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Dwelling
PRK 1201 BLDG 001 EQ2

Detailed Engineering Evaluation
Qualitative Report
Version FINAL

Barbadoes Cemetery, 357 Cambridge Terrace, Christchurch

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PRK 1201 BLDG 001 EQ2

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Qualitative Report
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Christchurch City Council

Prepared By
Mirjana Hrnjak

Reviewed By
Peter O’Brien

Date
6^{th} March 2013

Contents

Table Index

Figure Index

Appendices

Qualitative Report Summary

Dwelling

PRK 1201 BLDG 001 EQ2

Detailed Engineering Evaluation

Qualitative Report - SUMMARY

Version FINAL

Barbadoes Cemetery, 357 Cambridge terrace, Christchurch

Background

This is a summary of the Qualitative report for the building structure, and is based in part on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011 and visual inspections on 20th April 2012.

Building Description

The dwelling is located at 357 Cambridge Terrace, Barbadoes Cemetery, Christchurch. It was constructed in 1960's. The building is used as a residence.

The building is of lightweight timber frame construction. The linings appear to be plasterboard although lath and plaster linings may also be present. The building has weatherboard external wall cladding. The ceiling appears to be lath and plaster as sections are damaged and the laths are visible in some locations. The roof structure consists of lightweight steel roofing fixed to timber purlins on timber roof trusses. Foundations consist of timber flooring on timber bearers, supported by timber piles internally and the external concrete strip footing.

Key Damage Observed

Key damage observed includes:-

- Cracking to plasterboard lining
- Cracking to concrete perimeter strip foundation

Critical Structural Weaknesses

The following critical structural weaknesses have been identified for this building

- Site Characteristics (30% Reduction) 28% NBS.

Indicative Building Strength (from IEP and CSW assessment)

Based on the information available, and using the NZSEE Initial Evaluation Procedure, the capacity of the building has been assessed to be in the order of 28% NBS and post-earthquake capacity in the order of 21% NBS (25% reduction based on damage observed).

The building's capacity excluding critical structural weaknesses and excluding earthquake damage (baseline %NBS) is in order 40%.

The building has been assessed to have a seismic capacity in the order of 21% NBS and is therefore considered to be potentially Earthquake Prone.

Recommendations

As the building has achieved less than 33% NBS following a qualitative Detailed Engineering Evaluation of the building, further assessment is required. It is recommended that a quantitative assessment be carried out and if necessary strengthening options explored.

1. Background

GHD has been engaged by the Christchurch City Council (CCC) to undertake a detailed engineering evaluation of the Dwelling at Barbadoes Cemetery, 357 Cambridge Terrace.

This report is a Qualitative Assessment of the building structure, and is based in part on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011.

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).

At the time of this report, no intrusive site investigation, detailed analysis, or modelling of the building structure had been carried out. Construction drawings were made available, and these have been considered in our evaluation of the building. The building description is based on a review of the drawings and our visual inspections.

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 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

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 any 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)) 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.

2.2.1 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.

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.

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 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;
- A timeframe of 15-30 years for Earthquake Prone Buildings to be strengthened; and,
- Repair works for buildings damaged by earthquakes will be required to comply with the above.

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

We anticipate that any building with a capacity of less than 33% NBS (including consideration of critical structural weaknesses) will need to be strengthened to a target of 67% NBS of new building standard as recommended by the Policy.

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

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

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.

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

- Hazard Factor increased from 0.22 to 0.3 (36% increase in the basic seismic design load)
- 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.

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 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 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	Unacceptable	Unacceptable

Figure 1 NZSEE Risk Classifications Extracted from table 2.2 of the NZSEE 2006 AISPBE

Table 1 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.

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

Table 1 %NBS compared to relative risk of failure

4. Building Description

4.1 General

The dwelling is located at 357 Cambridge Terrace, at Barbadoes Cemetery, Christchurch. It was constructed in 1960's. The building is used as a residence.

The building is timber frame construction. The roof structure was not clearly visible from the inside, because of the existing lath and plaster ceiling, but was light weight steel cladding on timber framing. The roof structure is supported by the load bearing timber framed walls. Internal walls are likely to be plasterboard although areas of lath and plaster lining are possible. The external walls are clad with weatherboards.

The floors are timber flooring on timber bearers, supported by timber pile foundations internally and on the perimeter concrete strip footings.

