Report

Dog Shelter
Detailed Engineering Evaluation
BU 0890-001 EQ2
Quantitative Report

Prepared for Christchurch City Council (Client)

By Beca Carter Hollings & Ferner Ltd (Beca)

11 June 2013

Revision History

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Document Acceptance

Action	Name	Signed	Date
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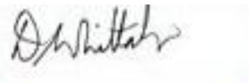
Approved by	David Whittaker		11 June 2013
on behalf of	Beca Carter Hollings & Ferner Ltd		

Dog Shelter
BU 0890-001 EQ2

Detailed Engineering Evaluation
Quantitative Report – SUMMARY
Version 1

Address
10 Metro Place
Bromley
Christchurch

Background

This is a summary of the Quantitative Assessment report for the building structure, and is based on the document 'Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings in Canterbury – Part 2 Evaluation Procedure' (draft) issued by the Engineering Advisory Group (EAG) on 19 July 2011.

A Qualitative Report for 10 Metro Place was issued to CCC on 15 June 2012.

The Dog Shelter is located at 10 Metro Place in Bromley, Christchurch. It was originally built in 1980 (approximate, inferred from personnel on site) with an approximate internal plan area of 400m^2. No drawings were made available, however, site investigations were carried out to determine all critical structural details. Calculations have been undertaken as part of the Quantitative Assessment.

Construction typically comprises of fully filled reinforced concrete masonry walls supporting a light timber framed roof and a lightweight metal roof. The walls are supported on an assumed strip footing foundation and a slab on grade. Also present are 1.4m high reinforced partially filled masonry block partitions that form the dog pens.

The format and content of this report follows a template provided by CCC, which is based on the EAG document.

Key Damage Observed

Key damage observed includes:

- Full height vertical cracking in the southern and western perimeter walls at mid-span of wall lengths.
- Vertical cracking at mid-span of headers above doors and windows along main corridor at the main entrance.
- Minor separation of floor slab at construction joints along corridor to wall connection.
- Minor cracking at corridor long slab spans, perpendicular to its length.
- Minor cracking in floor slabs.
- Settlement of the slab and surrounds in various areas

Critical Structural Weaknesses (CSW)

The following potential Critical Structural Weaknesses have been identified.

- Plan irregularity
- Site Characteristics - due to liquefaction occurring at the Metro Place site
- Unrestrained, large-span fully filled reinforced masonry walls

Indicative Building Strength (from Detailed Assessment)

The building has been assessed to have a seismic capacity of 43%NBS in its damaged state using the New Zealand Society for Earthquake Engineering (NZSEE) Detailed Assessment guideline 'Assessment and Improvement of the Structural Performance of Buildings in Earthquakes' (AISPBE), 2006, and is therefore classified as Earthquake Risk and Seismic Grade C.

The damage observed to the structure is not considered to have significantly reduced its ability to resist loads. The structural damage is considered moderate.

Our assessment has identified the following structural components that govern the building's seismic performance.

- Fully filled reinforced concrete block walls (190mm) in the longitudinal direction have a seismic capacity of 43%NBS in their damaged state, governed by out-of-plane flexural capacity.
- Fully filled reinforced concrete block walls (190mm) in the transverse direction have a seismic capacity of 62%NBS, governed by out-of-plane flexural capacity.

Recommendations

In order that the owner can make an informed decision about the on-going use and occupancy of their building, the following information is presented in line with the Department of Building and Housing document 'Guidance for engineers assessing the seismic performance of non-residential and multi-unit residential buildings in greater Christchurch', June 2012.

The building is considered to be earthquake risk, having an assessed capacity of between 34% and 67%NBS. The risk of collapse of an earthquake risk building is considered to be 5 to 10 times greater than that of an equivalent new building.

The damage sustained by the structure during the February 22nd earthquake has reduced its capacity slightly, but no restriction on use or occupancy is recommended.

It is recommended that:

- A full damage assessment is carried out for insurance purposes.
- Foundations are exposed to confirm suitability of assumptions and damage. This may be part of the damage assessment procedure.

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1 Background

Beca Carter Hollings & Ferner Ltd (Beca) has been engaged by the Christchurch City Council (CCC) to undertake a quantitative Detailed Engineering Evaluation (DEE) of the Dog Shelter, located 10 Metro Place in Bromley, Christchurch.

This report is a Quantitative Assessment of the building structure, and is based on the document 'Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings in Canterbury – Part 2 Evaluation Procedure' (draft) issued by the Engineering Advisory Group (EAG) on 19 July 2011.

A quantitative assessment involves analytical calculations of the building's strength and may involve material testing, geotechnical testing and intrusive investigation. The qualitative assessment previously carried out involved inspections of the building, a desktop review of existing structural and geotechnical information, including existing drawings and calculations, if available and an assessment of the level of seismic capacity against current code using the Initial Evaluation Procedure (IEP).

The purpose of these assessments is to determine the likely building performance and damage patterns, to identify any potential Critical Structural Weaknesses (CSW) or collapse hazards, and to make an assessment of the likely building strength in terms of percentage of New Building Standard (%NBS).

The building description below is based only on our intrusive and visual inspections as drawings were not available.

The format and content of this report follows a template provided by CCC, which is based on the EAG document.

