Cathedral Square Toilets

PRK 1224 BLDG 002 EQ2

Detailed Engineering Evaluation
Quantitative Assessment Report

CHRISTCHURCH CITY COUNCIL

Detailed Engineering Evaluation PRK 1224 BKDG 002 EQ2

Quantitative Assessment Report

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Cathedral Square Toilets Building
PRK 1224 BLDG 002 EQ2

Detailed Engineering Evaluation
Quantitative Report - SUMMARY
Final

13 Cathedral Square, Christchurch

Background

This is a summary of the quantitative report for the building structure at 12 Cathedral Square, and is based on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011, visual inspections on 12 October 2011 and 7 December 2011, available drawings and calculations.

Key Damage Observed

Key damage observed includes:

- Significant cracking in one of the reinforced masonry lift shaft panels at roof level;
- Minor cracking in the ground floor slab from the start of the precast stairs to the curved feature wall;
- There is significant pounding damage to the non-structural cover panel to the Philip King building at the south-east corner of the building. No pounding damage was observed to the structure;
- One of the glass panels on the first floor above the eastern canopy has broken.

Critical Structural Weaknesses

The following critical structural weaknesses have been identified:

a) The length of the 140mm thick masonry shear wall immediately south of the northern stairs is significantly reduced below the first floor. This results in a large vertical stiffness irregularly between the ground floor and floors above;
b) The Philip King building to the south and IBIS Hotel to the west are located within 50mm and 250mm of the building respectively. Both neighbouring buildings present a risk of imposing pounding effects;
c) The stair flights in the north-west corner of the building are fixed into the landings at each level and therefore attract seismic load. This has the potential to cause a flexural failure in the stair flight;
d) The diaphragm reinforcement throughout the building is known as ‘665 steel mesh’. This type of reinforcement exhibits non-ductile behaviour, and therefore presents a potential risk to diaphragm load carrying capacity.

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 10%NBS and post-earthquake capacity in the order of 10%NBS. The building is therefore classed as earthquake prone.

Recommendations

It is recommended that:

(a) A strengthening works scheme be developed to increase the seismic capacity of the building to at least 67% NBS; this will need to consider compliance with accessibility and fire requirements;

(b) A quantity surveyor be engaged to determine the costs for strengthening the building.

Contents

1 Introduction

Opus International Consultants Limited has been engaged by Christchurch City Council (CCC) to undertake a detailed seismic assessment of the Cathedral Square Toilets, located adjacent to Strand Lane, 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 qualitative and quantitative procedures detailed in the Detailed Engineering Evaluation Procedure (DEEP) document (draft) issued by the Structural Engineering Society (SESOC) on 19 July 2011.

2 Compliance

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

2.1 Canterbury Earthquake Recovery Authority (CERA)

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

Section 38 – Works

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

Section 51 – Requiring Structural Survey

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

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

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

1. The importance level and occupancy of the building.

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

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

2.2 Building Act

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

Section 112 - Alterations

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

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

Section 115 – Change of Use

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

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

Section 121 – Dangerous Buildings

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

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

Section 122 – Earthquake Prone Buildings

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

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

Section 124 – Powers of Territorial Authorities

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

Section 131 – Earthquake Prone Building Policy

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

2.3 Christchurch City Council Policy

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

The 2010 amendment includes the following:

1. A process for identifying, categorising and prioritising Earthquake Prone Buildings, commencing on 1 July 2012;
2. A strengthening target level of 67% of a new building for buildings that are Earthquake Prone;
3. A timeframe of 15-30 years for Earthquake Prone Buildings to be strengthened; and,
4. Repair works for buildings damaged by earthquakes will be required to comply with the above.

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

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

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

2.4 Building Code

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

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

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

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

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

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

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

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

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

3 Earthquake Resistance Standards

For this assessment, the building's earthquake resistance is compared with the current New Zealand Building Code requirements for a new building constructed on the site. This is expressed as a percentage of new building standard (%NBS). The loadings are in accordance with the current earthquake loading standard NZS1170.5 [2].

A generally accepted classification of earthquake risk for existing buildings in terms of %NBS that has been proposed by the NZSEE 2006 [3] 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
High 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.

Table 1: %NBS compared to relative risk of failure

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

3.1 Minimum and Recommended Standards

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

a) Occupancy

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

b) Cordoning

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

c) Strengthening

Industry guidelines (NZSEE 2006 [3]) strongly recommend that every effort be made to achieve improvement to at least 67%NBS. A solution to anything less than 67% would not provide an adequate reduction to the level of risk.

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

d) Our Ethical Obligation

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

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[i] This Order only applies to buildings within the Christchurch City, Selwyn District and Waimakariri District Councils authority.

4 Background Information

4.1 Building Description

The Cathedral Square Toilets building is located in the south west corner of the Cathedral Square. The original building was constructed in 1993, while alterations to the ground and first floors were completed in 1995. These alterations included the addition of an insitu concrete staircase to the east of the building, and an extension of the existing curved internal feature wall. The new wall divides the structure into east and west segments, which then separates the men's and women's facilities.

The three storey building is primarily a reinforced masonry wall structure with precast concrete floors. The plan dimensions of the perimeter walls are 15.4m in the longitudinal (north-south) direction and 9.7m in the transverse (east-west) direction. The perimeter walls run to the roof level height of 11m above ground.

The building is bounded by the ANZ building and Strand Lane to the east, the IBIS Hotel to the west and the Philip King building on Hereford Street to the south. For the purposes of this report we will refer to the direction parallel to Hereford Street as the east-west direction, and parallel to Colombo Street as the north-south direction.

The separation to the adjacent building to the south is 50mm, while the separation to the adjacent building to the west is approximately 250mm.

The foundations consist primarily of shallow strip footings with a raft foundation in the north-east corner of the building.

4.2 Gravity Load Resisting System

The gravity load resisting system generally consists of precast concrete floors spanning onto reinforced masonry walls. The southern and western walls are full height 190mm thick masonry walls, running the full length of the boundary. There is an internal curved wall, also 190mm thick masonry, running in the north-south direction which creates a central division wall. This wall has a large number of openings in it. All perimeter and internal masonry walls are assumed to be fully grouted.

The ground floor is a 100mm thick insitu concrete slab on grade, with 665 reinforcing mesh.

The insitu staircase (ground to first floor only) on the eastern side of the building is supported by a 140mm reinforced masonry wall. The landing and first floor are constructed with insitu HiBond floor slabs. The floor is supported on the wall and eastern perimeter concrete beam with starter bars and galvanised mild steel angles fixed with D20 dynabolts.

The second floor and remainder of the first floor are constructed from 75mm Unispan precast units with 75mm topping. These floors are tied into the masonry walls with D12 starter bars.

The central part of the roof slab is a 200mm thick concrete slab on HiBond steel decking. Starter bars are used to tie the floor slab into the load bearing walls.

The northern stairs are precast concrete flights, fixed top and bottom with 75x50x4.9mm rectangular hollow sections into the floor slab, R16 anchors and D12 anchor rods. There is a 20mm gap between the stairs and the insitu concrete landings.

To the south of the northern stairs there is a 140mm reinforced masonry wall running in the east-west direction. This reinforced masonry wall is present from the roof level down to first floor where it changes to an insitu reinforced concrete wall. The wall is 3.8m long at first floor and above, and tapers to a length of 0.8m at ground floor level.

The northern stairs have a 150mm insitu slab landing, and 150mm insitu slab at roof level. The landing is tied into the lift shaft and perimeter masonry wall with D12 starters at 300mm centres. At roof level the 200mm insitu floor slab is tied into the perimeter wall and lift shaft with D12 starters at 400mm centres.

To the east of the division wall, the floor slabs are supported by 340x540mm reinforced concrete beams on 200mm diameter gravity columns.

Refer to the floor plans in Appendix B for further details.

4.3 Seismic Load Resisting System

The seismic loads in the longitudinal (north-south) direction are resisted by in-plane shear resistance of the reinforced concrete masonry walls. It is assumed that the curved feature wall, with various openings and cut-outs, provides no lateral load resistance in the longitudinal direction.

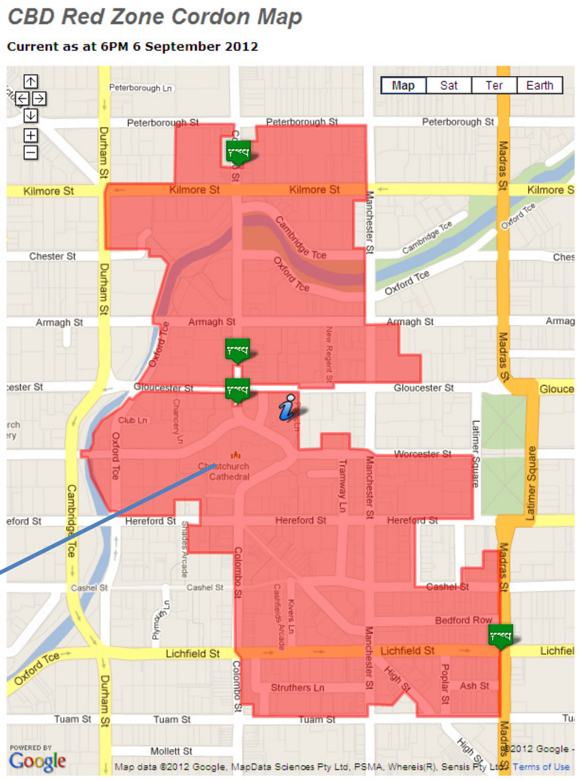
In the transverse (east-west) direction the seismic load resisting system consists of the 190mm perimeter block-work wall to the south, the 190mm perimeter reinforced concrete wall to the north, the 140mm block wall south of the eastern insitu stairs, and the 140mm block wall starting at the first floor adjacent to the precast stairs acting as in-plane shear walls.