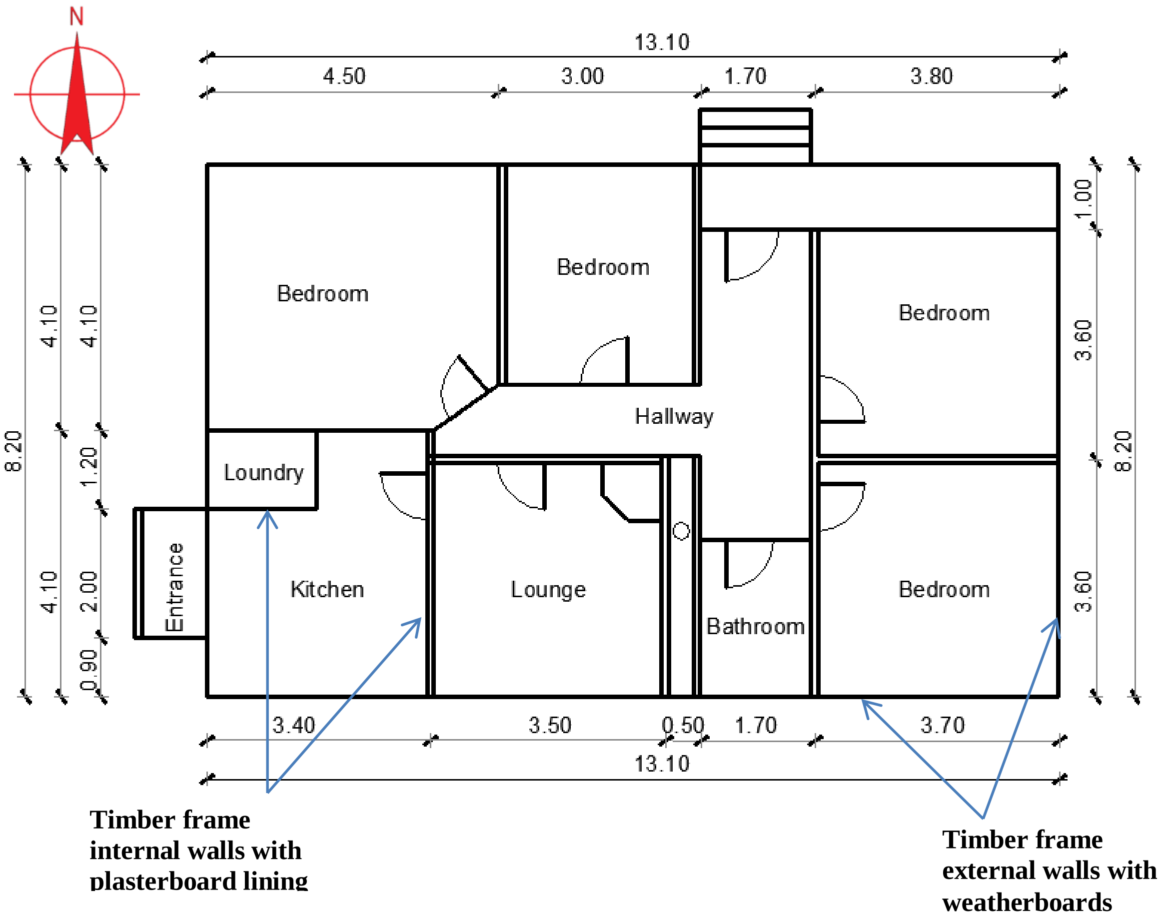


Figure 2 Plan Sketch Showing Key Structural Elements

The dimensions of the building are approximately 13m in length, 8m in width and 4.5m in height. The plan area of the building is approximately 100m^2.

The nearest building to the dwelling is the Garage building approximately 1m to the east. The closest waterway is the Avon River approximately 40m to the south. The site slopes approximately 2.0m between Cambridge Terrace and dwelling.

4.2 Gravity Load Resisting System

Gravity loads are carried by the roof framing to the timber framed walls. The external timber framed walls transfer the gravity loads to the concrete strip foundations.

Internal gravity loads are transferred through to the timber pile foundations below.

4.3 Lateral Load Resisting System

Lateral load resisting systems in both the longitudinal and transverse direction are similar.

The lath and plaster ceiling can be expected to act as partially as ceiling diaphragm. Lateral loads in both directions resisted by bracing from the plasterboard or lath and plaster lining.

At ground level the piles and perimeter strip footings transfer the lateral loads to the ground.

5. Assessment

An visual inspection of the building was undertaken on the 20th of April 2012. Both the interior and exterior of the building were inspected.

The inspection consisted of identifying and visually inspecting the structural elements of the building where these were visible without destructive investigation . The site was assessed for damage, including examination of the ground conditions, checking for damage in areas where damage would be expected for the type of structure and noting general damage observed throughout the building in both structural and non-structural elements.

The %NBS score determined for this building has been based on the IEP procedure described by the NZSEE and based on the information obtained from visual observation of the building and available drawings.