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 understood that CERA is adopting the Detailed Engineering Evaluation Procedure document (draft) issued by the Engineering Advisory Group on 19 July 2011, which sets out a methodology for both qualitative and quantitative assessments. We understand this report will be used in response to CERA Section 51.

The qualitative assessment includes a thorough visual inspection of the building coupled with a desktop review of available documentation such as drawings, specifications and IEP's. The quantitative assessment involves analytical calculation of the building's 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 that was assigned during the state of emergency following the 22 February 2011 earthquake
- 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.

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.

It is understood 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.

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.

3 Earthquake Resistance Standards

For this assessment, the building's Ultimate Limit State 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).

No consideration has been given at this stage to checking the level of compliance against the increased Serviceability Limit State requirements.

The likely ultimate 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 building's 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 3.1 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 3.1: NZSEE Risk Classifications Extracted from Table 2.2 of the NZSEE 2006 AISPBE Guidelines

Table 3.1 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. on average 0.2% in any year). It is noted that the current seismic risk in Christchurch results in a 6% risk of exceedance in the next year.

Table 3.1: %NBS Compared to Relative Risk of Failure

Building Grade	Percentage of New Building Standard (*%NBS*)	Approx. Risk Relative to a New Building
A+	>100	<1
A	80-100	1-2 times
B	67-80	2-5 times
C	33-67	5-10 times
D	20-33	10-25 times
E	<20	>25 times

4 Building Description

4.1 General

Summary information about the building is given in the following table. No drawings of the structure were available, therefore the building information is assumed from our visual inspections only.

Table 4.1: Building Summary Information

Item	Details	Comment
Building name	Dog Shelter	
Street Address	Metro Place Bromley Christchurch	
Age	Construction around 1980	No drawings available, the construction date inferred from site personnel
Description	Two large shelter rooms containing rows of dog spaces separated by half height concrete masonry walls. Various rooms for office space, utilities, and storage.	
Building Footprint / Floor Area	Approx. 18m x 22m. 400 m^2 internally	
No. of storeys / basements	1 storey / no basement	
Occupancy / use	Dog Shelter, offices and storage	Importance Level 2
Construction	Fully filled reinforced concrete masonry freestanding walls with light timber framing roof.	Based on intrusive site investigation by City Care
Gravity load resisting system	Timber rafters and beams supported by load bearing fully filled reinforced concrete masonry walls and galvanized steel pipe posts.	No drawings available
Seismic load resisting system	The competence of the roof	Reinforcing scanning

Item	Details	Comment
	diaphragm is unknown and a conservative system has been assumed. The system is fully filled reinforced concrete masonry walls acting as cantilevered freestanding walls for out-of-plane face loads. The reinforcing is spaced at 400V and 1200H in longitudinal direction and 800V with 1200H in transverse walls (Refer to Appendix B)	undertaken by City Care. See Appendix B for results.
Foundation system	Unknown but assumed to be strip footing foundations with a concrete slab on grade.	No drawings available.
Stair system	None	
Other notable features	None	
External works	Paved and landscaped carpark.	
Construction information	None	
Likely design standard	NZS4203:1976	
Heritage status	No heritage status	
Other	Dog pen walls – Reinforced partially filled masonry half-height partition walls	

4.2 Structural 'Hot-spots'

Areas in which damage may be expected to occur from earthquake shaking are outlined below:

- Reinforced masonry perimeter walls - Additional cracking is likely to occur in all perimeter walls due to out-of-plane movement or settlement and should be monitored.
- Masonry wall openings – Additional flexural cracking at mid span of lintel beams above door and window openings is likely to occur and should be monitored.

5 Site Investigations

5.1 Previous Assessments

Visual inspections as part of the Level 4 Qualitative Assessment were undertaken on 28 May 2012. A Qualitative Report was issued to CCC dated 15 June 2012.

5.2 Level 5 Intrusive Investigations

The following intrusive investigation was carried out as part of the Level 5 Quantitative Assessment.

- Reinforcing scanning of exterior and interior reinforced masonry walls undertaken by City Care. The nature of the masonry block fill was also confirmed during this investigation.

- A levels survey was undertaken by City Care.

6 Damage Assessment

6.1 Damage Summary

The table below provides a summary of damage observed during our inspection. Refer to Appendix A for the observed damage. Damage recorded is believed to be a direct result of the Canterbury Earthquake events.

Table 6.1: Damage Summary

Damage type	Unknown	Minor	Moderate	Major	Comment
settlement of foundations			✓		Global settlement indicated by building tenant during visual inspection, and minor vertical cracks in foundation. Levels survey undertaken by City Care indicated some differential settlements in the order of 70mm. A full levels survey to a set datum may be required.
tilt of building	✓				A quick spirit level verticality check was undertaken during the Qualitative investigation which indicated some out-of-alignment of walls. A full verticality survey may be required to confirm as part of a full damage assessment.
liquefaction		✓			Post-earthquake imagery from Koordinates Ltd shows liquefaction occurring in the vicinity of the structure. (Refer to Figure 2 in Appendix A).
settlement of external ground		✓			Settlement observed in car-park to north-west of building, indicated by ponding of surface water. Occupant also noticed jamming doors at entrance from carpark.
lateral spread / ground cracks		✓			Cracking in long corridor slabs and dog shelter spaces. Separation of slab at wall and at construction joints.
frame					N/A
concrete walls (masonry)			✓		Minor vertical hairline cracking along mid-span of headers above openings along main corridor. Vertical cracking at mid-span of perimeter walls and at ends where connected to perpendicular walls on the order of 1mm - 4mm. Major vertical cracking approximately 4mm in width at intersecting T-joint location on east wall, possibly due to plan irregularities, and out-of-plane face loading. This damage may have caused permanent elongation of reinforcing in the wall. A full damage assessment may be required to assess

