Christchurch City Council

PRK_3537_BLDG_001 EQ2

Cass Bay Toilets

Cnr Bay View Pl, Harbour View Tce

QUALITATIVE ASSESSMENT REPORT
FINAL

- Rev B
- 24 September 2012

Christchurch City Council
PRK_3537_BLDG_001 EQ2
Cass Bay Toilets
Cnr Bay View Pl & Harbour View Tce

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Contents

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1. Executive Summary

1.1. Background

A Qualitative Assessment was carried out on the building, PRK_3537_BLDG_001 EQ2 located on the corner of Bay View Place and Harbour View Terrace, Cass Bay. This building is a single storey concrete block structure that is used as public toilets. An aerial photograph illustrating these areas is shown below in Figure 1. Detailed descriptions outlining the buildings age and construction type are given in Section 5 of this report.

- **Figure 1 Aerial Photograph of PRK_3537_BLDG_001 EQ2 Located at Cass Bay**

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

This Qualitative report for the building structure is based on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011 and our visual inspection carried out on 31 May 2012.

1.2. Key Damage Observed

Key damage observed includes:-

- Cracking along concrete block mortar joints.

- Minor differential movement between the concrete slab and the concrete path outside the entrance to the Ladies toilet.

Repair recommendations for the damage above are included in section 6. A building consent is not likely to be required to repair the damage noted above.

1.3. Critical Structural Weaknesses

No critical structural weaknesses were identified during our site inspection.

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

Based on the information available, and using the NZSEE Initial Evaluation Procedure, the buildings original capacity has been assessed to be greater than 100%NBS. No structural damage was observed during our visual inspection and as a result the post earthquake capacity is also greater than 100%NBS. This assessment has been made without structural drawings and is accordingly limited.

The building has been assessed to have a seismic capacity greater than 100% NBS and is therefore not potentially earthquake prone. Due to this no further investigation is required for this building.

1.5. Recommendations

It is recommended that:

a) No placard was displayed on the building however we recommend that the current placard status of the building be Green 2.

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

2. Introduction

Sinclair Knight Merz was engaged by Christchurch City Council to prepare a qualitative assessment report for the building located on the corner of Bay View Place and Harbour View Terrace following the magnitude 6.3 earthquake which occurred in the afternoon of the 22nd of February 2011 and the subsequent aftershocks.

The Qualitative Assessment uses the methodology recommended in the Engineering Advisory Group document "Guidance on Detailed Engineering Evaluation of Earthquake affected Non-residential Buildings in Canterbury" (part 2 revision 5 dated 19/07/2011 and part 3 draft revision dated 13/12/2011). The qualitative assessment includes a summary of the building damage as well as an initial assessment of the likely current Seismic Capacity compared with current seismic code requirements.

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

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

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

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

At the time of this report, no intrusive site investigation, detailed analysis, or modelling of the building structure had been carried out. No construction drawings were made available, and as a result the building descriptions outlined in Section 5 is based on our visual inspection only.

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

3. Compliance

This section contains a summary of the requirements of the various statutes and authorities that control activities in relation to buildings in Christchurch at present.

3.1. Canterbury Earthquake Recovery Authority (CERA)

CERA was established on 28 March 2011 to take control of the recovery of Christchurch using powers established by the Canterbury Earthquake Recovery Act enacted on 18 April 2011. This act gives the Chief Executive Officer of CERA wide powers in relation to building safety, demolition and repair. Two relevant sections are:

Section 38 – Works

This section outlines a process in which the chief executive can give notice that a building is to be demolished and if the owner does not carry out the demolition, the chief executive can commission the demolition and recover the costs from the owner or by placing a charge on the owners' land.

Section 51 – Requiring Structural Survey

This section enables the chief executive to require a building owner, insurer or mortgagee carry out a full structural survey before the building is re-occupied.

We understand that CERA will require a detailed engineering evaluation to be carried out for all buildings (other than those exempt from the Earthquake Prone Building definition in the Building Act). It is anticipated that CERA will adopt the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011. This document sets out a methodology for both qualitative and quantitative assessments.

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

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

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

- The extent of any earthquake damage

3.2. Building Act

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

3.2.1. Section 112 – Alterations

This section requires that an existing building complies with the relevant sections of the Building Code to at least the extent that it did prior to any alteration. This effectively means that a building cannot be weakened as a result of an alteration (including partial demolition).

3.2.2. Section 115 – Change of Use

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

3.2.3. Section 121 – Dangerous Buildings

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

- in the ordinary course of events (excluding the occurrence of an earthquake), the building is likely to cause injury or death or damage to other property; or
- in the event of fire, injury or death to any persons in the building or on other property is likely because of fire hazard or the occupancy of the building; or
- there is a risk that the building could collapse or otherwise cause injury or death as a result of earthquake shaking that is less than a 'moderate earthquake' (refer to Section 122 below); or
- there is a risk that that other property could collapse or otherwise cause injury or death; or
- a territorial authority has not been able to undertake an inspection to determine whether the building is dangerous.

3.2.4. Section 122 – Earthquake Prone Buildings

This section defines a building as earthquake prone if its ultimate capacity would be exceeded in a 'moderate earthquake' and it would be likely to collapse causing injury or death, or damage to other property. A moderate earthquake is defined by the building regulations as one that would generate ground shaking 33% of the shaking used to design an equivalent new building.

3.2.5. Section 124 – Powers of Territorial Authorities

This section gives the territorial authority the power to require strengthening work within specified timeframes or to close and prevent occupancy to any building defined as dangerous or earthquake prone.

3.2.6. Section 131 – Earthquake Prone Building Policy

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

3.3. Christchurch City Council Policy

Christchurch City Council adopted their Earthquake Prone, Dangerous and Insanitary Building Policy in 2006. This policy was amended immediately following the Darfield Earthquake of the 4th September 2010.

The 2010 amendment includes the following:

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

The council has stated their willingness to consider retrofit proposals on a case by case basis, considering the economic impact of such a retrofit.

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

If strengthening works are undertaken, a building consent will be required. A requirement of the consent will require upgrade of the building to comply 'as near as is reasonably practicable' with:

- The accessibility requirements of the Building Code.
- The fire requirements of the Building Code. This is likely to require a fire report to be submitted with the building consent application.