6. Damage Assessment

6.1 Surrounding Buildings

The dwelling at Barbadoes Cemetery is located in a suburban area of Christchurch, at Cambridge Terrace with the garage, 1 m to the east. No significant earthquake damage to the garage was observed.

6.2 Residual Displacements and General Observations

Cracking as a result of earthquake forces was noted to the internal plasterboard wall and ceiling linings (see photograph 6-8) and on the perimeter strip footing (see photographs 9-11).

6.3 Ground Damage

The site at 357 Cambridge Terrace was significantly affected by lateral spreading (see photograph 5).

7. Critical Structural Weakness

7.1 Short Columns

No significant short columns are present in the structure.

7.2 Lift Shaft

The building does not contain a lift shaft.

7.3 Roof

Roof bracing is provided by timber roof members and plasterboard ceiling linings to the underside of the roof collar ties or ceiling framing.

7.4 Staircases

The building does not contain a staircase.

7.5 Site Characteristics

The geotechnical appraisal identifies that the site has a high potential for liquefaction. For the purposes of the IEP assessment of the building and the determination of the %NBS score, the effects of soil liquefaction on the performance of the building has been assessed as a 'significant' site characteristic in accordance with the NZSEE guidelines.

8. Geotechnical Consideration

8.1 Site Description

The subject site is located within the Christchurch Central Business District, at approximately 5m above mean sea level. It is surrounded by commercial and medium-density residential properties. The site is situated approximately 50m north of the Avon River, and 7.5km west of the coast (Pegasus Bay).

8.2 Published Information on Ground Conditions

8.2.1 Published Geology

The geological map of the area[1] indicates that the site is underlain by Holocene alluvial soils of the Yaldhurst Member, sub-group of the Springston Formation, comprising alluvial sand and silt overbank deposits.

Approximately 100m to the northwest, the map identifies an area of “Peat swamps, now drained”, also Holocene and of the Yaldhurst Member.

8.2.2 Environment Canterbury Logs

Information from Environment Canterbury (ECan) indicates that there are a number of boreholes located within 250m of the site. Of these boreholes, three contain an adequate lithographic log.

The conditions described within the logs indicate the geology to be layers of sand and clay/silt to ~9m bgl, underlain by layers of gravel, sand and clay.

The logs also indicate a 1.2m thick layer of peat between 1.2m and 2.7m below ground level (bgl).

[1] Brown, L. J. and Weeber, J.H. 1992: Geology of the Christchurch Urban Area. Institute of Geological and Nuclear Sciences 1:25,000 Geological Map 1. Lower Hutt. Institute of Geological and Nuclear Sciences Limited.

Table 2 ECan Borehole Summary

Bore Reference	Log Depth	Groundwater	Distance & Direction from Site
M35/1895	83m	3.9m	150m NE
M35/12171	9.1m	3.7m	200m N
M35/12789	4.6m	-	220m W

It should be noted that the purpose of the boreholes the well logs are associated with, were sunk for groundwater extraction and not for geotechnical purposes. Therefore, the amount of material recovered and available for interpretation and recording will have been variable at best and may not be representative. The logs have been written by the well driller and not a geotechnical professional or to a standard. In addition strength data is not recorded.

8.2.3 EQC Geotechnical Investigations

The Earthquake Commission has not undertaken geotechnical testing in the area of the site.

8.2.4 CERA Land Zoning

Canterbury Earthquake Recovery Authority (CERA) has published areas showing the Green Zone Technical Category in relation to the risk of future liquefaction and how these areas are expected to perform in future earthquakes.

The site itself is a non-residential property in urban area of Christchurch (but within the Green Zone), therefore it has not been given a CERA land zoning technical category.

However, properties immediately to the east of the dwelling on the site has been given a technical category of TC3 (blue) – CERA indicates that this means that moderate to significant land damage from liquefaction is possible in future significant earthquakes, and that site-specific geotechnical investigation and specific engineering foundation design is required.

8.2.5 Post February Aerial Photography

Aerial photography taken following the 22 February 2011 earthquake (Figure 3) shows significant evidence of liquefaction in the cemetery, adjacent properties and along the river reserve. There is also evidence of lateral spreading along both sides of the Avon River adjacent to the site. Extensive lateral spreading along the riverbank, through the road, and into a portion of the cemetary was observed (during a walkover) following the earthquake on 22 February 2011.

Figure 3 Post February 2011 Earthquake Aerial Photography [2]

8.2.6 Summary of Ground Conditions

From the information presented above, it is anticipated that the site is underlain by stratified alluvial deposits, consisting of layers of gravel, sand, silt and clay, typical of the Springston formation.

