Governors Bay Pool Structures
Detailed Engineering Evaluation
Quantitative Report

Christchurch City Council

Christchurch City Council

Governors Bay Pool Structures

Detailed Engineering Evaluation Quantitative Report

Opus International Consultants Ltd
Christchurch Office
20 Moorhouse Avenue
PO Box 1482, Christchurch Mail Centre,
Christchurch 8140, New Zealand

Telephone: +64 3 363 5400
Facsimile: +64 3 365 7858

Date:	August 2012
Reference:	6-QUCCC.61
Status:	Final

Governors Bay Pool Structures
BU 3569-002 EQ2 and PRK 3569 BLDG 007 EQ2

Detailed Engineering Evaluation
Quantitative Report - SUMMARY
Final

1 Cresswell Avenue, Governors Bay, Canterbury 8971

Background

This is a summary of the quantitative report for the Mens Changing Rooms and Plant Room including the connecting boundary wall/fence, at the Governors Bay Pool. The assessment is based on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011, visual inspections on 22 March, 2 May and 3 May 2012. No structural drawings of these structures were available by the time of writing this report.

Key Damage Observed

The structures had largely been cordoned off and ply shuttering and timber bracing installed and one masonry wall had been demolished prior to our inspection of 22 March 2012. Seismic damage identified in the block walls were vertical joints opened up and lateral displacement of the blocks.

Critical Structural Weaknesses

No critical structural weaknesses were identified in the structure.

Indicative Building Strength

Based on the limited information available, and from undertaking a quantitative assessment, the building capacities have been assessed to be 35% NBS and 34% NBS as limited by the out-of-plane bending capacity of the lightly-reinforced, partially-grouted, concrete masonry walls of the Mens Changing Rooms and Plant Room respectively.

For the masonry boundary fence connecting the above two buildings, the assessed seismic capacity is 47%NBS, as limited by the out-of-plane bending capacity of the reinforced masonry walls assuming that the block piers are not engaged with the wall.

All structures have been assessed to have seismic capacities of more than 33%NBS, and are therefore not classed as earthquake prone structures under the NZSEE classification system.

Recommendations

We recommend that:

(a) Further structural investigations should be undertaken and strengthening design proposals developed to improve the overall capacities to at least 67% NBS.
(b) The structures should remain closed to the public until strengthening works are carried out.
(c) On the neighbouring property side the boundary wall should be securely braced until strengthening has been carried out.

Contents

1 Introduction

Opus International Consultants Limited has been engaged by Christchurch City Council (CCC) to undertake detailed seismic assessments of the Governors Bay Pool structures, located at 1 Cresswell Ave, Canterbury, following the M6.3 Christchurch earthquake on 22 February 2011. The structures are listed as the Mens Changing Rooms and Plant Room. Both buildings are similar in construction form and are linked by a masonry boundary wall.

The purpose of the assessment is to determine if the buildings are classed as being earthquake prone in accordance with the Building Act 2004.

The seismic assessment and reporting have been undertaken based on the quantitative procedures detailed in the Detailed Engineering Evaluation Procedure (DEEP) document (draft) issued by the Structural Engineering Society (SESOC) on 19 July 2011.

2 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.

2.1 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 to carry out a full structural survey before the building is re-occupied.

We understand that CERA 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). CERA have adopted the Detailed Engineering Evaluation Procedure (DEEP) document (draft) issued by the Structural Engineering Society (SESOC) on 19 July 2011. This document sets out a methodology for both initial qualitative and detailed quantitative assessments.

It is anticipated that a number of factors, including the following, will determine the extent of evaluation and strengthening level required:

1. The importance level and occupancy of the building.
2. The placard status and amount of damage.
3. The age and structural type of the building.
4. Consideration of any critical structural weaknesses.

Any building with a capacity of less than 34% of new building standard (including consideration of critical structural weaknesses) will need to be strengthened to a target of 67% as required by the CCC Earthquake Prone Building Policy.

2.2 Building Act

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

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 the alteration.

This effectively means that a building cannot be weakened as a result of an alteration (including partial demolition).

Section 115 – Change of Use

This section requires that the territorial authority (in this case Christchurch City Council (CCC)) is satisfied that the building with a new use complies with the relevant sections of the Building Code 'as near as is reasonably practicable'.

This is typically interpreted by CCC as being 67% of the strength of an equivalent new building. This is also the minimum level recommended by the New Zealand Society for Earthquake Engineering (NZSEE).

Section 121 – Dangerous Buildings

This section was extended by the Canterbury Earthquake (Building Act) Order 2010, and defines a building as dangerous if:

1. 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
2. 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
3. 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
4. There is a risk that other property could collapse or otherwise cause injury or death; or

5. A territorial authority has not been able to undertake an inspection to determine whether the building is dangerous.

Section 122 – Earthquake Prone Buildings

This section defines a building as earthquake prone (EPB) 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 loads 33% of those used to design an equivalent new building.

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.