3.4. Building Code

The building code outlines performance standards for buildings and the Building Act requires that all new buildings comply with this code. Compliance Documents published by The Department of Building and Housing can be used to demonstrate compliance with the Building Code.

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

a) Hazard Factor increased from 0.22 to 0.3 (36% increase in the basic seismic design load)
b) Serviceability Return Period Factor increased from 0.25 to 0.33 (80% increase in the serviceability design loads when combined with the Hazard Factor increase)

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

4. Earthquake Resistance Standards

For this assessment, the building's earthquake resistance is compared with the current New Zealand Building Code requirements for a new building constructed on the site. This is expressed as a percentage of new building standard (%NBS). The new building standard load requirements have been determined in accordance with the current earthquake loading standard (NZS 1170.5:2004 Structural design actions - Earthquake actions - New Zealand).

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

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

Description	Grade	Risk	%NBS	Existing Building Structural Performance	Improvement of Structural Performance: Legal Requirement	Improvement of Structural Performance: NZSEE Recommendation
Low Risk Building	A or B	Low	Above 67	Acceptable (improvement may be desirable)	The Building Act sets no required level of structural improvement (unless change in use) This is for each TA to decide. Improvement is not limited to 34%NBS.	100%NBS desirable. Improvement should achieve at least 67%NBS
Moderate Risk Building	B or C	Moderate	34 to 66	Acceptable legally. Improvement recommended		Not recommended. Acceptable only in exceptional circumstances
High Risk Building	D or E	High	33 or lower	Unacceptable (Improvement	Unacceptable	Unacceptable

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

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

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

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

5. Building Details

5.1. Building description

Our evaluation was based on our visual inspection carried out the 31 May 2012.

Building PRK_3537_BLDG_001 EQ2 is a single story concrete block building that is used as public toilets at Cass Bay. The roof is constructed from timber framing and a light weight corrugated steel cladding and is supported on the concrete block walls. Due to the assumed age of this building we believe that the concrete block walls will be reinforced.The building is supported on concrete strip footings and has a concrete slab on grade. No structural drawings were available for this building. Due to this we are unable to confirm the buildings age. However based on the architecture and the condition of this structure we believe that this building was constructed sometime in the 1980's and as a result we have assumed a design period of 1976-1992 for our assessment.

5.2. Gravity Load Resisting system

The gravity load resisting structure of the building is made up of concrete block walls that are supported on concrete strip footings A concrete slab on grade creates the ground floor area.

5.3. Seismic Load Resisting system

For the purposes of this report the along (longitudinal) direction of the building is defined as being the north-south direction and the across (transverse) direction is defined as being in the east-west direction.

Lateral loads acting across and along the building are resisted by concrete block walls through bending and shear. The concrete block walls are supported on strip foundations which act to hold down the walls when they are subjected to both out-of-plane and in-plane bending.

5.4. Geotechnical Conditions

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

- The site has been assessed as being either NZS1170.5 Class C (shallow soil) or NZS 1170.5 Class B (rock) from surface geology. As no investigation information is available for the site and the depth to the underlying rock could not be reliably estimated, NZS 1170.5 Class C is recommended as the seismic site subsoil class in this report.
- Liquefaction risk has been assessed as low for the site.

The full geotechnical desktop study can be found in Appendix 4 – Geotechnical Desktop Study

6. Damage Summary and Remediation

SKM undertook a visual inspection on the 31 May 2012. The following areas of damage were observed during the time of inspection:

6.1. Damage Summary

1) Hairline cracking along block wall mortar joints. Occurs in various locations refer to PHOTOS 8-27.
2) Differential movement between the concrete floor slab and concrete path at the entrance to the ladies. Differential movement approximately 10mm-15mm. Refer to PHOTOS 28 & 29.

Photos of the above damage can be found in Appendix 1 – Photos. The damage noted above is not likely to require a building consent for repair works.

7. Initial Seismic Evaluation

7.1. The Initial Evaluation Procedure Process

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

The IEP is a coarse screening process designed to identify buildings that are likely to be earthquake prone. The IEP process ranks buildings according to how well they are likely to perform relative to a new building designed to current earthquake standards, as shown in Table 2. The building grade is indicated by the percent of the required New Building Standard (%NBS) strength that the building is considered to have. A building is earthquake prone for the purposes of this Act if, having regard to its condition and to the ground on which it is built, and because of its construction, the building:-

a) will have its ultimate capacity exceeded in a moderate earthquake (as defined in the regulations); and
b) would be likely to collapse causing:-
    i. injury or death to persons in the building or to persons on any other property; or
    ii. damage to any other property.

A moderate earthquake is defined as 'in relation to a building, an earthquake that would generate shaking at the site of the building that is of the same duration as, but that is one-third as strong as, the earthquake shaking (determined by normal measures of acceleration, velocity and displacement) that would be used to design a new building at the site.'

An earthquake prone building will have an increased risk that its strength will be exceeded due to earthquake actions of approximately 10 times (or more) than that of a building having a capacity in excess of 100% NBS (refer Table 1)[3]. Buildings in Christchurch City that are identified as being earthquake prone are required by law to be followed up with a detailed assessment and strengthening work within 30 years of the owner being notified that the building is potentially earthquake prone[4].

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[2] http://resources.ccc.govt.nz/files/EarthquakeProneDangerousAndInsanitaryBuildingsPolicy2010.pdf
[3] NZSEE June 2006, *Assessment and Improvement of the Structural Performance of Buildings in Earthquakes,* p 2-13
[4] http://resources.ccc.govt.nz/files/EarthquakeProneDangerousAndInsanitaryBuildingsPolicy2010.pdf

Table 2: IEP Risk classifications

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

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

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

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

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

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

7.2. Design Criteria and Limitations

Following our inspection on the 31 May 2012 SKM carried out a preliminary structural review. The structural review was undertaken using the available information which was as follows:

- SKM site measurements and inspection findings of the building. Please note no intrusive investigations were undertaken.
- Structural drawings were not available

The design criteria used to undertake the assessment include:

- Standard design assumptions for typical buildings as described in AS/NZS1170.0:2002
  - 50 year design life, which is the default NZ Building Code design life.
  - Structure Importance Level 1 since the total floor area is <30m^2 and represents structures presenting a low degree of hazard to life and other property.
- Ductility level of 1 based on our assessment and code requirements at the time of design. This is a conservative assumption as a ductility of 1.25 could be justified however since the seismic capacity was already greater than 100% increasing the ductility seemed unnecessary,
- Site hazard factor, Z = 0.3, NZBC, Clause B1 Structure, Amendment 11 effective from 1 August 2011
- Soil Class C as described in NZS1170.5 and our Geotechnical Desktop Study.

