CHRISTCHURCH CITY COUNCIL
PRK_2347_BLDG_002 EQ2
Travis Wetland Barn & Dairy Unit
280 Beach Road, Burwood

QUALITATIVE ASSESSMENT REPORT

FINAL

- Rev B
- 24 September 2013

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1. Executive Summary

1.1. Background

A Qualitative Assessment was carried out on the two single storey buildings PRK_2347_BLDG_002 EQ2 located in Travis Wetland at 280 Beach Road, Burwood. The Barn and Dairy Unit are currently utilised for storage. The Barn is constructed from timber-framed walls and roof. The Dairy Unit appears to be constructed from reinforced masonry walls on the east section, with reinforced concrete and timber walls on the west and a timber-framed roof. An aerial photograph illustrating this area is shown below in Figure 1. Detailed descriptions outlining the buildings age and construction type is given in Section 5 of this report.

- Figure 1: Aerial Photograph of PRK_2347_BLDG_002 EQ2 Travis Wetland, Burwood

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

This Qualitative report for the building structure is based on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011 and a visual inspection on 21 May 2012.

1.2. Key Damage Observed

1.2.1. Barn

No external or internal damage was observed during our site inspection for this building.

1.2.2. Dairy Unit

Key damage observed includes:-

- Hairline crack in concrete wall.

1.3. Critical Structural Weaknesses

1.3.1. Barn

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

1.3.2. Dairy Unit

The following potential critical structural weakness has been identified:

- Plan irregularity in the longitudinal direction due to the opening on the north wall in the west side of the structure, which offsets the centre of rigidity from the centre of mass. However, this is probably not an effective irregularity as the main mass component in the single storey structure is the selfweight of the walls.

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

1.4.1. Barn

Based on the information available, and using the NZSEE Initial Evaluation Procedure, the original capacity of the Barn has been assessed to be in the order to 74%NBS. There was no damage observed during the site investigation, therefore the post earthquake capacity will not change as a result of earthquake damage.

The buildings have been assessed to have a seismic capacity greater than 67% NBS and is therefore not a potential earthquake risk.

1.4.2. Dairy Unit

Based on the information available, and using the NZSEE Initial Evaluation Procedure, the original capacity of the Dairy Unit has been assessed to be in the order of 42%NBS. The damage observed during the site investigation was not significant, therefore the post earthquake capacity will not change as a result of earthquake damage.

The buildings have been assessed to have a seismic capacity less than 34% NBS and is therefore a potential earthquake risk.

Please note that structural strengthening is required by law for buildings that are confirmed to have a seismic capacity of less than 34% NBS.

1.5. Recommendations

1.5.1. Barn

It is recommended that:

a) There is no damage to the building that would cause it to be unsafe to occupy.

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

1.5.2. Dairy Unit

It is recommended that:

a) There is no damage to the building that would cause it to be unsafe to occupy.

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

2. Introduction

Sinclair Knight Merz was engaged by Christchurch City Council to prepare a qualitative assessment report for the buildings located in Travis Wetland at 280 Beach Road following the magnitude 6.3 earthquake which occurred in the afternoon of the 22nd of February 2011 and the subsequent aftershocks.

The Qualitative Assessment uses the methodology recommended in the Engineering Advisory Group draft document "Guidance on Detailed Engineering Evaluation of Earthquake affected Non-residential Buildings in Canterbury", issued 19 July 2011. The qualitative assessment includes a summary of the building damage as well as an initial assessment of the likely current Seismic Capacity compared with current seismic code requirements.

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

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

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

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

At the time of this report, no intrusive site investigation, detailed analysis, or modelling of the building structure had been carried out. The building description below is based on our visual inspections.

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

3. Compliance

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

3.1. Canterbury Earthquake Recovery Authority (CERA)

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

Section 38 – Works

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

Section 51 – Requiring Structural Survey

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

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

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

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

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

3.2. Building Act

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

3.2.1. Section 112 – Alterations

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

3.2.2. Section 115 – Change of Use

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

3.2.3. Section 121 – Dangerous Buildings

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

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

3.2.4. Section 122 – Earthquake Prone Buildings

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

3.2.5. Section 124 – Powers of Territorial Authorities

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

3.2.6. Section 131 – Earthquake Prone Building Policy

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

3.3. Christchurch City Council Policy

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

The 2010 amendment includes the following:

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

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

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

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

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

3.4. Building Code

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

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

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

b) Serviceability Return Period Factor increased from 0.25 to 0.33 (80% increase in the serviceability design loads when combined with the Hazard Factor increase)

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

4. Earthquake Resistance Standards

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

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

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

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

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

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

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

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

5. Building Details

5.1. Building description

The building is located in Travis Wetland at 280 Beach Road. There are two buildings on this site, the Barn and the Dairy Unit.

Our evaluation was based on the visual inspection carried out on 21 May 2012 and a cover meter survey on 30 July 2012. Drawings were not available to verity the foundation systems and the dates of construction.

5.1.1. Barn

The Barn has one storey and is currently utilised for storage of caretaking equipment. The building is constructed from timber-framed walls and a lightweight roof with corrugated sheeting. The timber roof rafters are 150mm x 50mm and spaced at 600mm centres. The walls are clad with weatherboards with vertical posts the same size and spacing as the roof rafters. One diagonal timber bracing member is present in each bay, of which the barn is split into roughly four longitudinally and two laterally. Internal beams and columns are present in the Barn as well, supporting the roof structure. The timber-framed walls appear to be anchored to the concrete ground slab below. It is assumed the building was designed and constructed in the late 1960’s. The roof was believed to be replaced in the 1990’s.

5.1.2. Dairy Unit

The Diary Unit has one storey and is currently utilised for storage of caretaking equipment. The building is divided into two sections, with the east section believed to be constructed from reinforced masonry walls. The west section appears to be constructed from reinforced concrete walls on the south and west, with a timber wall to the east, between the two sections, and an open north face with the roof supported by three steel hollow section posts that are evenly spaced. The roof is assumed to be timber-framed with lightweight cladding for both sections. The masonry walls have concrete strip footings underneath and both sections have a concrete ground slab. It is assumed the building was designed and constructed in the late 1960’s.

5.2. Gravity Load Resisting system

5.2.1. Barn

It appears that the gravity loads are transferred through the timber-framing in the roof and taken by the timber-framed walls with direct transfer into the concrete slab foundation below.

5.2.2. Dairy Unit

Gravity loads are transferred through the timber-framed roof and taken by the masonry walls on the east section and concrete walls and steel posts on the west section. They are then transferred into the concrete slab foundation below.

5.3. Seismic Load Resisting system

5.3.1. Barn

Lateral loads acting across and along the building will be resisted by timber bracing in the timber-framed walls.

Note that for this building the 'across direction' has been taken as east-west and the 'along direction' has been taken as north-south.

5.3.2. Dairy Unit

Lateral loads acting across and along with building will be resisted by the masonry walls in shear for the east section, and concrete walls in shear for the west section. There will also be some cantilever action for the steel hollow section posts. Due to the difference in materials in the lateral load-resisting system, plan irregularity is introduced in the transverse direction.

Note that for this building the 'across direction' has been taken as north-south and the 'along direction' has been taken as east-west.

5.4. Geotechnical Conditions

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

- In accordance with NZS1170.5 the site is likely to be seismic subsoil Class D (deep or soft soil) ground performance and properties.
- Liquefaction risk is expected to be moderate to severe for this site. Significant surface evidence of liquefaction on site as well as elevated water table could be seen from the aerial photographs.
- Even though there was no evidence of lateral spreading noted during the site walkover, there is future risk of lateral spreading on site due to the significant potential for liquefaction to occur on site and the presence of free faces caused by nearby waterways.

If a quantitative assessment is to be undertaken, further site specific investigations are required to confirm the liquefaction assessment and to estimate likely ground properties on site. Additional investigations recommended are:

- Two hands augurs near each structure to a depth of 3m to assess the composition of the shallow soil layer.
- Two CPT tests on site to refusal.

6. Damage Summary

SKM undertook an inspection on 21 May 2012. The following areas of damage were observed during the time of inspection.

6.1. Barn

General

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

Building Damage

1) No earthquake-related damage was observed during our site inspection.
2) Bowed weatherboards were noted throughout the structure, but this is due to age and not earthquake-related damage.
3) Cracking through the timber weatherboards were noted throughout the structure, but this is due to age and not earthquake-related damage.
4) Existing impact damage to the weatherboards was noted on the southeast corner but this is not earthquake-related damage.
5) Displaced weatherboards were noted, but this is due to age and not earthquake-related damage.
6) Rusted steel elements were noted throughout, but this is not earthquake-related damage.

Photos of the above damage can be found in Appendix 1 – Barn Photos.

6.2. Dairy Unit

General

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

Building Damage

1) Hairline crack in the south concrete wall.
2) Corroded roof sheeting was noted on the southeast side of the building, but this is not earthquake-related damage.
3) Missing soffit elements on the north side was noted, but this is not believed to be earthquake-related damage.
4) Spalling from the concrete wall on the south and west of the building was noted, but this is due to the large aggregate size in the concrete and is not earthquake-related damage.

Photos of the above damage can be found in Appendix 1 – Barn Photos.

7. Initial Seismic Evaluation

7.1. The Initial Evaluation Procedure Process

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

The IEP is a coarse screening process designed to identify buildings that are likely to be earthquake prone. The IEP process ranks buildings according to how well they are likely to perform relative to a new building designed to current earthquake standards, as shown in

Table 2. The building rank is indicated by the percent of the required New Building Standard (%NBS) strength that the building is considered to have. Earthquake prone buildings are defined as having less than 33% NBS strength which correlates to an increased risk of approximately 20 times that of 100% NBS[3]. Buildings that are identified to be earthquake prone are required by law to be followed up with a detailed assessment and strengthening work within 30 years of the owner being notified that the building is potentially earthquake prone[4].