Section 131 – Earthquake Prone Building Policy

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

2.3 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 on 4 September 2010.

The 2010 amendment includes the following:

1. A process for identifying, categorising and prioritising Earthquake Prone Buildings, commencing on 1 July 2012;
2. A strengthening target level of 67% of a new building for buildings that are Earthquake Prone;
3. A timeframe of 15-30 years for Earthquake Prone Buildings to be strengthened; and,
4. 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.

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.

2.4 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.

On 19 May 2011, Compliance Document B1: Structure was amended to include increased seismic design requirements for Canterbury as follows:

- 36% increase in the basic seismic design load for Christchurch (Z factor increased from 0.22 to 0.3);
- Increased serviceability requirements.

2.5 Institution of Professional Engineers New Zealand (IPENZ) Code of Ethics

One of the core ethical values of professional engineers in New Zealand is the protection of life and safeguarding of people. The IPENZ Code of Ethics requires that:

Members shall recognise the need to protect life and to safeguard people, and in their engineering activities shall act to address this need.

1.1 Giving Priority to the safety and well-being of the community and having regard to this principle in assessing obligations to clients, employers and colleagues.

1.2 Ensuring that responsible steps are taken to minimise the risk of loss of life, injury or suffering which may result from your engineering activities, either directly or indirectly.

All recommendations on building occupancy and access must be made with these fundamental obligations in mind.

3 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 loadings are in accordance with the current earthquake loading standard NZS1170.5 [1].

A generally accepted classification of earthquake risk for existing buildings in terms of %NBS that has been proposed by the NZSEE 2006 [2] is presented in Figure 1 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 required under Act)	Unacceptable	Unacceptable

Figure 1: 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

3.1 Minimum and Recommended Standards

Based on governing policy and recent observations, Opus makes the following general recommendations:

3.1.1 Occupancy

- The Canterbury Earthquake Order[1] in Council 16 September 2010, modified the meaning of "dangerous building" to include buildings that were identified as being EPB's. As a result of this, we would expect such a building would be issued with a Section 124 notice, by the Territorial Authority, or CERA acting on their behalf, once they are made aware of our assessment. Based on information received from CERA to date, this notice is likely to prohibit occupancy of the building (or parts thereof) until its seismic capacity is improved to the point that it is no longer considered an EPB.

3.1.2 Cordoning

– Where there is an overhead falling hazard, or potential collapse hazard of the building, the areas of concern should be cordoned off in accordance with current CERA/Christchurch City Council guidelines.

3.1.3 Strengthening

– Industry guidelines (NZSEE 2006 [2]) strongly recommend that every effort be made to achieve improvement to at least 67%NBS. A strengthening solution to anything less than 67%NBS would not provide an adequate reduction to the level of risk.

– It should be noted that full compliance with the current building code requires building strength of 100%NBS.

3.1.4 Our Ethical Obligation

– In accordance with the IPENZ code of ethics, we have a duty of care to the public. This obligation requires us to identify and inform CERA of potentially dangerous buildings; this would include earthquake prone buildings.

4 Building Description

Figure 2: Location of Governors Bay Pool Structures

4.1 General

The Mens Changing Rooms comprises reinforced, partially-grouted, concrete masonry walls, with a monoslope timber roof structure and steel roof sheeting. The roof structure is connected to the bond beam on top of the end block walls.

The Plant Room is of similar construction as the Mens Changing Rooms.

The two buildings are connected along the side boundary by a cantilevered, 2.2m high reinforced, partially-grouted block wall, having a top bond beam, and block piers at 4.0m centres.

4.2 Seismic Load Resisting System

Seismic loads to the buildings are resisted by the reinforced block walls acting as cantilever shear walls both in-plane and out-of-plane. The seismic loads are generated primarily by self-weight inertia with the remaining roof seismic load transferring to the shear walls through the bond beams. A few walls that are not apparently engaged with end return walls will resist seismic loading through out-of-plane flexure and shear.

5 Survey

A visual inspection was carried out 22 March 2012, and a follow-up cover-meter survey was undertaken on 3 May 2012. The reinforced, partially-grouted block walls appear likely to have been erected by voluntary community labour, which was confirmed by a member of the public during our inspection.

The buildings currently have no earthquake rapid assessment placard in place. Most of the Plant Room block walls and the boundary wall/fence have been laterally braced to prevent further seismic damage as a post-earthquake precaution. One external wall in the Plant Room building had been demolished prior to our site inspection on 22 March 2012. A post-earthquake photo of this wall (photo 14) shows a small amount of lateral displacement. We have not viewed any reports of the extent of the seismic damage to this wall, nor the reasons for its demolition.

No copies of the drawings or design calculations have been obtained for these buildings. Our measure up sketches and observations recorded when the site visits were undertaken have been exclusively used to confirm the structural systems, to investigate potential critical structural weaknesses (CSW) wherever possible, and identify details which required particular attention.

6 Damage Assessment

The assessment of the extent of damage as a result of the recent earthquake events was restricted by the installed ply sheeting and propping, and the cordon.