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

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

7.3. Survey

There was no visible settlement of the structure, nor was there any significant ground movement issues around the building. The building is zoned as 'Port Hills & Banks Peninsula' under the CERA Residential Technical Categories Map. The combination of these factors means that we do not recommend that any survey be undertaken at this point.

7.4. Critical Structural Weaknesses

No critical structural weaknesses were identified for this building.

7.5. Qualitative Assessment Results

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

Table 3: Qualitative Assessment Summary

Item	%NBS
Building Likely Seismic Capacity	>100%

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

No further investigation is required at this stage.

8. Further Investigation

Due to the likely seismic capacity of the building being greater than 67%NBS no further investigation is required at this stage.

A building consent is not likely to be required for the repair of the damage noted in Section 6.

9. Conclusion

A qualitative assessment was carried out on the building PRK_3537_BLDG_001 EQ2. The building has sustained minor cracking to concrete block walls. A building consent is not likely to be required to repair this damage

The building has been assessed to have a seismic capacity greater than 100% NBS and is therefore not potentially earthquake prone and is likely to be classified as a 'Low Risk Building' (capacity greater than 100% of NBS). Due to this no further investigation is required at this stage.

It is recommended that:

a) No placard was displayed on the building however we recommend that the current placard status of the building be Green 2.

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

10. Limitation Statement

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

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

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

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

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

11. Appendix 1 – Photos

	
Photo 1: East Elevation (Front)	Photo 2: North Elevation
	
Photo 3: West Elevation	Photo 4: South Elevation

	
Photo 5: Typical Entrance Detail	Photo 6: Roof Structure
	
Photo 7: Damage Observed in Ladies	Photo 8: Hairline Cracking along Mortar Joints

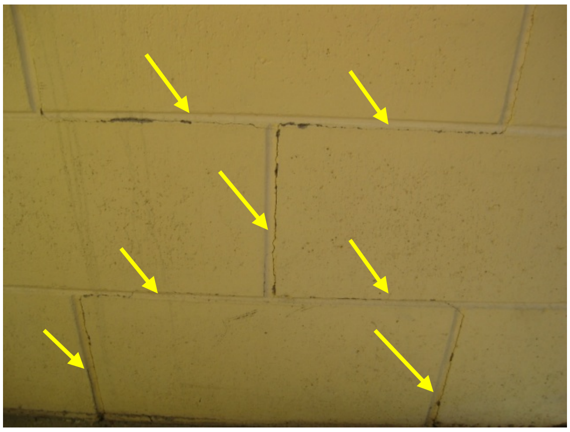
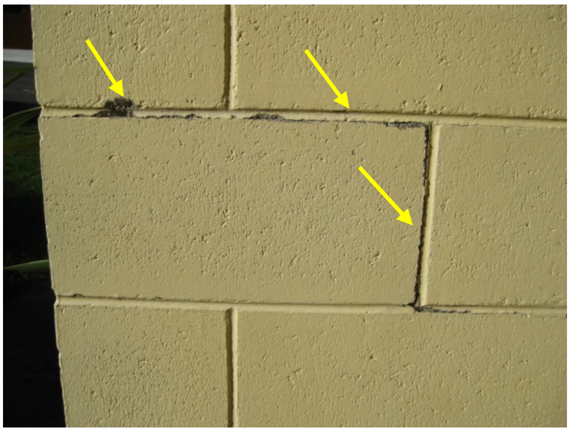
	

Photo 9: Close up of Photo 8 (Eastern Return Wall - 1)	Photo 10: Close up of Photo 8 (Eastern Front Wall - 2)

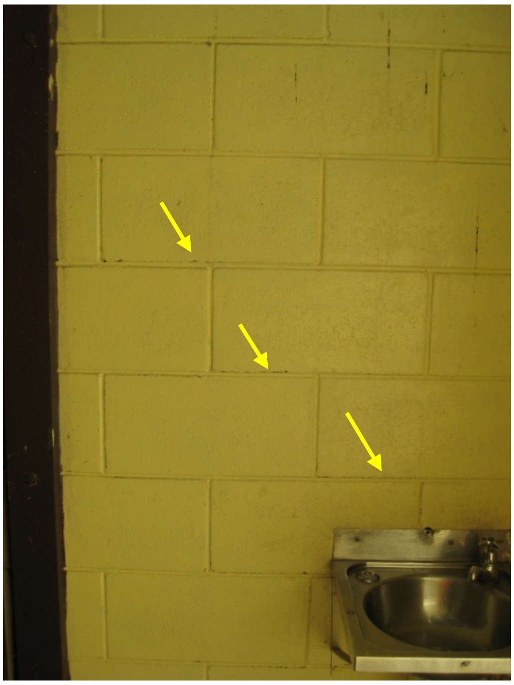



Photo 11: Hairline cracking along Mortar Joints on North Wall inside Ladies	Photo 12: Close up of Photo 11

	
Photo 13: West Wall in Ladies – Mortar Joints appear to have been Re-pointed	Photo 14: Continuation of Photo 13

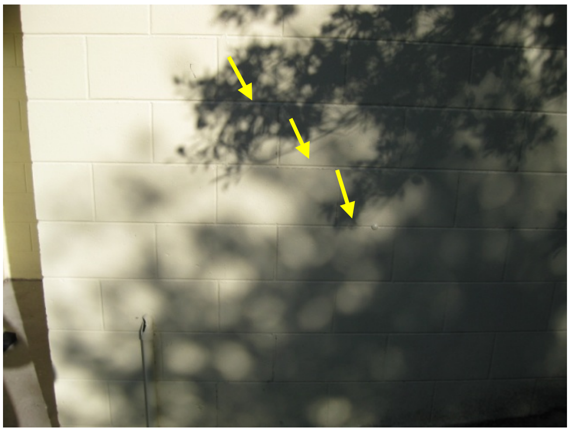



Photo 15: Hairline Cracking along Mortar Joints on West Wall – External View	Photo 16: Close up of Photo 15

