Somerfield Playcentre Building

BU 1129-002 EQ2

Detailed Engineering Evaluation

Quantitative Report

Christchurch City Council

Christchurch City Council

Somerfield Playcentre Building

Detailed Engineering Evaluation Quantitative Report

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Somerfield Playcentre Building
BU 1129-002 EQ2

Detailed Engineering Evaluation
Quantitative Report - SUMMARY
Final

47 Studholme Street, Somerfield, Christchurch

Background

This is a summary of the quantitative report for the building structure, and is based on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011, visual inspections on 15 December 2011, a set of proposed building drawings for Somerfield Playcentre dated July 1995 and wall bracing calculations.

Key Damage Observed

- Some ceiling lights had fallen to the floor and overhead lights hanging loose in the building. However, there was no significant structural damage found in or around the Somerfield Playcentre building.

Critical Structural Weaknesses

- There were no critical structural weaknesses identified for the building.

Indicative Building Strength (from quantitative assessment)

Based on the information available, and from undertaking a quantitative assessment, the building's original capacity has been assessed to be in the order of 47% NBS along the building and 81% NBS across the building and the post-earthquake capacity in the order of 47% NBS along the building and 81% NBS across the building. The building is therefore not classed as an earthquake prone building.

Recommendations

It is recommended that:

a) The current placard status of the building remains as green.

b) A strengthening scheme be developed for increasing the seismic capacity to at least 67% NBS.

Contents

1 Introduction

Opus International Consultants Limited has been engaged by Christchurch City Council (CCC) to undertake a detailed seismic assessment of the Somerfield Playcentre building, located at 47 Studholme Street, Somerfield, Christchurch, following the M6.3 Christchurch earthquake on 22 February 2011.

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

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

2 Compliance

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

2.1 Canterbury Earthquake Recovery Authority (CERA)

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

Section 38 – Works

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

Section 51 – Requiring Structural Survey

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

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

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

1. The importance level and occupancy of the building.

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

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

2.2 Building Act

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

Section 112 - Alterations

This section requires that an existing building complies with the relevant sections of the Building Code to at least the extent that it did prior to the alteration.

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

Section 115 – Change of Use

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

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

2.2.1 Section 121 – Dangerous Buildings

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

1. In the ordinary course of events (excluding the occurrence of an earthquake), the building is likely to cause injury or death or damage to other property; or
2. In the event of fire, injury or death to any persons in the building or on other property is likely because of fire hazard or the occupancy of the building; or
3. There is a risk that the building could collapse or otherwise cause injury or death as a result of earthquake shaking that is less than a 'moderate earthquake' (refer to Section 122 below); or
4. There is a risk that other property could collapse or otherwise cause injury or death; or

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

Section 122 – Earthquake Prone Buildings

This section defines a building as earthquake prone if its ultimate capacity would be exceeded in a 'moderate earthquake' and it would be likely to collapse causing injury or death, or damage to other property.

A moderate earthquake is defined by the building regulations as one that would generate loads 33% of those used to design an equivalent new building.

Section 124 – Powers of Territorial Authorities

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

Section 131 – Earthquake Prone Building Policy

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

2.3 Christchurch City Council Policy

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

The 2010 amendment includes the following:

1. A process for identifying, categorising and prioritising Earthquake Prone Buildings, commencing on 1 July 2012;

2. A strengthening target level of 67% of a new building for buildings that are Earthquake Prone;

3. A timeframe of 15-30 years for Earthquake Prone Buildings to be strengthened; and,

4. Repair works for buildings damaged by earthquakes will be required to comply with the above.

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

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

- The accessibility requirements of the Building Code.

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

2.4 Building Code

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

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

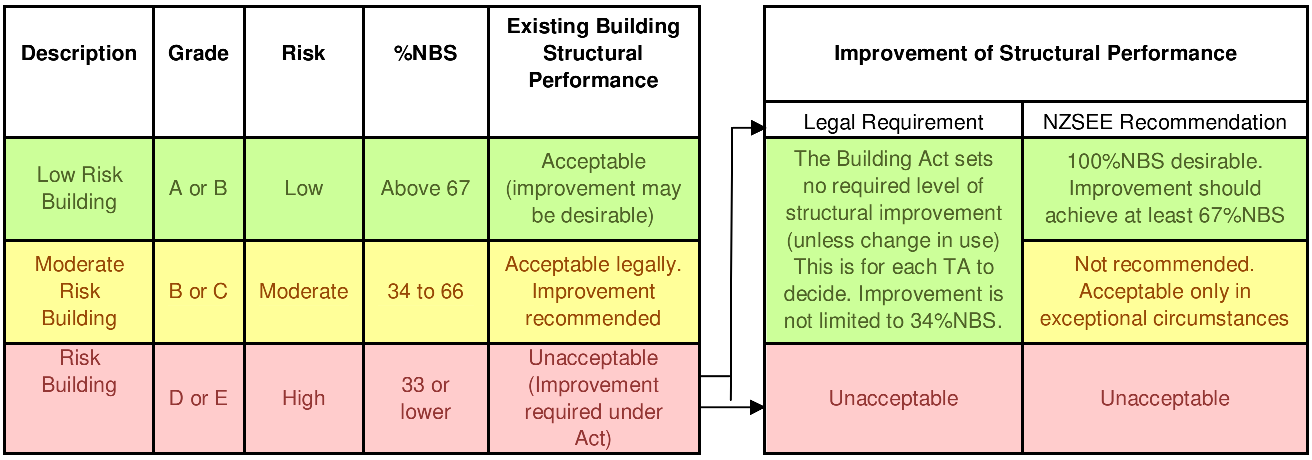
- 36% increase in the basic seismic design load for Christchurch (Z factor increased from 0.22 to 0.3);

- Increased serviceability requirements.

3 Earthquake Resistance Standards

For this assessment, the building's earthquake resistance is compared with the current New Zealand Building Code requirements for a new building constructed on the site. This is expressed as a percentage of new building standard (%NBS). The loadings are in accordance with the current earthquake loading standard NZS1170.5 [1].

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



Description	**Grade**	**Risk**	**%NBS**	**Existing Building Structural Performance**
Low Risk Building	A or B	Low	Above 67	Acceptable (improvement may be desirable)
Moderate Risk Building	B or C	Moderate	34 to 66	Acceptable legally. Improvement recommended
Risk Building	D or E	High	33 or lower	Unacceptable (Improvement required under Act)

Improvement of Structural Performance	
Legal Requirement	NZSEE Recommendation
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
	Not recommended. Acceptable only in exceptional circumstances
Unacceptable	Unacceptable

Figure 1: NZSEE Risk Classifications Extracted from Table 2.2 of the NZSEE 2006 AISPBE Guidelines

Table 1 below compares the percentage NBS to the relative risk of the building failing in a seismic event with a 10% risk of exceedance in 50 years (i.e. 0.2% in the next year). It is noted that the current seismic risk in Christchurch results in a 6% risk of exceedance in the next year.

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

Table 1: %NBS compared to relative risk of failure

4 Building Description

4.1 General

The Somerfield Playcentre building is a single storey timber-framed structure and is located on the north-western side of the property at 47 Studholme Street, Somerfield, Christchurch. The building is at the rear of the same section which contains the Somerfield Community Centre. For the purposes of this report we refer to the direction parallel to Studholme Street as north-east to south-west direction and the direction perpendicular to Studholme Street, as the north-west to south-east direction.

From archive drawings we have ascertained that the building was constructed in 1995. The building is clad with timber weatherboards and the roof structure is light-weight coloursteel corrugated roof cladding. The building structure is supported on shallow concrete pile foundations with a reinforced concrete foundation wall around the perimeter of the building.

The building is approximately 16m long in the north-west to south-east direction and 8.4m wide in the north-east to south-west direction. The roof apex is approximately 4.35m above ground level.

4.2 Gravity Load Resisting System

The light-weight roof cladding is supported by timber roof framing and a timber truss system spanning 6.4m between the side walls at 890mm centres. The walls are timber framed with 100 x 50mm studs at 600mm centres (maximum) and a stud height of approximately 2.5m. The floor is a suspended timber floor consisting of joists and bearers supported on shallow concrete piles. A concrete foundation wall is provided around the perimeter of the building.

4.3 Seismic Load Resisting System

The seismic load resisting system in both principal directions consists of plasterboard bracing elements provided on the timber-framed walls.

The plasterboard ceiling provides diaphragm action to distribute the seismic loads to the braced walls.

5 Survey

The playcentre building currently has a green placard (not issued as part of this inspection and authorised by an engineer working for a company other than Opus International Consultants).

Copies of the following archive drawings were used during this assessment:

- A set of proposed building drawings for Somerfield Playcentre dated July 1995.

No copies of the design calculations have been obtained as part of the documentation set.

The drawings have been used to confirm the structural systems, investigate potential critical structural weaknesses (CSW) wherever possible and identify details which required particular attention.

6 Damage Assessment

There were some ceiling lights that had fallen to the floor and overhead lights hanging loose in the building. However, there was no significant structural damage found in or around the Somerfield Playcentre building structure.

7 General Observations

Overall the building has performed well under seismic conditions which would be expected for a modern single storey structure. The building has sustained little damage and continues to be fully operational.

Due to the non-intrusive nature of the original survey, many connection details could not be ascertained.

8 Detailed Seismic Assessment

8.1 Critical Structural Weaknesses

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

There were no critical structural weaknesses identified for the building.