The damage noted was several displacement cracks in the reinforced partially grouted block walls of the Plant Room building, up to 10mm width, particularly at wall joint locations, and the separation of the masonry wall/fence from the block piers.

No displacements of the foundations or cracks in the footings were observed, but intrusive investigations and level surveys have not been undertaken. There is a large differential settlement crack in the Plant Room building floor slab. This crack was reported by the pool caretaker to have existed for some time before the recent seismic activity. The nearby diagonal wall crack may be related to this differential ground settlement and not seismic related.

7 General Observations

The buildings have performed well under seismic conditions which would be expected for single-storey, reinforced masonry wall structures. The buildings are cordoned off from the general public, with the Plant Room buildings still in use. The masonry boundary wall/fence has not performed as well with separation of the wall from the block piers. The external side was not visible, due to the installed ply sheeting and bracing.

Our inspection noted that a number of walls did not appear to have been built integrally with the end return walls. The now-demolished Plant Room wall was likely one of these. Consequently, the top bond beams may not span between return walls, requiring the wall to transmit seismic load by out-of-plane flexure. Our assessment of the seismic load distribution has been based on this feature and the actual extent of this will need to be confirmed in any future strengthening proposal. Similarly the block boundary wall piers may not be fully engaged with the wall compromising the strength of this wall.

Due to the non-intrusive nature of the original survey, many connection details could not be confirmed, including connection of bond beams and anchorage of vertical wall reinforcing in the foundations.

8 Detailed Seismic Assessment

8.1 Critical Structural Weaknesses

As outlined in the Critical Structural Weakness and Collapse Hazards draft briefing document, issued by the Structural Engineering Society (SESOC) on 7 May 2011, the term ‘Critical Structural Weakness’ (CSW) refers to a component of a building that could contribute to increased levels of damage or cause premature collapse of the building.

Based on the limited structural details available no critical structural weaknesses have been identified in these structures.

8.2 Seismic Coefficient Parameters

The seismic design parameters based on current design requirements from NZS1170.5:2004 and the NZBC clause B1 for this building are:

- Site soil class D, Clause 3.1.3 of NZS 1170.5:2004;
- Site hazard factor, Z=0.3, B1/VM1 Clause 2.2.14B of NZS1170.5:2004;

- Return period factor R_u = 1.0 from Table 3.5, NZS 1170.5:2004, for an Importance Level 2 structure with a 50 year design life;
- μ_{max} = 1.25 and Sp = 0.9, Table 3.2 of NZS4230:2004.

8.3 Detailed Seismic Assessment Results

A summary of the structural performance of the building is shown in the following table. Note that the values given represent the worst performing elements in the buildings, as these effectively define the building's capacity. Other elements within the buildings may have significantly greater capacity when compared with the governing elements.

Table 2: Summary of Seismic Performance

Structural Element/System	Failure Mode, or description of limiting criteria	% NBS based on calculated capacity
Masonry walls in the east-west direction ie. across	In-plane shear In-plane bending	100% 100%
Masonry walls in the east-west direction ie. across	Out-of-plane shear Out-of-plane bending	70% 34%
Masonry walls in the north-south direction ie. along	In-plane shear In-plane bending	100% 100%
Masonry walls in the north-south direction ie. along	Out-of-plane shear Out-of-plane bending	100% 47%
Masonry boundary wall	Out-of-plane shear Out-of-plane bending	100% 47%
Masonry piers to boundary wall	In-plane shear In-plane bending	100% 76%

8.4 Discussion of Results

The assessment analysis has been based on assumed material properties for partially-grouted, lightly-reinforced (Y12 at 1800 centres) concrete masonry (Grade C) as determined by the visual inspection and cover meter survey. The survey was unable to determine the full extent of wall vertical reinforcement and adequacy of embedment into the foundations - a critical element in developing the full bending capacity of the cantilevered masonry walls.

The assessment has assumed a seismic load distribution of each wall taking its own selfweight inertial seismic load, with cross walls also taking the inertial load from the tributary roof area, where the roof is connected to those walls.

As the building has an assessed capacity of more than 33% NBS it is not defined as earthquake prone in accordance with the Building Act 2004.

8.5 Limitations and Assumptions in Results

Our analysis and assessment is based on an assessment of the building in its undamaged state. Therefore the current capacity of the building will be lower than that stated.

The results have been reported as a %NBS and the stated value is that obtained from our analysis and assessment. Despite the use of best national and international practice in this analysis and assessment, this value contains uncertainty due to the many assumptions and simplifications which are made during the assessment. These include:

- Simplifications made in the analysis, including boundary conditions such as foundation fixity;
- Assessments of material strengths based on limited drawings, specifications and site inspections;
- The normal variation in material properties which change from batch to batch;
- Approximations made in the assessment of the capacity of each element, especially when considering the post-yield behaviour.