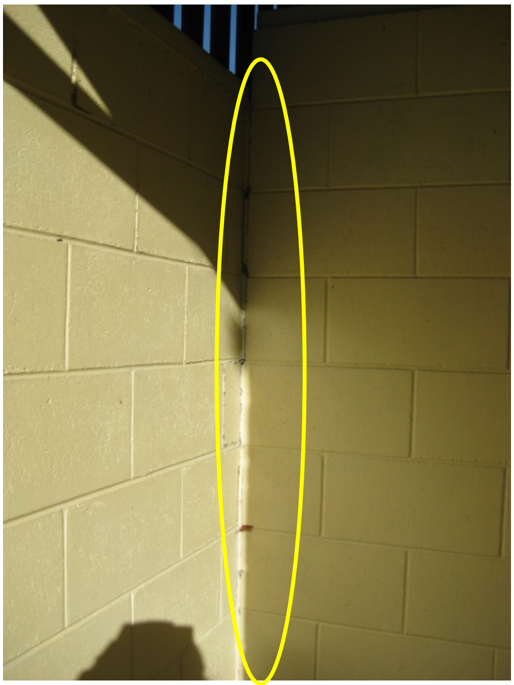


Photo 17: Cracking along Mortar Joint in SE Corner of Ladies	Photo 18: Close up of Photo 17

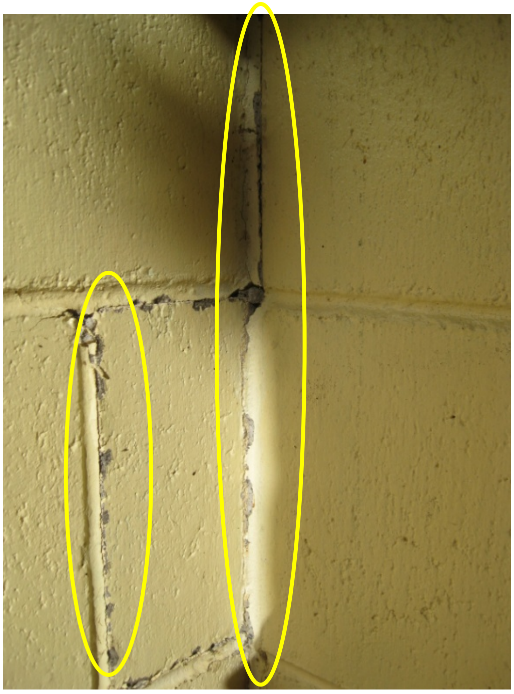
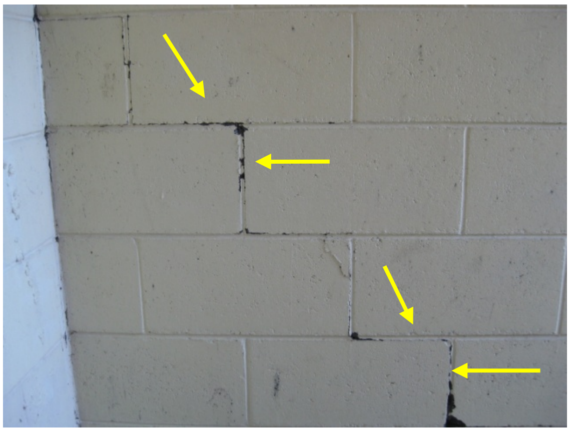



Photo 19: Close up of Photo 17	Photo 20: Damage to Gents

	
Photo 21: Hairline Cracking along Mortar Joints on East Wall of Gents	Photo 22: Close up of Photo 21
	
Photo 23: Hairline Cracking along the Mortar Joints on the North Wall of the Gents	Photo 24: Close up of Photo 23

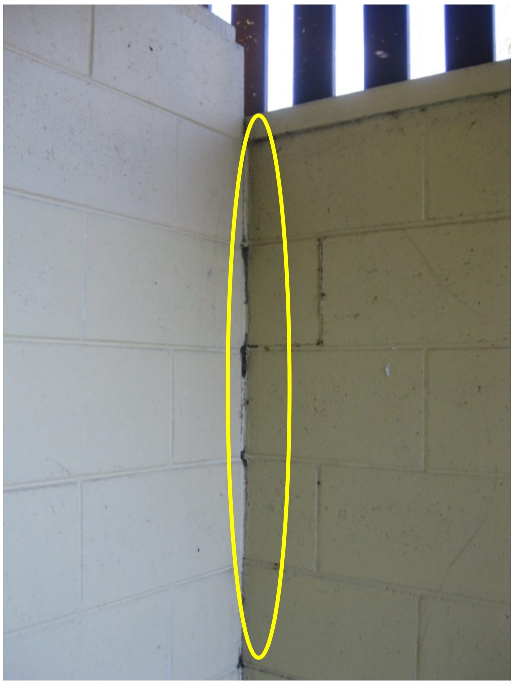


Photo 25: Cracking along the Mortar Joint in the NE Corner of the Joint	Photo 26: Close up of Photo 25

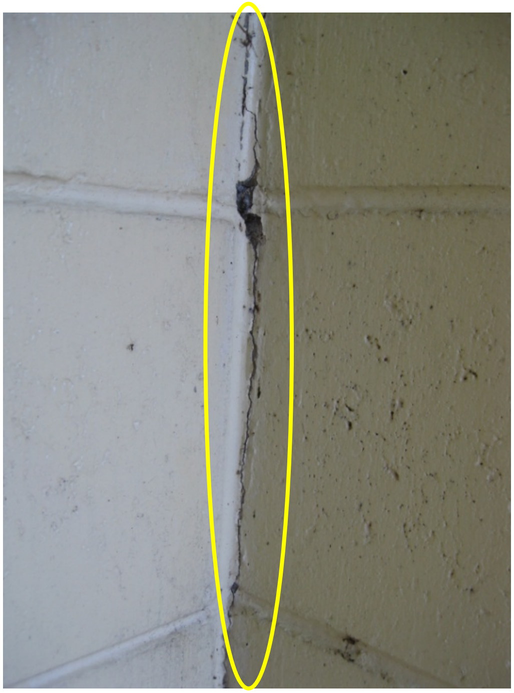
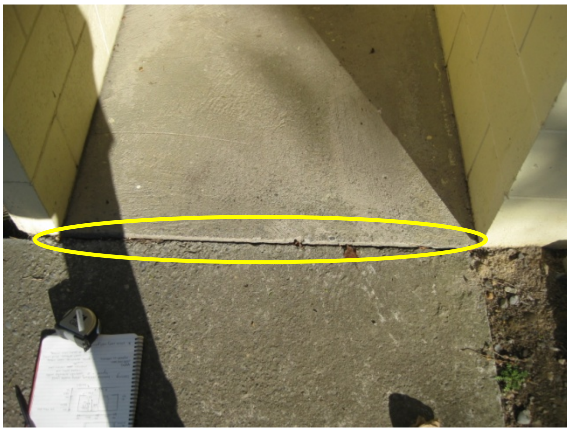