Table 2: IEP Risk classifications

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

The IEP is a simple desktop study that is useful for risk management. No detailed calculations are done and so it relies on an inspection of the building and its plans to identify the structural members and describe the likely performance of the building in a seismic event. A review of the

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

plans is also likely to identify any critical structural weaknesses. The IEP assumes that the building was properly designed and built according to the relevant codes at the time of construction. The IEP method rates buildings based on the code used at the time of construction and some more subjective parameters associated with how the building is detailed and so it is possible that %NBS derived from different engineers may differ.

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

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

- AS/NZS 1170 Structural Design Actions
- NZS 3101:2006 Concrete Structures Standard
- NZS 3404:1997 Steel Structures Standard

7.2. Available Information, Assumptions and Limitations

Following our inspection on 21 May 2012, SKM carried out a preliminary structural review. The structural review was undertaken using the available information which was as follows:

- SKM site measurements and external and internal inspection findings of the buildings. Please note no intrusive investigations were undertaken.
- There were no drawings available to carry out our review.

The following assumptions and design criteria were used in this assessment:

- Standard design assumptions for typical office and factory buildings as described in AS/NZS1170.0:2002
  - 50 year design life, which is the default NZ Building Code design life.
  - Structure Importance Level 2. This level of importance is described as ‘normal’ with medium or considerable consequence of failure.
  - Ductility level of 1.25 in both directions, based on our assessment and code requirements at the time of design.

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

- Site hazard factor, Z = 0.3, NZBC, Clause B1 Structure, Amendment 11 effective from 1 August 2011

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

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

7.3. Critical Structural Weaknesses

7.3.1. Barn

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

7.3.2. Dairy Unit

The following potential critical structural weakness has been identified:

- Plan irregularity in the longitudinal direction due to the opening on the north wall in the west side of the structure, which offsets the centre of rigidity from the centre of mass. However, this is probably not an effective irregularity as the main mass component in the single storey structure is the selfweight of the walls.

7.4. Qualitative Assessment Results

7.4.1. Barn

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

Table 3: Qualitative Assessment Summary

Item	%NBS
Likely Seismic Capacity of Building	74

Our qualitative assessment found that the building is not likely to be classed as a potential earthquake risk and is probably a ‘Low Risk Building’ (capacity greater than 67% of NBS). The full IEP assessment form is detailed in Appendix 3 – IEP Reports.

7.4.2. Dairy Unit

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

Table 4: Qualitative Assessment Summary

Item	%NBS
Likely Seismic Capacity of Building	42

Our qualitative assessment found that the building is likely to be classed as a potential earthquake risk and probably a ‘Moderate Risk Building’ (capacity less than 34% of NBS). The full IEP assessment form is detailed in Appendix 3 – IEP Reports.

Further investigation is required to confirm our initial findings and establish possible strengthening concepts.

The Council regulations state that if the %NBS of the building is less than 34%, this building is considered earthquake prone and is required to be strengthened.

The Engineering Advisory Group notes:

> *“For buildings with insignificant damage, but that have %NBS<33%, and buildings with significant damage, a quantitative assessment is required. Note that according to the extent of damage, it may be possible to complete a quantitative assessment for part only of the structure, with a qualitative analysis for the structure as a whole. This could be sufficient when there is highly localised severe damage but the building has otherwise suffered little or no damage.”*

8. Further Investigation

8.1. Barn

Since the building has a likely seismic capacity greater than 67% NBS and is believed to have sustained no structural damage no further investigation is required at this stage.

8.2. Dairy Unit

Due to the lack of structural drawings and the likely seismic capacity of both of the building being less than 67% NBS we recommend that a quantitative assessment is carried out due to the potential margin of errors that may be inherent in our initial assessment. This will allow us to confirm our findings and establish possible strengthening concepts.

If a quantitative assessment is carried out then intrusive investigations will be required to confirm the following structural details.

- Foundation layout and size of elements.
- Structural roof member sizes and layouts.
- Connections sizes and layouts.

It is believed that a building consent is not likely to be required for the repair of the damage noted in Section 6, but a consent will likely be required to strengthen the building.

9. Conclusion

A qualitative assessment was carried out on the buildings located in Travis Wetland at 280 Beach Road, Burwood.

9.1. Barn

The building has sustained no earthquake-related damage. The building has been assessed to have a seismic capacity in the order of 74% NBS and is therefore not a potential earthquake risk and is likely to be classified as a 'Low Risk Building' (capacity greater than 67% of NBS).

No further investigation is required at this stage of the assessment.

It is recommended that:

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

9.2. Dairy Unit

The building has sustained minor damage to the external concrete wall with a hairline crack on the south wall. The building has been assessed to have a seismic capacity in the order of 42% NBS and is therefore a potential earthquake risk and is likely to be classified as a 'Moderate Risk Building' (capacity less than 67% of NBS).

Further investigation is required to confirm our initial findings and to establish possible strengthening concepts. This investigation will require carrying out a quantitative assessment on the building to determine if there is enough capacity in the structural elements to resist the required earthquake demand. If the building is to be strengthened, building consent will likely be required.

It is recommended that:

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

10. Limitation Statement

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

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

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

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

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

11. Appendix 1 – Barn Photos

	
Photo 1: South elevation	Photo 2: East elevation
	
Photo 3: North elevation	Photo 4: West elevation

Photo 5: Cracking in timber weatherboards on southern wall.

Photo 6: Cracking in timber weatherboards on southern wall.

Photo 7: Damaged timber cladding on southern wall.

Photo 8: Corrugated sheet metal roof cladding and timber wall cladding on southern side.

	
Photo 9: Opening on south side of building.	Photo 10: Internal timber walls with 150x50mm posts at 600mm spacing.
	
Photo 11: Timber roof rafters at 600mm spacing.	Photo 12: Timber roof rafters at 600mm spacing and external timber wall with 150x50mm posts at 600mm spacing.

Photo 13: Timber wall in southeast corner of building with timber diagonal bracing.

Photo 14: Existing impact damage to timber weatherboards on southeast corner.

Photo 15: Cracking to timber weatherboards on east wall.

Photo 16: Cracking to timber weatherboards on east wall.

	
Photo 17: Cracking to timber weatherboards on east wall.	Photo 18: Bowed weatherboards on east timber wall.
	
Photo 19: Bowed weatherboards on east timber wall and roller door entrance to building.	Photo 20: Missing weatherboards at roof apex on east wall.

	
Photo 21: Northeast elevation with extension shown.	Photo 22: Rusted steel elements of building.
	
Photo 23: Bowed weatherboards on east timber wall.	Photo 24: Bowed weatherboards on east timber wall.

Photo 25: Window on east wall showing diagonal timber bracing member.

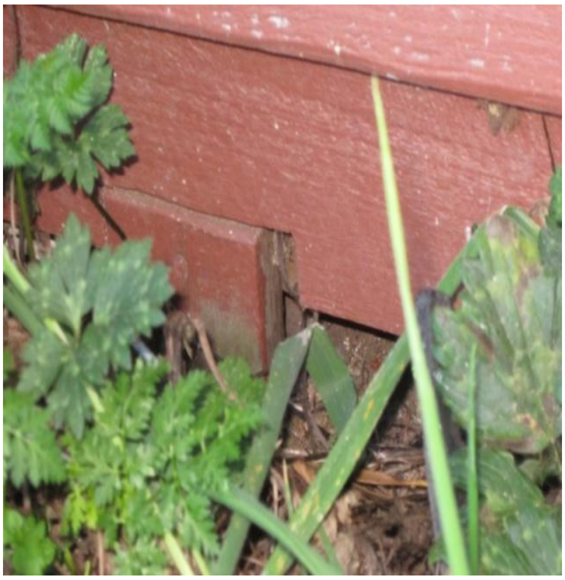


Photo 26: Base of external east wall.

Photo 27: East wall of extension on the north side of the building.

Photo 28: Entrance to corrugated sheeting extension on north side of building.

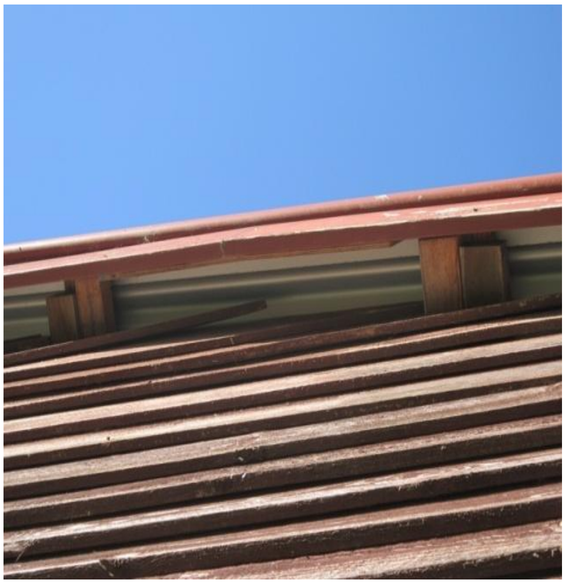
Photo 29: External corrugated metal and timber wall members of north extension.

Photo 30: Internal timber wall of north extension.

Photo 31: Internal wall and door in north extension.

Photo 32: Internal timber wall of north extension with corrugated metal roof.

	
Photo 33: West entrance to north extension.	Photo 34: Internal layout of north extension showing corrugated metal external walls with timber posts and internal timber walls.
	
Photo 35: Opening on shared wall between original barn building and north extension.	Photo 36: Rusted roller door elements on west wall.

	
Photo 37: Rusted roller door elements on west wall.	Photo 38: Rusted roller door elements on west wall.
	
Photo 39: Bowed weatherboards on west wall.	Photo 40: Soffit on west side with exposed corrugated roof sheeting and timber roof rafters.