Damage type	Unknown	Minor	Moderate	Major	Comment
					this.
cracking to concrete floors		✓			Cracking in long corridor slabs and dog shelter spaces.
bracing					N/A
precast flooring seating					N/A
stairs					N/A
cladding /envelope		✓			No damage (apart from concrete masonry walls) observed during visual inspection.
internal fit out		✓			Minor damage at fitment of door framing and in 1400mm high partition walls.
building services	✓				No inspections of services were carried out.
adjacent buildings					No adjacent buildings are close enough to affect this building in an earthquake.
roof diaphragm	✓				Competence of and damage to roof diaphragm is unknown.
other					N/A

6.2 Surrounding Buildings

There are no adjacent buildings that are close enough that may affect this building during an earthquake. All buildings in the Dog Shelter footprint are considered as one structure.

6.3 Residual Displacements and General Observations

Cracking to the concrete masonry walls at mid-span and at the joints is likely to have occurred due to the differential settlement of approximately 70mm around the south-east corner of the building.

6.4 Implications of Damage

We believe that the damage observed to this building does not pose a hazard in its current condition and the structural capacity of the structure has not been significantly affected.

7 Generic Issues

The following generic issues referred to in Appendix 6A and 7A of the EAG guideline document have been identified as applicable to the Dog Shelter building:

Fully Filled and Partially Filled Reinforced Concrete Masonry

- Inadequate flexural strength
- Inadequate shear strength

8 Geotechnical Consideration

No Geotechnical information was available for this site.

During the inspection, damage to the surrounding ground was noted. Based on visual observations, this damage does not appear to cause a global instability as a ductile failure mechanism is expected from the foundations.

9 Survey

A level survey was carried out by City Care which indicated differential settlement across the floor in the order of 70mm. Refer to Appendix B. This is believed to be due to earthquake induced liquefaction. A full verticality survey and levels survey is recommended as part of a full damage assessment, which would better identify any intentional drainage channels as well as site differential settlement.

10 Detailed Seismic Capacity Assessment

10.1 Assessment Methodology

The building has had its seismic capacity assessed using the Detailed Assessment Procedures in the NZSEE 2006 AISPBE guidelines, based on the site measurements and intrusive investigations undertaken.

The structure has suffered moderate damage. A damage ratio of 10% has been assumed in the CERA DEE summary spreadsheet. This has resulted in a reduction of 5%NBS between the pre-earthquake and post-earthquake capacity. However the buildings classification Grade C (Seismic Risk) is substantially unchanged.

10.2 Assumptions

The following assumptions were used in our quantitative assessment:

- Reinforcing steel yield strength, f_y = 275 MPa
- Fully filled concrete masonry compressive strength, f'_m = 12 MPa
- The foundation is capable of sustaining the moment demand creating a cantilever action of the wall.
- The roof diaphragm is not capable of transferring lateral loads to in-plane elements.

10.3 Critical Structural Weaknesses

The following Critical Structural Weaknesses were identified in the qualitative report:

- Plan irregularity
- Site Characteristics - due to liquefaction occurring at the Metro Place site
- Unrestrained, large-span masonry walls with vertical reinforcement at 400mm c/c and horizontal reinforcement spaced at a maximum of 1200mm.

10.4 Seismic Parameters

The seismic design parameters based on current design requirements from NZS 1170.5:2004 and the NZBC clause B1 for this building are:

- Site soil class: D – NZS 1170.5:2004, Clause 3.1.3, Soft Soil
- Site hazard factor, Z = 0.3 – NZBC, Clause B1 Structure, Amendment 11 effective from 19 May 2011
- Return period factor R_u = 1 – NZS 1170.5:2004, Table 3.5, Importance Level 2 structure with a 50 year design life.
- Near fault factor N(T,D) = 1 – NZS 1170.5:2004, Clause 3.1.6, Distance more than 20 km from fault line.

10.5 Results of Seismic Assessment

The results of our quantitative assessment indicate the building has a seismic capacity in the order of 48%NBS in the undamaged pre-earthquake condition and 43%NBS in its current damaged state. This is lower than the IEP assessment of 58%NBS in the previous Qualitative Report. Table 10.1 presents the evaluated seismic capacity in terms of %NBS of the individual structural systems in each building direction.