9 Geotechnical Assessment

9.1 Expected Ground Conditions

There are no subsurface investigations in the vicinity of the site. Given the site benching that has occurred during pool excavation, it is likely that fill has been placed under the eastern part of the site, under the floor slabs and paved areas. No areas of sinkholes, an indicator of tunnel gullying, were observed.

9.2 Liquefaction Hazard

The Christchurch Earthquake Recovery Authority (CERA) last updated 10 February 2012 has classified 1 Cresswell Ave and the surrounding residential properties as Green Zone, indicating repair and rebuilding process can begin. The area around the pool grounds is not shown as being liquefaction prone.

9.3 Site Walkover Inspection

A walkover inspection of the interior of the buildings and surrounding land was carried out by Opus Geotechnical Engineer on 2 May 2012. The following observations were made (refer to the Walkover Inspection Plan and Site Photographs attached to this report):

- Confirmed evidence of building damage, likely due to seismic shaking. Damage comprises extensive wall cracking and movement; separation of the wall from the column "buttress" units.

- Propping of the structure.

9.4 Discussion

Cracking of the walls of the hollow concrete block buildings has occurred to the Governors Bay Pool buildings at 1 Cresswell Ave due to the Canterbury Earthquake Sequence following the 4 September 2010 earthquake. This has resulted in building closure, and propping of the structure has been required.

No evidence of liquefaction or lateral spreading due to the recent earthquakes was observed on the property or adjoining properties. An internal inspection of the pool buildings did not identify any evidence of differential settlement of the foundations, however no level survey has been completed. There was some differential settlement noted on paths around the pool. Discussions with the pool caretaker indicate cracking in the storeroom floor slab and paths was existing prior to the September 2010 earthquake.

Detailed drawings of the foundations have not been located. Based on the walkover it is assumed that the foundations are strip foundations along the perimeter of the building and some of the interior walls. The existing foundations have performed satisfactorily and do not appear to have sustained damage from cracking from differential settlement.

GNS Science indicates an elevated risk of seismic activity is expected in the Canterbury region as a result of the earthquake sequence following the 4 September 2010 earthquake. Recent advice[2] indicates there is a 14% probability of another Magnitude 6 or greater earthquake occurring in the next 12 months in the Canterbury region. This event may cause further building damage at the site, dependent on the location of the earthquake's epicentre. It is expected that the probability of occurrence is likely to decrease with time following periods of reduced seismic activity.

9.5 Geotechnical Recommendations

- Based on the land performance in and around the Governors Bay pool in recent earthquakes, the land is not likely to be susceptible to slope failure, liquefaction or settlement. No further geotechnical investigations or geotechnical assessments are therefore considered necessary.

- Should the building be rebuilt on new foundations, we recommend carrying out a site specific investigations, comprising hand augers and scala penetrometers to provide information for foundation design.

[2] GNS Science reporting on Geonet Website: http://www.geonet.org.nz/canterbury-quakes/aftershocks/ updated on 9th July 2012.

10 Remedial Options

Any remedial options for increasing the seismic capacity of the building above 67% NBS would need to address both the ability of the bond beams to span between return walls and the capacity of the reinforced masonry block walls.

For any strengthening proposal the design capacity of the existing masonry block walls should be ascertained by testing of grout and block strength. A detailed mapping of reinforcing locations would also be required. Strengthening proposals may need to incorporate part demolition and rebuild.

Full demolition and rebuild may need to be considered due to the high degree of uncertainty in the reinforcement details of the existing masonry walls. This could result in requiring extensive strengthening structural work making it uneconomical to strengthen to 67%NBS.

11 Conclusions

(a) The pool structures have seismic capacities of more than 33% NBS, and are therefore not classed as earthquake prone.

(b) The capacities are limited by the flexural and shear capacity of the lightly-reinforced, partially-grouted block walls.

(c) Strengthening work is required to increase the overall building capacity to at least 67% NBS. Alternatively consider full demolition and rebuild to achieve more than 100%NBS.

(d) The existing foundations have performed satisfactorily.

12 Recommendations

(a) Further structural investigations should be undertaken and strengthening design proposals developed to improve the overall capacities to at least 67% NBS.

(b) The structures should remain closed to the public until strengthening works are carried out.

(c) On the neighbouring property side the boundary wall should be securely braced until strengthening has been carried out.

(d) Demolition and re-build should be considered as a remedial option.

13 Limitations

(a) This report is based on an inspection of the structures with a focus on the damage sustained from the 22 February 2011 Canterbury Earthquake and aftershocks only. Some non-structural damage is mentioned but this is not intended to be a comprehensive list of non-structural items.

(a) Our professional services are performed using a degree of care and skill normally exercised, under similar circumstances, by reputable consultants practicing in this field at the time.

(b) This report is prepared for the CCC to assist with assessing remedial works required for council buildings and facilities. It is not intended for any other party or purpose.

14 References

[1] NZS 1170.5: 2004, *Structural design actions, Part 5 Earthquake actions,* Standards New Zealand.