The reinforced concrete floor slabs will act as rigid diaphragms to distribute forces to the in-plane shear walls, and subsequently down to the foundation beams. The floor slabs are tied into the masonry walls with starter bars.

The concrete frame at first floor level on the eastern side of the structure is assumed to not provide any lateral load resistance.

4.4 CBD Red Zone Cordon

Following the Lyttelton Earthquake of 22 February 2011, the central business district (CBD) suffered major damage to a large proportion of its building stock and so a central area of the city was cordoned off and closed to the public, forming what is known as the red zone. The Cathedral Square Toilets are located within the red zone cordon. The red zone extent, as of 6 September 2012, is displayed below in Figure 2.



Cathedral Square Toilets

Figure 2: CBD Red Zone as at 6 September 2012

4.5 Survey

a) Post 22 February 2011 Rapid Assessment

An initial structural assessment of the building was undertaken on 12 October 2011 by Opus International Consultants. The whole building was assessed during this inspection.

b) Further Inspections

Further investigations were undertaken by Opus International Consultants on 7 December 2011. Access could not be gained to the roof level of the building for this inspection.

The above investigations included external and internal visual inspections of all structural elements above foundation level, and of areas of damage to structural and non-structural elements.

4.6 Original Documentation

Copies of the following construction drawings were provided by the CCC:

- New Toilets and Associated Facilities Cathedral Square Christchurch, architectural and structural drawings (Warren and Mahoney and Holmes Consulting Group) dated July 1993 and stamped for building consent.

- Alterations to Toilets and Facilities Cathedral Square Christchurch, architectural and structural drawings (Warren and Mahoney and Holmes Consulting Group) dated May 1995 and stamped for building consent.

These drawings were used to confirm the structural systems, investigate potential critical structural weaknesses (CSW's) and identify details which required particular attention.

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

5 Damage Assessment

The following damage has been noted:

5.1 Ground floor slab

The ground floor of the women's facilities has a minor crack from the start of the precast stairs to the curved feature wall. Slight vertical movement was also observed with doors sticking at ground floor.

5.2 Glass panels

One of the glass panels on the first floor above the eastern canopy has broken.

5.3 Precast panels

There are significant cracks in one of the reinforced masonry lift shaft panels at roof level.

5.4 Pounding

There is significant pounding damage to the non-structural cover panel to the Philip King building at the south-east corner of the building. No pounding damage was observed to the structure.

6 General Observations

The building performed well and better than expected given the potential Critical Structural Weaknesses identified below. The visible damage observed during our inspection was minor. The potential pounding hazards do not appear to have caused any significant damage to the structure. Intrusive investigations may be required to further confirm the extent of the pounding damage.

7 Detailed Seismic Assessment

The detailed seismic assessment has been based on the NZSEE 2006 [3] guidelines for the "Assessment and Improvement of the Structural Performance of Buildings in Earthquakes" together with the "Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings in Canterbury, Part 2 Evaluation Procedure" [4] draft document prepared by the Engineering Advisory Group on 19 July 2011, and the SESOC guidelines "Practice Note – Design of Conventional Structural Systems Following Canterbury Earthquakes" [6] issued on 21 December 2011.

7.1 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. We have identified the following potential CSW's for the building:

a) Vertical Irregularity

The length of the 140mm thick masonry shear wall immediately south of the northern stairs is significantly reduced below the first floor. This results in a large vertical stiffness irregularly between the ground floor and floors above.

b) Pounding Effects

The Philip King building to the south and IBIS Hotel to the west are located within 50mm and 250mm of the building respectively. Both neighbouring buildings present a risk of imposing pounding effects.

c) Precast Built In Stairs

The stair flights in the north-west corner of the building are fixed into the landings at each level and therefore attract seismic load. This has the potential to cause a flexural failure in the stair flight.

d) Diaphragm Mesh Reinforcement

The main floor diaphragms are reinforcement throughout with 665 steel mesh. This type of reinforcement exhibits non-ductile behaviour, and therefore presents a potential risk to diaphragm load carrying capacity.

7.2 Quantitative Assessment Methodology

The assessment assumptions and methodology have been included in Appendix 3 of the report due to the technical nature of the content. A brief summary follows:

A 3D model of each of the buildings was created in ETABS, which is a finite element structural analysis programme.

Static and modal response spectrum analyses were carried out using the spectral values established from NZS1170.5, with an updated Z factor of 0.3 (B1/VM1). These analyses were used to establish the actions on the structural elements. Based on the actions determined from the analyses, an assessment of the building capacities was made.

Axial-moment and moment curvature analyses were carried out for the walls in SP COLUMN, which is a computer analysis programme.

A global ductility factor of 1.25 has been taken for all reinforced masonry and reinforced concrete shear wall elements, in accordance with the SESOC Practice Note [6].

7.3 Limitations and Assumptions in Results

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

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

7.4 Quantitative Assessment

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 elements. This will be considered further when developing the strengthening options.

Table 2: Summary of Seismic Performance – μ = 1.25

Structural Element/System	Failure mode or description of limiting criteria based on displacement capacity of critical element.	% NBS based on calculated capacity
Reinforced Masonry South Boundary Wall – North South direction	Flexural failure in the wall resulting in a plastic hinge forming at the base of the wall.	63%
South of Stairwell Reinforced Masonry Wall – East West direction	Flexural failure in the wall resulting in a plastic hinge forming at the base of the wall.	44%

Structural Element/System	Failure mode or description of limiting criteria based on displacement capacity of critical element.	% NBS based on calculated capacity
Reinforced Masonry Spandrel – Opening in Central Division Wall	Shear failure of the spandrel above second floor wall opening. Alterations to the building dated 1995 included an opening in the existing wall, reducing the shear capacity of the spandrel.	35%
Reinforced Concrete Wall – North Boundary Wall	Flexural failure in the wall resulting in a plastic hinge forming at the base of the wall. This wall has well detailed boundary elements and will fail in a ductile manner. The torsional response of the building increases the displacement demand on this wall.	10%
Reinforced Concrete Wall – Stairwell South Wall below First Floor	Flexural failure in the wall resulting in a plastic hinge forming at the base of the wall. This wall is well detailed and will fail in a ductile manner.	11%
Reinforced Concrete Wall – North Boundary Wall	Shear failure resulting in diminished lateral load carrying capacity	72%
Curved Feature Wall – Roof level	Flexural failure of the cantilevered wall above roof level. This wall is well detailed and will fail in a ductile manner.	>100%
In-situ Concrete Columns	Flexural failure resulting in plastic hinge formation in order to accommodate lateral storey drift.	>100%
Pounding	It has been assumed that pounding could occur if the building drift exceeds the seismic gap of 50mm to the south and 250mm to the west. Although this is unlikely be the initiator of collapse, damage will be increased because of this effect. It should be noted that although the structure will not drift over the buildings' boundary, the performance of the adjacent buildings is unknown.	>100% (ii)

7.5 Discussion of Quantitative Assessment Results

The results of the quantitative assessment outlined in the tables above are generally consistent with the level of damage sustained in by the building in the recent earthquakes.

The main issue with the building relates to the torsional response under seismic loads. Torsional behaviour is a result of the plan irregularity of the building, and increases the displacement demand on parts of the structure, particularly the north boundary wall.

The north boundary wall, with a capacity of around 10%NBS, governs the global seismic performance of the building. Although the wall is considered critical, the ductile failure mode and lateral restraint provided by surrounding walls of the lift shaft will help prevent a collapse mechanism forming. The capacity of the wall is reduced due to the low level of axial dead load in the wall.

The northern stairs are locked in top and bottom as identified in the Critical Structural Weaknesses section above with the connection typically consisting of a RHS member protruding from the stairs and cast into the slab topping. Although the performance of these stairs has not been checked for Maximum Credible Earthquake (MCE) actions, the stair support detailing is not resilient and they should be retrofitted to allow one end of the stairs to slide.

The building has a seismic capacity of around 10% NBS. In accordance with NZSEE guidelines, this relates to a relative failure risk of greater than 25 times that of a building constructed to the New Building Standard, and is therefore considered to pose a high risk to occupancy.

8 Summary of Geotechnical Appraisal

A copy of the desktop geotechnical report is attached as Appendix 1. A summary of this report is as follows:

(a) There is no evidence of land damage at the Cathedral Square Toilets due to the Canterbury Earthquake sequence following the 4 September 2010 earthquake.

(b) No differential settlement or evidence of liquefaction was observed during the site walkover.

(c) ECan and EQC borehole logs indicate the building is likely to be founded on a thin layer of fill and sand overlying a 4.5m to 8m thick layer of sandy GRAVEL (medium dense). The sand beneath the gravel could be liquefiable but due to the presence of the shallow gravel layer, the potential for differential settlement is reduced. The perimeter strip footing and raft foundations appear to have performed well in previous SLS shaking.

(d) 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[iii] (Geonet) indicates there is a 12% 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.

(e) Based on the current external 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.