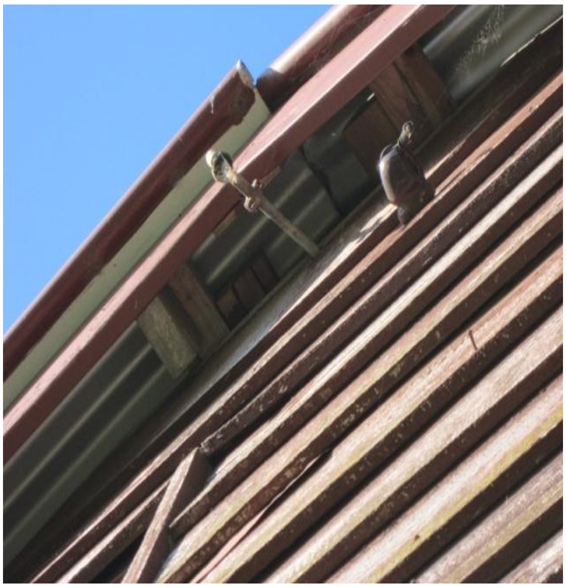


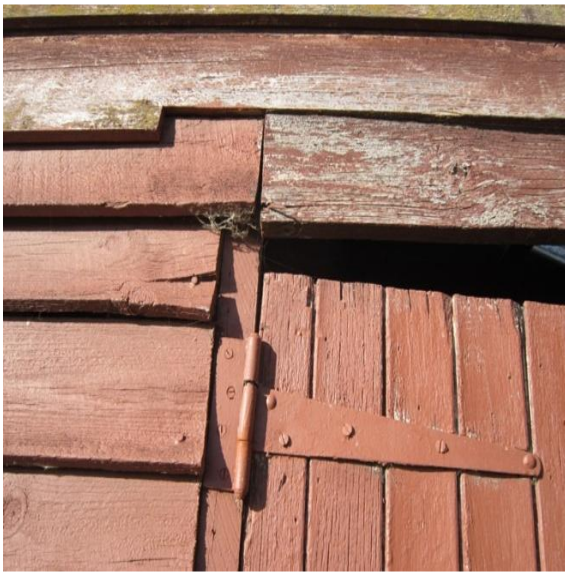
Photo 41: Soffit on west side with exposed corrugated roof sheeting and timber roof rafters.	Photo 42: Gap between doors on west side showing timber roof rafters inside.
	
Photo 43: Existing damage to timber members on west wall.	Photo 44: Cracking of timber weatherboards on west wall by door.

	
Photo 45: Displaced timber roof beam over west entrace to northern extension.	Photo 46: Base of west timber wall.
	
Photo 47: Internal timber wall by west door.	Photo 48: Concrete ground slab by west door.

	
Photo 49: Unlevelled surface of concrete slab inside the barn.	Photo 50: Underneath raised platform in centre of barn, supported by timber elements.

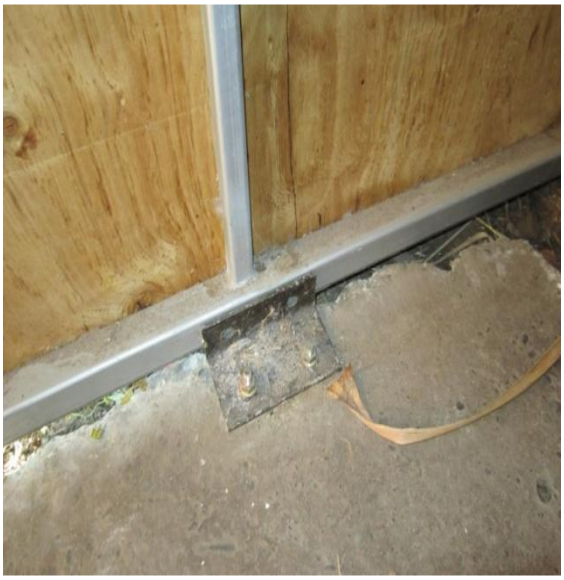



Photo 51: Anchors in concrete slab in west roller door support.	Photo 52: Exposed corrugated roof sheeting with timber roof rafters and raised platform.

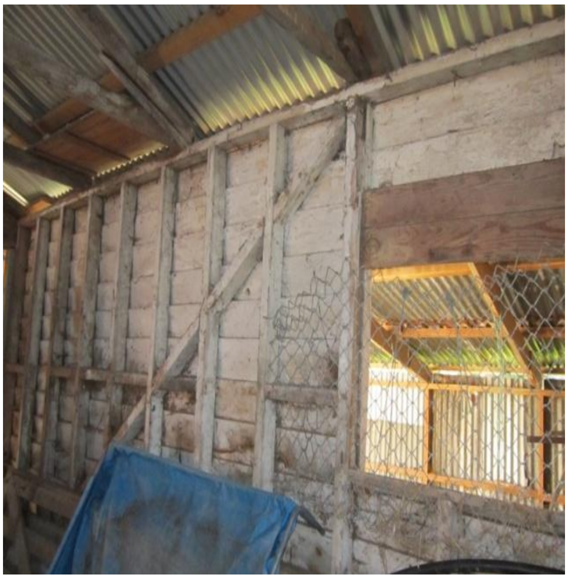
	
Photo 53: Base of timber wall on concrete slab.	Photo 54: Timber wall base anchored into concrete slab.
	
Photo 55: Exposed corrugated roof sheeting with timber roof rafters. Internal timber beams and columns also shown.	Photo 56: Diagonal timber wall brace on internal wall shown.

	
Photo 57: Diagonal timber wall brace on internal wall shown.	Photo 58: Exposed corrugated roof sheeting and timber roof rafters, with internal timber beams and columns shown providing support to the roof elements.
	
Photo 59: Exposed corrugated roof sheeting and timber roof rafters, with internal timber beams and columns shown providing support to the roof elements.	Photo 60: Exposed corrugated roof sheeting and timber roof rafters, with internal timber beams and columns shown providing support to the roof elements, by raised platform.

12. Appendix 2 – Dairy Unit Photos

	
Photo 1: East elevation	Photo 2: North elevation
	
Photo 3: South elevation	Photo 4: West elevation

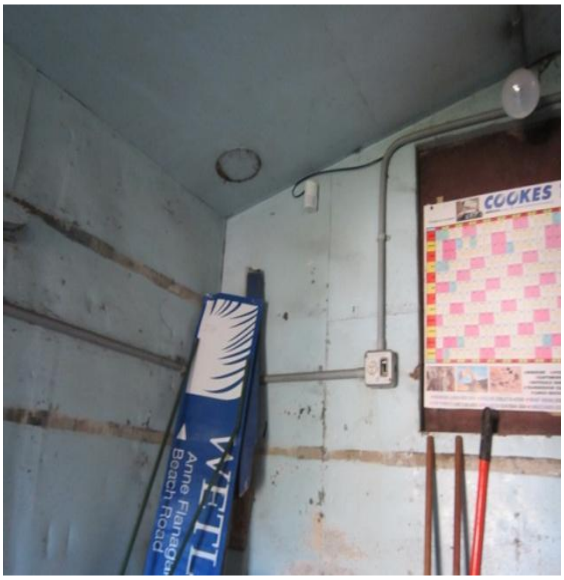


Photo 5: Internal layout of east section showing plasterboard cladding.	Photo 6: Internal layout of east section showing plasterboard cladding and internal masonry wall.

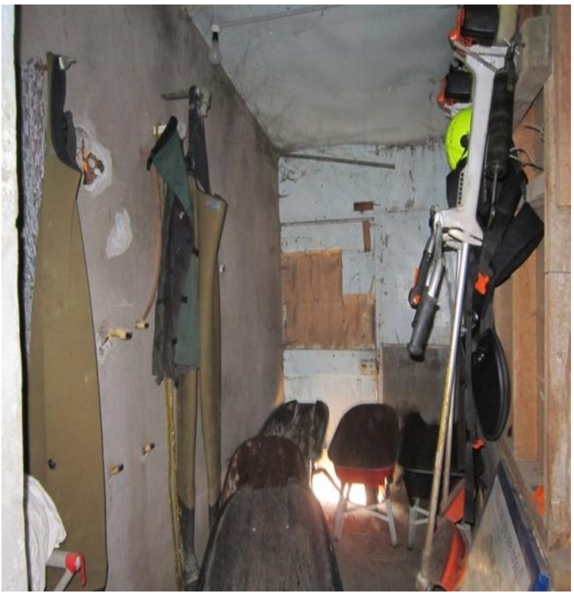



Photo 7: Internal layout of east section showing plasterboard cladding.	Photo 8: Internal layout of east section showing plasterboard cladding and internal masonry wall.

	
Photo 9: Lean-to on the south of the building with a timber-framed roof and corrugated metal roof.	Photo 10: Concrete slab at ground level.
	
Photo 11: Lean-to on the south of the building with a timber-framed roof and corrugated metal roof.	Photo 12: Lean-to on the south of the building with corroded metal roof sheeting.

	
Photo 13: Cracking in timber weatherboards on south lean-to.	Photo 14: Timber column on east side of lean-to.
	
Photo 15: Lean-to on the south of the building with a timber-framed roof and rusted corrugated metal roof.	Photo 16: Base of timber column on east side appears to have no fixed shear connection to the concrete ground slab.

	
Photo 17: Lean-to on the south of the building with a timber-framed roof and corrugated metal roof.	Photo 18: East masonry wall with two garage doors.
	
Photo 19: East masonry wall with two garage doors and concrete strip footing.	Photo 20: East masonry wall with two garage doors and concrete strip footing.

	
Photo 21: East masonry section of north wall with extended lightweight roof.	Photo 22: West section of building with three equally spaced steel hollow section posts.
	
Photo 23: North gutter on west section.	Photo 24: Internal steel hollow section props in the west section.