8.2 Detailed Seismic Assessment Methodology

As the building is a timber framed structure constructed in 1995 it has been considered appropriate to derive the seismic loadings from NZS 3604:2011 as the building falls within the scope of this design standard.

The seismic design parameters based on current design requirements from NZS 3604:2011 and the NZBC clause B1 for this building are as follows:

- Site soil class D, clause 3.1.3 NZS 1170.5:2004
- Earthquake Zone 2, Figure 5.4 – Earthquake zones NZS 3604:2011
- Multiplication factor = 0.8, Table 5.8 NZS 3604:2011
- Importance Level 2 structure with a 50 year design life to NZS 1170.5:2004

8.3 Detailed Seismic Assessment Results

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

Table 2: Summary of Seismic Performance

Structural Element/System	Failure mode and description of limiting criteria	Critical Structural Weakness and Collapse Hazard	% NBS based on calculated capacity
GIB board capacity along the building (north-west to south-east)	Capacity of GIB board braced walls along the building	No	47%
GIB board capacity across the building (north-east to south-west)	Capacity of GIB board braced walls across the building	No	81%
Concrete foundation perimeter wall (both directions)	Concrete foundation perimeter wall capacity around the building (both principal directions)	No	313%

8.4 Discussion of Results

The building has a calculated seismic capacity of 47% NBS along the building and 81% NBS across the building. The lateral capacity of the building is provided by a series of GIB® standard plasterboard, construction ply and GIB Braceline® bracing elements integrated in the timber-framed walls. In the current code NZS 3604:2011 the seismic demand on the building is now 8.8 bracing units per square metre of floor area giving a requirement of 1183 bracing units (59kN) in each direction.

Although the seismic demand on the building has now increased from the original seismic loads the overall bracing demand has not increased significantly as it appears that wind loading was the critical load case in the original design.

The building governing seismic capacity of 47% NBS means that the building is not considered to be earthquake prone, however it has a relative risk of 5-10 times that of a building designed to the New Building Standard failing in a seismic event with a 10% risk of exceedance in 50 years (i.e. 0.2% in the next year). It is noted that the current seismic risk in Christchurch results in a 6% risk of exceedance in the next year.

The ceiling diaphragm complies with the requirements set out in NZS 3604 and the GIB Bracing Manual.

8.5 Limitations and Assumptions in Results

Our analysis and assessment is based on an assessment of the building in its undamaged state, although this building has not suffered significant structural damage. Therefore the current capacity of the building may be lower than that stated.

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

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

9 Geotechnical Assessment

The geotechnical report is contained in Appendix C of this report. A summary of the report is as follows:

9.1 Discussion

Minor land damage has occurred to the Somerfield Playcentre due to the Canterbury Earthquake Sequence following the 4 September 2010 earthquake.

There appears to have been minor movement (up to 10mm) of the ground illustrated by the repaired asphalt areas.

Liquefaction appears to have been relatively minor at the site and within close vicinity (no liquefaction was reported at the adjacent Somerfield Community Centre). Possible minor settlement and/or heave (<10mm) is present in the asphalt paving to the north-east and north-west of the playcentre.

Cracks in the reinforced concrete foundation wall appear to be minor, and will not affect the structural integrity of the building or its performance in future earthquakes.

ECan well logs and CPTs indicate the building is probably founded on interbedded layers of clay, liquefiable silt and sand, with gravels likely to be encountered between 17m and 22.8m bgl. The foundation system of a suspended floor on concrete piles and a perimeter strip footing has performed well.

Buildings are typically designed to allow for up to 50mm of land settlement in a serviceability limit state (SLS) event, or up to 100mm in an ultimate limit state event (ULS).

GNS Science indicates an elevated risk of seismic activity is expected in the Canterbury region as a result of the earthquake sequence following the 4 September 2010 earthquake. Recent advice (Geonet) indicates there is a 18% probability of another Magnitude 6 or greater earthquake occurring in the next 12 months in the Canterbury region. It is expected that the probability of occurrence is likely to decrease with time, following periods of reduced seismic activity. However, we would expect that similar liquefaction and ground damage could occur in a future earthquake.

Based on current evidence, the existing foundations are considered appropriate for the building with the client's acceptance that the potential for differential settlement may occur in future seismic events.

If CCC wish to quantify the risk of damage from differential settlement in future seismic events, consideration could be given to undertaking ground investigations to more accurately estimate the potential differential settlement from liquefaction. Allowance for predrilling through shallow gravels may need to be included in the scope of a site investigation.

9.2 Recommendations

a) Based on the past performance in recent earthquakes, the existing foundations should be acceptable in terms of future ULS and SLS loadings, although CCC may have to accept the risk for potential differential settlement in the order of 0 to 50mm in a future seismic event;

b) If CCC wishes to further evaluate and quantify the liquefaction potential at this site, additional site specific testing with CPT's and associated analysis would be necessary.

10 Remedial Options

The building has a seismic capacity of 47%NBS and it is therefore not considered to be earthquake prone, however it is recommended that the bracing elements in the north-west to south-east (along building) direction be strengthened to at least 67% NBS.

11 Conclusions

(a) The building has a seismic capacity of 47% NBS in the north-west to south-east (along building) direction and 81% NBS in the north-east to south-west (across building) direction and is therefore not considered to be an earthquake prone building.

(b) Strengthening works should be undertaken to improve the seismic capacity of the building in the north-west to south-east direction.

(c) There were no critical structural weaknesses identified for the building.

(d) Based on the past performance in recent earthquakes, the existing foundations should be acceptable in terms of future ULS and SLS loadings, although CCC may have to accept the risk for potential differential settlement in the order of 0 to 50mm in a future seismic event;

(e) If CCC wishes to further evaluate and quantify the liquefaction potential at this site, additional site specific testing with CPT's and associated analysis would be necessary.

12 Recommendations

(a) It is recommended that strengthening or improving the bracing elements in the north-west to south-east (along building) direction is undertaken so that the seismic capacity of the building is increased to at least 67% NBS.

(b) The CCC should consider whether further evaluation of the liquefaction potential at the site is necessary.

13 Limitations

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

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

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

Appendix A – Photographs

Photo 1 – South-east elevation of building

Photo 2 – North-west elevation of building

Photo 3 – North-east elevation of building

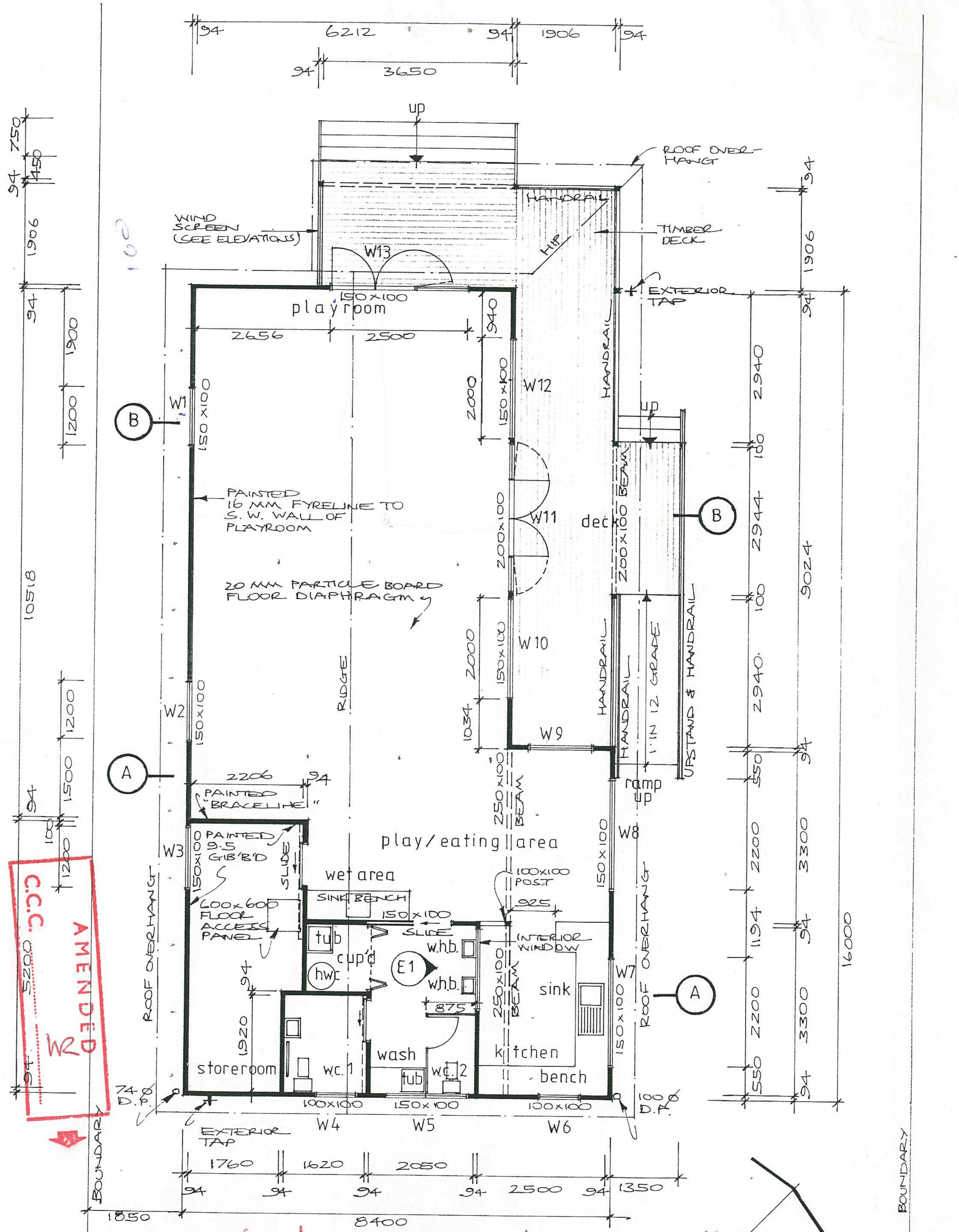
Photo 4 – Exposed truss arrangement in the main play room of the building