9 Conclusions

(a) The seismic performance of the building is governed by the capacity of the north boundary reinforced concrete shear wall, which has an expected strength of

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[iii] GNS Science reporting on Geonet Website: http://www.geonet.org.nz/canterbury-quakes/aftershocks/ updated on 24 February 2012.

10%NBS. The building is therefore considered to be earthquake prone in accordance with the Building Act 2004.

(b) The building has a seismic capacity of around 10%NBS. In accordance with NZSEE guidelines, this related to a relative failure risk of greater than 25 times that of a building constructed to the New Building Standard, and is therefore considered to pose a high risk to occupancy.

(c) Strengthening the building to at least 67% is recommended.

(d) The northern stairs of the building are fully fixed to the landings at each level. The stairs are therefore unable to tolerate the lateral displacement imposed by inter-storey drift.

(e) Based on the current external 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.

10 Recommendations

(a) Develop a strengthening works scheme to increase the seismic capacity of the building to at least 67% NBS; this will need to consider compliance with accessibility and fire requirements.

(b) A quantity surveyor be engaged to determine the costs for strengthening the building.

11 Limitations

(a) This report is based on an inspection of the structure of the buildings and focuses on the structural damage resulting from the 22 February 2011 Canterbury Earthquake and aftershocks only. Some non-structural damage is described but this is not intended to be a complete list of damage to 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 this time.

(c) This report is prepared for CCC to assist with assessing the remedial works required for council buildings and facilities. It is not to be relied upon or used out of context by any other party without further reference to Opus International Consultants.

12 References

[1] Cathedral Square Toilets, *Detailed Engineering Evaluation, Stage One Qualitative Report*, prepared by Opus International Consultants for Christchurch City Council, December 2011.

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

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

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

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

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

Appendix 1:

Geotechnical Appraisal

8 March 2012

Christchurch City Council
C/O:- Michael Sheffield
Property Asset Manager

6-QUCCC.42/005SC

Dear Michael

Geotechnical Desktop Study - Cathedral Square Toilets

1. Introduction

Christchurch City Council (CCC) has commissioned Opus International Consultants (Opus) to undertake a geotechnical desktop study and site walkover of the Cathedral Square Toilets, 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 1 November 2011. Refer to Appendix A for site photos. The site has not been re-inspected following the 23 December 2011 earthquake.

It is our understanding this is the first inspection by a Geotechnical Engineer following the earthquakes. A structural inspection was carried out by Opus on 12 October 2011.

2. Desktop Study

2.1 Site Description

The Cathedral Square Toilets are located on the south west corner of Cathedral Square. It is bounded to the north by Cathedral Square, to the west by the IBIS Hotel, to the east by the IBM / ANZ Building and to the south by the Philip King Building located on Hereford Street. Access to the toilets is from Strand Lane to the east adjacent to the IBM / ANZ Building.

The Cathedral Square Toilets were constructed in 1995 as an addition to the original reinforced masonry building that was originally built in 1993.

The Avon River is 180m west of the site at its closest point. The ground profile is relatively flat and level with the adjacent buildings and paved 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 generally supported by an 800mm deep perimeter strip footing, varying in width from 600 – 800mm. The north-east corner is founded on a 800mm deep concrete raft system. A copy of the foundation plan is included in Appendix C.

No geotechnical report or record of ground investigations were on the CCC building file.

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 115m of the property (refer to Site Plan in Appendix B). Two CPT's were completed by the Earthquake Commission (EQC) within 115m of site have also been reviewed plus EQC borehole BH-CBD-16. A MASW survey was completed by the EQC of the central city, the Colombo St (Cathedral Sq – Cashel St) line is located approximately 70m east of the site. Material logs available from the wells, CPT's, borehole and MASW survey data 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)
SILT, SAND and CLAY	0.9 – 3.7	0
Medium dense, fine to coarse sandy GRAVEL	4.6 – 8.1	0.9 – 3.7
SAND, Organic SILT and SAND, PEAT	15.2 – 18.1	5.8 – 9.1
Gravel (Riccarton)	-	23.4 – 25.6

The groundwater table inferred from the deep (>20m) Ecan Wells above is identified as artesian. The Brown and Weeber "Geology of the Christchurch Urban Area" map suggests a water table less than 1m below ground level.

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 Cathedral Square Toilet site is located in an area identified as 'no liquefaction ground damage potential' for a low groundwater scenario.

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 4 September 2010 earthquake, and the aftershocks of February 2011 and June 2011. An interpretation of these maps indicates the area suffered from liquefaction in both the 22 February and 13 June 2011 earthquakes. However, no evidence of liquefaction was observed in aerial photographs in the immediate vicinity of the Cathedral Square Toilets taken on 4 September 2010, 24 February 2011 and 14-15 June 2011 after each earthquake.

3. Ground Damage

A walkover inspection of the exterior and interior of the building was completed by Emily Hodgkinson, an Opus Geotechnical Engineer on 3 November 2011. The following observations were made; refer to the Site Photos attached in Appendix A of this report.

- Inspection of the toilet building's perimeter and ground level revealed no surface evidence of liquefaction or differential settlement. Some differential settlement may have occurred in the paving stones in the footpath between the toilet and IBM building, likely as a result of surficial movement on top of poorly compacted fill; refer to Photograph 4.

- There appears to have been no damage to the building that is the result of ground settlement or liquefaction. A minor crack approximately 5mm wide was observed in a floor tile in the women's toilets; refer to Photograph 3; however this may have been present before the earthquake as no other cracking was observed.

- Lateral spreading is not considered to be a risk due to the relatively large distance from the Avon River.

4. Discussion

There is no evidence of land damage at the Cathedral Square Toilets due to the Canterbury Earthquake sequence following the 4 September 2010 earthquake.

No differential settlement or evidence of liquefaction was observed during the site walkover.

ECan and EQC borehole logs indicate the building is likely to be founded on a thin layer of fill and sand overlying a 4.5m to 8m thick layer of sandy GRAVEL (medium dense). The sand beneath the gravel could be liquefiable but due to the presence of the shallow gravel layer, the potential for differential settlement is reduced. The perimeter strip footing and raft foundations appear to have performed well in previous SLS shaking.

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[1] (Geonet) indicates there is a 16% 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.

Based on the current external 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.

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[1] GNS Science reporting on Geonet Website: http://www.geonet.org.nz/canterbury- quakes/aftershocks/ updated on 24 February 2012.

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.

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

Tonkin and Taylor, 2011: Christchurch City Council Zone 5 Geotechnical Factual Report Appendix E: MASW Investigation Results.

Prepared By:

Danielle Belcher
Geotechnical Engineer

Reviewed By:

Greg Saul
Principal Geotechnical Engineer

Appendices:
Appendix A: Site Photos
Appendix B: Site Plan, Ecan Wells, CPT Logs and MASW Survey
Appendix C: Extract from Structural Drawings

APPENDIX A:
Site Photos

<u>Photos of the Cathedral Square Toilet taken 3 November 2011</u>

Photograph 1. Looking southeast at the Toilet building from Cathedral Square.

Photograph 2. Looking south at Strand Lane between the IBM and Toilet buildings.

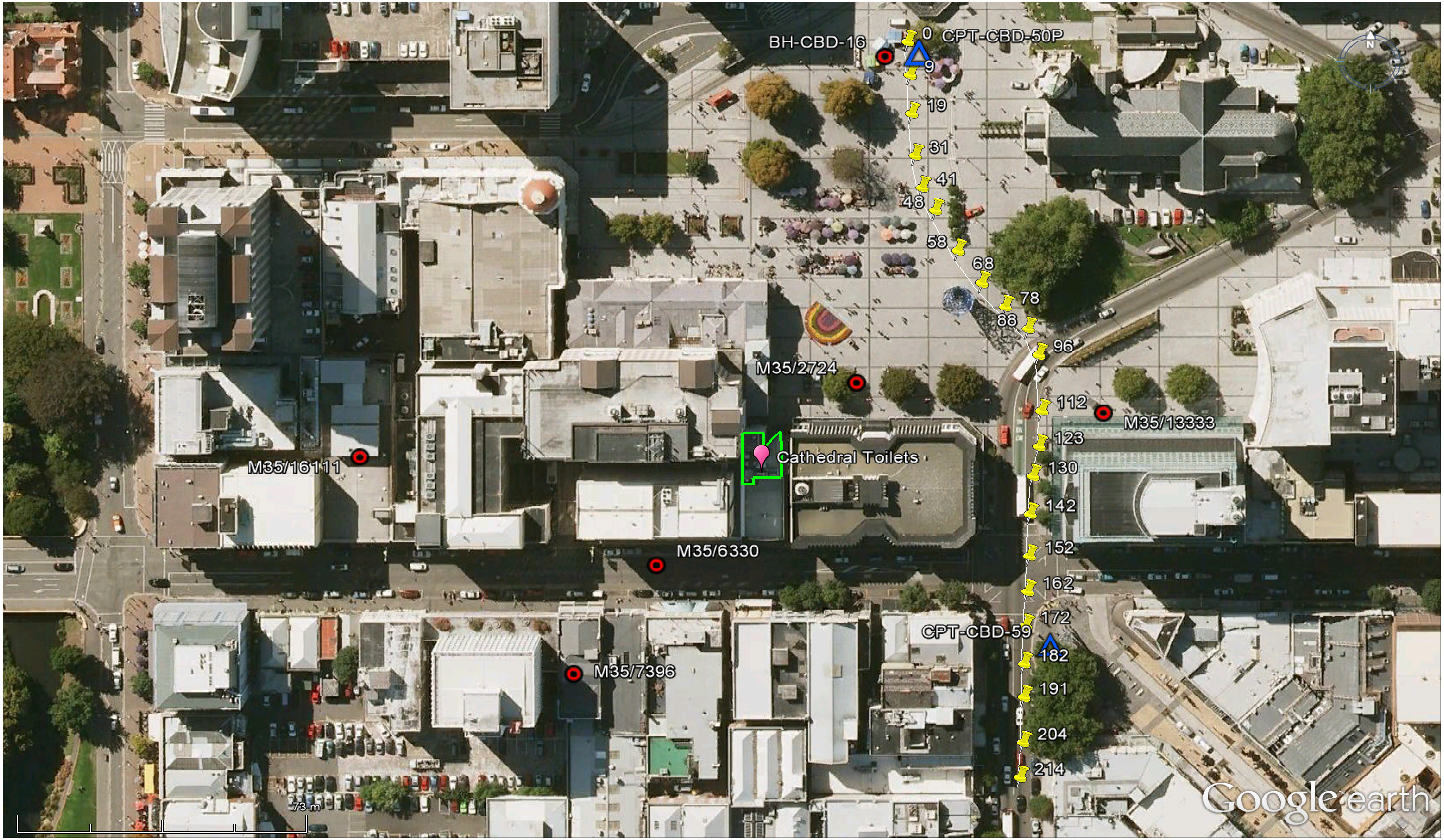
Photograph 3. Small crack in floor tile inside Women's Toilets (Ground Level).

