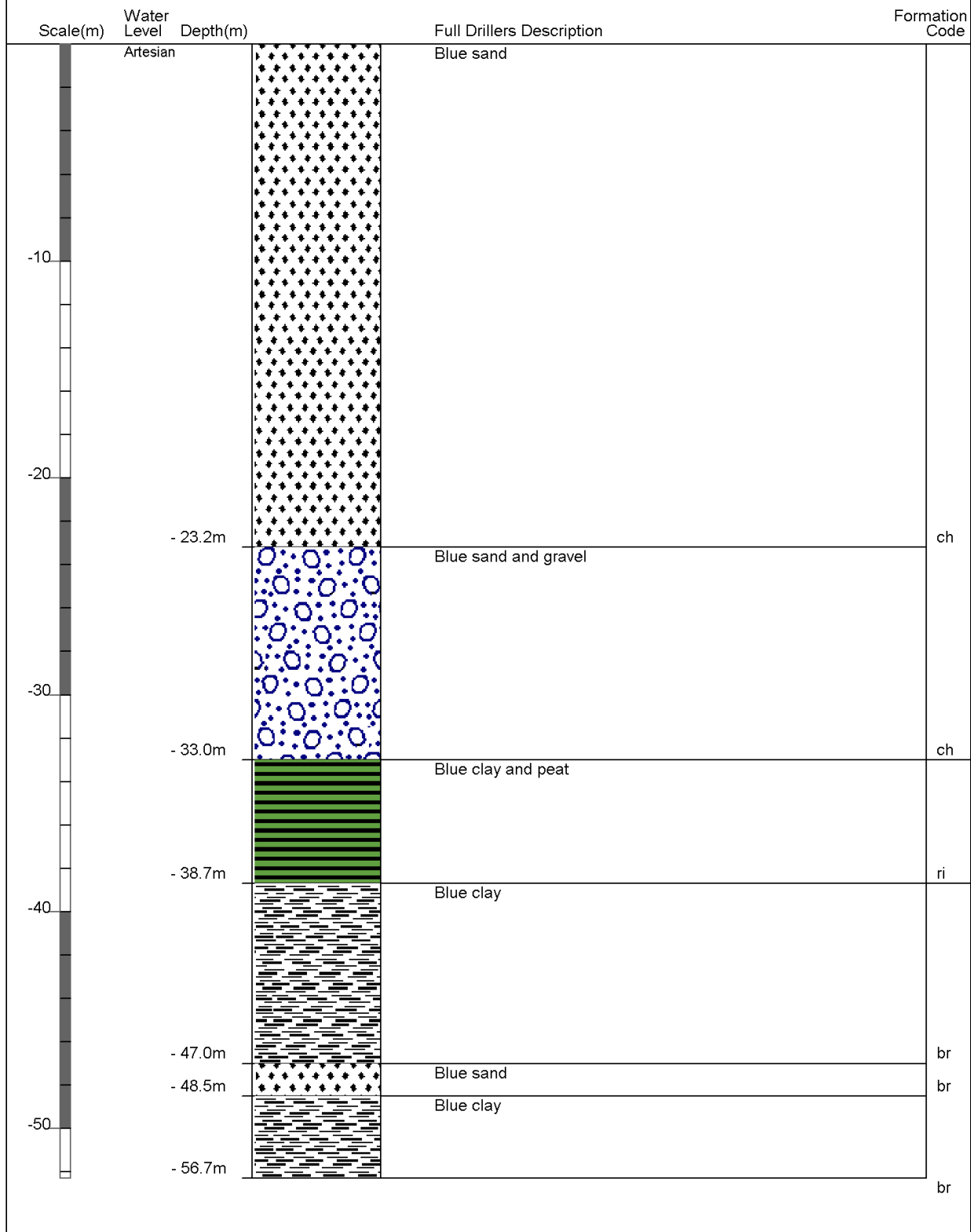
Gridref: M36:880-390 Accuracy : 4 (1=best, 4=worst)

Ground Level Altitude : 1 +MSD

Driller : Job Osborne (& Co/Ltd)

Drill Method : Hydraulic/Percussion

Drill Depth : -104.6m Drill Date : 22/11/1944



Borelog for well M36/1011 page 2 of 2

Gridref: M36:880-390 Accuracy : 4 (1=best, 4=worst)

Ground Level Altitude : 1 +MSD

Driller : Job Osborne (& Co/Ltd)

Drill Method : Hydraulic/Percussion

Drill Depth : -104.6m Drill Date : 22/11/1944



Scale(m)	Water Level	Depth(m)	Full Drillers Description	Formation Code
	Artesian		Blue clay	
		- 56.7m		li?
		- 57.0m	Blue sand	li?
		- 58.2m	Scoria	
			Brown sand	
-60				
		- 62.8m		li?
		- 64.0m	Yellow clay	li?
			Blue clay	
		- 68.3m		li?
		- 70.4m	Yellow clay & scoria	li?
-70			Brown sand	
		- 74.1m		li?
			Blue sand & clay	
-80				
		- 81.6m		he?
			Brown sand & pieces of rock	
		- 86.0m		he?
			Blue clay	
		- 88.7m		he?
		- 90.2m	Scoria	bu?
-90			Blue sand	
		- 93.3m		bu?
			Blue clay	
-100				
		- 104.5m		sh?
		- 104.6m	Rock	vo