	

Photo 27: Close up of Photo 25	Photo 28: Differential Movement between the Concrete Floor Slab and Concrete Path outside Ladies

Photo 29: Close up of Photo 28

12. Appendix 2 – IEP Reports

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

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

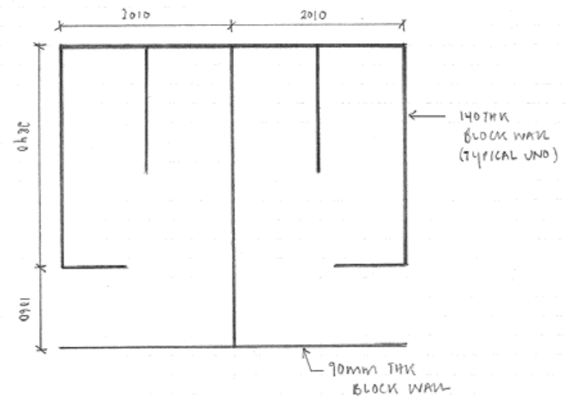
SKM

Building Name:	PRK_3537_BLDG_001 EQ2 - Cass Bay Toilets	Ref.	ZB01276.148
Location:	Cass Bay - Cnr Bayview & Harbour View	By	KW
		Date	6/06/2012

Step 1 - General Information

1.1 Photos (attach sufficient to describe building)

1.2 Sketch of building plan



1.3 List relevant features

Building CCC-PRK-3537-001 is a single story concrete block building that is used as public toilets at Cass Bay. The roof is constructed from timber framing and a light weight corrugated steel cladding and is supported on the concrete block walls. Due to the assumed age of this building we believe that the concrete block walls will be reinforced.The building is supported on concrete strip footings and has a concrete slab on grade. No structural drawings were available for this building. Due to this we are unable to confirm the buildings age. However based on the architecture and the condition of this structure we believe that this building was constructed sometime in the 1980's and as a result we have assumed a design period of 1976-1992 for our assessment. Lateral loads acting across and along the building are carried resisted by concrete block walls through bending and shear. The concrete block walls are supported on strip foundations which act to hold down the walls when they are subjected to both out-of-plane and in-plane bending.

1.4 Note information sources

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

Drawings - Waimairi County Council, Dated 11/06/1971

Date of Inspection - 31/05/2012

Table IEP-2 Initial Evaluation Procedure – Step 2

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

Building Name:	PRK_3537_BLDG_001 EQ2 - Cass Bay Toilets	Ref.	ZB01276.148
Location:	Cass Bay - Cnr Bayview & Harbour View	By	KW
Direction Considered:	**Longitudinal & Transverse**	Date	6/06/2012

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

Step 2 - Determination of (%NBS)b

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

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

b) Soil Type

From NZS1170.5:2004, Cl 3.1.3

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

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

a) Rigid	◉	N-A
b) Intermediate	○	

c) Estimate Period, T

building Ht = 3 meters

	Longitudinal	Transverse	
Ac =			m2

Can use following:

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

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

Longitudinal	Transverse	
0.4	0.4	Seconds

d) (%NBS)nom determined from Figure 3.3

Longitudinal	21	$(\%NBS)_{nom}$
Transverse	21	$(\%NBS)_{nom}$

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

Longitudinal	21.0	$(\%NBS)_{nom}$
Transverse	21.0	$(\%NBS)_{nom}$

Continued over page

Building Name:	PRK_3537_BLDG_001 EQ2 - Cass Bay Toilets	Ref.	ZB01276.148
Location:	Cass Bay - Cnr Bayview & Harbour View	By	KW
Direction Considered:	**Longitudinal & Transverse**	Date	6/06/2012

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

2.2 Near Fault Scaling Factor, Factor A

If T < 1.5sec, Factor A = 1

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

(from NZS1170.5:2004, Cl 3.1.6)

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

2.3 Hazard Scaling Factor, Factor B

Select Location: Christchurch

a) Hazard Factor, Z, for site

(from NZS1170.5:2004, Table 3.3)

Z = 0.3

Z 1992 = 0.8

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

b) Hazard Scaling Factor

For pre 1992 = 1/Z

\# For 1992 onwards = Z 1992/Z

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

Factor B 3.33

2.4 Return Period Scaling Factor, Factor C

a) Building Importance Level 1

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

b) Return Period Scaling Factor from accompanying Table 3.1 — **Factor C** 2.00

2.5 Ductility Scaling Factor, D

a) Assessed Ductility of Existing Structure, μ

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

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

b) Ductility Scaling Factor

For pre 1976 = k_μ

For 1976 onwards = 1

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

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

2.6 Structural Performance Scaling Factor, Factor E

Select Material of Lateral Load Resisting System

Longitudinal: Masonry Block

Transverse: Masonry Block

a) Structural Performance Factor, S_p

from accompanying Figure 3.4

Longitudinal	Sp	1.00
Transverse	Sp	1.00

b) Structural Performance Scaling Factor

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

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

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

Longitudinal	140.0	(%NBS)b
Transverse	140.0	(%NBS)b

Table IEP-3 Initial Evaluation Procedure – Step 3

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

SKM

Building Name:	PRK_3537_BLDG_001 EQ2 - Cass Bay Toilets	Ref.	ZB01276.148
Location:	Cass Bay - Cnr Bayview & Harbour View	By	KW
Direction Considered:	**a) Longitudinal**	Date	6/06/2012

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

Step 3 - Assessment of Performance Achievement Ratio (PAR)

(Refer Appendix B - Section B3.2)