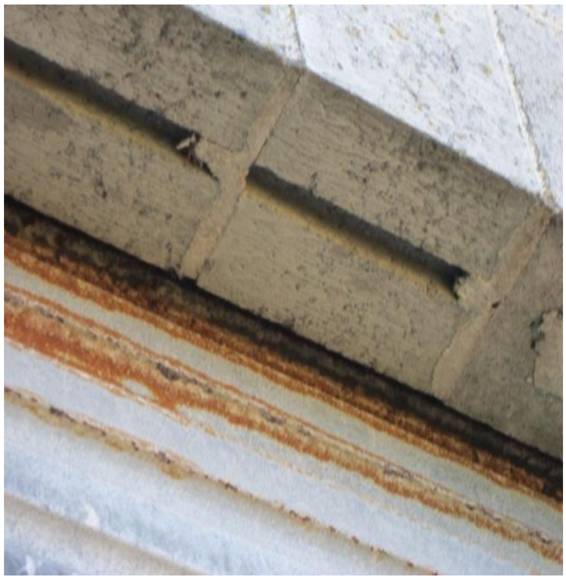
	
Photo 25: Area between the east and west sections.	Photo 26: Timber wall above low concrete wall dividing the east and west sections.
	
Photo 27: Soffit element missing on north side.	Photo 28: Roller door on east side has rusted.

	
Photo 29: Rusted corrugated roof sheeting on south lean-to.	Photo 30: Missing weatherboard on south side of south lean-to.
	
Photo 31: South timber wall joins with south concrete wall.	Photo 32: Deflected corrugated wall sheeting on south lean-to.

	
Photo 33: South concrete wall.	Photo 34: Area between east and west sections.
	
Photo 35: Timber wall of east section.	Photo 36: South concrete wall of west section, with timber roof rafters shown under corrugated roof sheeting.

	
Photo 37: Spalling of south concrete wall due to large aggregate sizes. Timber roof elements also shown.	Photo 38: Vertical hairline crack on south concrete wall.
	
Photo 39: Large aggregate sizes in west concrete wall.	Photo 40: Large aggregate sizes in concrete wall on southwest corner.

	
Photo 41: Timber roof rafters shown on west side.	Photo 42: Large aggregate sizes in west concrete wall.

13. Appendix 3 – IEP Reports

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

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

Page 1

Building Name:	**PRK_2347_BLDG_002 EQ2 Travis Wetland - Barn**	Ref.	**ZB01276.136**
Location:	280 Beach Road, Burwood	By	WPK
		Date	31/05/2012

Step 1 - General Information

1.1 Photos (attach sufficient to describe building)

1.2 Sketch of building plan

1.3 List relevant features

The building in Travis Wetlands at 280 Beach Road is one storey and is currently utilised for storage. The building consists of timber-framed walls. The main lateral load-resisting system appear to be the walls. These are braced in the north-south and east-west direction. The roof structure appears to consist of timber rafters that support a lightweight roof. The timber-framed walls appear to be anchored to a concrete slab below. The building is assumed to have been constructed in the late 1960's, however the roof was replaced recently and this is assumed to have taken place in the 1990's.

1.4 Note information sources

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

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Table IEP-2 Initial Evaluation Procedure – Step 2

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

Building Name:	**PRK_2347_BLDG_002 EQ2 Travis Wetland - Barn**	Ref.	**ZB01276.136**
Location:	280 Beach Road, Burwood	By	WPK
Direction Considered:	**Longitudinal & Transverse**	Date	31/05/2012

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

Step 2 - Determination of (%NBS)b

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

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

b) Soil Type

From NZS1170.5:2004, Cl 3.1.3

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

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

a) Rigid	○	N-A
b) Intermediate	○	

c) Estimate Period, T

building Ht = 7 meters

	Longitudinal	Transverse	
Ac =	130	56	m2

Can use following:

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

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

Longitudinal	Transverse	
0.3	0.3	Seconds

d) (%NBS)nom determined from Figure 3.3

Longitudinal	5	$(\%NBS)_{nom}$
Transverse	5	$(\%NBS)_{nom}$

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

Longitudinal	5.0	$(\%NBS)_{nom}$
Transverse	5.0	$(\%NBS)_{nom}$

Continued over page

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Table IEP-2 **Initial Evaluation Procedure – Step 2 continued** SKM Page 3

Building Name:	PRK_2347_BLDG_002 EQ2 Travis Wetland - Barn	Ref.	ZB01276.136
Location:	280 Beach Road, Burwood	By	WPK
Direction Considered:	**Longitudinal & Transverse**	Date	31/05/2012

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

2.2 Near Fault Scaling Factor, Factor A
If T < 1.5sec, Factor A = 1

a) Near Fault Factor, N(T,D) 1
(from NZS1170.5:2004, Cl 3.1.6)

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

2.3 Hazard Scaling Factor, Factor B

Select Location: Christchurch

a) Hazard Factor, Z, for site
(from NZS1170.5:2004, Table 3.3) Z = 0.3
Z 1992 = 0.8

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

b) Hazard Scaling Factor
For pre 1992 = 1/Z
\# For 1992 onwards = Z 1992/Z
(Where Z 1992 is the NZS4203:1992 Zone Factor from accompanying Figure 3.5(b))

Factor B 3.33

2.4 Return Period Scaling Factor, Factor C

a) Building Importance Level 2
(from NZS1170.0:2004, Table 3.1 and 3.2)

b) Return Period Scaling Factor from accompanying Table 3.1 **Factor C** 1.00

2.5 Ductility Scaling Factor, D

a) Assessed Ductility of Existing Structure, μ
(shall be less than maximum given in accompanying Table 3.2)

Longitudinal	2	μ Maximum = 2
Transverse	2	μ Maximum = 2

b) Ductility Scaling Factor
For pre 1976 = k_μ
For 1976 onwards = 1
(where k_μ is NZS1170.5:2005 Ductility Factor, from accompanying Table 3.3)

Longitudinal	**Factor D**	1.57
Transverse	**Factor D**	1.57

2.6 Structural Performance Scaling Factor, Factor E

Select Material of Lateral Load Resisting System
Longitudinal Timber
Transverse Timber

a) Structural Performance Factor, S_p
from accompanying Figure 3.4

Longitudinal	Sp	0.70
Transverse	Sp	0.70

b) Structural Performance Scaling Factor

Longitudinal	$1/S_p$	**Factor E**	1.43
Transverse	$1/S_p$	**Factor E**	1.43

2.7 Baseline %NBS for Building, $(\%NBS)_b$
(equals $(\%NSB)_{nom}$ x A x B x C x D x E)

Longitudinal	37.4	(%NBS)b
Transverse	37.4	(%NBS)b

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Table IEP-3 **Initial Evaluation Procedure – Step 3**

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

Building Name:	**PRK_2347_BLDG_002 EQ2 Travis Wetland - Barn**	Ref.	**ZB01276.136**
Location:	280 Beach Road, Burwood	By	WPK
Direction Considered:	**a) Longitudinal**	Date	31/05/2012

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

Step 3 - Assessment of Performance Achievement Ratio (PAR)
(Refer Appendix B - Section B3.2)

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

3.1 Plan Irregularity
Effect on Structural Performance: Severe ○ / Significant ○ / Insignificant ◉ — **Factor A** 1
Comment

3.2 Vertical Irregularity
Effect on Structural Performance: Severe ○ / Significant ○ / Insignificant ◉ — **Factor B** 1
Comment

3.3 Short Columns
Effect on Structural Performance: Severe ○ / Significant ○ / Insignificant ◉ — **Factor C** 1
Comment

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

a) Factor D1: - Pounding Effect
Select appropriate value from Table

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

Factor D1 1

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

b) Factor D2: - Height Difference Effect
Select appropriate value from Table

Factor D2 1

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

Factor D 1
(Set D = lesser of D1 and D2 or..
set D = 1.0 if no prospect of pounding)

3.5 Site Characteristics - (Stability, landslide threat, liquefaction etc)
Effect on Structural Performance: Severe ○ 0.5 / Significant ○ 0.7 / Insignificant ◉ 1 — **Factor E** 1

3.6 Other Factors
For < 3 storeys - Maximum value 2.5,
otherwise - Maximum value 1.5. No minimum. — **Factor F** 2

Record rationale for choice of Factor F:
Lightweight, single storey timber structure not governed by seismic loads. Timber wall bracing present.

3.7 Performance Achievement Ratio (PAR)
(equals A x B x C x D x E x F) — **PAR** 2

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Table IEP-3 — **Initial Evaluation Procedure – Step 3** Page 5

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

Building Name:	PRK_2347_BLDG_002 EQ2 Travis Wetland - Barn	Ref.	ZB01276.136
Location:	280 Beach Road, Burwood	By	WPK
Direction Considered:	b) Transverse	Date	31/05/2012

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

Step 3 - Assessment of Performance Achievement Ratio (PAR)

(Refer Appendix B - Section B3.2)

Critical Structural Weakness	Effect on Structural Performance (Choose a value - Do not interpolate)				Building Score
	Severe	Significant	Insignificant		
3.1 Plan Irregularity – Effect on Structural Performance	○	○	◉	**Factor A**	1
Comment					
3.2 Vertical Irregularity – Effect on Structural Performance	○	○	◉	**Factor B**	1
Comment					
3.3 Short Columns – Effect on Structural Performance	○	○	◉	**Factor C**	1
Comment					

3.4 Pounding Potential

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

a) Factor D1: - Pounding Effect
Select appropriate value from Table

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

Factor D1 1

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

b) Factor D2: - Height Difference Effect
Select appropriate value from Table

Factor D2 1

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

Factor D 1

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

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

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

3.6 Other Factors

For < 3 storeys - Maximum value 2.5,

otherwise - Maximum value 1.5. No minimum. **Factor F** 2

Record rationale for choice of Factor F:
Lightweight, single storey timber structure not governed by seismic loads. Timber wall bracing present.