8.3 Seismicity

8.3.1 Nearby Faults

There are many faults in the Canterbury region, however only those considered most likely to have an adverse effect on the site are detailed below.

[2] Aerial Photography Supplied by Koordinates sourced from http://koordinates.com/layer/3185-christchurch-post-earthquake-aerial-photos-24-feb-2011/

Table 3 Summary of Known Active Faults[3,4]

Known Active Fault	Distance from Site	Direction from Site	Max Likely Magnitude	Avg Recurrence Interval
Alpine Fault	120 km	NW	~8.3	~300 years
Greendale (2010) Fault	30 km	W	7.1	~15,000 years
Hope Fault	110 km	N	7.2~7.5	120~200 years
Kelly Fault	115 km	NW	7.2	~150 years
Porters Pass Fault	54 km	NW	7.0	~1100 years

Recent earthquakes since 22 February 2011 have identified the presence of a previously unmapped active fault system underneath Christchurch City and the Port Hills. Research and published information on this system is in development and not generally available. Average recurrence intervals are yet to be estimated.

8.3.2 Ground Shaking Hazard

This seismic activity has produced earthquakes of Magnitude 6.3 with peak ground accelerations (PGA) up to twice the acceleration due to gravity (2g) in some parts of the city. This has resulted in widespread liquefaction throughout Christchurch.

New Zealand Standard NZS 1170.5:2004 quantifies the Seismic Hazard factor for Christchurch as 0.30, being in a moderate to high earthquake zone. This value has been provisionally upgraded recently (from 0.22) to reflect the seismicity hazard observed in the earthquakes since 4 September 2010.

In addition, anticipation, the ground conditions are anticipated to be Holocene alluvial soils comprising alluvial gravel, sand and silt, with bedrock expected to be in excess of 500m deep. Combining this with a 475-year PGA (peak ground acceleration) of ~0.4 (Stirling et al, 2002[4], the ground shaking is expected to be moderate to high.

8.4 Slope Failure and/or Rockfall Potential

The site is located on flat land within Central Christchurch. Global slope instability is considered negligible. However, due to its proximity to the Avon River and evidence from previous earthquakes, the site is susceptible to lateral spreading in a significant earthquake.

In addition, any localised retaining structures and/or embankments should be further investigated to determine the site-specific slope instability potential.

[3] Stirling, M.W, McVerry, G.H, and Berryman K.R. (2002): A New Seismic Hazard Model for New Zealand, Bulletin of the Seismological Society of America, Vol. 92 No. 5, pp. 1878-1903, June 2002.

[4] GNS Active Faults Database, http://maps.gns.cri.nz/website/af/viewer.htm

8.5 Liquefaction Potential

Due to the anticipated presence of alluvial deposits, it is considered possible and likely that liquefaction will occur where sands and silts are present. This is further supported by observations of liquefaction in the form of sand boils and lateral spreading on the site due to the recent seismic events.

Further investigation is recommended to better determine subsoil conditions. From this, a more comprehensive liquefaction assessment could be undertaken.

8.6 Recommendations

A soil class of **E** (in accordance with NZS 1170.5:2004) should be adopted for the site. This may be re-assessed following intrusive investigation.

In light of the limited intrusive testing information available, and given the site's anticipated geology, it is recommended that intrusive investigation be conducted. Specifically, we recommend this comprise two piezocone CPT tests to 20m bgl. This will provide a better understanding of the ground conditions, and allow a numerical liquefaction analysis to be carried out.

8.7 Conclusions & Summary

This assessment is based on a review of the geology and existing ground investigation information, and observations from the Christchurch earthquakes since 4 September 2010.

A soil class of E (in accordance with NZS 1170.5:2004) should be adopted for the site.

The site is anticipated to be situated on recent alluvial deposits, comprising sand and silt/clay. Combining the ground conditions anticipated, along with observations of liquefaction at the site, the site also has a high liquefaction potential, in particular where sands and/or silts are present. It is also possible that peat may be present beneath the subject site.

Liquefaction in this area is also likely to manifest in the form of lateral spreading, cause displacement and or settlement of ground resulting in damage to property.

It is recommended that intrusive investigation comprising two piezocone CPTs be conducted.

9. Survey

No level or verticality surveys have been undertaken for this building at this stage in accordance with Christchurch City Council guidelines.

10. Initial Capacity Assessment

10.1 % NBS Assessment

The building's capacity was assessed using the Initial Evaluation Procedure based on the information available. The building's capacity excluding critical structural weaknesses and the capacity of any identified weaknesses are expressed as a percentage of new building standard (%NBS) and the results of the initial calculations are shown below in Table 4. These capacities are subject to confirmation by a more detailed quantitative analysis.