Photo 5 – Internal view from the play / eating area

Photo 6 – Internal view of the main play room

Photo 7 – Internal or overhead lights hanging loose or fallen in the building

Appendix B – Floor Plan



C.C.C.
AMENDED
WRD

Door locks to comply with NZBC C2/AS1 7.2.2
Signs to comply with NZBC C2/AS1 7.6.1

PROPOSED NEW CRECHE BUILDING FOR SOMERFIELD CRECHE , 1:100 JULY, 1995

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9365

Appendix C – Geotechnical Appraisal

20 February 2012

Christchurch City Council
C/O:- Lindsay Fleming
Property Asset Manager

6-QUCCC.59/005SC

Dear Lindsay

Geotechnical Desktop Study – Somerfield Playcentre

1. Introduction

Christchurch City Council (CCC) has commissioned Opus International Consultants (Opus) to undertake a geotechnical desktop study and site walkover of the Somerfield Playcentre, Christchurch. The purpose of this study is to collate existing subsoil information and undertake an appraisal of the potential geotechnical hazards at this site and to determine whether further investigations are required. The site walkover was completed by Opus on 16 February 2012. Refer to Appendix A for site photos.

It is our understanding that this is the first geotechnical inspection of this property and forms part of a Detailed Engineering Evaluation prepared by Opus.

2. Desktop Study

2.1 Site Description

The Somerfield Playcentre is located at the rear of the property of 47 Studholme Street, and backs onto the Somerfield Park. The Somerfield Community Centre is located at the front of the property. The Heathcote River is approximately 700m south-east of the site. The property consists of an asphalt carpark directly behind the community centre, with the area adjacent to the playcentre also asphalted. The rear of the playcentre is dominantly comprised of grassed areas, with asphalt paths and a raised bark playground. A storage shed is located on the rear boundary with Somerfield Park

The building is a timber framed, single storey structure. Refer to the quantitative structural assessment report for a more detailed description of the building.

The ground profile is relatively flat and level with the adjacent buildings and grassed areas.

2.2 Structural Drawings

Extracts from the Structural drawings illustrating a cross section of the building have been available for review. The drawings indicate that the floor is supported by concrete piles and a 250mm wide concrete footing to a minimum of 350mm below ground level (bgl) and a reinforced concrete perimeter strip footing.

2.3 Regional Geology

The published geological map of the area, (Geology of the Christchurch Urban Area 1:25,000, Brown and Weeber, 1992) indicates the site is the Yaldhurst member of the Springston Formation with dominantly alluvial sand and silt overbank deposits.

2.4 Expected Ground Conditions

A review of the Environmental Canterbury (Ecan) wells database showed five wells located within approximately 260m of the property (refer to site location plan in Appendix B). Two CPT's were completed by the Earthquake Commission within 140m of site have also been reviewed. Material logs available from the wells and CPTs have been used to infer the ground conditions at the site as shown in Table 1 below.

Table 1:Inferred Ground Conditions

Stratigraphy	Thickness (m)	Depth Encountered From (m)
CLAY, SILT and SAND	2.6-17.0m	Surface
Sandy and clay-bound GRAVEL	0.5m	2.6m
GRAVEL (Riccarton Gravels)	-	17.0-22.8m

The groundwater table inferred from the ECan wells above is identified as artesian or 2.2m bgl. The Brown and Weeber "Geology of the Christchurch Urban Area" map suggests a water table less than 1m bgl.

2.5 Liquefaction Hazard

A liquefaction hazard study was conducted by the Canterbury Regional Council (ECan) in 2004 to identify areas of Christchurch susceptible to liquefaction during an earthquake. The Somerfield Playcentre site is located in an area identified as 'moderate ground damage potential may be expected' for a low groundwater scenario. According to this study, the ground damage potential is moderate indicating the ground may be affected by 100 to 300mm of subsidence.

Tonkin and Taylor Ltd (T&T Ltd) have been engaged as the Earthquake Commission's (EQC) geotechnical consultants and have prepared maps showing areas of liquefaction interpreted from high resolution aerial photos for the 4th September earthquake, and the aftershocks of February 2011 and June 2011. An interpretation of these maps indicates the area suffered from liquefaction in the 22 February 2011 earthquake.

The University of Canterbury (UC) conducted a drive by of Christchurch roads post 22 February 2011 earthquake, identifying areas where liquefaction had occurred. UC did not observe liquefaction on Studholme Street during their reconnaissance between 23 February and 1 March 2011.

After consultation with the staff of the Somerfield Playcentre, it was discovered that minor liquefaction occurred on site in one location of an area of approximately 0.25m^2. Refer to the Site Walkover Plan in Appendix B.

The Waltham Community Cottage is located in the CERA “green” zone. The “green” zone has been further categorised into technical categories by the Department of Building and Housing (DBH), this site has been identified as “Technical Category 2” (TC2) released in October 2011. The DBH technical categories are guidelines for residential foundations, however are likely to be used as a guideline by Christchurch City Council for building consent. TC2 identifies the area may be subject to minor to moderate land damage from liquefaction in future large earthquakes.

3. Site Walkover Inspection

A walkover inspection of the exterior and interior was carried out by Danielle Belcher, Opus Engineering Geologist on 16 February 2012. The following observations were made (refer to the Site Walkover Plan and Site Photos attached to this report):

- Based on visual observations of the building, there is no evidence of differential settlement or rotation of the foundations.
- Asphalt paving has been damaged and replaced in several areas due to cracking during the shaking of the 22 February 2011 earthquake. Refer to Photos 2, 4-7 and Site Walkover Plan for location.
- Some paved areas seem slightly uneven, may have been present prior to earthquakes. Refer to Photo 3 and 5.
- An area of approximately 0.25m^2 located 5m north of the building was affected by surface rupture liquefaction. Refer to Photo 4 and Site Walkover Plan for location.
- Minor cracking to existing asphalt paving, may have been present prior to earthquakes. Refer to Photo 8 and Site Walkover Plan for location.
- Minor cracking was observed around the vents in the perimeter strip footing. Refer to Photo 9 and 10.

4. Discussion

Minor land damage has occurred to the Somerfield Playcentre due to the Canterbury Earthquake Sequence following the 4 September 2010 earthquake.

There appears to have been minor movement (up to 10mm) of the ground illustrated by the repaired asphalt areas.

Liquefaction appears to have been relatively minor at the site and within close vicinity (no liquefaction was reported at the adjacent Somerfield Community Centre). Possible minor settlement and/or heave (<10mm) is present in the asphalt paving to the north-east and north-west of the playcentre.

Cracks in the reinforced concrete foundation wall appear to be minor, and will not affect the structural integrity of the building or its performance in future earthquakes.

ECan well logs and CPTs indicate the building is probably founded on interbedded layers of clay, liquefiable silt and sand, with gravels likely to be encountered between 17m and 22.8m bgl. The foundation system of a suspended floor on concrete piles and a perimeter strip footing has performed well.

Buildings are typically designed to allow for up to 50mm of land settlement in a serviceability limit state (SLS) event, or up to 100mm in an ultimate limit state event (ULS).

GNS Science indicates an elevated risk of seismic activity is expected in the Canterbury region as a result of the earthquake sequence following the 4 September 2010 earthquake. Recent advice (Geonet) indicates there is a 18% probability of another Magnitude 6 or greater earthquake occurring in the next 12 months in the Canterbury region. It is expected that the probability of occurrence is likely to decrease with time, following periods of reduced seismic activity. However, we would expect that similar liquefaction and ground damage could occur in a future earthquake.

Based on current evidence, the existing foundations are considered appropriate for the building with the client's acceptance that the potential for differential settlement may occur in future seismic events.

If CCC wish to quantify the risk of damage from differential settlement in future seismic events, consideration could be given to undertaking ground investigations to more accurately estimate the potential differential settlement from liquefaction. Allowance for predrilling through shallow gravels may need to be included in the scope of a site investigation.

5. Recommendations

- Based on the past performance in recent earthquakes, the existing foundations should be acceptable in terms of future ULS and SLS loadings, although CCC may have to accept the risk for potential differential settlement in the order of 0 to 50mm in a future seismic event;

- If CCC wishes to further evaluate and quantify the liquefaction potential at this site, additional site specific testing with CPT's and associated analysis would be necessary.

6. Limitation

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

7. *References:*

Brown, LJ; Webber, JH 1992: Geology of the Christchurch Urban Area. Scale 1:25,000. Institute of Geological and Nuclear Sciences geological map, 1 sheet + 104p.

Environment Canterbury, Canterbury Regional Council (ECan) website:

ECan Well Card
http://ecan.govt.nz/services/online-services/tools-calculators/Pages/well-card.aspx

ECan 2004: The Soild Facts on Christchurch Liquefaction. Canterbury Regional Council, Christchurch, 1 sheet.