3.7 Performance Achievement Ratio (PAR)
(equals A x B x C x D x E x F) **PAR** 2

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Table IEP-4 **Initial Evaluation Procedure – Steps 4, 5 and 6**
(Refer Table IEP - 1 for Step 1; Table IEP - 2 for Step 2, Table IEP - 3 for Step 3)

Page 6

Building Name:	**PRK_2347_BLDG_002 EQ2 Travis Wetland - Barn**	Ref.	**ZB01276.136**
Location:	280 Beach Road, Burwood	By	WPK
Direction Considered:	**Longitudinal & Transverse**	Date	31/05/2012

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

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

	Longitudinal	Transverse
4.1 Assessed Baseline (%NBS)$_b$ (from Table IEP - 1)	37	37
4.2 Performance Achievement Ratio (PAR) (from Table IEP - 2)	2.00	2.00
4.3 PAR x Baseline (%NBS)$_b$	74	74
4.4 Percentage New Building Standard (%NBS) (Use lower of two values from Step 4.3)		74

Step 5 - Potentially Earthquake Prone?
(Mark as appropriate)

%NBS ≤ 33 — NO

Step 6 - Potentially Earthquake Risk?

%NBS < 67 — NO

Step 7 - Provisional Grading for Seismic Risk based on IEP

Seismic Grade — B

Evaluation Confirmed by

Signature

NICK CALVERT Name

242062 CPEng. No

Relationship between Seismic Grade and % NBS :

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

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

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

Building Name:	**PRK_2347_BLDG_002 EQ2 Dairy Unit**	Ref.	**ZB01276.136**
Location:	280 Beach Road, Burwood	By	WPK
		Date	31/05/2012

Step 1 - General Information

1.1 Photos (attach sufficient to describe building)

1.2 Sketch of building plan

1.3 List relevant features

The building in Travis Wetlands at 280 Beach Road is one storey and is currently in utilised for storage. The building appears to consist of reinforced masonry walls on the east section, and a combination of timber-framed and concrete walls on the west section. The main lateral load-resisting system appear to be the walls. These act as shear walls in the north-south and east-west direction. The roof structure appears to consist of timber rafters that support a lightweight roof. The masonry walls are supported on concrete strip footings with a concrete ground slab while the timber-framed and concrete walls appear to be supported on the concrete slab. The building is assumed to have been constructed in the late 1960's.

1.4 Note information sources

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

Cover meter survey

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Table IEP-2 **Initial Evaluation Procedure – Step 2**

Page 2

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

Building Name:	PRK_2347_BLDG_002 EQ2 Dairy Unit	Ref.	ZB01276.136
Location:	280 Beach Road, Burwood	By	WPK
Direction Considered:	Longitudinal & Transverse	Date	31/05/2012

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

Step 2 - Determination of (%NBS)b

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

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

b) Soil Type

From NZS1170.5:2004, Cl 3.1.3

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

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

a) Rigid	○	N-A
b) Intermediate	○	

c) Estimate Period, T

building Ht = 4.4 meters

	Longitudinal	Transverse	
Ac =	50	43	m2

Can use following:

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

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

Longitudinal	Transverse	
0.0	0.4	Seconds

d) (%NBS)nom determined from Figure 3.3

Longitudinal	5	$(\%NBS)_{nom}$
Transverse	5	$(\%NBS)_{nom}$

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

Longitudinal	5.0	$(\%NBS)_{nom}$
Transverse	5.0	$(\%NBS)_{nom}$

Continued over page

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Table IEP-2 **Initial Evaluation Procedure – Step 2 continued** Page 3

Building Name:	**PRK_2347_BLDG_002 EQ2 Dairy Unit**	Ref.	**ZB01276.136**
Location:	280 Beach Road, Burwood	By	WPK
Direction Considered:	**Longitudinal & Transverse**	Date	31/05/2012

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

2.2 Near Fault Scaling Factor, Factor A
If T < 1.5sec, Factor A = 1

a) **Near Fault Factor, N(T,D)** 1
(from NZS1170.5:2004, Cl 3.1.6)

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

2.3 Hazard Scaling Factor, Factor B

Select Location Christchurch

a) **Hazard Factor, Z, for site**
(from NZS1170.5:2004, Table 3.3) Z = 0.3
Z 1992 = 0.8

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

b) **Hazard Scaling Factor**
For pre 1992 = 1/Z
For 1992 onwards = Z 1992/Z
(Where Z 1992 is the NZS4203:1992 Zone Factor from accompanying Figure 3.5(b))

Factor B 3.33

2.4 Return Period Scaling Factor, Factor C

a) **Building Importance Level** 2
(from NZS1170.0:2004, Table 3.1 and 3.2)

b) **Return Period Scaling Factor from accompanying Table 3.1** **Factor C** 1.00

2.5 Ductility Scaling Factor, D

a) **Assessed Ductility of Existing Structure, μ**
(shall be less than maximum given in accompanying Table 3.2)

Longitudinal	2	μ Maximum = 2
Transverse	1.25	μ Maximum = 2

b) **Ductility Scaling Factor**
For pre 1976 = k_μ
For 1976 onwards = 1
(where k_μ is NZS1170.5:2005 Ductility Factor, from accompanying Table 3.3)

Longitudinal	**Factor D**	1.57
Transverse	**Factor D**	1.14

2.6 Structural Performance Scaling Factor, Factor E

Select Material of Lateral Load Resisting System
Longitudinal Concrete
Transverse Masonry Block

a) **Structural Performance Factor, S_p**
from accompanying Figure 3.4

Longitudinal	Sp	0.81
Transverse	Sp	0.90

b) **Structural Performance Scaling Factor**

Longitudinal	$1/S_p$	**Factor E**	1.23
Transverse	$1/S_p$	**Factor E**	1.11

2.7 Baseline %NBS for Building, $(\%NBS)_b$
(equals $(\%NSB)_{nom}$ x A x B x C x D x E)

Longitudinal	32.2	(%NBS)b
Transverse	21.2	(%NBS)b

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Table IEP-3 **Initial Evaluation Procedure – Step 3**

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

Page 4

Building Name:	**PRK_2347_BLDG_002 EQ2 Dairy Unit**	Ref.	**ZB01276.136**
Location:	280 Beach Road, Burwood	By	WPK
Direction Considered:	**a) Longitudinal**	Date	31/05/2012

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

Step 3 - Assessment of Performance Achievement Ratio (PAR)
(Refer Appendix B - Section B3.2)

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

3.1 Plan Irregularity
Effect on Structural Performance: Severe ○ | Significant ◉ | Insignificant ○ — **Factor A** 0.7
Comment

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

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

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

a) Factor D1: - Pounding Effect
Select appropriate value from Table

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

Factor D1 1

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

b) Factor D2: - Height Difference Effect
Select appropriate value from Table

Factor D2 1

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

Factor D 1
(Set D = lesser of D1 and D2 or..
set D = 1.0 if no prospect of pounding)

3.5 Site Characteristics - (Stability, landslide threat, liquefaction etc)
Effect on Structural Performance: Severe ○ 0.5 | Significant ○ 0.7 | Insignificant ◉ 1 — **Factor E** 1

3.6 Other Factors
For < 3 storeys - Maximum value 2.5,
otherwise - Maximum value 1.5. No minimum. — **Factor F** 2.5

Record rationale for choice of Factor F:
Small, single storey building with most of the mass in the walls themselves. Plan irregularity offset as it is probably not an effective irregularity as the only weight in the west part of the structure where the opening occurs is the concrete wall on the opposite side of the opening and the lightweight roof. Constrained by maximum allowable Factor F value.

3.7 Performance Achievement Ratio (PAR)
(equals A x B x C x D x E x F) — **PAR** 1.75

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Table IEP-3 **Initial Evaluation Procedure – Step 3**

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

Page 5

Building Name:	**PRK_2347_BLDG_002 EQ2 Dairy Unit**	Ref.	**ZB01276.136**
Location:	280 Beach Road, Burwood	By	WPK
Direction Considered:	**b) Transverse**	Date	31/05/2012

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

Step 3 - Assessment of Performance Achievement Ratio (PAR)
(Refer Appendix B - Section B3.2)

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

3.1 Plan Irregularity

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

3.2 Vertical Irregularity

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

3.3 Short Columns

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

3.4 Pounding Potential

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

a) Factor D1: - Pounding Effect
Select appropriate value from Table

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

Factor D1 1

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

b) Factor D2: - Height Difference Effect
Select appropriate value from Table

Factor D2 1

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

Factor D 1

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

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

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

3.6 Other Factors

For < 3 storeys - Maximum value 2.5,

otherwise - Maximum value 1.5. No minimum. **Factor F** 2

Record rationale for choice of Factor F:
Small, single storey building with most of the mass in the walls themselves.

3.7 Performance Achievement Ratio (PAR)
(equals A x B x C x D x E x F) **PAR** 2

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Table IEP-4 **Initial Evaluation Procedure – Steps 4, 5 and 6** Page 6

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

Building Name:	**PRK_2347_BLDG_002 EQ2 Dairy Unit**	Ref.	**ZB01276.136**
Location:	280 Beach Road, Burwood	By	WPK
Direction Considered:	**Longitudinal & Transverse**	Date	31/05/2012

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

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

	Longitudinal	Transverse
4.1 Assessed Baseline ($\%NBS)_b$ (from Table IEP - 1)	32	21
4.2 Performance Achievement Ratio (PAR) (from Table IEP - 2)	1.75	2.00
4.3 PAR x Baseline ($\%NBS)_b$	56	42
4.4 Percentage New Building Standard (%NBS) (Use lower of two values from Step 4.3)		42

Step 5 - Potentially Earthquake Prone?
(Mark as appropriate)

%NBS ≤ 33 — NO

Step 6 - Potentially Earthquake Risk?