Item	%NBS
Building excluding CSW's	40
Liquefaction Potential (30% Reduction)	21
Earthquake Damage (25% Reduction)	

Table 4 Indicative Building and Critical Structural Weaknesses Capacities based on the NZSEE Initial Evaluation Procedure

Following an IEP assessment, the building has been assessed as achieving 21% New Building Standard (NBS). Under the New Zealand Society for Earthquake Engineering (NZSEE) guidelines the building is considered potentially Earthquake Prone as it achieves less than 33% NBS.

10.2 Seismic Parameters

The seismic design parameters based on current design requirements from NZS 1170:2002 and the NZBC clause B1 for this building are:

- Site soil class: E, NZS 1170.5:2004, Clause 3.1.3, Soft Soil
- Site hazard factor, Z = 0.3, NZBC, Clause B1 Structure, Amendment 11 effective from 1 August 2011
- Return period factor R_u = 1, NZS 1170.5:2004, Table 3.5, Importance level 2 structure with a 50 year design life.

An increased Z factor of 0.3 for Christchurch has been used in line with requirements from the Department of Building and Housing resulting in a reduced % NBS score.

10.3 Expected Structural Ductility Factor

A structural ductility factor of 2.0 has been assumed based on the structural system observed and the date of construction.

10.4 Discussion of Results

The results obtained from the initial IEP assessment are consistent with those expected for a building of this age and construction type. The building was constructed in 1960's and would have been designed to the standards at the time, NZS 1900: 1965. This standard would have used design loads significantly less than those required by current loading standards and lower detailing requirements for ductile seismic behaviour than those that are present in current standards.

Based on the construction type and age, the building achieved 40% of the NBS.

A critical structural weakness in the form of ‘significant’ liquefaction potential has reduced the % NBS by 30% to 28%.

Including in consideration the observed earthquake damage as 25% reduction, the assessed % NBS after earthquake was estimated as 21%.

11. Initial Conclusions

The building has been assessed to have a seismic capacity in the order of 21% NBS and is therefore potentially Earthquake Prone. The recent seismic activity in Christchurch has caused the damage to the building, with cracking to the plasterboard and perimeter strip foundations.

12. Recommendations

The building has achieved less than 33% NBS following a qualitative Detailed Engineering Evaluation of the building, further assessment is required. It is recommended that a quantitative assessment be carried out and if necessary strengthening options explored.

13. Limitations

13.1 General

This report has been prepared subject to the following limitations:

- No intrusive structural investigations have been undertaken.
- No intrusive geotechnical investigations have been undertaken.
- No level or verticality surveys have been undertaken.
- No material testing has been undertaken.
- No calculations, other than those included as part of the IEP in the CERA Building Evaluation Report, have been undertaken. No modelling of the building for structural analysis purposes has been performed.

It is noted that this report has been prepared at the request of Christchurch City Council and is intended to be used for their purposes only. GHD accepts no responsibility for any other party or person who relies on the information contained in this reportrite a specific limitations section.

13.2 Geotechnical Limitations

This report presents the results of a geotechnical appraisal prepared for the purpose of this commission, and for prepared solely for the use of Christchurch City Council and their advisors. The data and advice provided herein relate only to the project and structures described herein and must be reviewed by a competent geotechnical engineer before being used for any other purpose. GHD Limited (GHD) accepts no responsibility for other use of the data.

The advice tendered in this report is based on a visual geotechnical appraisal. No subsurface investigations have been conducted. An assessment of the topographical land features have been made based on this information. It is emphasised that Geotechnical conditions may vary substantially across the site from where observations have been made. Subsurface conditions, including groundwater levels can change in a limited distance or time. In evaluation of this report cognisance should be taken of the limitations of this type of investigation.

An understanding of the geotechnical site conditions depends on the integration of many pieces of information, some regional, some site specific, some structure specific and some experienced based. Hence this report should not be altered, amended or abbreviated, issued in part and issued incomplete in any way without prior checking and approval by GHD. GHD accepts no responsibility for any circumstances, which arise from the issue of the report, which have been modified in any way as outlined above.

Appendix A

Photographs

Photograph 1 Aerial photograph of site at 357 Cambridge Terrace.

Photograph 2 View of the dwelling form the north.

Photograph 3 View of the dwelling form the south.

Photograph 4 View of Cambridge Terrace and Avon River.

Photograph 5 View of the site lateral spreading.

Photograph 6 Vertical cracking in what is likely to be plasterboard wall lining.

Photograph 7 Cracking to plasterboard ceiling lining.

Photograph 8 Cracking to lath and plaster ceiling lining.