Photograph 4. Some movement in the pavers outside the toilet building entrance.

Photograph 5. View of the inside of the ground level of the Women's Toilets.

APPENDIX B:

Site Plan, Ecan Wells, EQC Borehole, CPT Logs and MASW Survey



Key: Blue: CPTs
Red: Boreholes
Yellow/White: MASW Survey Line
Green: 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: Cathedral Square Toilets
Geotechnical Desk Study

Project No.: 6-QUCCC.42/005SC

Client: Christchurch City Council

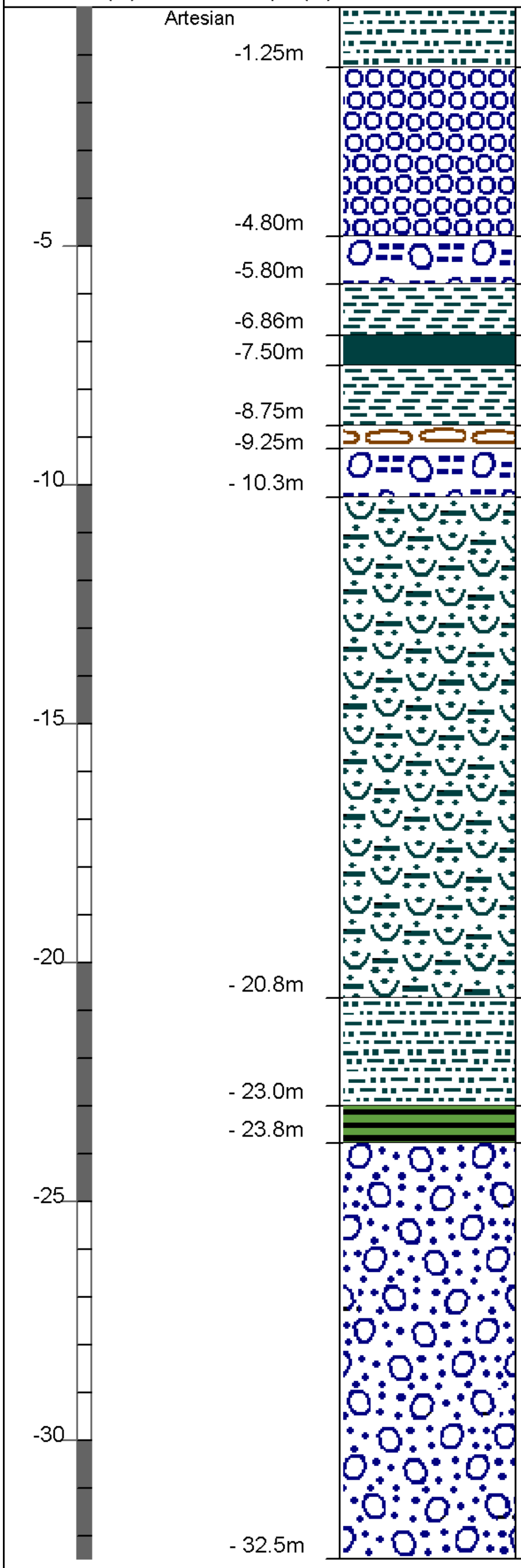
Site Plan

Drawn: Danielle Belcher
Engineering Geologist

Date: 5-Mar-12

Borelog for well M35/2724

Gridref: M35:806-417 Accuracy : 4 (1=best, 4=worst)
Ground Level Altitude : 5.65 +MSD
Driller : Ministry of Works
Drill Method : Cable Tool
Drill Depth : -32.5m Drill Date : 10/06/1983

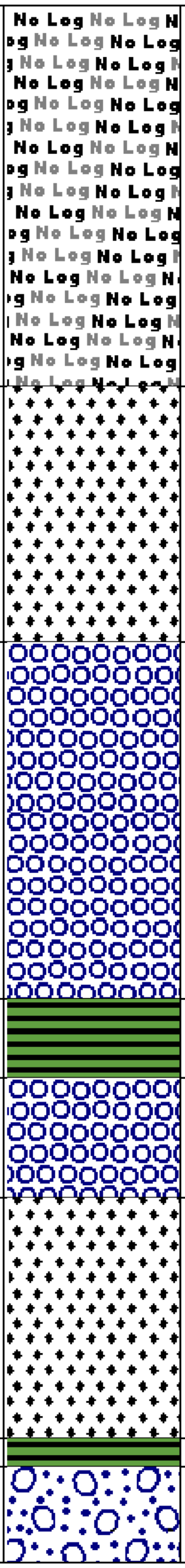


Water Level	Depth(m)	Full Drillers Description	Formation Code
Artesian	-1.25m	Grey/Brown silty sand	sp?
	-4.80m	Gravel	sp?
	-5.80m	Grey silt lumps in gravel	sp?
	-6.86m	Grey silt	sp?
	-7.50m	Peat	sp?
	-8.75m	Lumps of silt	sp?
	-9.25m	Pieces of wood	sp?
	- 10.3m	Silt lumps & gravel	sp?
	- 20.8m	Fine Grey sand with silt lenses 5mm thick 11.0m - 20.0m.shells @ 20.75m	ch
	- 23.0m	Grey silt, sand, some wood	ch
	- 23.8m	Grey/Brown silt, some wood, peat	ch
	- 32.5m	Sandy gravel becoming rust stained	ri

Borelog for well M35/6330

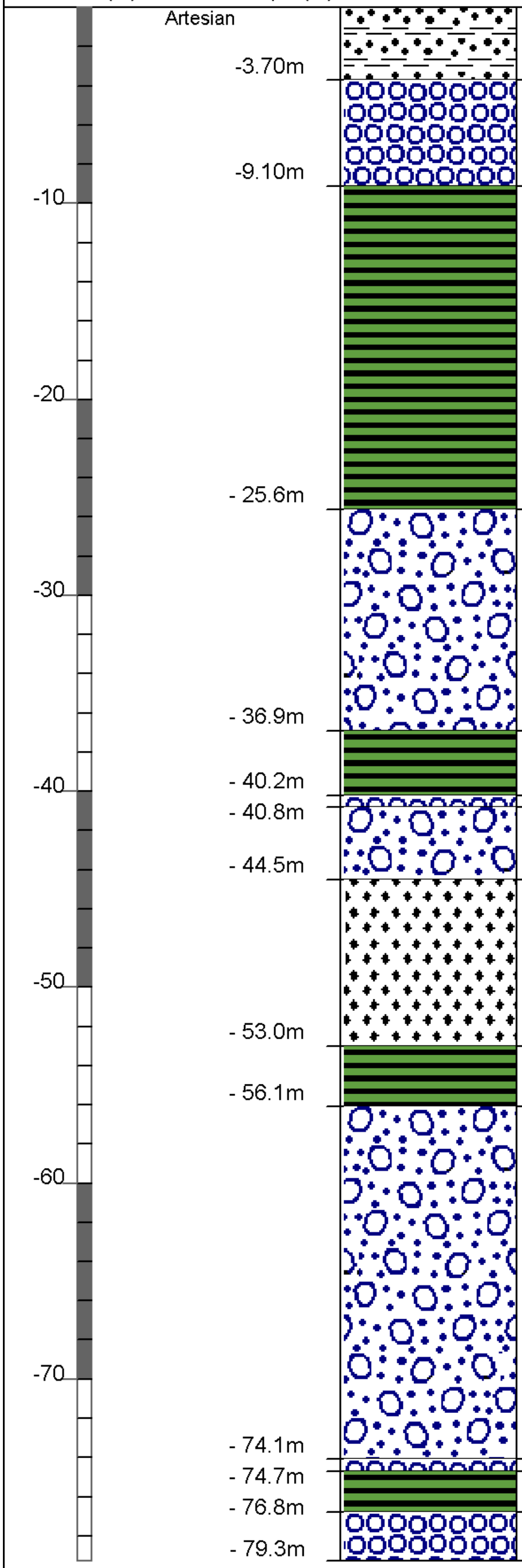
Gridref: M35:8055-4165
Ground Level Altitude 5.8 +MSD
Driller : Job Osborne (& Co/Ltd)
Drill Method: Unknown
Drill Depth : -59.7m Drill Date : 1/07/1889