Table 10.1: Summary of Seismic Assessment of Structural Systems

Item	Direction	Ductility, μ	Seismic Performance	Notes
Overall %NBS adopted from DEE.	**Longitudinal**	**1.25**	**43%NBS (damaged state)** **48%NBS (undamaged)**	**Governed by out-of-plane flexural capacity of longitudinal perimeter masonry block walls**
Roof to wall bolted connections	Longitudinal	1.25	100%NBS	-
Out-of-plane wall action for eastern perimeter wall in undamaged state	Longitudinal	1.25	48%NBS	Out-of-plane flexural capacity
"	Longitudinal	1.25	52%NBS	Out-of-plane shear capacity
Out-of-plane wall action, with return walls for southern perimeter wall in undamaged state	Transverse	1.25	62%NBS	Out-of-plane flexural capacity
Out-of-plane wall action on dog pen partition walls in undamaged state	Transverse	1.25	98%NBS	Out-of-plane flexural capacity
In plane wall action in undamaged state	Longitudinal	1.25	100%NBS	In plane flexural capacity
"	Longitudinal	1.25	100%NBS	In plane shear capacity

*Refer to Figure 3 in Appendix A for direction of longitudinal and transverse axis.

**Ductility factors in accordance with NZSEE 2006

10.6 Discussion of results

The key findings of the assessment are as follows:

- The main lateral load resisting system is reinforced concrete masonry walls constructed using masonry blocks located internally and externally in both the transverse and longitudinal directions. The reinforced masonry blocks in the transverse direction of the building have an out-of-plane flexural capacity of 48%NBS in their undamaged state. Based on an assumed 10% damage ratio, this is reduced to 43%NBS

Based on the results of our Quantitative Assessment, the Dog Shelter is considered Earthquake Risk and Seismic Grade C as the seismic capacity was assessed to be between 34%NBS and 67%NBS.

11 Recommendations

11.1 Occupancy

In order that the owner can make an informed decision about the on-going use and occupancy of their building the following information is presented in line with the Department of Building and Housing document 'Guidance for engineers assessing the seismic performance of non-residential and multi-unit residential buildings in greater Christchurch', June 2012.

The building is considered to be earthquake risk, having an assessed capacity of between 34%NBS and 67%NBS, and is classified as Seismic Grade C. The risk of collapse of an earthquake risk building of this grade is considered to be 5 to 10 times greater than that of an equivalent new building.

The damage sustained by the structure during the February 22nd earthquake has reduced its capacity slightly, but no restriction on use or occupancy is recommended.

11.2 Further Investigations, Survey or Geotechnical Work

It is recommended that:

- A full damage assessment is carried out for insurance purposes.
- Foundations are exposed to confirm suitability of the key assumptions made in Table 4.1, and also to inspect any post-earthquake damage. This may be part of the damage assessment procedure.
- Full level and verticality survey carried out.

11.3 Damage Reinstatement

Repairs that would bring the building back to an "as new" condition are typically entitled under typical replacement insurance policies. We suggest you consult with your insurance advisor as to how you wish to proceed.

12 Design Features Report

Repairs will be required to reinstate the existing structural system. A repair methodology has not been prepared at this stage. No new load paths are expected as a result of the repairs required, however may be developed as a result of the strengthening options outlined above.

13 Limitations

The following limitations apply to this engagement:

- Beca and its employees and agents are not able to give any warranty or guarantee that all defects, damage, conditions or qualities have been identified.
- Inspections are primarily limited to visible structural components. Appropriate locations for invasive inspection, if required, will be based on damage patterns observed in visible elements, and review of the construction drawings and structural system. As such, there will be concealed structural elements that will not be directly inspected.
- The inspections are limited to building structural components only.

- Inspection of building services, pipework, pavement, and fire safety systems is excluded from the scope of this report.
- Inspection of the glazing system, linings, carpets, claddings, finishes, suspended ceilings, partitions, tenant fit-out, or the general water tightness envelope is excluded from the scope of this report.
- The assessment of the lateral load capacity of the building is limited by the completeness and accuracy of the drawings provided. Assumptions have been made in respect of the geotechnical conditions at the site and any aspects or material properties not clear on the drawings. Where these assumptions are considered material to the outcome further investigations may be recommended. It is noted the assessment has not been exhaustive, our analysis and calculations have focused on representative areas only to determine the level of provision made. At this stage we have not undertaken any checks of the gravity system, wind load capacity, or foundations.
- The information in this report provides a snapshot of building damage at the time the detailed inspection was carried out. Additional inspections required as a result of significant aftershocks are outside the scope of this work.

This report is of defined scope and is for reliance by CCC only, and only for this commission. Beca should be consulted where any question regarding the interpretation or completeness of our inspection or reporting arises.