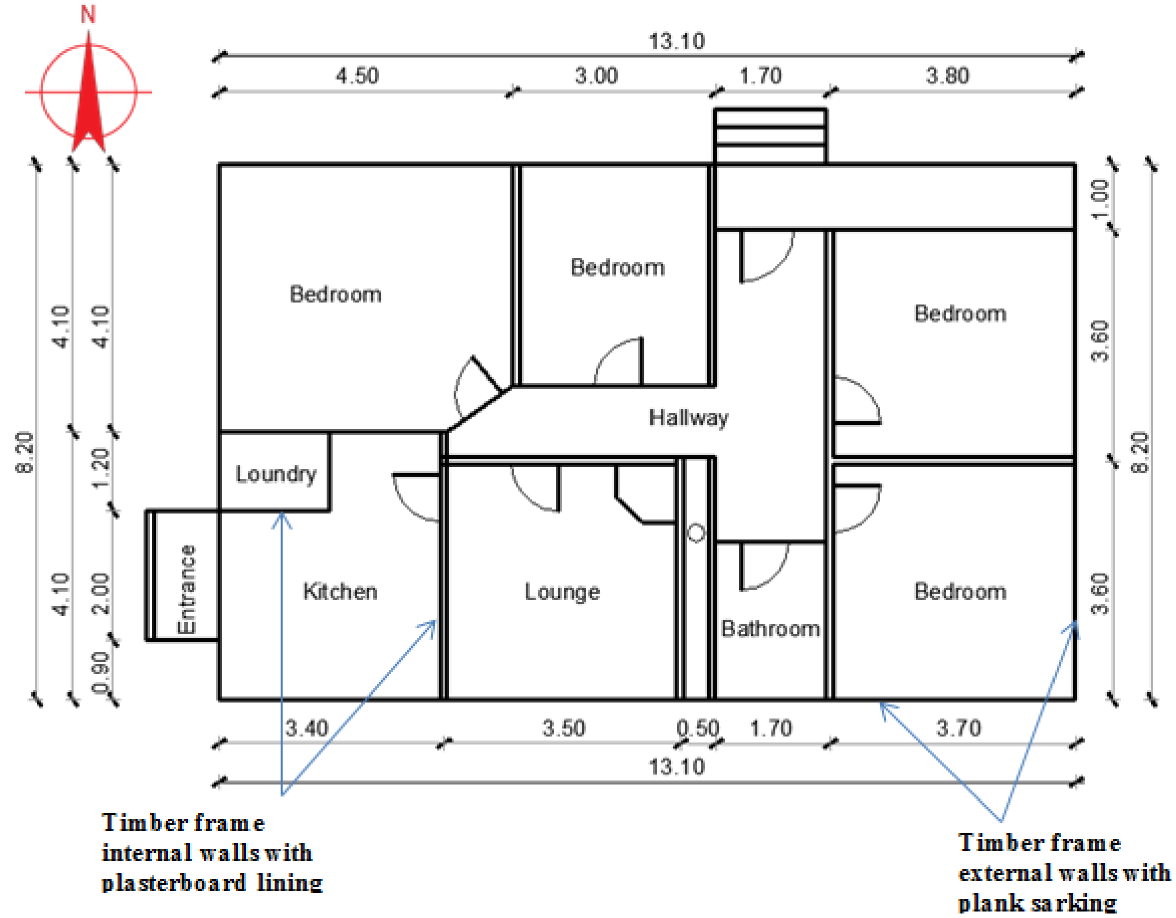
Photograph 9 Cracking to concrete perimeter strip foundation.