Scale	Depth	Drillers Description	Formation
-10	- 14.6m	Unknown	sp-ch
-20	- 24.4m	Blue sand	ch
-30	- 38.1m	Shingle	ri
-40	- 41.1m	Peat & clay	br
	- 45.7m	Gravel wl +0.9m flow 13.6 l/min	br
-50	- 54.9m	Yellow sand	br
	- 56.0m	Peat & clay	br
	- 59.7m	Shingle & sand	li-1



Borelog for well M35/7396

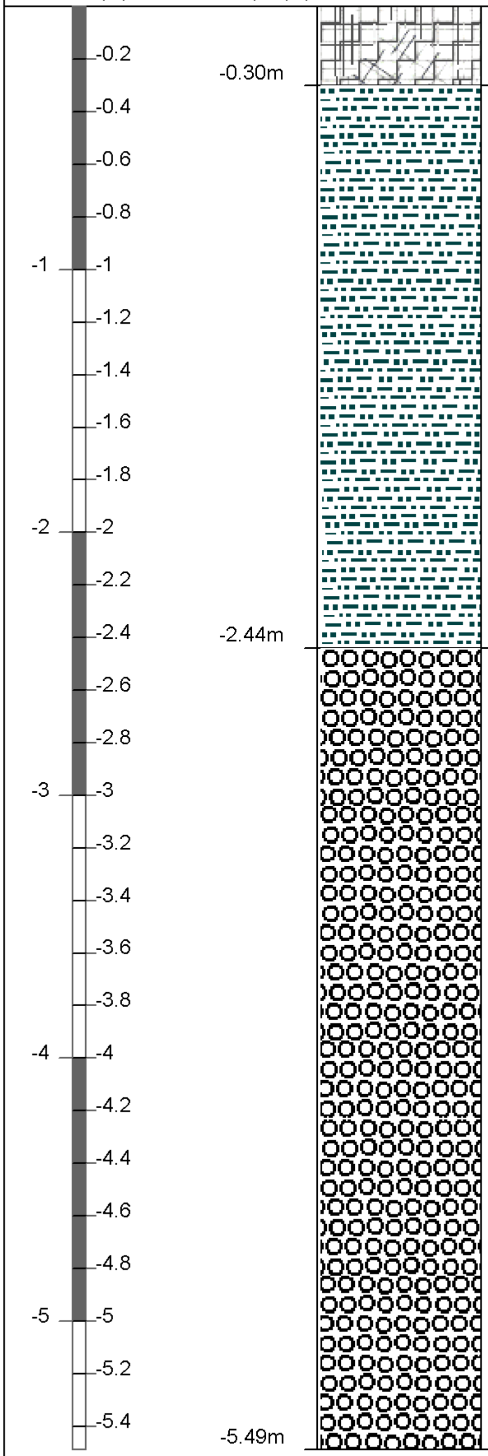
Gridref: M35:8053-4162 Accuracy : 4 (1=best, 4=worst)
Ground Level Altitude : 5.9 +MSD
Driller : Job Osborne (& Co/Ltd)
Drill Method : Hydraulic/Percussion
Drill Depth : -79.3m Drill Date : 11/07/1900



Water Level	Depth(m)	Full Drillers Description	Formation Code
Artesian	-3.70m	Soft Yellow sand & clay	sp?
	-9.10m	Blue & Brown gravel	sp?
	- 25.6m	Blue sand peat & clay	ch
	- 36.9m	Grey gravel & sand	ri
	- 40.2m	Peat & clay	br
	- 40.8m	Blue shingle	br
	- 44.5m	Brown gravel & sand	br
	- 53.0m	Soft Yellow running sand	br
	- 56.1m	Peat & clay	br
	- 74.1m	Hard Brown gravel & sand	li
	- 74.7m	Blue gravel	li
	- 76.8m	Peat & clay	li
	- 79.3m	Brown gravel	li

Borelog for well M35/13333

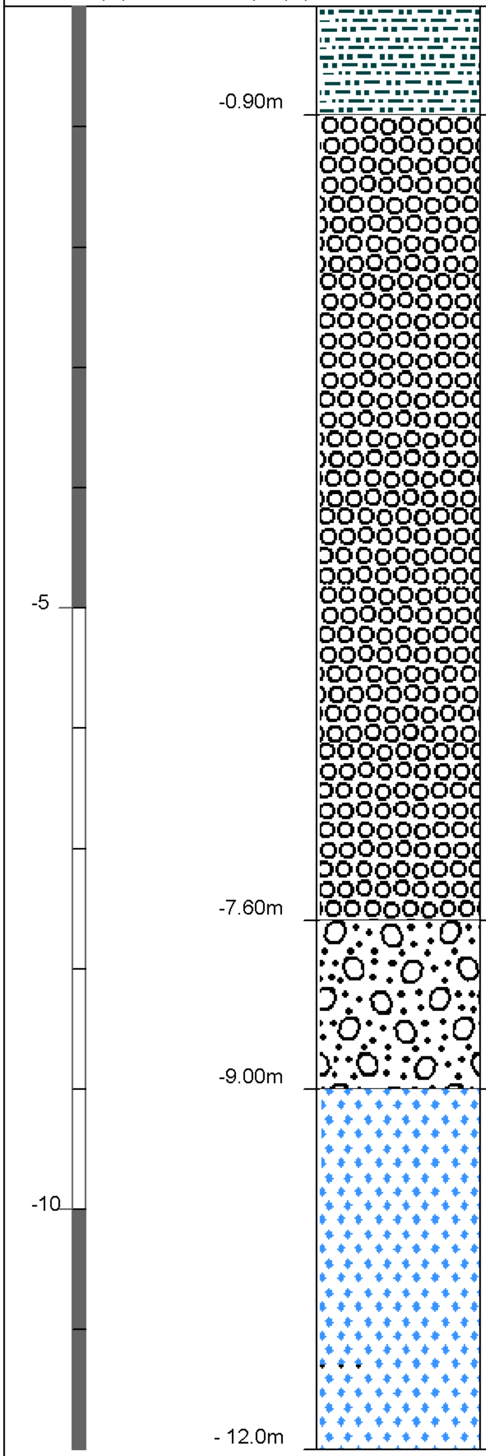
Gridref: M35:80662-41692 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 7.9 +MSD
Well name : CCC BorelogID 1640
Drill Method : Not Recorded
Drill Depth : -5.49m Drill Date : 1/01/1963



Depth(m)	Full Drillers Description	Formation Code
-0.30m	road metal	
-2.44m	grey brown silt with a trace of sand	
-5.49m	medium dense gravel	

Borelog for well M35/16111

Gridref: M35:80475-41679 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 7.97 +MSD
Well name   : CCC BorelogID 5495
Drill Method : Not Recorded
Drill Depth : -12m   Drill Date : 1/01/1968



Depth(m)	Full Drillers Description	Formation Code
-0.90m	silt and sand	
-7.60m	gravel	
-9.00m	sand and medium gravel	
- 12.0m	blue sand	

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BOREHOLE LOG

BOREHOLE No: CBD 16
Hole Location: Cathedral Sq close to police kiosk
SHEET 1 OF 6

PROJECT: CHRISTCHURCH CITY 2011 EARTHQUAKE	LOCATION: CENTRAL CITY	JOB No: 52000.3400
CO-ORDINATES 5741788.87 mN 2480611.12 mE	DRILL TYPE: Direct Push	HOLE STARTED: 25/9/11
	DRILL METHOD: Sonic Vibration	HOLE FINISHED: 26/9/11
R.L. 5.09 m		DRILLED BY: DCN
DATUM NZMG	DRILL FLUID: N/A	LOGGED BY: TH CHECKED: BMcD

GEOLOGICAL — ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.

SOIL DESCRIPTION
Soil type, minor components, plasticity or particle size, colour.

ROCK DESCRIPTION
Substance: Rock type, particle size, colour, minor components.
Defects: Type, inclination, thickness, roughness, filling.

SHEAR STRENGTH (kPa): 10 25 50 100 200
COMPRESSIVE STRENGTH (MPa): 1 5 20 50 100 250
DEFECT SPACING (mm): 50 250 1000 2000

DEPTH (m)	GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	CORE RECOVERY (%)	METHOD	TESTS	CLASSIFICATION SYMBOL	MOISTURE CONDITION	STRENGTH/DENSITY CLASSIFICATION	DESCRIPTION
0	HAND DIG FILL. (Potholed for services check and backfilled.)	0	PRE-DUG					FILL: Borehole drilled through pre-dug and backfilled pothole.
1.2	YALDHURST MEMBER OF THE SPRINGSTON FORMATION (ALLUVIAL).	100	SV		SW	M	MD	Fine to medium SAND, brown. Medium dense, moist.
1.5			SPT	11/10/15 N=25	GW	M	MD	Fine to coarse GRAVEL with some sand and silt, brownish grey. Medium dense, moist. Gravel is subrounded. Sand is fine to coarse.
1.95		100	SONIC VIBRATION					
3.0			SPT	9/14/18 N=32			D	- becoming dense
3.45		76	SONIC VIBRATION					3.45 to 3.7m no recovery
3.7								- becoming sandy with some silt
4.5			SPT	12/14/19 N=33	SW	W	D	Fine to medium SAND with trace gravel, dark grey. Dense, wet. Gravel is medium, subrounded to angular.