Appendix A

Photographs and Repairs

Figure 1: Site Layout (Google Maps)

Figure 2: Site plan showing post-February liquefaction in the area. (Photo courtesy of Koordinates)

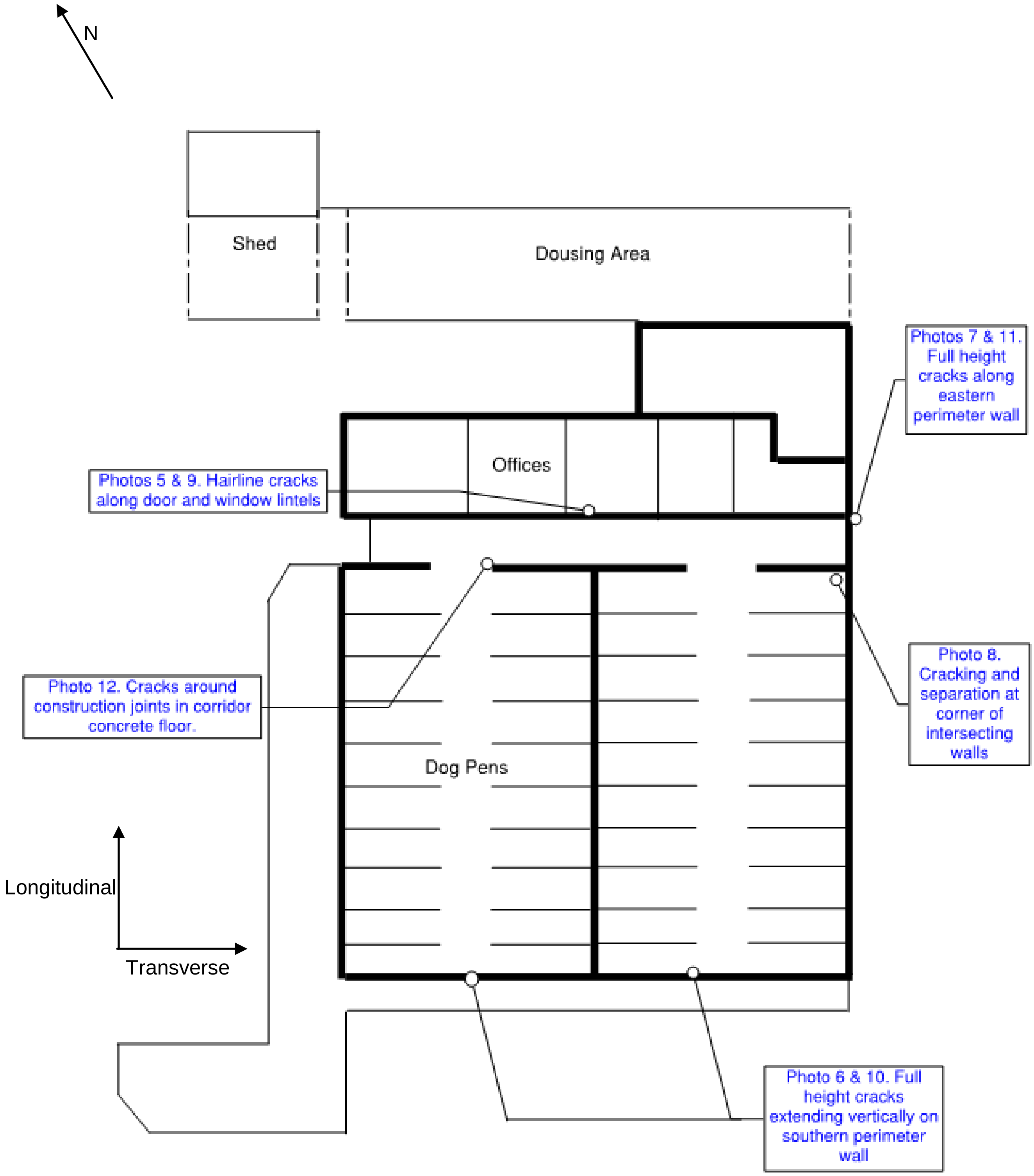

Figure 3: Site plan with damage type and location

Photo 1: Entrance to Dog Shelter

Photo 2: Interior view of Dog Shelter corridor and spaces

Photo 3: Interior view of typical dog shelter space with transverse half height concrete masonry partitions

Damage Description: Vertical cracking at interface of partition wall and perimeter wall.

Photo 4: Interior corridor at entrance to dog pens on eastern side of building.

Damage Description: Cracking to concrete slab on grade and separation of construction joints potentially due to lateral spreading.

Photo 5: Interior view of headers and lintels in the main corridor.

Damage Description: Hairline cracking to masonry headers and lintels above doorways.

Photo 6: Exterior view of south-west perimeter wall at Dog Shelter building.

Damage Description: Full height vertical cracking at wall quarter points i.e halfway between the interior perpendicular return wall. Cracks are 0.8mm at mid-height of wall, increasing to 1.0mm at base.

Photo 7: Exterior view of east perimeter wall at Dog Shelter building.

Damage Description: Large vertical crack at intersection with interior return wall. Crack typically 1.8mm wide at mid-height, increasing to 3.5mm or more at base.

Photo 8: Vertical cracking to concrete masonry wall in the order of 3.5mm at corner where intersecting walls occur

Damage Description: Crack possibly due to flexural forces, created by out-of-plane face loads.

Photo 9: Hairline cracking at concrete masonry lintel.

Damage Description: Vertical cracking at concrete masonry header along midspan of header.