[2] NZSEE: 2006, *Assessment and improvement of the structural performance of buildings in earthquakes,* New Zealand Society for Earthquake Engineering.

[3] Engineering Advisory Group, *Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings in Canterbury, Part 2 Evaluation Procedure*, Draft Prepared by the Engineering Advisory Group, Revision 5, 19 July 2011.

[4] Engineering Advisory Group, *Guidance on Detailed Engineering Evaluation of Non-residential buildings, Part 3 Technical Guidance*, Draft Prepared by the Engineering Advisory Group, 13 December 2011.

[5] SESOC, *Practice Note – Design of Conventional Structural Systems Following Canterbury Earthquakes*, Structural Engineering Society of New Zealand, 21 December 2011.

Appendix A – Photographs

Photo 1: General photo of the structures

Photo 2: Mens Changing Rooms general photo

Photo 3: Plant Room side wall (prior to propping)

Photo 4: Plant Room back wall (prior to propping)

Photo 5: Mens Changing Rooms front corner

Photo 6: Mens Changing Rooms timber roof purlins and wall plate

Photo 7: Mens Changing Rooms - front corner bond beam and vertical rebar

Photo 8: Freestanding boundary wall and Mens Changing Rooms (prior to propping)

Photo 9: Separation of pier and block boundary wall.

Photo 10: Plant Room – opening in block wall

Photo 11: Plant Room – crack in floor (non-seismic damage)

Photo 12: Pool Plant Room - block wall opening crack

Photo 13: Pool Plant Room block wall opening crack

Photo 14: Pool Plant Room block wall propping

Photo 15: Similar photo as photo 14 – prior to wall demolition and propping

Appendix B – Geotechnical Report

12 July 2012

Michael Sheffield
Christchurch City Council
PO Box 237
CHRISTCHURCH 8140

6-QUCCC.61/055SC

Dear Michael

Geotechnical Desktop Study – Governors Bay Pool – Shed, Plant Room and Storage Room (BU-3569-001 EQ2 BU 3569-003 EQ2)

1. Introduction

This report summarises the findings of a geotechnical desktop study and site walkover completed by Opus International Consultants (Opus) for the Christchurch City Council (CCC) at the above property on 2 May 2012. The Geotechnical desk study follows the Canterbury Earthquake Sequence initiated by the 4 September 2010 earthquake.

The purpose of the geotechnical study is to assess the current ground conditions and the potential geotechnical hazards that may be present at the site, and determine whether further subsurface geotechnical investigations are necessary.

It is our understanding this is the first inspection by a Geotechnical Engineer of this property following the Canterbury Earthquake Sequence. The Geotechnical Desk Study has been undertaken without the benefit of any site specific investigations and is therefore preliminary in its nature.

2. Desktop Study

2.1 Site Description

The Governors Bay Pool is located at 1 Cresswell Ave, Governors Bay within the Lyttelton Harbour. The pool complex faces south on to Cresswell St, and is bounded to the east by a residential section, to the north by a gently sloping bank planted in trees, and to the west by a gently sloping grass area.

The building is a single storey structure with reinforced masonry walls, timber frame roof structure, and concrete floors. Though no detailed drawings for the foundations have been found, it is assumed that the foundations are likely to be shallow perimeter strip footings.

The building and wall extend a total length of 30 m on the eastern boundary of the site.

2.2 Structural Drawings

A search of CCC property files has not located any extracts from construction drawings.

No geotechnical reports or records of a ground condition assessment associated with the construction of the original building or additions have been identified.

The structure was constructed in approx. 1972 (pers comm. Pool Caretaker) and comprises two separate buildings containing two changing sheds, a plant room and a store room, all sharing a hollow block fence/wall at the rear. The northern building houses one changing room (approx. 2.4m x 4.7m), the second building houses a changing room (approx. 2.4m x 4.6m); a plant room (approx. 2.4m x 2.9m) and a store room (approx. 4.3m x 2.4m).

2.3 Regional Geology

The Banks Peninsula Geological Map[1] indicates the site to be underlain by a loess mantle over rocks of the Lyttelton Volcanic Group. Loess is a windblown deposit and typically consists of sandy silt in the Banks Peninsula region. ECAN well information indicates groundwater approximately 2 m below the surface (M36/10180, approx. 300 m from the site).

2.4 Expected Ground Conditions

There are no subsurface investigations in the vicinity of the site. Given the site benching that has occurred during pool excavation, it is likely that fill has been placed under the eastern part of the site, under the floor slabs and paved areas. No areas of sinkholes, an indicator of tunnel gullying, were observed.

2.5 Liquefaction Hazard

The Christchurch Earthquake Recovery Authority (CERA) last updated 10 February 2012 has classified 1 Cresswell Ave and the surrounding residential properties as Green Zone, indicating repair and rebuilding process can begin. The area around the pool grounds is not shown as being liquefaction prone.