DEPTH (m)	R.L. (m)
	5.0
0.5	4.5
1.0	4.0
1.5	3.5
2.0	3.0
2.5	2.5
3.0	2.0
3.5	1.5
4.0	1.0
4.5	0.5
5	

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: CBD 16
Hole Location: Cathedral Sq close to police kiosk
SHEET 2 OF 6

PROJECT: CHRISTCHURCH CITY 2011 EARTHQUAKE
LOCATION: CENTRAL CITY
JOB No: 52000.3400

CO-ORDINATES 5741788.87 mN
2480611.12 mE
R.L. 5.09 m
DATUM NZMG

DRILL TYPE: Direct Push
DRILL METHOD: Sonic Vibration
DRILL FLUID: N/A

HOLE STARTED: 25/9/11
HOLE FINISHED: 26/9/11
DRILLED BY: DCN
LOGGED BY: TH
CHECKED: BMcD

Depth (m)	R.L. (m)	Geological Unit	Core Recovery (%)	Method	Tests	Samples	Classification Symbol	Moisture Condition	Strength/Density Classification	Soil Description
5.0–5.6	0.0 to -0.5	YALDHURST MEMBER OF THE SPRINGSTON FORMATION (ALLUVIAL).	100	SONIC VIBRATION	✱FC		SW	W	D	Fine to medium SAND with trace gravel, dark grey. Dense, wet. Gravel is medium, subrounded to subangular.
5.6–6.0							GW	W	D	Fine to coarse GRAVEL with some sand and silt, dark bluish grey. Dense, wet. Gravel is subrounded to subangular. Sand is fine to coarse.
6.0–6.45	-1.0			SPT	16/17/21 N=38	■ 6.0–6.1 ■ 6.35–6.45	SW	W	D	Fine to medium SAND with trace gravel, dark grey. Dense, wet. Gravel is medium, subrounded to subangular.
6.45–7.0	-1.5		90	SONIC VIBRATION						
7.0–8.2	-2.0 to -3.0				✱PSD WS		GW	W	D	Fine to coarse GRAVEL with some sand and silt, dark bluish grey. Dense, wet. Gravel is subrounded to subangular. Sand is fine to coarse. - contains some rootlets
7.5–9.0	-2.5 to -4.0		83	SONIC VIBRATION						
8.2–8.5							ML	W	St	SILT, bluish grey. Stiff, wet, non-plastic. - very thin fibrous peat layer
8.5–10	-3.5 to -4.5	CHRISTCHURCH FORMATION (MARINE & ESTUARINE)					SW	W	L	Fine to coarse SAND with trace gravel, grey. Loose, wet. Gravel is fine to medium, subrounded. 8.75 to 9.45m no recovery - contains trace silt
9.0–9.45	-4.0			SPT	1/3/6 N=9	■ 9.0–9.1 ■ 9.35–9.45				
9.45–10	-4.5		100	SONIC VIBR.						

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BOREHOLE LOG

BOREHOLE No: CBD 16
Hole Location: Cathedral Sq close to police kiosk

SHEET 3 OF 6

PROJECT: CHRISTCHURCH CITY 2011 EARTHQUAKE | LOCATION: CENTRAL CITY | JOB No: 52000.3400

CO-ORDINATES 5741788.87 mN
2480611.12 mE
R.L. 5.09 m
DATUM NZMG

DRILL TYPE: Direct Push
DRILL METHOD: Sonic Vibration
DRILL FLUID: N/A

HOLE STARTED: 25/9/11
HOLE FINISHED: 26/9/11
DRILLED BY: DCN
LOGGED BY: TH
CHECKED: BMcD

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.

SOIL DESCRIPTION
Soil type, minor components, plasticity or particle size, colour.

ROCK DESCRIPTION
Substance: Rock type, particle size, colour, minor components.
Defects: Type, inclination, thickness, roughness, filling.

SHEAR STRENGTH (kPa): 10 25 50 100 200
COMPRESSIVE STRENGTH (MPa): 1 5 20 50 100 250
DEFECT SPACING (mm): 50 250 1000 2000

GEOLOGICAL UNIT	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION
CHRISTCHURCH FORMATION (MARINE & ESTUARINE)								-5.0			SW	W	L				Fine to coarse SAND with trace gravel and trace silt, dark grey. Loose, wet. Gravel is fine to medium, subrounded.
						*PSD WS											
				SPT		4/9/13 N=22		-5.5	10.5				MD				- becoming medium dense
						*FC		-6.0	11.0								- sand becoming fine to medium
			100	SONIC VIBRATION													- very thin fibrous peat layer - thin, non plastic silt layer
								-6.5	11.5								- thin, non plastic silt layer
				SPT		5/11/15 N=26		-7.0	12.0								12.0 12.25m no recovery
								-7.5	12.5								
			86	SONIC VIBRATION				-8.0	13.0								13.35 to 13.95m no recovery
				SPT		4/14/13 N=27		-8.5	13.5								
								-9.0	14.0								
			100	SONIC VIBRATION				-9.5	14.5								
									15								

T+T DATATEMPLATE.GDT eek

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: CBD 16
Hole Location: Cathedral Sq close to police kiosk
SHEET 4 OF 6

PROJECT: CHRISTCHURCH CITY 2011 EARTHQUAKE
LOCATION: CENTRAL CITY
JOB No: 52000.3400

CO-ORDINATES 5741788.87 mN
2480611.12 mE
R.L. 5.09 m
DATUM NZMG

DRILL TYPE: Direct Push
DRILL METHOD: Sonic Vibration
DRILL FLUID: N/A

HOLE STARTED: 25/9/11
HOLE FINISHED: 26/9/11
DRILLED BY: DCN
LOGGED BY: TH
CHECKED: BMcD

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa) 10 25 50 100 200	COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250	DEFECT SPACING (mm) 50 250 1000 2000	SOIL DESCRIPTION Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
CHRISTCHURCH FORMATION (MARINE & ESTUARINE)				SPT		7/15/19 N=34					SW	W	D				Fine to medium SAND with trace gravel and trace silt, dark grey. Dense, wet. Gravel is fine to medium, subrounded.
			100	SONIC VIBRATION													
				SPT		9/7/21 N=38											
			100	SONIC VIBRATION													
				SPT		7/16/34 for 140mm N>50			18.0				VD				- becoming very dense
			100	SONIC VIBRATION													- contains trace shells
						No SPT data recorded			19.5		ML	W	S				SILT with trace sand, grey. Soft, wet, low plasticity. Sand is fine.

R.L. (m): -10.0, -10.5, -11.0, -11.5, -12.0, -12.5, -13.0, -13.5, -14.0, -14.5

DEPTH (m): 15.5, 16.0, 16.5, 17.0, 17.5, 18.0, 18.5, 19.0, 19.5, 20

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BOREHOLE LOG

BOREHOLE No: CBD 16
Hole Location: Cathedral Sq close to police kiosk
SHEET 5 OF 6

PROJECT: CHRISTCHURCH CITY 2011 EARTHQUAKE
LOCATION: CENTRAL CITY
JOB No: 52000.3400

CO-ORDINATES 5741788.87 mN
2480611.12 mE
R.L. 5.09 m
DATUM NZMG

DRILL TYPE: Direct Push
DRILL METHOD: Sonic Vibration
DRILL FLUID: N/A

HOLE STARTED: 25/9/11
HOLE FINISHED: 26/9/11
DRILLED BY: DCN
LOGGED BY: TH
CHECKED: BMcD

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	R.L. (m)	DEPTH (m)	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SOIL DESCRIPTION Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
CHRISTCHURCH FORMATION (MARINE & ESTUARINE)			100	SONIC VIBRATION		✱FC	-15.0 -15.5	20.5	ML	W	S	SILT with trace sand, grey. Soft, wet, low plasticity. Sand is fine. - contains some fine sand - contains trace fine sand
				SPT		5/5/7 N=12	-16.0	21.0				- layer of fibrous PEAT, dark brown. Firm, moist, non plastic.
									ML	W	St	SILT with trace sand and rootlets, grey. Stiff, moist, non plastic. Sand is fine.
			100	SONIC VIBRATION		✱FC	-16.5 -17.0	21.5 22.0				
				SPT		2/5/8 N=13	-17.5	22.5				- 250mm layer of fibrous PEAT, dark brown. Stiff, moist, non plastic.
			100	SONIC VIBRATION			-18.0	23.0	ML	W	St	SILT, grey. Stiff, moist, low plasticity. - 50mm layer of fibrous PEAT, dark brown. Firm, moist, non plastic.
									ML	W	St	SILT with some sand, grey. Stiff, moist, non plastic.
RICCARTON GRAVELS							-18.5	23.5	GW	W	VD	Silty, sandy, fine to coarse GRAVEL, bluish grey. Very dense, wet. Gravel is rounded to subangular. Sand is fine to coarse.
				SPT		42/8 for 20mm N>50	-19.0	24.0				- becoming brown
			100	SONIC VIBRATION			-19.5	24.5 25				

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: CBD 16
Hole Location: Cathedral Sq close to police kiosk
SHEET 6 OF 6