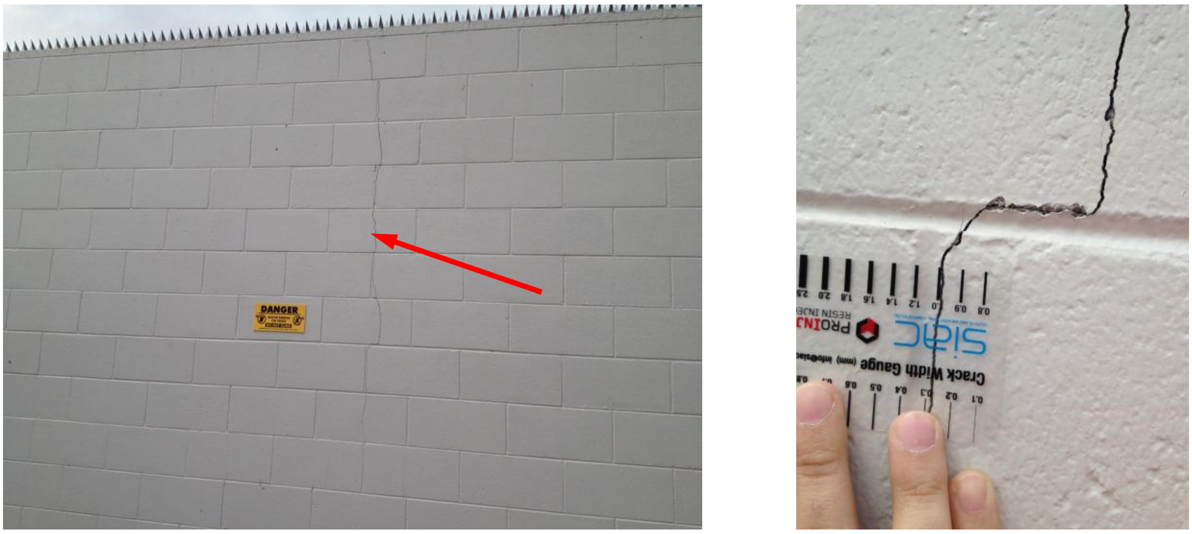

Photo 10A and 10B: Vertical cracking to concrete masonry in the order of 1.0mm at midspan of wall length.

Damage Description: Crack possibly due to flexural forces, instigated by out-of-plane face loads.

Photo 11A, 11B & 11C: Vertical cracking to concrete masonry wall on the order of 4.0mm at midspan of wall length

Damage Description: Crack possibly due to flexural forces caused by out-of-plane face loads.

Photo 12: Cracks and separation of floor slab on the order of 1.0mm – 4.0mm at construction joints and at walls.

Damage Description: Minor cracking and separation possibly due to settlement and lateral spreading.