%NBS < 67 — YES

Step 7 - Provisional Grading for Seismic Risk based on IEP

Seismic Grade — **C**

Evaluation Confirmed by

Signature

NICK CALVERT — Name

242062 — CPEng. No

Relationship between Seismic Grade and % NBS :

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

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14. Appendix 4 – CERA Standardised Report Form

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Travis Wetland - Barn	Reviewer:	NICK CALVERT
Unit / No: / Street	280 Beach Road, Burwood	CPEng No:	242062
Building Address:		Company:	SKM
Legal Description:		Company project number:	ZB01276.136
		Company phone number:	09 928 5500
GPS south (Degrees / Min / Sec):		Date of submission:	24-Sep
GPS east:		Inspection Date:	21/05/2012
		Revision:	B
Building Unique Identifier (CCC):	PRK 2347 BLDG 002	Is there a full report with this summary?	yes

Site

Site slope:	flat	Max retaining height (m):	
Soil type:		Soil Profile (if available):	
Site Class (to NZS1170.5):	D		
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:	mat slab	if Foundation type is other, describe:	
Building height (m):	7.00	height from ground to level of uppermost seismic mass (for IEP only) (m):	7
Floor footprint area (approx):	147		
Age of Building (years):	100	Date of design:	1965-1976
Strengthening present?	no	If so, when (year)?	
		And what load level (%g)?	
Use (ground floor):	public	Brief strengthening description:	
Use (upper floors):			
Use notes (if required):			
Importance level (to NZS1170.5):	IL2		

Gravity Structure

Gravity System:	frame system		
Roof:	timber framed	rafter type, purlin type and cladding	Timber rafters & purlins and lightweight steel cladding
Floors:	concrete flat slab	slab thickness (mm)	Unknown
Beams:	timber	type	Unknown
Columns:	timber	typical dimensions (mm x mm)	150x50
Walls:	non-load bearing		0

Lateral load resisting structure

Note: Define along and across in detailed report!

Lateral system along:	lightweight timber framed walls		note typical wall length (m)	18.3
Ductility assumed, μ:	2.00			
Period along:	0.30	0.00	estimate or calculation?	estimated
Total deflection (ULS) (mm):	10		estimate or calculation?	estimated
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	estimated
Lateral system across:	lightweight timber framed walls		note typical wall length (m)	8
Ductility assumed, μ:	2.00			
Period across:	0.30	0.00	estimate or calculation?	estimated
Total deflection (ULS) (mm):	10		estimate or calculation?	estimated
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	estimated

Separations:

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

Non-structural elements

Stairs:			
Wall cladding:	exposed structure	describe	Timber framing & weatherboard
Roof Cladding:	Metal	describe	Assumed corrugated sheeting
Glazing:	timber frames		
Ceilings:	plaster, fixed		Assumed
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	partial	original designer name/date	

Damage

Site: (refer DEE Table 4-2)

Site performance:		Describe damage:	
Settlement:	none observed	notes (if applicable):	
Differential settlement:	none observed	notes (if applicable):	
Liquefaction:	none apparent	notes (if applicable):	
Lateral Spread:	none apparent	notes (if applicable):	
Differential lateral spread:	none apparent	notes (if applicable):	
Ground cracks:	none apparent	notes (if applicable):	
Damage to area:	none apparent	notes (if applicable):	

Building:

	Current Placard Status:	green		
Along	Damage ratio:	0%	Describe how damage ratio arrived at:	No damage observed, therefore the building's capacity will be unchanged.
	Describe (summary):	No damage observed		
Across	Damage ratio:	0%		
	Describe (summary):	No damage observed		
Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	no	Describe:	
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	no	Describe:	No damage observed.

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

Recommendations

	Level of repair/strengthening required:	minor non-structural	Describe:	
	Building Consent required:	no	Describe:	
	Interim occupancy recommendations:	full occupancy	Describe:	Not an immediate collapse hazard.
Along	Assessed %NBS before:	74%	%NBS from IEP below	
	Assessed %NBS after:	74%	If IEP not used, please detail assessment methodology:	Qualitative Assessment carried out includes NZSEE IEP (refer to SKM report).
Across	Assessed %NBS before:	74%	%NBS from IEP below	
	Assessed %NBS after:	74%		

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Travis Wetland - Dairy Unit	Reviewer:	NICK CALVERT
Building Address:	Unit: ; No: 280; Street: Beach Road, Burwood	CPEng No:	242062
Legal Description:		Company:	SKM
		Company project number:	ZB01276.136
		Company phone number:	09 928 5500
GPS south (Degrees / Min / Sec):		Date of submission:	24-Sep
GPS east (Degrees / Min / Sec):		Inspection Date:	21/05/2012
		Revision:	B
Building Unique Identifier (CCC):	PRK_2347_BLDG_002	Is there a full report with this summary?	yes

Site

Site slope:	flat	Max retaining height (m):	
Soil type:		Soil Profile (if available):	
Site Class (to NZS1170.5):	D		
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:	mat slab	if Foundation type is other, describe:	
Building height (m):	4.40	height from ground to level of uppermost seismic mass (for IEP only) (m):	4.4
Floor footprint area (approx):	150		
Age of Building (years):	100	Date of design:	1965-1976
Strengthening present?	no	If so, when (year)?	
		And what load level (%g)?	
Use (ground floor):	public	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	Timber rafters & purlins and lightweight steel cladding
Floors:	concrete flat slab	slab thickness (mm)	Unknown
Beams:	timber	type	Unknown
Columns:	timber	typical dimensions (mm x mm)	Unknown
Walls:	unreinforced concrete masonry	thickness (mm)	200

Lateral load resisting structure

Note: Define along and across in detailed report!

Lateral system along:	concrete shear wall	note total length of wall at ground (m):	15.6
Ductility assumed, μ:	2.00	wall thickness (m):	
Period along:	0.00 ##### enter height above at H31	estimate or calculation?	estimated
Total deflection (ULS) (mm):	10	estimate or calculation?	estimated
maximum interstorey deflection (ULS) (mm):		estimate or calculation?	estimated
Lateral system across:	unreinforced masonry bearing wall - stone	note wall thickness and cavity	200mm
Ductility assumed, μ:	1.25		
Period across:	0.40 (0.00)	estimate or calculation?	estimated
Total deflection (ULS) (mm):	10	estimate or calculation?	estimated
maximum interstorey deflection (ULS) (mm):		estimate or calculation?	estimated

Separations: (leave blank if not relevant)

north (mm):	
east (mm):	
south (mm):	
west (mm):	

Non-structural elements

Stairs:			
Wall cladding:	plaster system	describe	Plasterboard
Roof Cladding:	Metal	describe	Assumed corrugated sheeting
Glazing:	timber frames		
Ceilings:	plaster, fixed		Assumed
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	partial	original designer name/date	

Damage

Site: (refer DEE Table 4-2)

Site performance:		Describe damage:	
Settlement:	none observed	notes (if applicable):	
Differential settlement:	none observed	notes (if applicable):	
Liquefaction:	none apparent	notes (if applicable):	
Lateral Spread:	none apparent	notes (if applicable):	
Differential lateral spread:	none apparent	notes (if applicable):	
Ground cracks:	none apparent	notes (if applicable):	
Damage to area:	none apparent	notes (if applicable):	

Building:

	Current Placard Status:	green		
Along	Damage ratio:	0%	Describe how damage ratio arrived at:	Current damage noted will not diminish the capacity of the building.
	Describe (summary):	Hairline crack in concrete wall.		
Across	Damage ratio:	0%		
	Describe (summary):	No damage observed		
Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	no	Describe:	
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	no	Describe:	Hairline crack in concrete wall.

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

Recommendations

Level of repair/strengthening required:	minor non-structural	Describe:	
Building Consent required:	no	Describe:	
Interim occupancy recommendations:	full occupancy	Describe:	Not an immediate collapse hazard.

Along	Assessed %NBS before:	56%	%NBS from IEP below	If IEP not used, please detail assessment methodology: Qualitative Assessment carried out includes NZSEE IEP (refer to SKM report).
	Assessed %NBS after:	56%		
Across	Assessed %NBS before:	42%	%NBS from IEP below	
	Assessed %NBS after:	42%		

15. Appendix 5 – Geotechnical Desktop Study

Christchurch City Council - Structural Engineering Service

Geotechnical Desk Study

SKM project number	ZB01276
SKM project site number	57 and 58 inclusive
Address	Travis Wetland
Report date	28 May 2012
Author	Dominic Hollands
Reviewer	Leah Bateman
Approved for issue	Yes

1. Introduction

This report outlines the geotechnical information that Sinclair Knight Merz (SKM) has been able to source from our database and other sources in relation to the property listed above. We understand that this information will be used as part of an initial qualitative Detailed Engineering Evaluation (DEE), and will be supplemented by more detailed information and investigations to allow detailed scoping of the repair or rebuild of the building.

2. Scope

This geotechnical desk top study incorporates information sourced from:

- Published geology
- Publically available borehole records
- Liquefaction records
- Aerial photography
- Council files
- A preliminary site walkover

3. Limitations

This report was prepared to address geotechnical issues relating to the specific site in accordance with the scope of works as defined in the contract between SKM and our Client. This report has been prepared on behalf of, and for the exclusive use of, our Client, and is subject to, and issued in accordance with, the provisions of the contract between SKM and our Client. The findings presented in this report should not be applied to another site or another development within the same site without consulting SKM.

The assessment undertaken by SKM was limited to a desktop review of the data described in this report. SKM has not undertaken any subsurface investigations, measurement or testing of materials from the site. In preparing this report, SKM has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by our Client, and from other sources as described in the report. Except as otherwise stated in this report, SKM has not attempted to verify the accuracy or completeness of any such information.

This report should be read in full and no excerpts are to be taken as representative of the findings. It must not be copied in parts, have parts removed, redrawn or otherwise altered without the written consent of SKM.