Project Orbit, 2011: interagency/organisation collaboration portal for Christchurch recovery effort. https://canterburyrecovery.projectorbit.com/SitePages/Home.aspx

GNS Science reporting on Geonet Website: http://www.geonet.org.nz/canterbury-quakes/aftershocks/ updated on 3 February 2012.

Prepared By:

D Belcher

Danielle Belcher
Engineering Geologist

Reviewed By:

Graham Brown
Senior Geotechnical Engineer

Appendices:
Appendix A: Site Photos
Appendix B: Site Walkover Plan
Appendix C: ECan Well and CPT Logs

APPENDIX A:

Site Photos

Photo 1: Street elevation, Somerfield Community Centre, 47 Studholme St.

Photo 2: Playcentre down driveway, behind community centre. Note new asphalt.

Photo 3: Localised settlement of asphalt (<10mm).

Photo 4: Approximate location of liquefaction on site ($0.25m^2$), note new asphalt.

Photo 5: View from rear of building, note uneven asphalt and newly paved areas.

Photo 6: Shed at rear of property.

Photo 7: View from rear of property looking south-east.

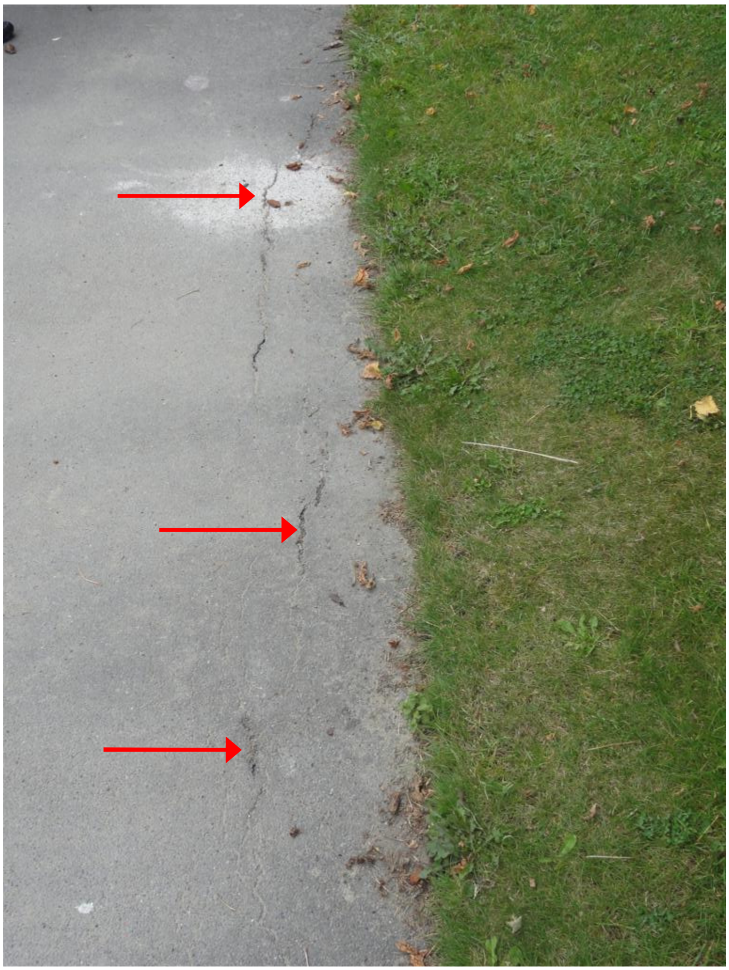


Photo 8: Possible earthquake induced cracks in asphalt.

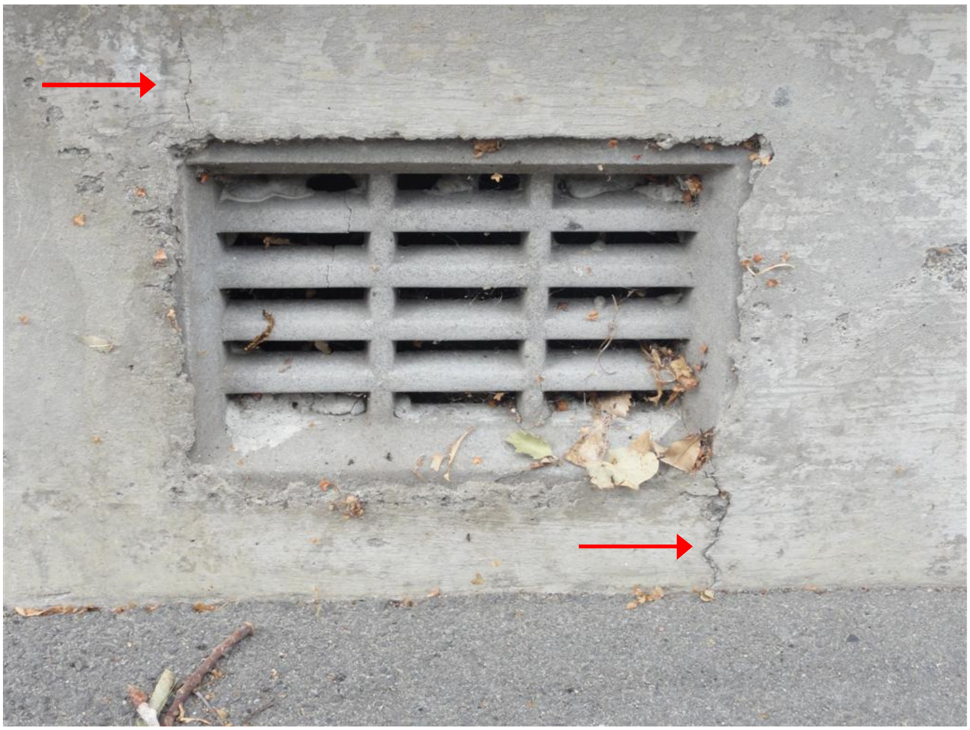


Photo 9: Minor cracking in concrete foundation wall around vent on north-eastern side.

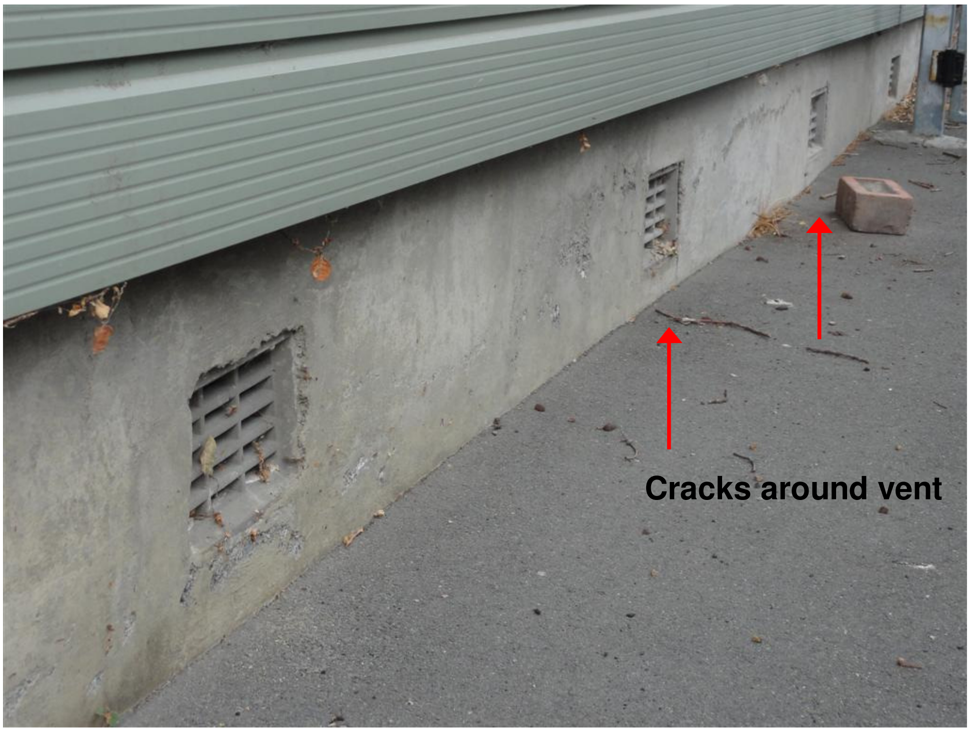


Photo 10: Reinforced concrete foundation wall, north-east side.