Appendix B

Site survey results

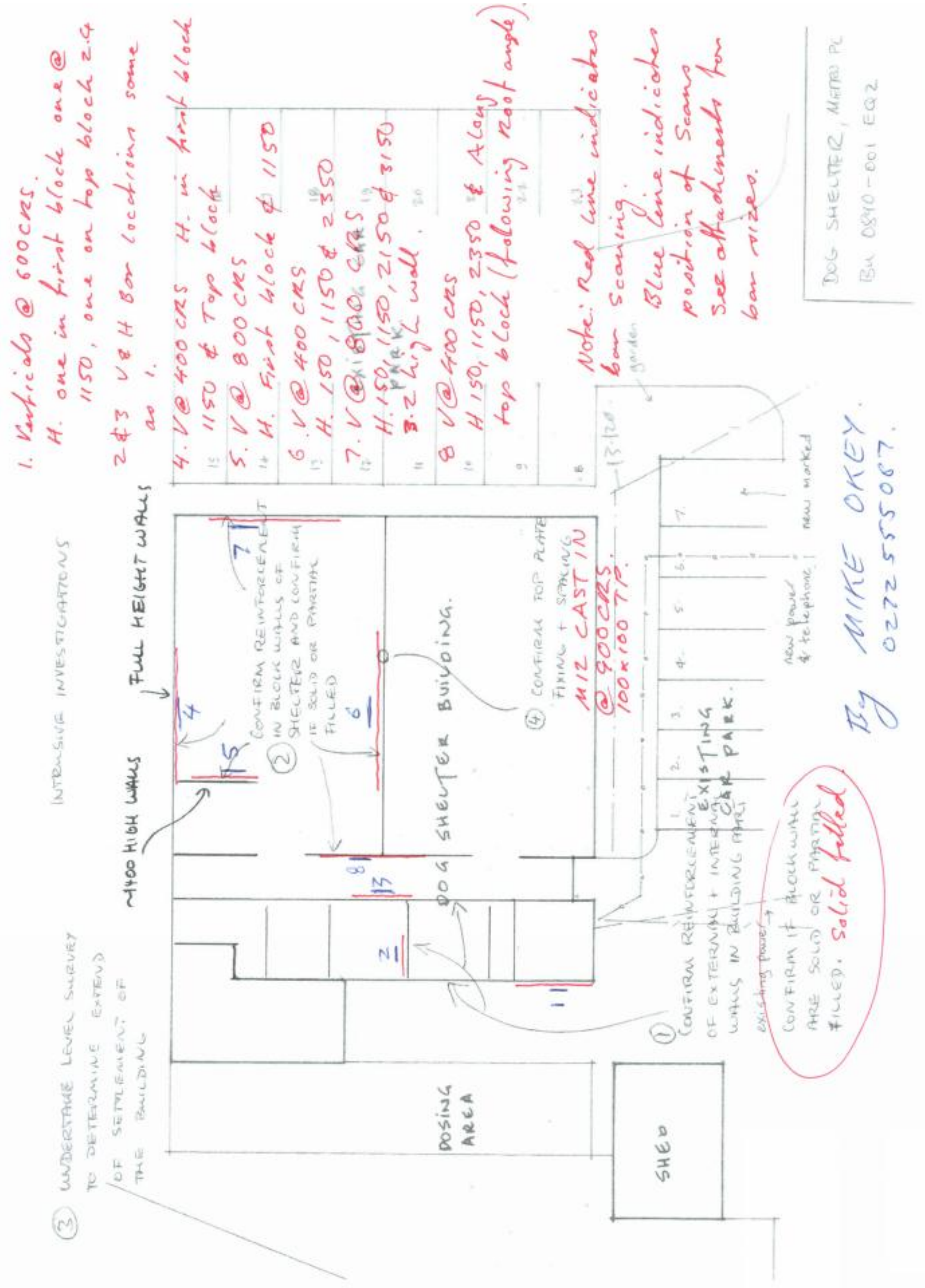

Figure 4: Reinforcing scanning and intrusive investigation mark up

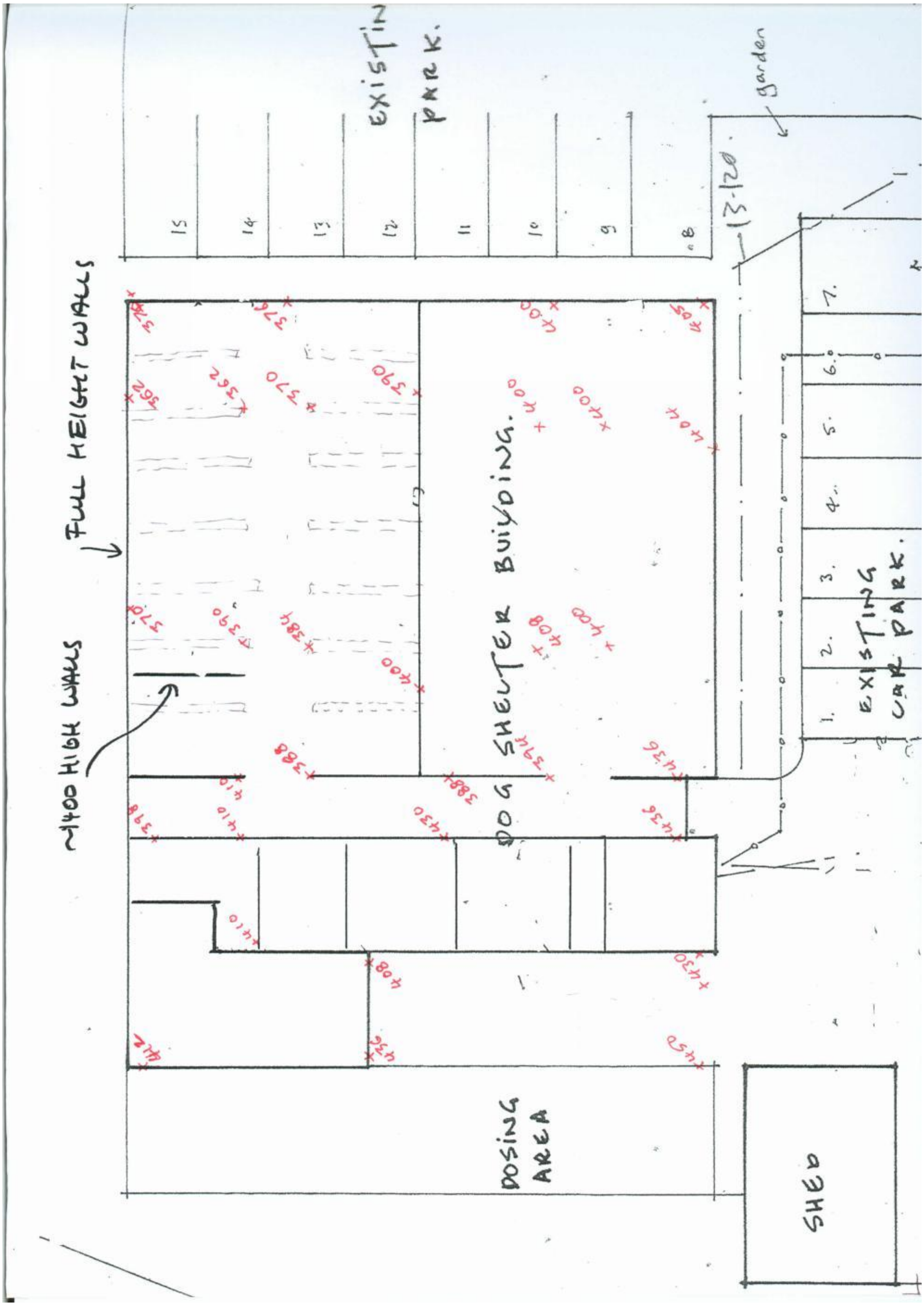

Figure 5: Levels survey plan with levels marked in red

Appendix C

CERA DEE Summary Data

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Main Dog Shelter	Reviewer:	David Whittaker
	Unit No: Street	CPEng No:	123089
Building Address:	10 Metro Place, Bromley 8062	Company:	Beca
Legal Description:	BU 0890-001	Company project number:	5323355
		Company phone number	03 3663521
	Degrees Min Sec		
GPS south:		Date of submission:	13/05/2013
GPS east:		Inspection Date:	
		Revision:	B
Building Unique Identifier (CCC):	BU 0890-001	Is there a full report with this summary?	yes