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

3.1 Plan Irregularity

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

3.2 Vertical Irregularity

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

3.3 Short Columns

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

3.4 Pounding Potential

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

a) Factor D1: - Pounding Effect

Select appropriate value from Table

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

Factor D1 1

Table for Selection of Factor D1	Severe	Significant	Insignificant
Separation	0<Sep<.005H	.005<Sep<.01H	Sep>.01H
Alignment of Floors within 20% of Storey Height	○ 0.7	○ 0.8	◉ 1
Alignment of Floors not within 20% of Storey Height	○ 0.4	○ 0.7	○ 0.8

b) Factor D2: - Height Difference Effect

Select appropriate value from Table

Factor D2 1

Table for Selection of Factor D2	Severe	Significant	Insignificant
Separation	0<Sep<.005H	.005<Sep<.01H	Sep>.01H
Height Difference > 4 Storeys	○ 0.4	○ 0.7	○ 1
Height Difference 2 to 4 Storeys	○ 0.7	○ 0.9	○ 1
Height Difference < 2 Storeys	○ 1	○ 1	◉ 1

Factor D 1

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

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

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

3.6 Other Factors

For < 3 storeys - Maximum value 2.5,

otherwise - Maximum value 1.5. No minimum. **Factor F** 1

Record rationale for choice of Factor F:

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

PAR 1

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

Building Name:	PRK_3537_BLDG_001 EQ2 - Cass Bay Toilets	Ref.	ZB01276.148
Location:	Cass Bay - Cnr Bayview & Harbour View	By	KW
Direction Considered:	**b) Transverse**	Date	6/06/2012

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

Step 3 - Assessment of Performance Achievement Ratio (PAR)

(Refer Appendix B - Section B3.2)

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

3.1 Plan Irregularity

Effect on Structural Performance: Severe ○ | Significant ○ | Insignificant ◉ — **Factor A** 1

Comment:

3.2 Vertical Irregularity

Effect on Structural Performance: Severe ○ | Significant ○ | Insignificant ◉ — **Factor B** 1

Comment:

3.3 Short Columns

Effect on Structural Performance: Severe ○ | Significant ○ | Insignificant ◉ — **Factor C** 1

Comment:

3.4 Pounding Potential

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

a) Factor D1: - Pounding Effect

Select appropriate value from Table

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

Factor D1 1

Table for Selection of Factor D1

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

b) Factor D2: - Height Difference Effect

Select appropriate value from Table

Factor D2 1

Table for Selection of Factor D2

Separation	Severe 0<Sep<.005H	Significant .005<Sep<.01H	Insignificant Sep>.01H
Height Difference > 4 Storeys	○ 0.4	○ 0.7	○ 1
Height Difference 2 to 4 Storeys	○ 0.7	○ 0.9	○ 1
Height Difference < 2 Storeys	○ 1	○ 1	◉ 1

Factor D 1

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

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

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

3.6 Other Factors

For < 3 storeys - Maximum value 2.5,

otherwise - Maximum value 1.5. No minimum. — **Factor F** 1

Record rationale for choice of Factor F:

3.7 Performance Achievement Ratio (PAR)
(equals A x B x C x D x E x F) — **PAR** 1

Initial Evaluation Procedure – Steps 4, 5 and 6

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

Building Name:	PRK_3537_BLDG_001 EQ2 - Cass Bay Toilets	Ref.	ZB01276.148
Location:	Cass Bay - Cnr Bayview & Harbour View	By	KW
Direction Considered:	**Longitudinal & Transverse**	Date	6/06/2012

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

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

	Longitudinal	Transverse
4.1 Assessed Baseline $(\%NBS)_b$ (from Table IEP - 1)	140	140
4.2 Performance Achievement Ratio (PAR) (from Table IEP - 2)	1.00	1.00
4.3 PAR x Baseline $(\%NBS)_b$	140	140

4.4 Percentage New Building Standard (%NBS) (Use lower of two values from Step 4.3) — **140**

Step 5 - Potentially Earthquake Prone?

(Mark as appropriate)

%NBS ≤ 33 — NO

Step 6 - Potentially Earthquake Risk?

%NBS < 67 — NO

Step 7 - Provisional Grading for Seismic Risk based on IEP

Seismic Grade — **A+**

Evaluation Confirmed by

[signature] Signature

Trevor Robertson Name

28892 CPEng. No

Relationship between Seismic Grade and % NBS :

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

13. Appendix 3 – CERA Standardised Report Form

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	PRK_3537_BLDG_001 EQ2	Reviewer:	Trevor Robertson
Building Address (Unit / No: / Street):	Cass Bay toilets / / Crn Bay View Pl & Harbour View Tce	CPEng No:	43522
		Company:	SKM
Legal Description:		Company project number:	ZB01276.148
		Company phone number:	03 940 4900
GPS south (Degrees / Min / Sec):		Date of submission:	
GPS east:		Inspection Date:	3/05/2012
		Revision:	A
Building Unique Identifier (CCC):		Is there a full report with this summary?	yes

Site

Site slope:	flat	Max retaining height (m):	0.4
Soil type:	mixed	Soil Profile (if available):	Refer to SKM Qualitative Report
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):	20.00

Building

No. of storeys above ground:	1	single storey = 1	Ground floor elevation (Absolute) (m):	20.00
Ground floor split?	no		Ground floor elevation above ground (m):	0.20
Storeys below ground	0			
Foundation type:	strip footings		if Foundation type is other, describe:	
Building height (m):	3.00		height from ground to level of uppermost seismic mass (for IEP only) (m):	3
Floor footprint area (approx):	16			
Age of Building (years):	36	(max)	Date of design:	1976-1992
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):	Public Toilet			
Importance level (to NZS1170.5):	IL1			

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber framed	rafter type, purlin type and cladding	Light weight corrugated steel cladding on timber purlins on timber rafters.
Floors:	concrete flat slab	slab thickness (mm)	125 (assumed)
Beams:	timber	type	Timber roof rafters present. No beams present in floor structure.
Columns:	load bearing walls	typical dimensions (mm x mm)	140mm thick concrete block walls
Walls:	partially filled concrete masonry	thickness (mm)	140

Lateral load resisting structure

Note: Define along and across in detailed report!