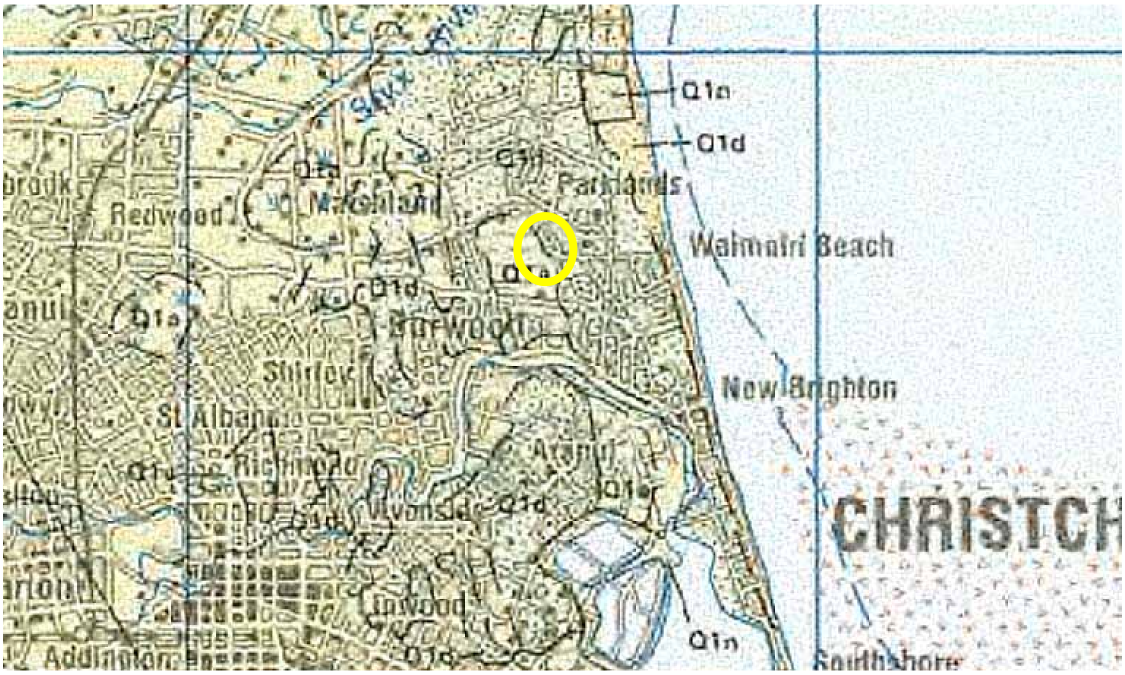
4. Site location

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

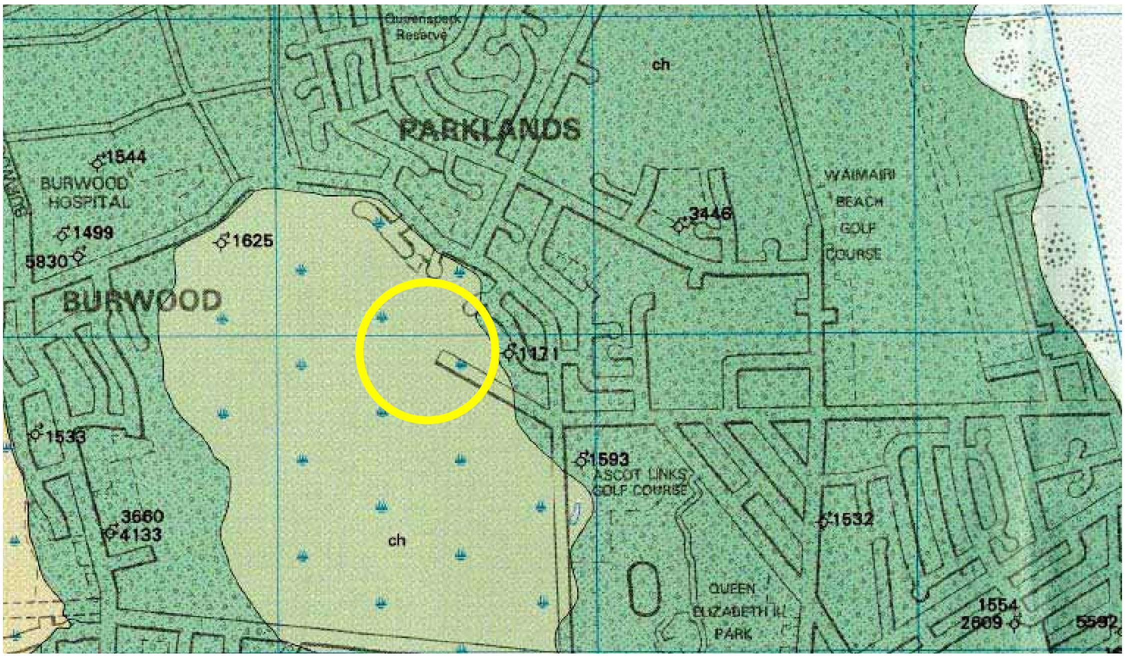
These structures are located on 280 Beach Road at grid reference 1575565 E, 5185267 N (NZTM).

5. Review of available information

5.1 Geological maps



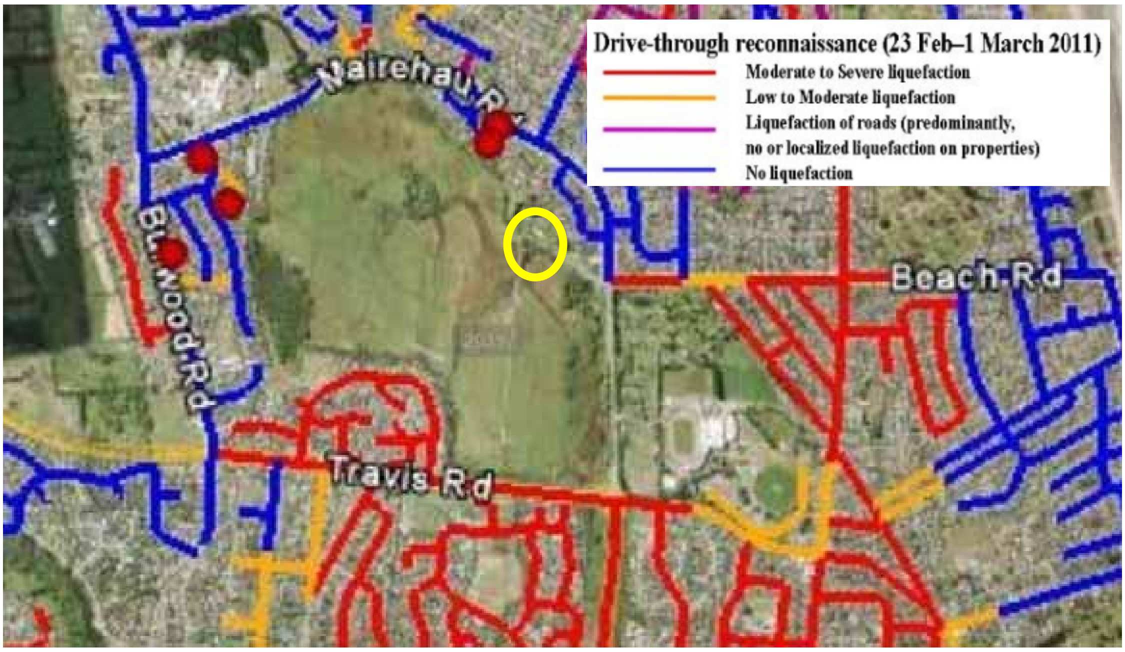
- **Figure 2 – Regional geological map (Forsyth et al, 2008). Site marked in red.**



- **Figure 3 – Local geological map (Brown et al, 1992). Site marked in red.**

The local geological map shows the area to be underlain by sand, silt and peat of drained lagoons and estuaries. Immediately east of the site the area is shown to be underlain by sand of fixed and semi-fixed dunes and beached.

5.2 Liquefaction map



- **Figure 4 – Liquefaction map (Cubrinovski & Taylor, 2011). Site marked in red.**

Following the 22 February 2011 event drive through reconnaissance was undertaken from 23 February until 1 March by M Cubrinovsko and M Taylor of Canterbury University. Their findings show no liquefaction on Mairehau Road and Medina Crescent to the north east and moderate to severe liquefaction on Beach Road to the east.

5.3 Aerial photography

- **Figure 5 – Aerial photography from 24 Feb 2011 (http://viewers.geospatial.govt.nz/)**

- **Figure 6 - Aerial photography from 24 Feb 2011 (http://viewers.geospatial.govt.nz/)**

- **Figure 7 - Aerial photography from 24 Feb 2011 (http://viewers.geospatial.govt.nz/)**

- **Figure 8 - Aerial photography from 24 Feb 2011 (http://viewers.geospatial.govt.nz/)**

Aerial photography shows significant liquefaction in the area after the 22 Feb 2011 event in particular the elevated water table within the site and surrounding the site.

5.4 CERA classification

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

- Zone: Green
- DBH Technical Category – N/A – Urban Non residential - in general residential properties around the site are classed as TC3

5.5 Historical land use

In reference to historical documents (e.g. Appendix A) it is shown that the site lies within land that was recorded as marshland or swamp in 1856 which is not too dissimilar to what is present today. It is therefore possible that soft or liquefiable ground would be present at the site. Some of the land area however has likely been built up since then including roads and paths on the site.

5.6 Existing ground investigation data

- **Figure 9 - Local Boreholes from project orbit (https://canterburygeotechnicaldatabase.projectorbit.com/)**

Where available logs from these investigation locations are attached to this report (Appendix B), and the results are summarised in Section 6.1 and Appendix C. Only investigations within 350m have been summarised however our existing knowledge of the area and wider boreholes have been used to draw conclusions regarding ground condition

5.7 Council property files

No council property files were available for the structures on site.

5.8 Site walkover

An external site walkover was conducted by an SKM engineer on 2 May 2012 for the information kiosk and Bird Hide structures and on 29 May 2012 for the dairy shed and barn structures.

The site housing the dairy shed and barn was noted to be located in a low lying grassed area. There was a 20-30 degree slope at the northern side of the barn sloping up to adjacent houses. There was evidence of liquefaction having occurred at the site with sand ejecta still present more than a year after the earthquake event. It is expected that the water table will be within 0.5 below ground level due to nearby water ways.