3. Site Walkover Inspection

A walkover inspection of the interior of the buildings and surrounding land was carried out by Opus Geotechnical Engineer on 2 May 2012. The following observations were made (refer to the Walkover Inspection Plan and Site Photographs attached to this report):

- Confirmed evidence of building damage, likely due to seismic shaking. Damage comprises extensive wall cracking and movement; separation of the wall from the column “buttress” units.
- Propping of the structure.

4. Discussion

Cracking of the walls of the hollow concrete block buildings has occurred to the Governors Bay Pool buildings at 1 Cresswell Ave due to the Canterbury Earthquake Sequence following the 4 September 2010 earthquake. This has resulted in building closure, and propping of the structure has been required.

No evidence of liquefaction or lateral spreading due to the recent earthquakes was observed on the property or adjoining properties. An internal inspection of the pool buildings did not identify any evidence of differential settlement of the foundations,

---

[1] Sewell, R.J.; Weaver, S.D.; Reay, M.B. 1992: Geology of Banks Peninsula. Scale 1:100,000. Institute of Geological & Nuclear Sciences geological map 3.

however no level survey has been completed. There was some differential settlement noted on paths around the pool. Discussions with the pool caretaker indicate cracking in the storeroom floor slab and paths was existing prior to the September 2010 earthquake.

Detailed drawings of the foundations have not been located. Based on the walkover it is assumed that the foundations are strip foundations along the perimeter of the building and some of the interior walls. The existing foundations have performed satisfactorily and do not appear to have sustained damage from cracking from differential settlement.

GNS Science indicates an elevated risk of seismic activity is expected in the Canterbury region as a result of the earthquake sequence following the 4 September 2010 earthquake. Recent advice[2] indicates there is a 14% probability of another Magnitude 6 or greater earthquake occurring in the next 12 months in the Canterbury region. This event may cause further building damage at the site, dependent on the location of the earthquake's epicentre. It is expected that the probability of occurrence is likely to decrease with time following periods of reduced seismic activity.

5. Recommendations

- Based on the land performance in and around the Governors Bay pool in recent earthquakes, the land is not likely to be susceptible to slope failure, liquefaction or settlement. No further geotechnical investigations or geotechnical assessments are therefore considered necessary.

- Should the building be rebuilt on new foundations, we recommend carrying out a site specific investigations, comprising hand augers and scala penetrometers to provide information for foundation design.

6. Limitation

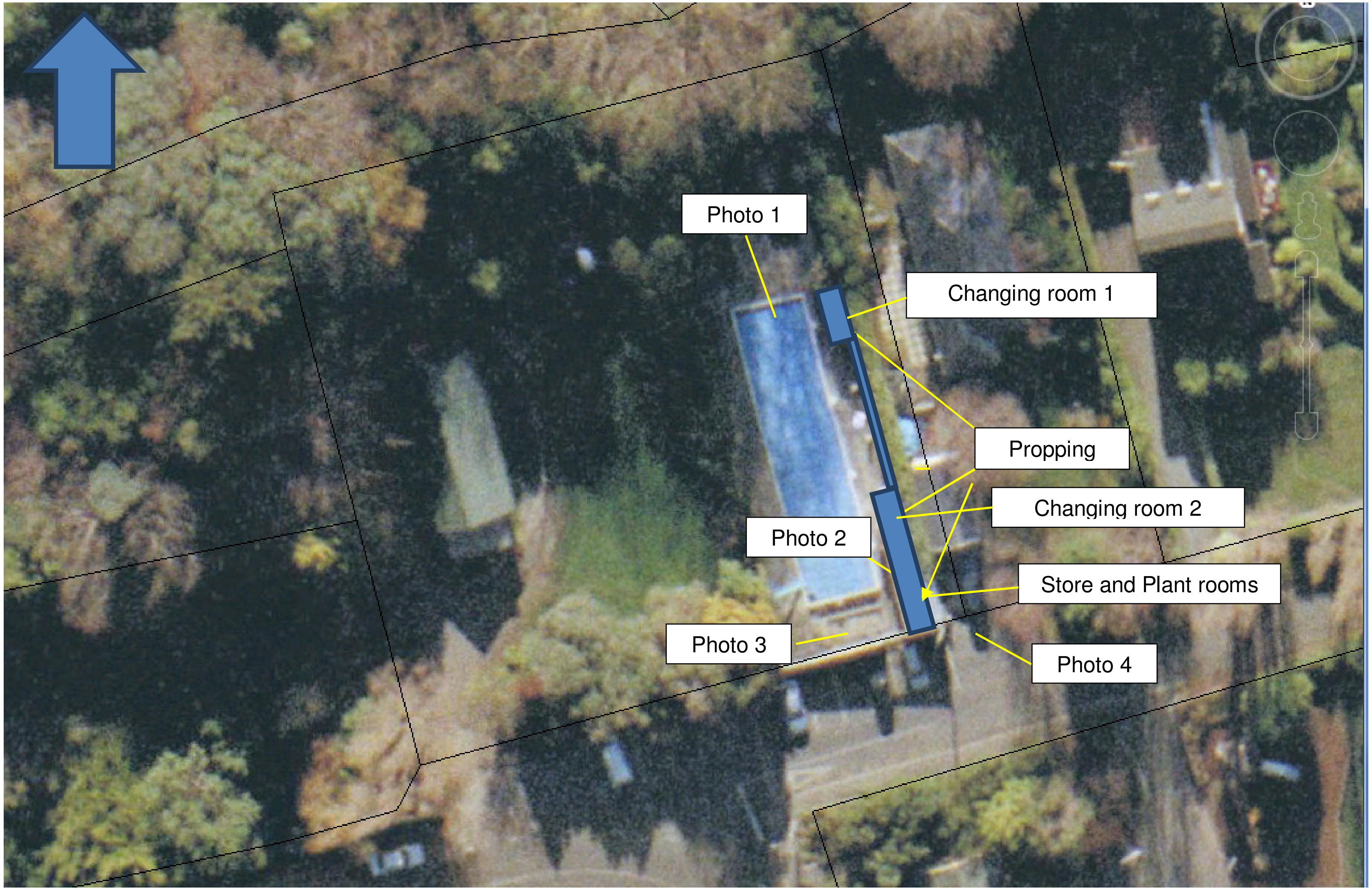
This report has been prepared solely for the benefit of Christchurch City Council as our client with respect to the brief. The reliance by other parties on the information or opinions contained in the report shall, without our prior review and agreement in writing, be at such parties' sole risk.