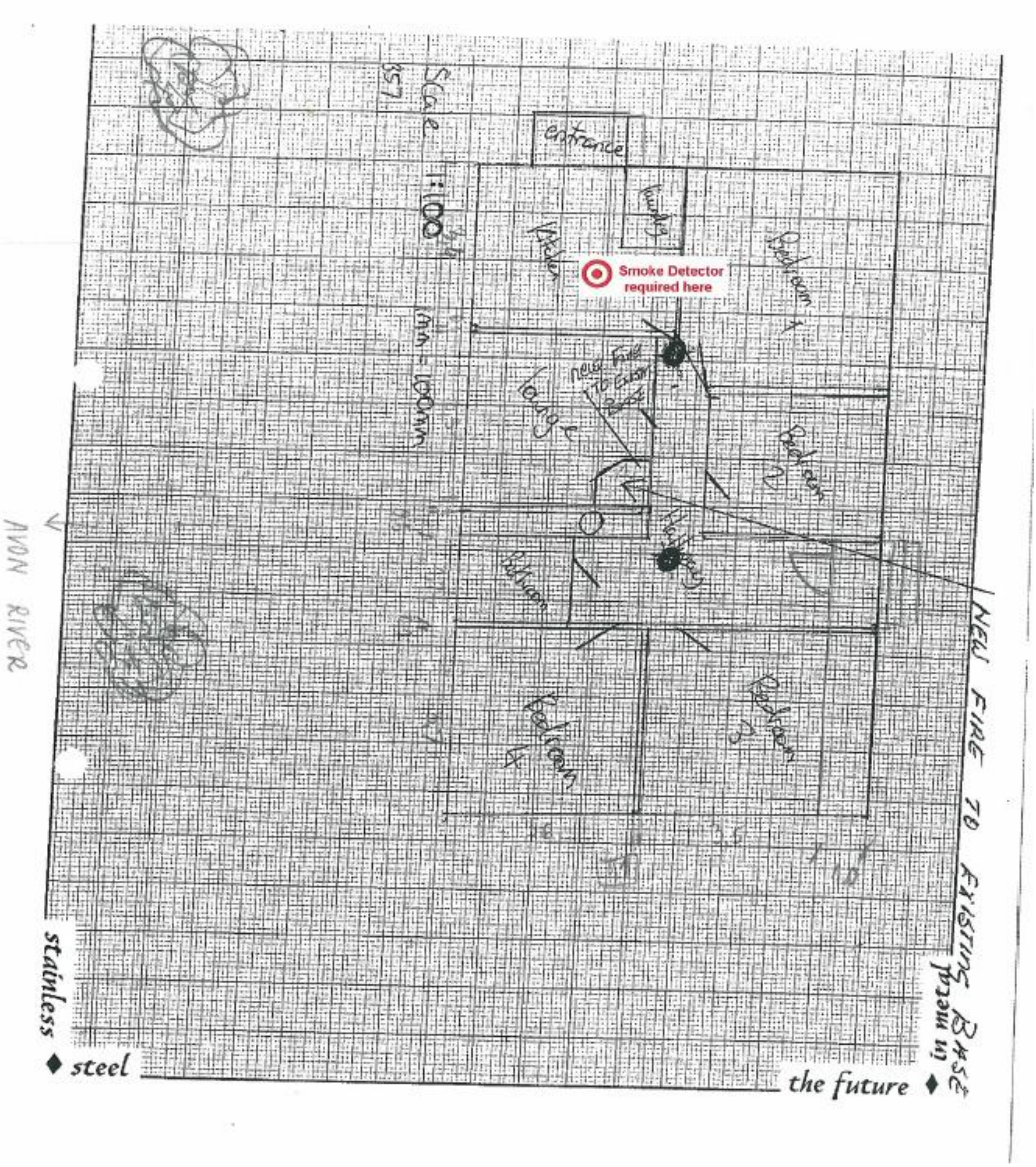
Photograph 10 Cracking to concrete perimeter strip foundation.

Photograph 11 Cracking to concrete perimeter strip foundation.

Appendix B

Existing Drawings


N
13.10
4.50
3.00
1.70
3.80
Bedroom
Bedroom
Bedroom
Hallway
Loundry
Kitchen
Lounge
Bathroom
Bedroom
Entrance
3.40
3.50
0.50
1.70
3.70
13.10
8.20
4.10
4.10
4.10
1.20
2.00
0.90
1.00
3.60
3.60
8.20
Timber frame internal walls with plasterboard lining
Timber frame external walls with plank sarking


Smoke Detector
required here
entrance
laundry
kitchen
Bedroom 1
lounge
Bedroom 2
Hallway
Bathroom
Bedroom 3
Bedroom 4
Scale 1:100
357
AVON RIVER
NEW FIRE TO EXISTING BASE
stainless
steel
the future
in mind

Appendix C

CERA Building Evaluation Form

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Dwelling	Reviewer:	Stephen Lee
Building Address:	Unit: ; No: 357 ; Street: Cambridge Terrace	CPEng No:	1006840
Legal Description:	LOT 6 DP 52797	Company:	GHD
		Company project number:	513059695
		Company phone number:	(03) 3780900
GPS south:	Degrees 43, Min 31, Sec 20.00	Date of submission:	6/3/2013
GPS east:	Degrees 172, Min 38, Sec 53.00	Inspection Date:	20/04/12
		Revision:	FINAL
Building Unique Identifier (CCC):	PRK 1201 BLDG 001 EQ2	Is there a full report with this summary?	yes

Site

Site slope:	slope < 1in 5	Max retaining height (m):	
Soil type:	mixed	Soil Profile (if available):	no
Site Class (to NZS1170.5):	E		
Proximity to waterway (m, if <100m):	50	If Ground improvement on site, describe:	n/a
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):	5.80
Ground floor split?	no	Ground floor elevation above ground (m):	0.80
Storeys below ground			
Foundation type:	timber piles	if Foundation type is other, describe:	Timber piles+perimeter strip footing
Building height (m):	4.50	height from ground to level of uppermost seismic mass (for IEP only) (m):	
Floor footprint area (approx):	107		
Age of Building (years):		Date of design:	1965-1976
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):	residence		
Importance level (to NZS1170.5):	IL2		

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber truss	truss depth, purlin type and cladding	
Floors:	timber	joist depth and spacing (mm)	
Beams:	none	overall depth x width (mm x mm)	
Columns:			None
Walls:			

Lateral load resisting structure

Note: Define along and across in detailed report!