The Barn was noted to be a timber structure (frame and clad), with a corrugated iron lean to on the northern side. The roof was also noted to be an iron construction. The structure appears to be supported on a slab foundation at the western end only. There appears to be some significant cracks in the concrete but this could be not confirmed during the external site walkover.

The dairy shed appears to be a masonry block construction at the eastern end with poured in situ concrete walls for the remaining parts of the structure. The roof was an iron sheet construction. Gapping, some cracking and differential movement of slabs was noted in the concrete paving outside. However, it is not clear how much of this damage is due to the earthquake event. No other significant cracking of blocks or any differential settlement of the structure was noted during the site walkover.

The information kiosk and bird hide buildings are a single storey timber framed building with timber pile foundations.

- **Figure 10 – Exterior front view of the information kiosk (eastern elevation)**

- **Figure 11 - Overview of the information kiosk (western elevation)**

- **Figure 12 - Exterior front view of the bird hide (eastern elevation)**

- **Figure 13 – Foundation details of the bird hide**

- **Figure 14 - Overview of the barn structure**

- **Figure 15 - Overview of the Dairy shed**

- **Figure 16 - Noted damage to the concrete paving**

- **Figure 17 - Ejected sand**

6. Conclusions and recommendations

6.1 Site geology

An interpretation of the most relevant geotechnical investigation data suggests that the site is underlain by:

Depth range (mBGL)	Soil type
0 - 1	Top soil
1 - 29	Sand (Springston Formation)
29 - 40	Gravel (Riccarton Gravels)

A shallow water table within 0.5m BGL is expected due to nearby water ways.

6.2 Seismic site subsoil class

The site has been assessed as NZS 1170.5 Class D (soft or deep soil, including gravel exceeding 100 m in depth) using nearby borehole investigation data. As no information regarding the composition of the top soil layer is available, Class D is recommended as a conservative estimate of the seismic site subsoil class.

As described in NZS1170, the preferred site classification method is from site periods based on four times the shear wave travel time through material from the surface to the underlying rock. The next preferred methods are from borelogs including measurement of geotechnical properties or by evaluation of site periods from Nakamura ratios or from recorded earthquake motions. Lacking this information, classification may be based on boreholes with descriptors but no geotechnical measurements. The least preferred method is from surface geology and estimates of the depth to underlying rock.

The third preferred method has been used in the assessment of site subsoil class. It should be noted that only one borehole near the site was available however we are relatively confident of ground conditions in this area.

6.3 Building Performance

The performance to date suggests that in general the existing foundations are adequate for their current purpose. However some damage to the concrete slab supporting the barn structure was noted. From the site walkover it was noted that the shallow piled foundations in general performed better than the slab foundations.

It should be noted that no significant evidence of lateral spreading was noted during the external site walkover but, as waterways are present nearby lateral spread could occur on site. This could mean that the current foundations may be unsuitable if lateral spreading occurs during a future event. As surrounding residential properties are classed as TC3, for buildings that are frequently used or open to public a specialised foundation solution in accordance with the TC3 residential guidelines would be recommended if the foundations are to be remediated.

6.4 Ground performance and properties

Liquefaction risk is expected to be moderate to severe for this site. Significant surface evidence of liquefaction on site as well as elevated water table could be seen from the aerial photographs. No evidence of liquefaction was noted during the site visit; however, this is most likely due to the significant lapse of time between the seismic event and the external site walkover undertaken. The density of the sand layer inferred to underlay the site is not known. However, it is likely that the sand layers, in particular the shallow layers, are susceptible to liquefaction. Even though there was no evidence of lateral spreading noted during the site walkover, there is future risk of lateral spreading on site due to the significant potential for liquefaction to occur on site and the presence of free faces caused by nearby waterways.

As no information for the first 5m below ground level is available from the borehole log, an estimation of ground properties, which can be reliably used in a quantitative DEE, has not been made in this desk study.

6.5 Further investigations

If a quantitative DEE is to be undertaken further site specific investigation are required to confirm the liquefaction assessment and to estimate likely ground properties on site. Additional investigations recommended are:

- Two hand augers near each structure to a depth of 3m to assess the composition of the shallow soil layer
- Two CPTs to refusal on site

7. References

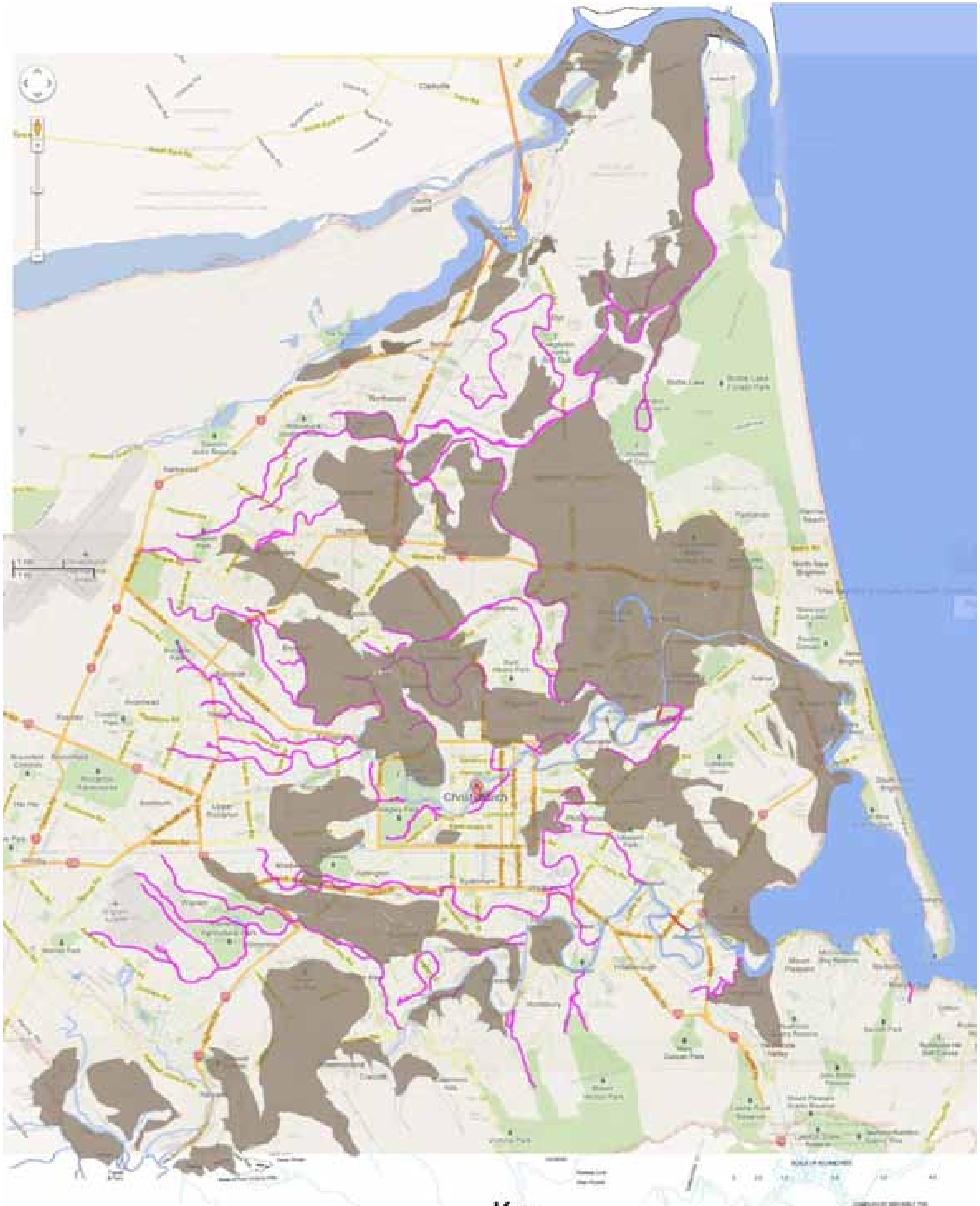
Cubrinovski & Taylor, 2011. Liquefaction map summarising preliminary assessment of liquefaction in urban areas following the 2010 Darfield Earthquake.

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

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

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

Appendix A – Christchurch 1856 land use



Key

- Previous creeks/rivers
- Existing creeks/rivers
- New creeks/rivers
- Swamp/Marshland

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

Appendix B – Existing ground investigation logs

Borelog for well M35/1171

Gridref: M35:8560-4690 Accuracy : 4 (1=high, 5=low)
Ground Level Altitude : 5.6 +MSD
Driller : McMillan Water Wells Ltd
Drill Method : Cable Tool
Drill Depth : -39.59m Drill Date : 1/09/1976

Environment Canterbury Regional Council

Water Level: -1.2CalcMin

Depth(m)	Full Drillers Description	Formation Code
-4.59m	Not logged	ch
- 28.9m	Grey medium sand	ch
- 30.5m	Grey coarse silt with shells	ch
- 32.0m	Grey silty sand, some peat	ch
- 39.6m	Gravel & sand	ri

Scale(m): -5, -10, -15, -20, -25, -30, -35

Appendix C – Geotechnical Investigation Summary

Table 1 Summary of most relevant investigation data

ID		1
Type *		BH**
Ref		M35 - 1171
Depth (m)		40
Distance from site (m)		0
Ground water level (mBGL)		1.2
Simplified recorded geological profile (depth below ground level to top of stratum, m)	0	
	1	
	2	
	3	
	4	
	5	Sand
	6	Sand
	7	Sand
	8	Sand
	9	Sand
	10	Sand
	11	Sand
	12	Sand
	13	Sand
	14	Sand
	15	Sand
	16	Sand
	17	Sand
	18	Sand
	19	Sand
	20	Sand
	21	Sand
	22	Sand
	23	Sand
	24	Sand
	25	Sand
Greater depths		

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

** 0-5m not logged

Sensitive or organic clay/silt | Clay to silty clay | Clayey silt to silt | Silty sand to silt

Clayey sand | Sand | Gravelly sand or gravel

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

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