Figures:
Site Location Plan
Walkover Inspection Plan
Site Photographs

[2] GNS Science reporting on Geonet Website: http://www.geonet.org.nz/canterbury-quakes/aftershocks/ updated on 9th July 2012.

Opus International Consultants Ltd.
Christchurch Office
20 Moorhouse Ave
PO Box 1482
Christchurch, New Zealand
Tel: +64 3 363 5400 Fax: +64 3 365 7857

Project:	1 Cresswell Ave, Governors Bay Geotechnical Desktop Study	**Site Location Plan**
Project No.:	6-QUCCC.61/055SC	
Client:	Christchurch City Council	



OPUS Opus International Consultants Ltd. Christchurch Office 20 Moorhouse Ave PO Box 1482 Christchurch, New Zealand Tel: +64 3 363 5400 Fax: +64 3 365 7857	**Project:** 1 Cresswell Ave Governors Bay Geotechnical Desktop Study **Project No.:** 6-QUCCC.61/055SC **Client:** Christchurch City Council	**Walkover Inspection Plan** **Date Drawn:** 21/05/2012

Photo 1. Pool service building on left, with concrete block wall on boundary. Note site slopes gently to far back left (SE)

Photo 2. Store room floor slab cracking

Photo 3 Extensive propping of building. Paving slabs around pool tilted.

Photo 4. Blockwork on SE corner of building at back of storeroom propped.

Appendix C – CERA DEE Form

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Governors Bay Pool Structures	Reviewer:	Dave Dekker
	Unit / No: 1 / Street: Cresswell Ave	CPEng No:	1003026
Building Address:	1 Cresswell Ave	Company:	Opus International Consultants
Legal Description:		Company project number:	6-QUCCC.93
		Company phone number:	03 363 5400
GPS south:	Degrees 43, Min 37, Sec 24.00	Date of submission:	29/08/2012
GPS east:	Degrees 172, Min 38, Sec 58.50	Inspection Date:	22-Mar-12
		Revision:	Final
Building Unique Identifier (CCC):	BU 3569-002 EQ2 & PRK 3569 BLDG 007 EQ2	Is there a full report with this summary?	yes

Site

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

Building

No. of storeys above ground:	1	single storey = 1 / Ground floor elevation (Absolute) (m):	
Ground floor split?	no	Ground floor elevation above ground (m):	
Storeys below ground	0		
Foundation type:	strip footings	if Foundation type is other, describe:	
Building height (m):	2.20	height from ground to level of uppermost seismic mass (for IEP only) (m):	
Floor footprint area (approx):	42		
Age of Building (years):	25	Date of design:	
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):			
Importance level (to NZS1170.5):	IL2		

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber framed	rafter type, purlin type and cladding	140x45 timber purlns on wall plates
Floors:			
Beams:			
Columns:			
Walls:	partially filled concrete masonry	thickness (mm)	190

Lateral load resisting structure

Note: Define along and across in detailed report!