APPENDIX B:

Site Walkover Plan

Red line: Playcentre Boundary

● Liquefaction

▨ Areas of new asphalt

\ Cracks in asphalt

○ Areas of uneven asphalt

OPUS

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

Project: Somerfield Playcentre
Geotechnical Desk Study

Project No.: 6-QUCCC.59/005SC

Client: Christchurch City Council

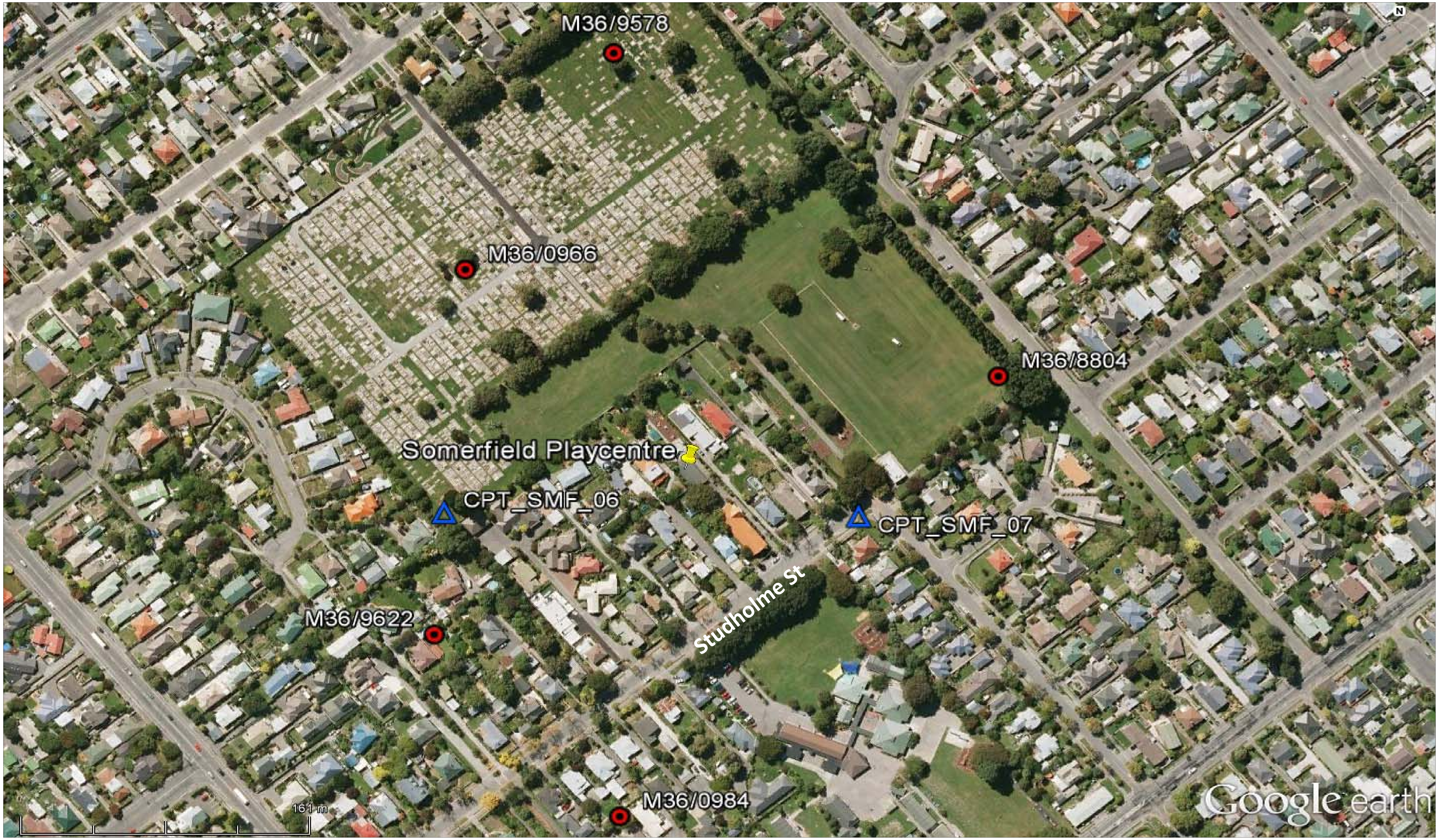
Site Walkover Plan

Drawn: Danielle Belcher
Engineering Geologist

Date: 20/20/2012

APPENDIX C:

ECan Site Plan
Well Logs
CPT Logs



Key: Blue: CPTs
Red: Boreholes
Yellow: Site Location

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

Project:	Somerfield Playcentre Geotechnical Desk Study
Project No.:	6-QUCCC.59/005SC
Client:	Christchurch City Council

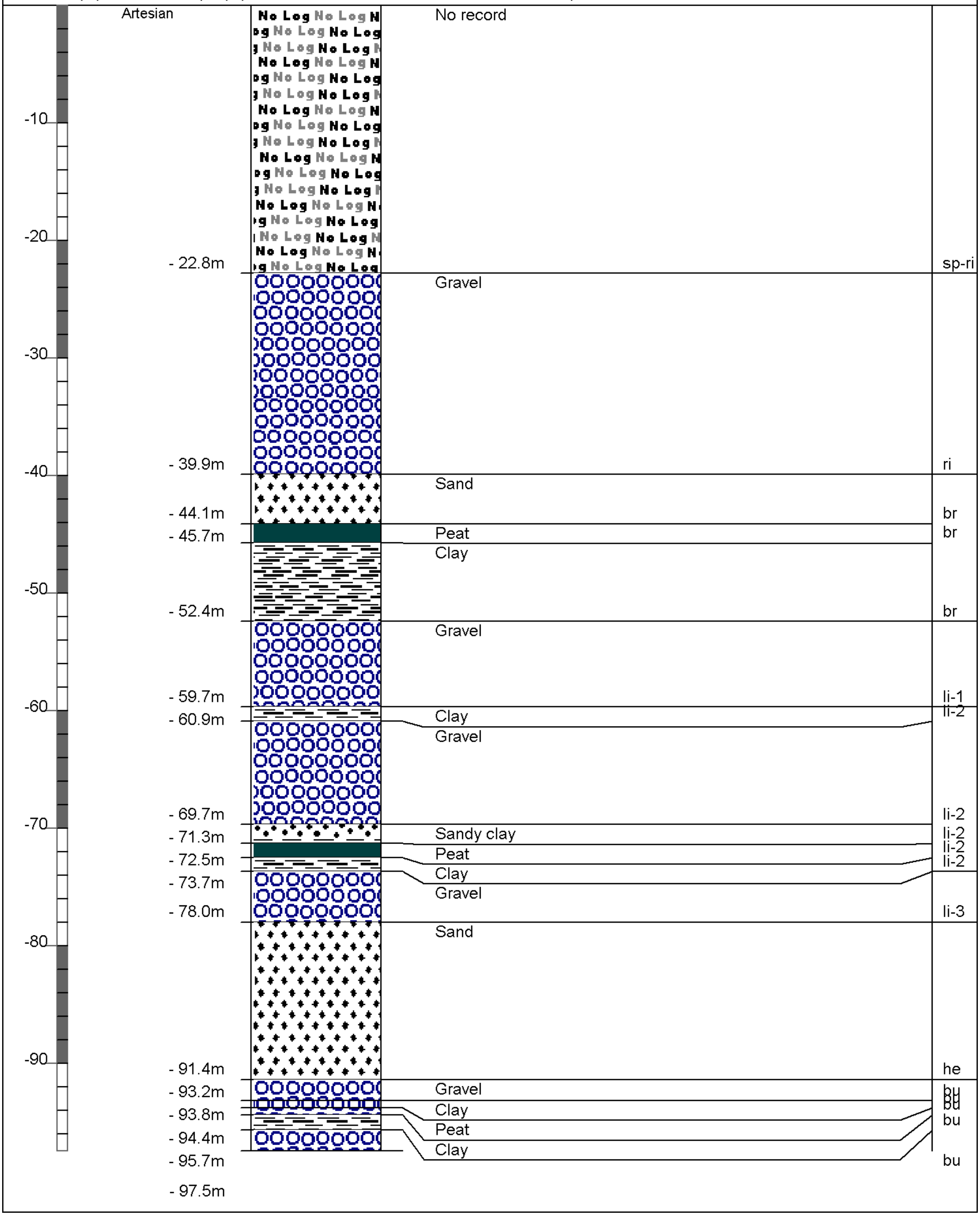
Site Plan

Drawn: Danielle Belcher
Engineering Geologist

Date: 20-Feb-12

Borelog for well M36/0966

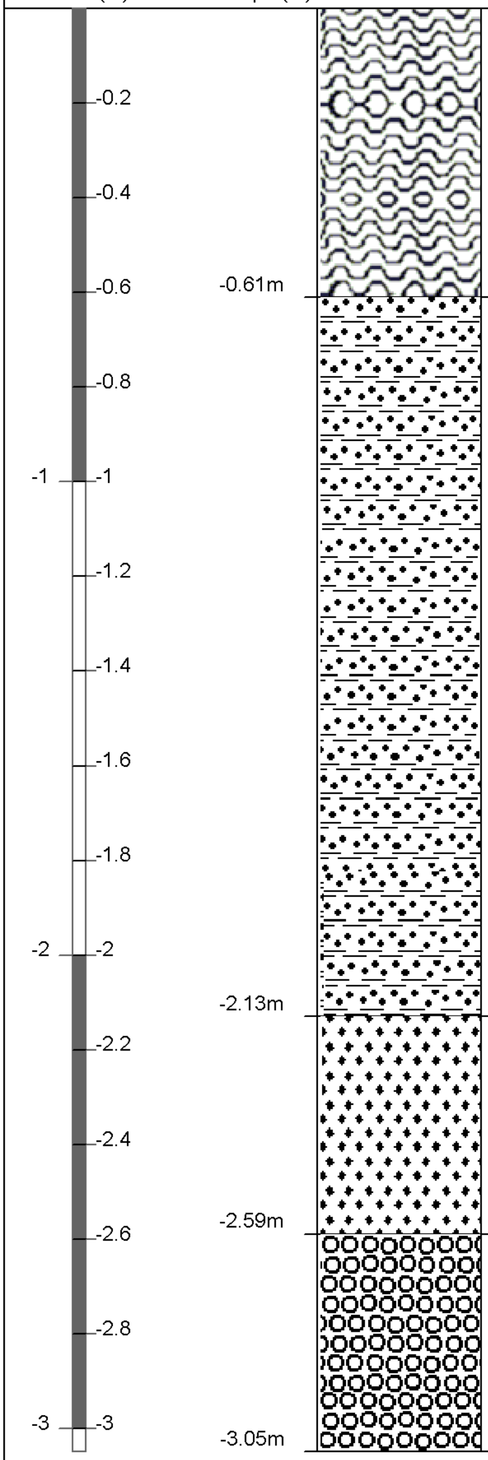
Gridref: M36:797-387 Accuracy : 4 (1=best, 4=worst)
Ground Level Altitude : 10.2 +MSD
Driller : not known
Drill Method : Unknown
Drill Depth : -97.5m Drill Date :