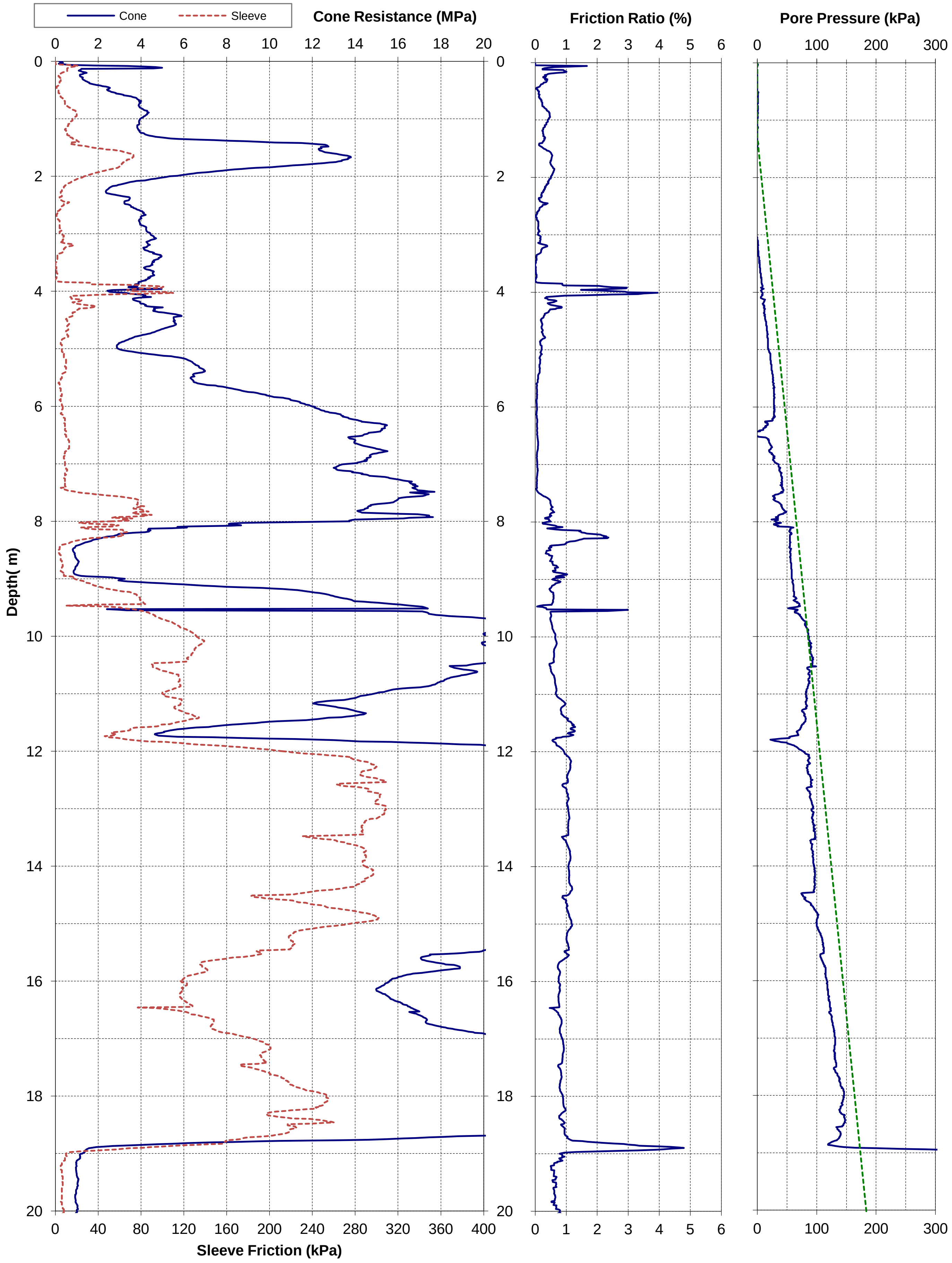
PROJECT: CHRISTCHURCH CITY 2011 EARTHQUAKE	LOCATION: CENTRAL CITY	JOB No: 52000.3400
CO-ORDINATES 5741788.87 mN 2480611.12 mE	DRILL TYPE: Direct Push	HOLE STARTED: 25/9/11
	DRILL METHOD: Sonic Vibration	HOLE FINISHED: 26/9/11
R.L. 5.09 m		DRILLED BY: DCN
DATUM NZMG	DRILL FLUID: N/A	LOGGED BY: TH CHECKED: BMcD

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa) 10 25 50 100 200	COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250	DEFECT SPACING (mm) 50 250 1000 2000	SOIL DESCRIPTION Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
RICCARTON GRAVELS								-20.0			GW	W	VD				Silty, sandy, fine to coarse GRAVEL, brown. Very dense, wet. Gravel is rounded to subangular. Sand is fine to coarse.
				SPT		17/21/25 N=46	■	-20.5	25.5				D				- becoming dense
			100	SONIC VIBRATION		✱PSD WS		-21.0 -21.5	26.0 26.5								
				SPT		50 for 145mm N>50	■	-22.0	27.0				VD				27.0 to 27.145m no recovery, becoming very dense
								-22.5 -23.0 -23.5 -24.0 -24.5	27.5 28.0 28.5 29.0 29.5 30								**End of borehole at 27.145mbgl.** Open standpipe piezometer installed. Please see attached diagram in Appendix F.

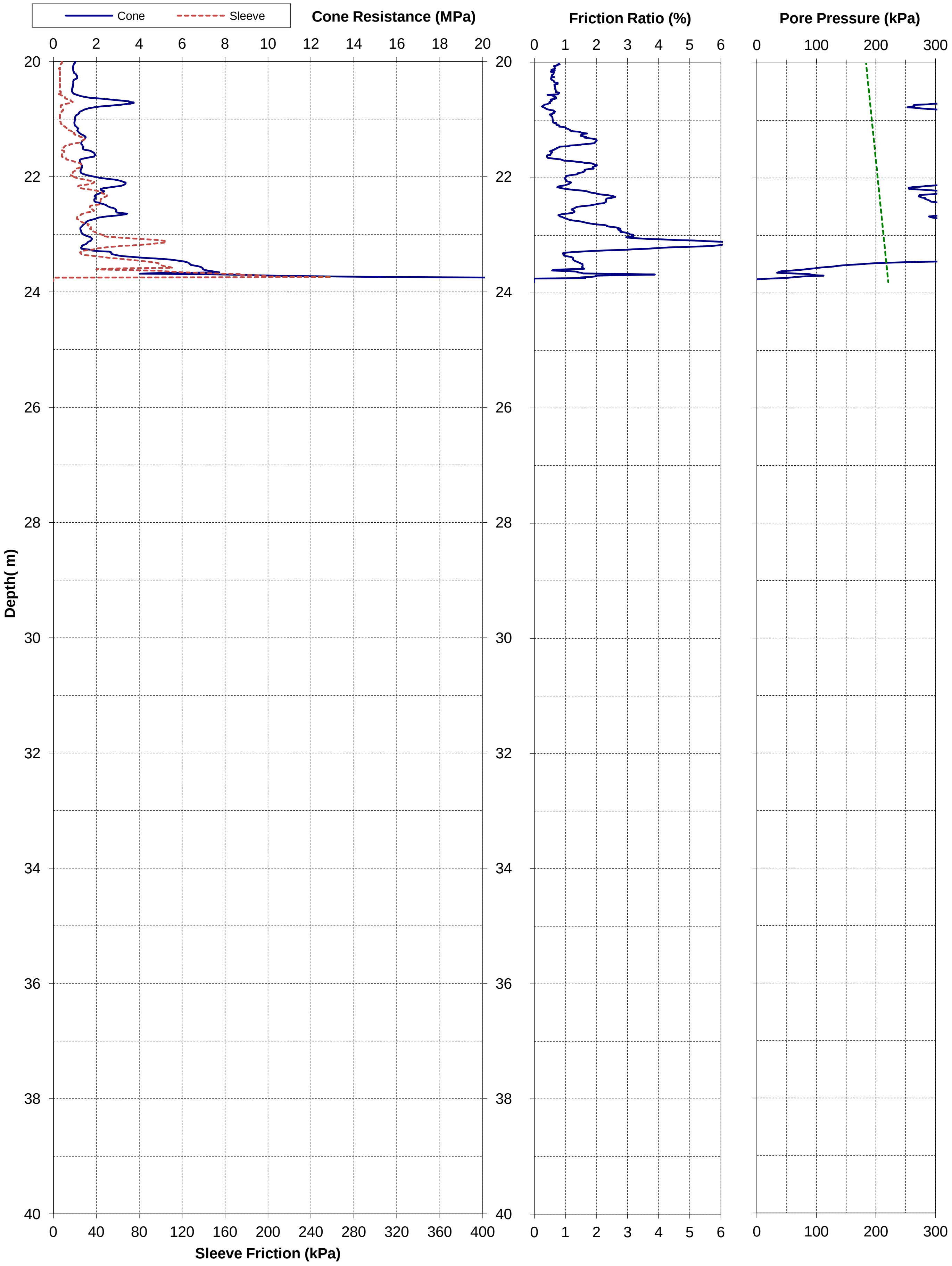
Depth scale (right margin): 25.5, 26.0, 26.5, 27.0, 27.5, 28.0, 28.5, 29.0, 29.5