Lateral system along:	lightweight timber framed walls			
Ductility assumed, μ:	2.00		note typical wall length (m)	
Period along:	0.40	0.00	estimate or calculation?	
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	
Lateral system across:	lightweight timber framed walls			
Ductility assumed, μ:	2.00		note typical wall length (m)	
Period across:	0.40	0.00	estimate or calculation?	
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	

Separations:

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

Non-structural elements

Stairs:	cast insitu	notes	external
Wall cladding:	other light	describe	plank sarking
Roof Cladding:	Metal	describe	
Glazing:	other (specify)		
Ceilings:	fibrous plaster, fixed		
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:	bad	Describe damage:	Lateral spreading
Settlement:	0-25mm	notes (if applicable):	
Differential settlement:	0-1:350	notes (if applicable):	
Liquefaction:	2-5 m³/100m²	notes (if applicable):	
Lateral Spread:	more than 500mm	notes (if applicable):	
Differential lateral spread:	1:100-1:50	notes (if applicable):	
Ground cracks:	100-200mm/20m	notes (if applicable):	
Damage to area:	widespread to major (in in 3 to most)	notes (if applicable):	

Building:

	Current Placard Status:			
Along	Damage ratio:	25%	Describe how damage ratio arrived at:	
	Describe (summary):	cracking to perimeter strip		
Across	Damage ratio:	25%		
	Describe (summary):	cracking to perimeter strip		
Diaphragms	Damage?:	yes	Describe:	cracking of perimeter strip foundation
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	Describe:	strengthening the perimeter strip
	Building Consent required:	yes	Describe:	
	Interim occupancy recommendations:	full occupancy	Describe:	
Along	Assessed %NBS before e'quakes:	28% (28% %NBS from IEP below)	If IEP not used, please detail assessment methodology:	
	Assessed %NBS after e'quakes:	21%		
Across	Assessed %NBS before e'quakes:	28% (28% %NBS from IEP below)		
	Assessed %NBS after e'quakes:	21%		

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):	1965-1976	h_n from above:	m
Seismic Zone, if designed between 1965 and 1992:	B	not required for this age of building	E very soft soil
		not required for this age of building	

along across

		along	across
	Period (from above):	0.4	0.4
	(%NBS)nom from Fig 3.3:	5.0%	5.0%
	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:	**5%**	**5%**
2.2 Near Fault Scaling Factor	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:		0.30
	Z_{1992}, from NZS4203:1992		
	Hazard scaling factor, **Factor B:**		3.333333333
2.4 Return Period Scaling Factor	Building Importance level (from above):		2
	Return Period Scaling factor from Table 3.1, **Factor C**:		1.00
2.5 Ductility Scaling Factor	Assessed ductility (less than max in Table 3.2)	2.00	2.00
	Ductility scaling factor: =1 from 1976 onwards; or =kμ, if pre-1976, fromTable 3.3:	1.70	1.70
	Ductiity Scaling Factor, **Factor D**:	1.70	1.70
2.6 Structural Performance Scaling Factor:	Sp:	0.700	0.700
	Structural Performance Scaling Factor **Factor E**:	1.428571429	1.428571429
2.7 Baseline %NBS, (NBS%)b = (%NBS)nom x A x B x C x D x E	**%NBSb:**	**40%**	**40%**

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

3.1. Plan Irregularity, factor A:	insignificant	1
3.2. Vertical irregularity, Factor B:	insignificant	1
3.3. Short columns, Factor C:	insignificant	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	significant	0.7

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

		Along	Across
3.6. Other factors, Factor F	For ≤ 3 storeys, max value =2.5, otherwise max value =1.5, no minimum	1.0	1.0
	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)		**0.70**	**0.70**
4.3 PAR x (%NBS)b:	PAR x Baselline %NBS:	**28%**	**28%**
4.4 Percentage New Building Standard (%NBS), (before)			**28%**

GHD

GHD Building
226 Antigua Street, Christchurch 8013
T: 64 3 378 0900   F: 64 3 377 8575   E: chcmail@ghd.com

Document Status

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		Name	Signature	Name	Signature	Date
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