Water Level	Depth(m)	Full Drillers Description	Formation Code
Artesian	- 22.8m	No record	sp-ri
	- 39.9m	Gravel	ri
	- 44.1m	Sand	br
	- 45.7m	Peat	br
	- 52.4m	Clay	br
	- 59.7m	Gravel	li-1
	- 60.9m	Clay	li-2
	- 69.7m	Gravel	li-2
	- 71.3m	Sandy clay	li-2
	- 72.5m	Peat	li-2
	- 73.7m	Clay	li-2
	- 78.0m	Gravel	li-3
	- 91.4m	Sand	he
	- 93.2m	Gravel	bu
	- 93.8m	Clay	bu
	- 94.4m	Peat	bu
	- 95.7m	Clay	bu
	- 97.5m		

Borelog for well M36/9622

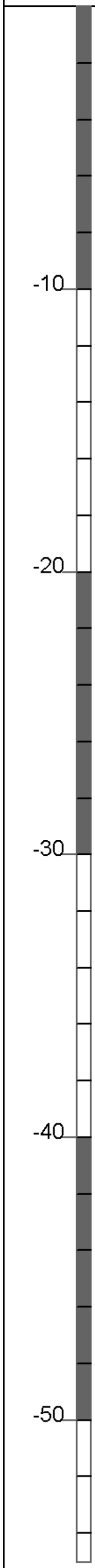
Gridref: M36:79690-38495 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 10.7 +MSD
Well name : CCC BorelogID 4108
Drill Method : Not Recorded
Drill Depth : -3.05m Drill Date :

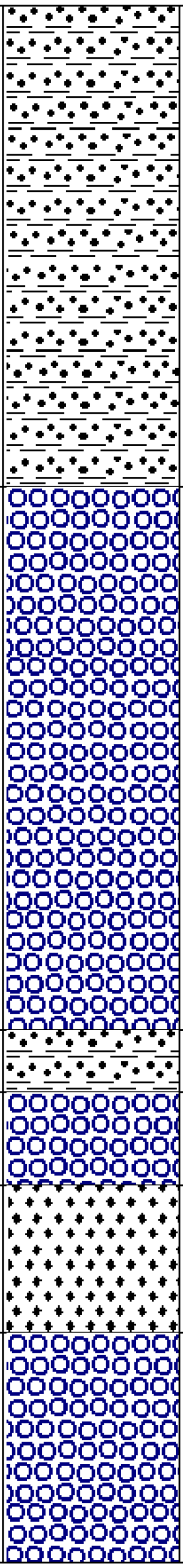


Depth(m)	Full Drillers Description	Formation Code
	topsoil	
-0.61m	clay and sand	
-2.13m	sand	
-2.59m	gravel	
-3.05m		

Borelog for well M36/0984 page 1 of 2

Gridref: M36:798-384 Accuracy : 4 (1=best, 4=worst)
Ground Level Altitude : 10.7 +MSD
Driller : Job Osborne (& Co/Ltd)
Drill Method : Hydraulic/Percussion
Drill Depth : -110.1m Drill Date : 17/10/1911

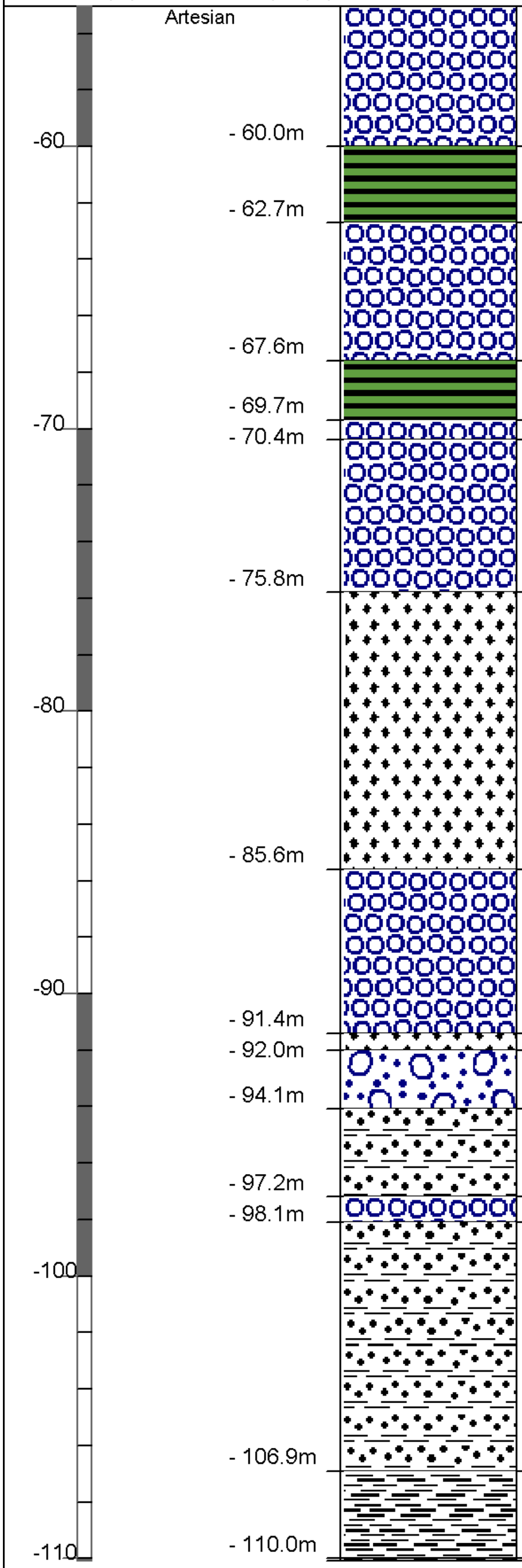




Scale(m)	Water Level	Depth(m)	Full Drillers Description	Formation Code
	Artesian	- 17.0m	Sand & clay	sp
		- 36.2m	Brown shingle water 2.4m bgs	sp-ri
		- 38.4m	Yellow sand & clay	br
		- 41.7m	Brown shingle	br
		- 46.9m	Yellow sand	br
		- 60.0m	Brown shingle	li-1

Borelog for well M36/0984 page 2 of 2

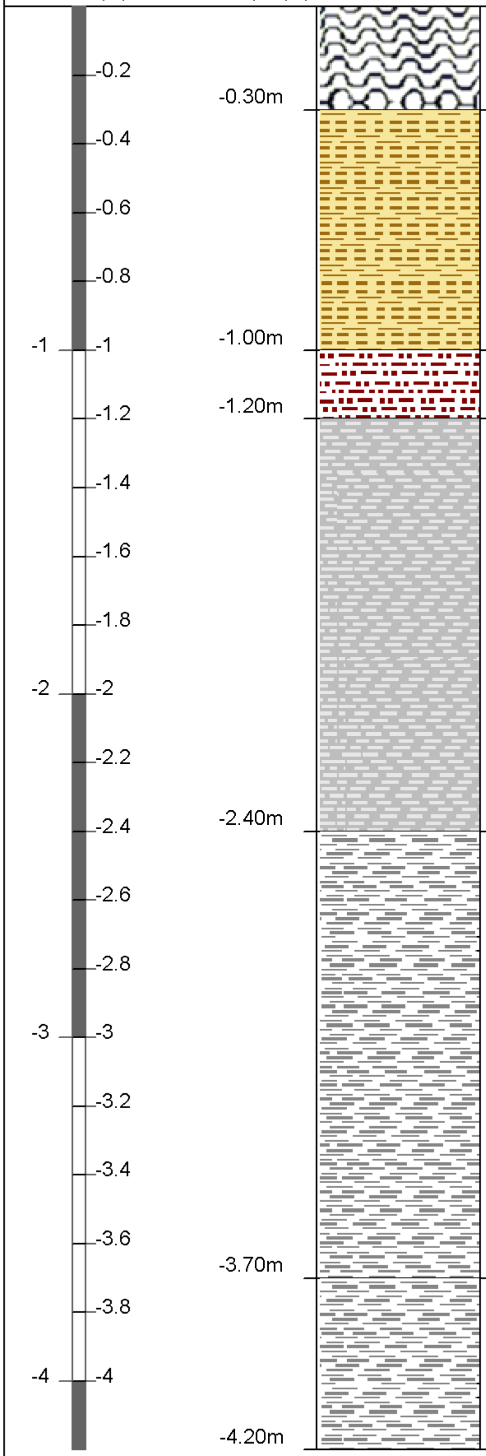
Gridref: M36:798-384 Accuracy : 4 (1=best, 4=worst)
Ground Level Altitude : 10.7 +MSD
Driller : Job Osborne (& Co/Ltd)
Drill Method : Hydraulic/Percussion
Drill Depth : -110.1m Drill Date : 17/10/1911