Site

Site slope:	flat	Max retaining height (m):	0
Soil type:	silty sand	Soil Profile (if available):	
Site Class (to NZS1170.5):	D		
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):	0.00

Building

No. of storeys above ground:	1	single storey = 1	
		Ground floor elevation (Absolute) (m):	0.00
Ground floor split?	no	Ground floor elevation above ground (m):	0.00
Storeys below ground	0		
Foundation type:	other (describe)	if Foundation type is other, describe:	Assumed slab on grade
Building height (m):	3.20	height from ground to level of uppermost seismic mass (for IEP only) (m):	3.2
Floor footprint area (approx):	400		
Age of Building (years):	32	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):	other (specify)		
Use notes (if required):	Dog Shelter		
Importance level (to NZS1170.5):	IL2		

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber framed	rafter type, purlin type and cladding	timber
Floors:	other (note)	describe sytem	Concrete slab on grade
Beams:	timber	type	
Columns:	structural steel	typical dimensions (mm x mm)	50mm round
Walls:	fully filled concrete masonry	#N/A	

Lateral load resisting structure

Lateral system along:	fully filled CMU	**Note: Define along and across in detailed report!**	note total length of wall at ground (m):	48.9
Ductility assumed, μ:	1.25		wall thickness (m):	0.19
Period along:	0.40	0.00 from parameters in sheet	estimate or calculation?	estimated
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	
Lateral system across:	fully filled CMU		note total length of wall at ground (m):	40.8
Ductility assumed, μ:	1.25		wall thickness (m):	0.19
Period across:	0.40	0.01 from parameters in sheet	estimate or calculation?	estimated
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	

Separations:

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

Non-structural elements

Stairs:	other (specify)	describe	N/A
Wall cladding:	other light	describe	N/A
Roof Cladding:	Metal	describe	Light corrugated element
Glazing:	aluminium frames		
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:	Okay	Describe damage:	Cracking to slab and CMU walls
Settlement:	25-100m	notes (if applicable):	Unkown
Differential settlement:	0-1:350	notes (if applicable):	Survey shows approx. 70mm max
Liquefaction:	0-2 m²/100m²	notes (if applicable):	Survey required to confirm
Lateral Spread:	0-50mm	notes (if applicable):	Survey required to confirm
Differential lateral spread:	0-1:400	notes (if applicable):	Survey required to confirm
Ground cracks:	0-20mm/20m	notes (if applicable):	Survey required to confirm
Damage to area:	slight	notes (if applicable):	

Building:

	Current Placard Status:	green		
Along	Damage ratio:	10%	Describe how damage ratio arrived at:	estimate on visual observation
	Describe (summary):			
Across	Damage ratio:	10%		
	Describe (summary):			
Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	yes	Describe:	vert. cracks in walls due to plan irreg.
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	no	Describe:	

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

Recommendations

	Level of repair/strengthening required:	minor structural	Describe:	
	Building Consent required:	yes	Describe:	
	Interim occupancy recommendations:	full occupancy	Describe:	
Along	Assessed %NBS before:	48%	0% %NBS from IEP below	If IEP not used, please detail assessment methodology: Hand calculations to estimate in-plane and out-of-plane c
	Assessed %NBS after:	43%		
Across	Assessed %NBS before:	62%	0% %NBS from IEP below	
	Assessed %NBS after:	56%		

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):	1976-1992	h_n from above:	3.2m
Seismic Zone, if designed between 1965 and 1992:	B	not required for this age of building	
		not required for this age of building	

	along	across
Period (from above):	0.4	0.4
(%NBS)nom from Fig 3.3:	0.0%	0.0%

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

	along	across
Final (%NBS)nom:	**0%**	**0%**

2.2 Near Fault Scaling Factor

Near Fault scaling factor, from NZS1170.5, cl 3.1.6: 1.00

	along	across
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: 0.8
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

	along	across
Assessed ductility (less than max in Table 3.2)	1.25	1.25
Ductility scaling factor: =1 from 1976 onwards; or =kμ, if pre-1976, fromTable 3.3:	1.00	1.00
Ductiity Scaling Factor, **Factor D**:	1.00	1.00

2.6 Structural Performance Scaling Factor:

	along	across
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

	along	across
%NBSb:	**0%**	**0%**

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

3.1. Plan Irregularity, factor A:	significant	0.7
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

3.6. Other factors, Factor F

	Along	Across
For ≤ 3 storeys, max value =2.5, otherwise max valule =1.5, no minimum	0.0	0.0
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)	**0.00**	**0.00**
4.3 PAR x (%NBS)b: PAR x Baselline %NBS	**0%**	**0%**

4.4 Percentage New Building Standard (%NBS), (before) **0%**