Lateral system along:	partially filled CMU			lightly reinforced
Ductility assumed, μ:	1.25		note total length of wall at ground (m):	
Period along:	0.20	##### enter height above at H31	estimate or calculation?	estimated
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	
Lateral system across:	partially filled CMU			
Ductility assumed, μ:	1.25		note total length of wall at ground (m):	
Period across:	0.20	##### enter height above at H31	estimate or calculation?	
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	

Separations:

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

Non-structural elements

Stairs:			
Wall cladding:			
Roof Cladding:	Metal	describe	corrugated iron
Glazing:			
Ceilings:			
Services(list):			

Available documentation

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

Damage

Site: (refer DEE Table 4-2)

Site performance:		Describe damage:	
Settlement:		notes (if applicable):	
Differential settlement:		notes (if applicable):	
Liquefaction:		notes (if applicable):	
Lateral Spread:		notes (if applicable):	
Differential lateral spread:		notes (if applicable):	
Ground cracks:		notes (if applicable):	
Damage to area:		notes (if applicable):	

Building:

	Current Placard Status:			
Along	Damage ratio:	0%	Describe how damage ratio arrived at:	
	Describe (summary):			
Across	Damage ratio:	0%		
	Describe (summary):	blockwork cracking and separation		
Diaphragms	Damage?:		Describe:	
CSWs:	Damage?:		Describe:	
Pounding:	Damage?:		Describe:	
Non-structural:	Damage?:		Describe:	

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

Recommendations

	Level of repair/strengthening required:	significant structural and strengthening	Describe:	investigate strengthening options/ demo
	Building Consent required:		Describe:	
	Interim occupancy recommendations:	partial occupancy	Describe:	
Along	Assessed %NBS before e'quakes:	34%	##### %NBS from IEP below / If IEP not used, please detail assessment methodology:	quantitative
	Assessed %NBS after e'quakes:	34%		
Across	Assessed %NBS before e'quakes:	47%	##### %NBS from IEP below	
	Assessed %NBS after e'quakes:	47%		

IEP

Use of this method is not mandatory - more detailed analysis may give a different answer, which would take precedence. Do not fill in fields if not using IEP.

Period of design of building (from above): 0

h_n from above: m

Seismic Zone, if designed between 1965 and 1992:

not required for this age of building

not required for this age of building

	along	across
Period (from above):	0.2	0.2
(%NBS)nom from Fig 3.3:		
Note:1 for specifically design public buildings, to the code of the day: pre-1965 = 1.25; 1965-1976, Zone A =1.33; 1965-1976, Zone B = 1.2; all else 1.0		1.00
Note 2: for RC buildings designed between 1976-1984, use 1.2		1.0
Note 3: for buildngs designed prior to 1935 use 0.8, except in Wellington (1.0)		1.0
Final (%NBS)nom:	**0%**	**0%**

2.2 Near Fault Scaling Factor

	along	across
Near Fault scaling factor, from NZS1170.5, cl 3.1.6:		1.00
Near Fault scaling factor (1/N(T,D), **Factor A**:	1	1

2.3 Hazard Scaling Factor

Hazard factor Z for site from AS1170.5, Table 3.3:	
Z_{1992}, from NZS4203:1992	
Hazard scaling factor, **Factor B:**	#DIV/0!

2.4 Return Period Scaling Factor

Building Importance level (from above):	2
Return Period Scaling factor from Table 3.1, **Factor C**:	

2.5 Ductility Scaling Factor

	along	across
Assessed ductility (less than max in Table 3.2)	1.00	1.00
Ductility scaling factor: =1 from 1976 onwards; or =kμ, if pre-1976, fromTable 3.3:		
Ductiity Scaling Factor, **Factor D**:	0.00	0.00

2.6 Structural Performance Scaling Factor:

	along	across
Sp:	1.000	1.000
Structural Performance Scaling Factor **Factor E**:	1	1

2.7 Baseline %NBS, $(NBS\%)_b = (\%NBS)_{nom} \times A \times B \times C \times D \times E$

	along	across
$\%NBS_b$:	**#DIV/0!**	**#DIV/0!**

Global Critical Structural Weaknesses: (refer to NZSEE IEP Table 3.4)

3.1. Plan Irregularity, factor A: 1

3.2. Vertical irregularity, Factor B: 1

3.3. Short columns, Factor C: 1

3.4. Pounding potential

Pounding effect D1, from Table to right 1.0

Height Difference effect D2, from Table to right 1.0

Therefore, Factor D: 1

3.5. Site Characteristics 1

Table for selection of D1	Severe	Significant	Insignificant/none
Separation	0<sep<.005H	.005<sep<.01H	Sep>.01H
Alignment of floors within 20% of H	**0.7**	**0.8**	**1**
Alignment of floors not within 20% of H	**0.4**	**0.7**	**0.8**

Table for Selection of D2	Severe	Significant	Insignificant/none
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

3.6. Other factors, Factor F

	Along	Across
For ≤ 3 storeys, max value =2.5, otherwise max valule =1.5, no minimum		
Rationale for choice of F factor, if not 1		

Detail Critical Structural Weaknesses: (refer to DEE Procedure section 6)

List any: Refer also section 6.3.1 of DEE for discussion of F factor modification for other critical structural weaknesses

	Along	Across
3.7. Overall Performance Achievement ratio (PAR)	**0.00**	**0.00**
4.3 PAR x (%NBS)b: PAR x Baselline %NBS:	**#DIV/0!**	**#DIV/0!**
4.4 Percentage New Building Standard (%NBS), (before)		**#DIV/0!**

OPUS