Water Level	Depth(m)	Full Drillers Description	Formation Code
Artesian	- 60.0m	Brown shingle	li-1
	- 62.7m	Clay & peat	li-2
	- 67.6m	Blue shingle, water at surface	li-2
	- 69.7m	Clay & peat	li-2
	- 70.4m	Blue shingle. Water at surface	li-3
	- 75.8m	Brown shingle	li-3
	- 85.6m	Brown sand	he
	- 91.4m	Brown shingle	he
	- 92.0m	Brown sand	he
	- 94.1m	Brown sand & shingle	bu
	- 97.2m	Yellow sand & clay	bu
	- 98.1m	Brown shingle 26.2m3/d at 97.8m	bu
	- 106.9m	Blue sand & clay	sh
	- 110.0m	Yellow clay	sh
	- 110.1m	Black rock	vo

Borelog for well M36/8804

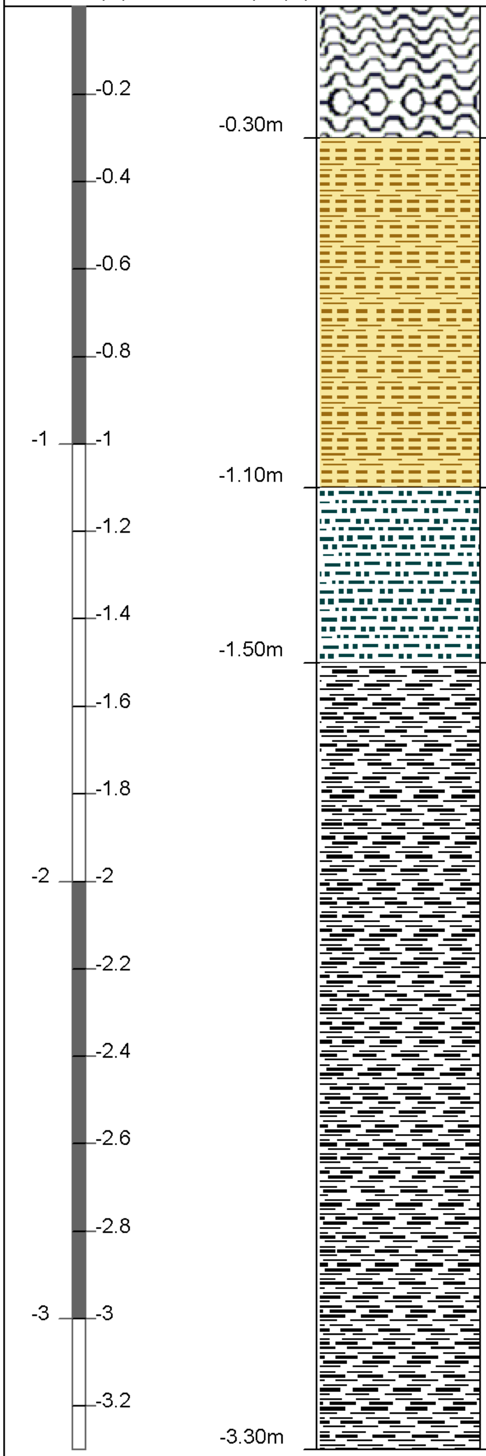
Gridref: M36:80002-38665 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 8.1 +MSD
Well name : CCC BorelogID 667
Drill Method : Not Recorded
Drill Depth : -4.2m Drill Date :



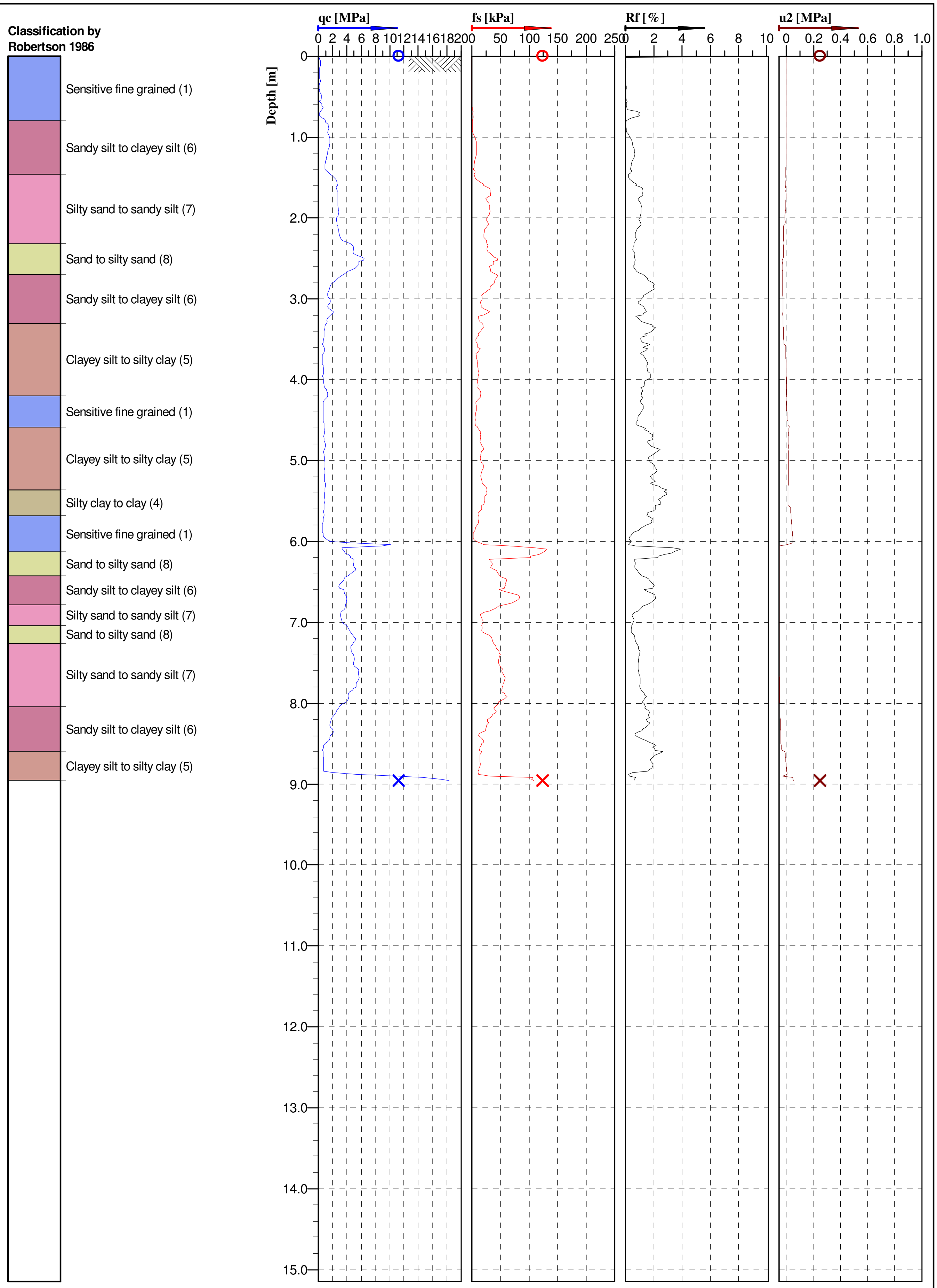
Depth(m)	Full Drillers Description	Formation Code
-0.30m	black loose topsoil	
-1.00m	light brown loose moist clayey silt	
-1.20m	light brown loose moist silty sand	
-2.40m	grey loose moist silt	
-3.70m	grey moist clay	
-4.20m	light grey moist clay	

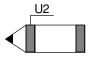
Borelog for well M36/9578

Gridref: M36:79838-38887 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 10.2 +MSD
Well name : CCC BorelogID 3761
Drill Method : Not Recorded
Drill Depth : -3.3m Drill Date : 11/12/1985