Borelog for well M36/9602

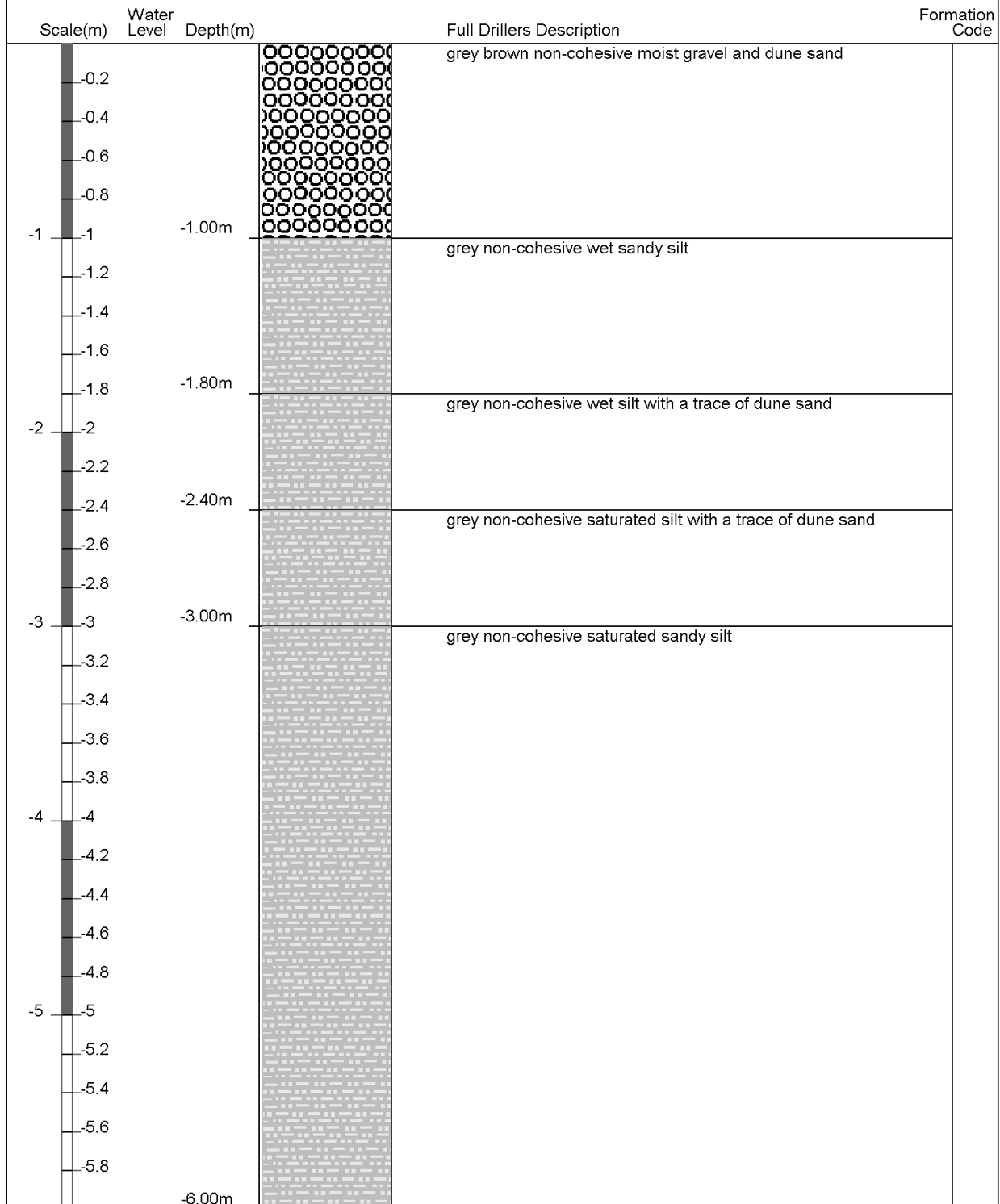
Gridref: M36:88043-38524 Accuracy : 3 (1=high, 5=low)

Ground Level Altitude : 1 +MSD

Well name : CCC BorelogID 4011

Drill Method : Not Recorded

Drill Depth : -6m Drill Date : 5/02/1988





Appendix C – Geotechnical Investigation Summary

■ Table 1 Summary of most relevant investigation data

ID	1	2
Type *	WW	WW
Ref	M36_1011	M36_9602
Depth (m)	104	6
Distance from site (m)	228	272
Ground water level (mBGL)	Artesian	
Simplified recorded geological profile (depth below ground level to top of stratum, m)	0	
	1	
	2	
	3	
	4	
	5	
	6	
	7	
	8	
	9	
	10	
	11	
	12	
	13	
	14	
	15	
	16	
	17	
	18	
	19	
	20	
	21	
	22	
	23	
	24	
	25	
Greater depths		

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

Sensitive or organic clay/silt	Clay to silty clay	Clayey silt to silt	Silty sand to silt
Clayey sand	Sand	Gravelly sand or gravel	

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

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