Lateral system along:	partially filled CMU		note total length of wall at ground (m):	9.6
Ductility assumed, μ:	1.00		wall thickness (m):	0.14
Period along:	0.40	0.40 from parameters in sheet	estimate or calculation?	estimated
Total deflection (ULS) (mm):	5		estimate or calculation?	estimated
maximum interstorey deflection (ULS) (mm):	0		estimate or calculation?	
Lateral system across:	partially filled CMU		note total length of wall at ground (m):	12.8
Ductility assumed, μ:	1.00		wall thickness (m):	0.14
Period across:	0.40	0.40 from parameters in sheet	estimate or calculation?	estimated
Total deflection (ULS) (mm):	5		estimate or calculation?	estimated
maximum interstorey deflection (ULS) (mm):	0		estimate or calculation?	

Separations:

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

Non-structural elements

Stairs:			n/a
Wall cladding:	other heavy	describe	block walls form the wall cladding
Roof Cladding:	Metal	describe	light weight corrugated steel
Glazing:			n/a
Ceilings:			n/a
Services(list):	none		

Available documentation

Architectural		original designer name/date	
Structural		original designer name/date	
Mechanical		original designer name/date	
Electrical		original designer name/date	
Geotech report		original designer name/date	

Damage

Site: (refer DEE Table 4-2)

Site performance:	Good	Describe damage:	no damage observed during site inspection
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:	no structural damage noted during site inspection
	Describe (summary):			
Across	Damage ratio:	0%		
	Describe (summary):			
Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	no	Describe:	
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	yes	Describe:	hairline cracking to block wall mortar joints, minor differential movement between concrete slab and concrete path

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

Recommendations

	Level of repair/strengthening required:	minor non-structural		Describe:	repair damage above - recommendations given in section 6 of qualitative report
	Building Consent required:	no		Describe:	
	Interim occupancy recommendations:	full occupancy		Describe:	
Along	Assessed %NBS before:	100%	%NBS from IEP below	If IEP not used, please detail assessment methodology:	NZSEE IEP used, refer to SKM Qualitative Report
	Assessed %NBS after:	100%			
Across	Assessed %NBS before:	100%	%NBS from IEP below		
	Assessed %NBS after:	100%			

14. Appendix 4 – Geotechnical Desktop Study

Christchurch City Council - Structural Engineering Service

Geotechnical Desk Study

SKM project number	ZB01276
SKM project site number	148
Address	End of Bayview Place, Cass Bay, Lyttelton – Toilet Block
Report date	June 2012
Author	Chris Ritchie/ Ain Kim
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
- A preliminary site walkover