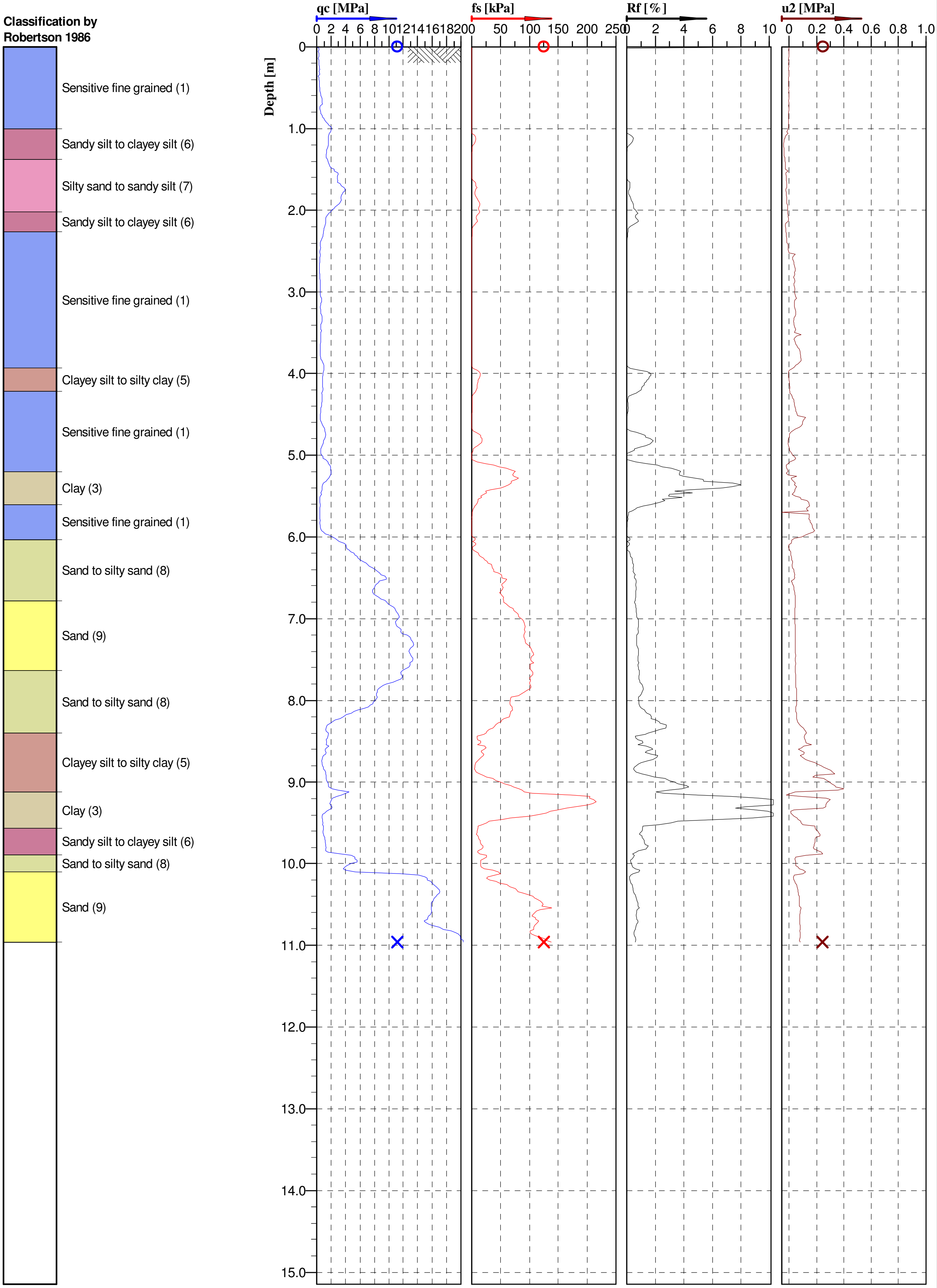
Water Level	Depth(m)	Full Drillers Description	Formation Code
	-0.30m	topsoil	
	-1.10m	light brown non-cohesive dry silty clay	
	-1.50m	blue grey saturated sandy silt	
	-3.30m	blue grey cohesive saturated clay	

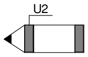




Cone No: 100KN 4341
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: CHRISTCHURCH	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test no: SMF-CPT-06
Project ID:	Client: TONKIN & TAYLOR LTD	Date: 5/05/2011	Scale: 1 : 65
Project: EQC SITES		Page: 1/1	Fig:
		File: SMF-CPT-06.CPT	





Cone No: 100KN 4341
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: CHRISTCHURCH	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test no: SMF-CPT-07
Project ID:	Client: TONKIN & TAYLOR LTD	Date: 3/05/2011	Scale: 1 : 65
Project: EQC SITES		Page: 1/1	Fig:
		File: SMF-CPT-07.CPT	

Appendix D – CERA DEE Spreadsheet

Detailed Engineering Evaluation Summary Data

V1.11

Location

Building Name: Somerfield Playcentre
Building Address: Unit: — No: 47 Street: Studholme Street, Somerfield
Legal Description:

	Degrees	Min	Sec
GPS south:	43	33	34.00
GPS east:	172	37	35.30

Building Unique Identifier (CCC): BU 1129-002 EQ2

Reviewer: Alistair Boyce
CPEng No: 209860
Company: Opus International Consultants
Company project number: 6-QUCCC.59
Company phone number: 03 363 5400

Date of submission: 15-Oct-12
Inspection Date: 15/12/2011
Revision: Final
Is there a full report with this summary? yes

Site

Site slope: flat
Soil type: mixed
Site Class (to NZS1170.5): D
Proximity to waterway (m, if <100m):
Proximity to clifftop (m, if < 100m):
Proximity to cliff base (m,if <100m):

Max retaining height (m): 0
Soil Profile (if available):
If Ground improvement on site, describe:
Approx site elevation (m): 7.00

Building

No. of storeys above ground: 1 single storey = 1
Ground floor split? no
Storeys below ground 0
Foundation type: other (describe)
Building height (m): 4.40
Floor footprint area (approx): 115
Age of Building (years): 17

Ground floor elevation (Absolute) (m): 7.00
Ground floor elevation above ground (m): 0.30
if Foundation type is other, describe: Perimeter wall and shallow piles
height from ground to level of uppermost seismic mass (for IEP only) (m):
Date of design: 1992-2004

Strengthening present? no
Use (ground floor): public
Use (upper floors):
Use notes (if required):
Importance level (to NZS1170.5): IL2

If so, when (year)?
And what load level (%g)?
Brief strengthening description:

Gravity Structure

Gravity System: load bearing walls
Roof: timber truss
Floors: timber
Beams: timber
Columns: timber
Walls:

truss depth, purlin type and cladding Corrugated iron cladding
joist depth and spacing (mm)
type
typical dimensions (mm x mm)

Lateral load resisting structure

Lateral system along: lightweight timber framed walls
Ductility assumed, μ: 3.00
Period along: 0.40 0.00
Total deflection (ULS) (mm):
maximum interstorey deflection (ULS) (mm):

Note: Define along and across in detailed report!

note typical wall length (m) 1m - 4m
estimate or calculation? estimated
estimate or calculation?
estimate or calculation?

Lateral system across: lightweight timber framed walls
Ductility assumed, μ: 3.00
Period across: 0.40 0.00
Total deflection (ULS) (mm):
maximum interstorey deflection (ULS) (mm):

note typical wall length (m) 1m-4m
estimate or calculation? estimated
estimate or calculation?
estimate or calculation?

Separations:

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

leave blank if not relevant

Non-structural elements

Stairs:
Wall cladding: other light describe Timber weatherboard
Roof Cladding: Metal describe Corrugated iron
Glazing: aluminium frames
Ceilings: none GIB lined roof plane
Services(list):

Available documentation

Architectural partial original designer name/date Christopher W Hadlee / July 1995
Structural none original designer name/date
Mechanical none original designer name/date
Electrical none original designer name/date
Geotech report none original designer name/date

Damage

Site:
(refer DEE Table 4-2)

Site performance:
Describe damage:

Settlement: 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: 100%
Describe (summary):
Describe how damage ratio arrived at:

Across Damage ratio:
Describe (summary):

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

Diaphragms Damage?: no Describe:
CSWs: Damage?: yes Describe: Lack of subfloor bracing
Pounding: Damage?: no Describe:
Non-structural: Damage?: yes Describe: Cracking & separation of chimney

Recommendations

Level of repair/strengthening required: significant structural Describe: Replacement of wall linings
Building Consent required: yes Describe:
Interim occupancy recommendations: full occupancy Describe:

Along Assessed %NBS before: 47% ##### %NBS from IEP below
Assessed %NBS after:

If IEP not used, please detail assessment methodology: Quantitative assessment

Across Assessed %NBS before: 81% ##### %NBS from IEP below
Assessed %NBS after:

IEP

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

Period of design of building (from above): 1992-2004
h_n from above: m

Seismic Zone, if designed between 1965 and 1992:
not required for this age of building
Design Soil type from NZS4203:1992, cl 4.6.2.2:

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

Note:1 for specifically design public buildings, to the code of the day: pre-1965 = 1.25; 1965-1976, Zone A =1.33; 1965-1976, Zone B = 1.2; all else 1.0: 1.00
Note 2: for RC buildings designed between 1976-1984, use 1.2: 1.0
Note 3: for buildngs designed prior to 1935 use 0.8, except in Wellington (1.0): 1.0

	along	across
Final $(\%NBS)_{nom}$:	**0%**	**0%**

2.2 Near Fault Scaling Factor

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

	along	across
Near Fault scaling factor (1/N(T,D), **Factor A**:	1	1

2.3 Hazard Scaling Factor

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

2.4 Return Period Scaling Factor

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

2.5 Ductility Scaling Factor

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

2.6 Structural Performance Scaling Factor:

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

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

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

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

3.1. Plan Irregularity, factor A: 1

3.2. Vertical irregularity, Factor B: 1

3.3. Short columns, Factor C: 1

3.4. Pounding potential
Pounding effect D1, from Table to right 1.0
Height Difference effect D2, from Table to right 1.0

Therefore, Factor D: 1

3.5. Site Characteristics 1

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

Table for Selection of D2	Severe	Significant	Insignificant/none
Separation	0<sep<.005H	.005<sep<.01H	Sep>.01H
Height difference > 4 storeys	0.4	0.7	1
Height difference 2 to 4 storeys	0.7	0.9	1
Height difference < 2 storeys	1	1	1

3.6. Other factors, Factor F

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

Detail Critical Structural Weaknesses: (refer to DEE Procedure section 6)
List any: Refer also section 6.3.1 of DEE for discussion of F factor modification for other critical structural weaknesses

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

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