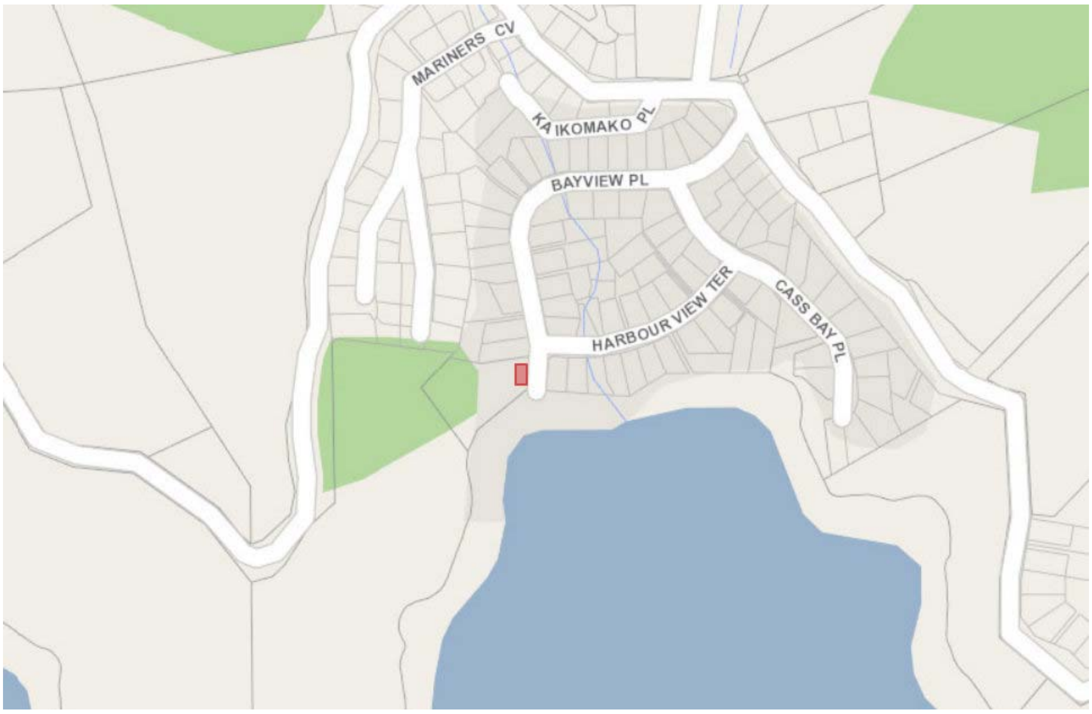
3. Limitations

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

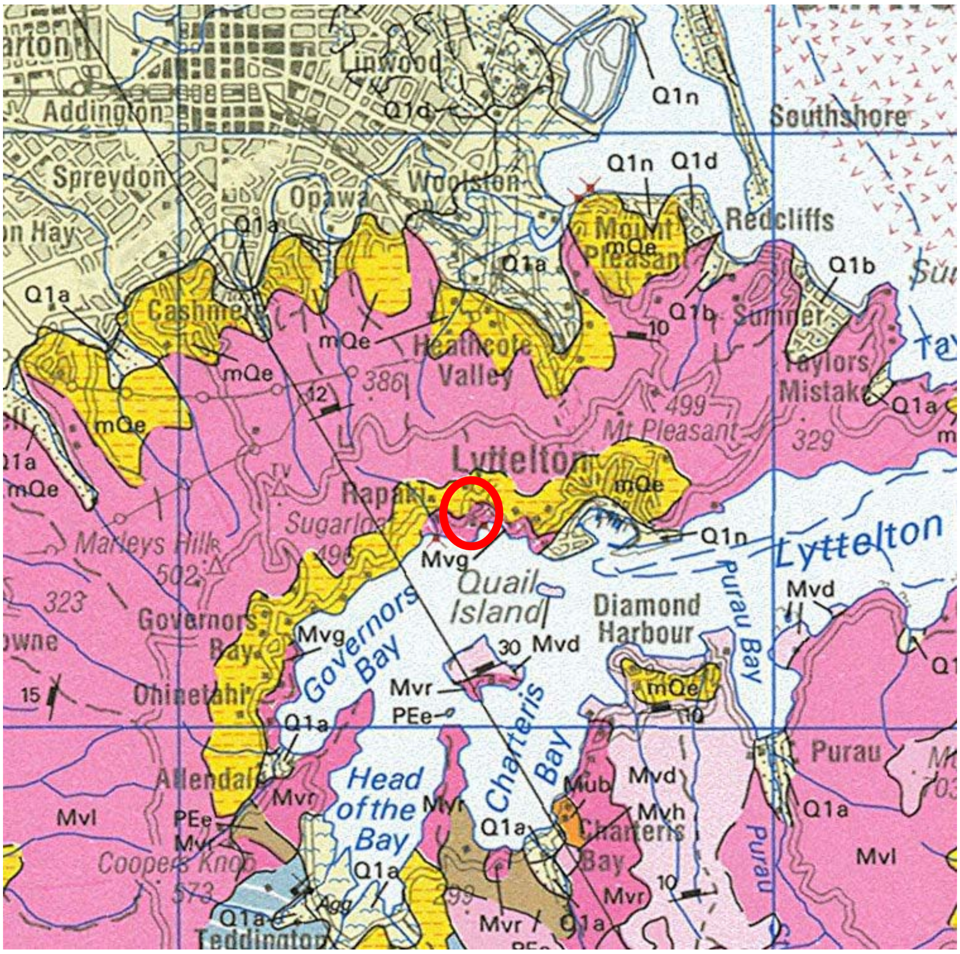


- **Figure 1 – Site location (courtesy of LINZ http://viewers.geospatial.govt.nz)**

The structure is located at the end of Bayview place 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.**

The site is located at the boundary between andesite and Loess.

5.2 Aerial photography

- **Figure 3 – Aerial photography from 24 Feb 2011 (http://viewers.geospatial.govt.nz/)**

Aerial photography shows no evidence of liquefaction but some dark grey patches to the south of the building which indicate a possible evidence of water piping failure. This piping failure was observed from the site walkover.

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: N/A (Port Hills and Banks Peninsula)

5.4 Historical land use

No information on the historical use of the land is available.

5.5 Existing ground investigation data

- **Figure 4 – 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 A), and the results are summarised in Appendix B.

5.6 Council property files

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

5.7 Site walkover

An external site walkover was conducted by an SKM engineer on 11 July 2012.

The building was noted to be a masonry block building with a sheet metal roof and slab on grade foundation. No cracking was noticed in the masonry blocks or in the concrete ground slab. Some cracking was noted in the footpaths leading up to the toilets however it is difficult to determine in this cracking was earthquake related.

The playground looks to be situated on an area of loess cut and fill. No liquefaction was identified or would be expected from the soils at this location. A brief walkover of the slopes above the identified the slopes are predominantly covered by loess and vegetation.

Some slumping and depressions were noted around the pump station approximately 5m southeast of the toilet building. Collapse of the concrete was noted at the back of the pump station structure. The depressions noted here may have been caused by poorly compacted fill settling around the structure or damaged pipe work may have allowed uncontrolled water/sewerage flow which tends to cause erosion and piping failure of the loess material.

- **Figure 5 Overview of structures (eastern wall) and damaged pump station in the foreground**

- **Figure 6 Cracking and settlement noted in concrete path northeast of building**

- **Figure 7 cracking and settlement of block work and concrete at the back of the pump station**

▪ **Figure 8 Loess cut faces behind the building standing near vertical and stable**

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 – 2m+	Loess

6.2 Seismic site subsoil class

The site has been assessed as being either NZS1170.5 Class C (shallow soil) or NZS 1170.5 Class B (rock) from surface geology. As no investigation information is available for the site and the depth to the underlying rock could not be reliably estimated, NZS 1170.5 Class C is recommended as the seismic site subsoil class in this report.

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 borehole logs including measurement of geotechnical properties or by evaluation of site periods from Nakamura ratios or from recorded earthquake motions. Lacking this information, classification may be based on boreholes with descriptors but no geotechnical measurements. The least preferred method is from surface geology and estimates of the depth to underlying rock.

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 has been assessed as low for the site.

No clear evidence of liquefaction was noted in the aerial photographs taken shortly after the 22 February earthquake or during the external site walkover undertaken by an SKM engineer. The composition of any fill or top soil layer is not known.

A brief site walkover showed that the slopes are predominantly covered by loess and vegetation. However, it is 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

As no ground investigation data is available within 50 m from the site, in order to perform a quantitative DEE further geotechnical site investigation is required. Further site investigations recommended are:

- Two hand augers to a depth of 5m near the site
- Depending on the underlying geology shown by the hand augers either two cone penetration tests if rock is not present at shallow depths or two dynamic cone penetration tests to estimate the surface soil properties
- 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 – Existing ground investigation logs

Borelog for well M36/10181

Gridref: M36:84957-33724 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 42.43 +MSD
Well name : CCC BorelogID 6522
Drill Method : Not Recorded
Drill Depth : -0.7m Drill Date : 18/05/2004

Environment Canterbury Regional Council

Scale(m)	Water Level	Depth(m)	Full Drillers Description	Formation Code
			yellow / brown silty sand fill	
-0.2				
-0.4				
		-0.55m	yellow / brown silty sand	
-0.6				
		-0.70m		

Borelog for well M36/10438

Gridref: M36:84892-33700 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 66.68 +MSD
Well name : CCC BorelogID 7305
Drill Method : Not Recorded
Drill Depth : -1m Drill Date : 23/05/2006

Scale(m)	Water Level	Depth(m)	Full Drillers Description	Formation Code
			topsoil	
-0.2		-0.30m		
-0.4			loess / silt	
-0.6		-0.60m		
-0.8			loess / silt	
		-1.00m		

Appendix B – Geotechnical Investigation Summary

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

ID		1	2
Type *		WW	WW
Ref		M36/10438	M36/10181
Depth (m)		2	1
Distance from site (m)		237	224
Ground water level (mBGL)			
Simplified recorded geological profile (depth below ground level to top of stratum, m)	0	Loess	Loess
	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