T+T DATATEMPLATE.GDT eek

Project:	Christchurch 2011 Earthquake - CCC Ground Investigations		**Page:** 1 of 2		**CPT-CBD-50P**
Test Date:	5-Dec-2011	**Location:**	Central City	**Operator:**	Perry
Pre-Drill:	8.5m	**Assumed GWL:**	1.3mBGL	**Located By:**	Survey GPS
Position:	2480611.1mE	5741788.9mN	5.09mRL	**Coord. System:**	NZMG & MSL
Other Tests:				**Comments:**	



Project:	Christchurch 2011 Earthquake - CCC Ground Investigations			**Page:**	2 of 2	**CPT-CBD-50P**
Test Date:	5-Dec-2011	**Location:**	Central City	**Operator:**	Perry	
Pre-Drill:	1.5m	**Assumed GWL:**	1.3mBGL	**Located By:**	Survey GPS	
Position:	2480611.1mE	5741788.9mN	5.09mRL	**Coord. System:**	NZMG & MSL	
Other Tests:				**Comments:**		



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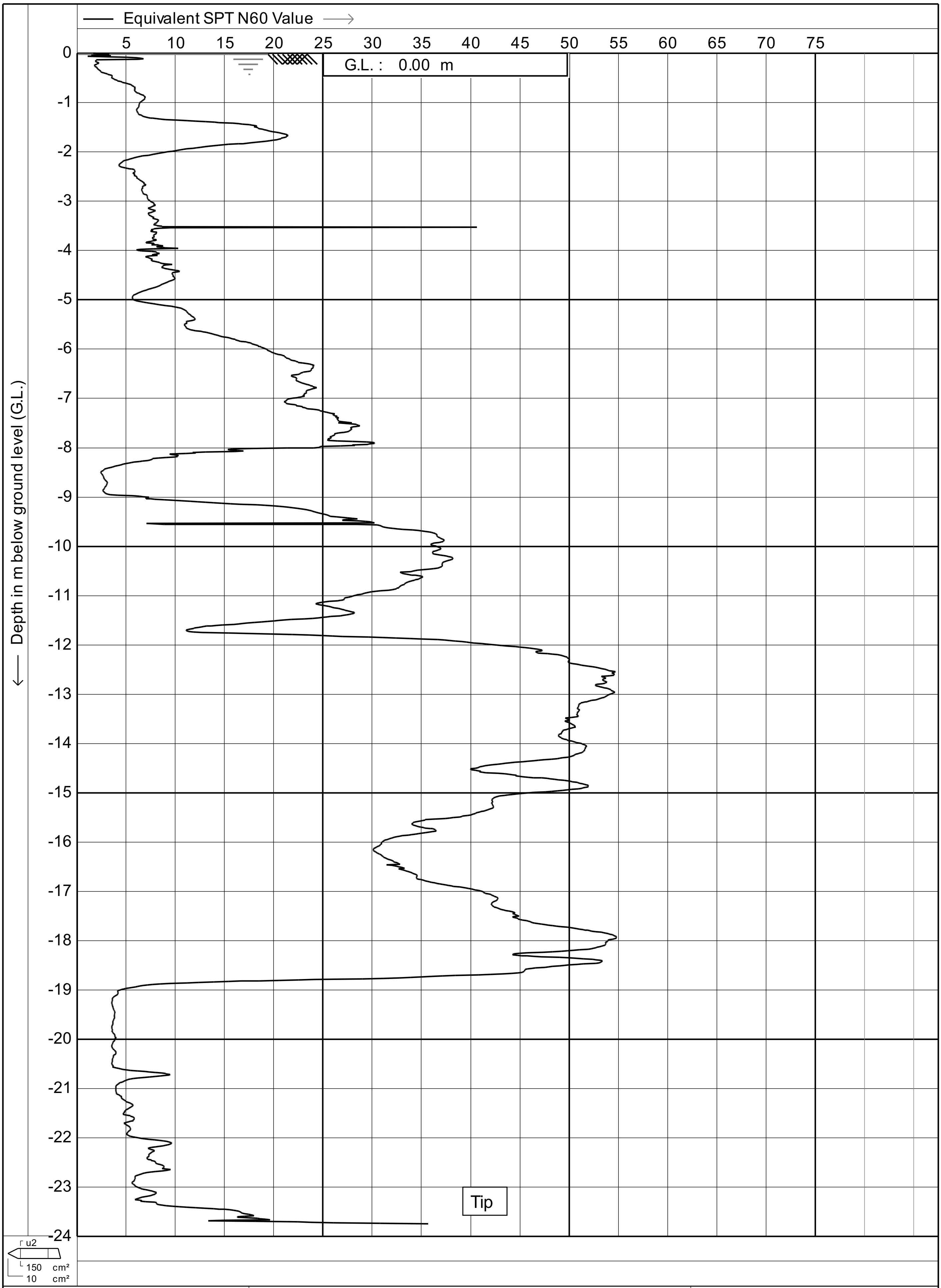


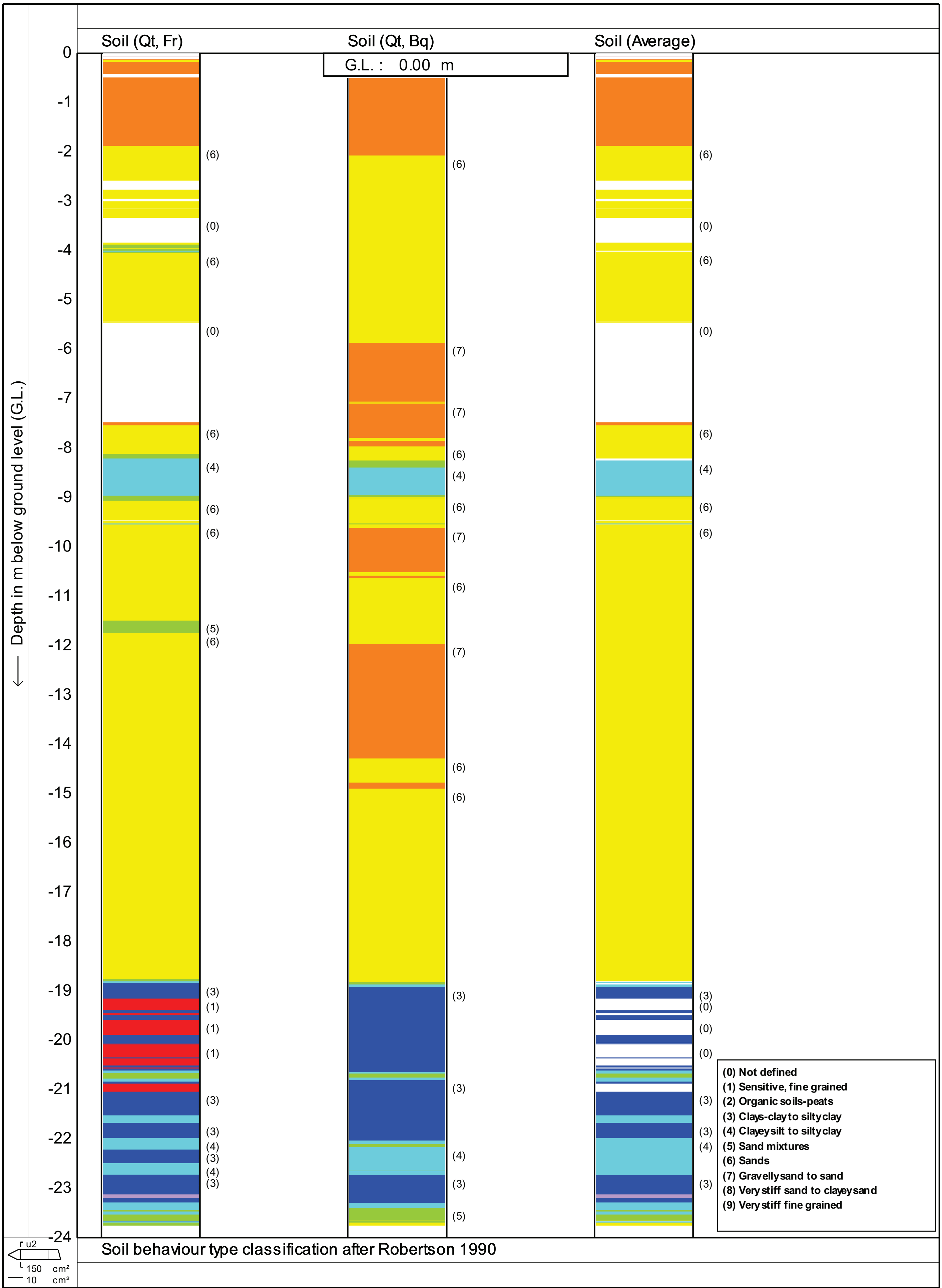
Test according A.S.T.M. Standard D 5778-07

Project : **Site Investigations**

Location: **CBD - Christchurch City**

Date	: **5-12-2011**
Cone no.	: **C10CFIIP.F56**
Project no.	: **01TT26**
CPT no.	: **CBD-50a** **12/14**

CPTask V1.31



Soil behaviour type classification after Robertson 1990

Perry DRILLING GEO PROBE A DIVISION OF PERRY DRILLING
Ground Drilling and Environmental Specialists

CPTask V1.31

Test according A.S.T.M. Standard D 5778-07

Project : **Site Investigations**

Location: **CBD - Christchurch City**

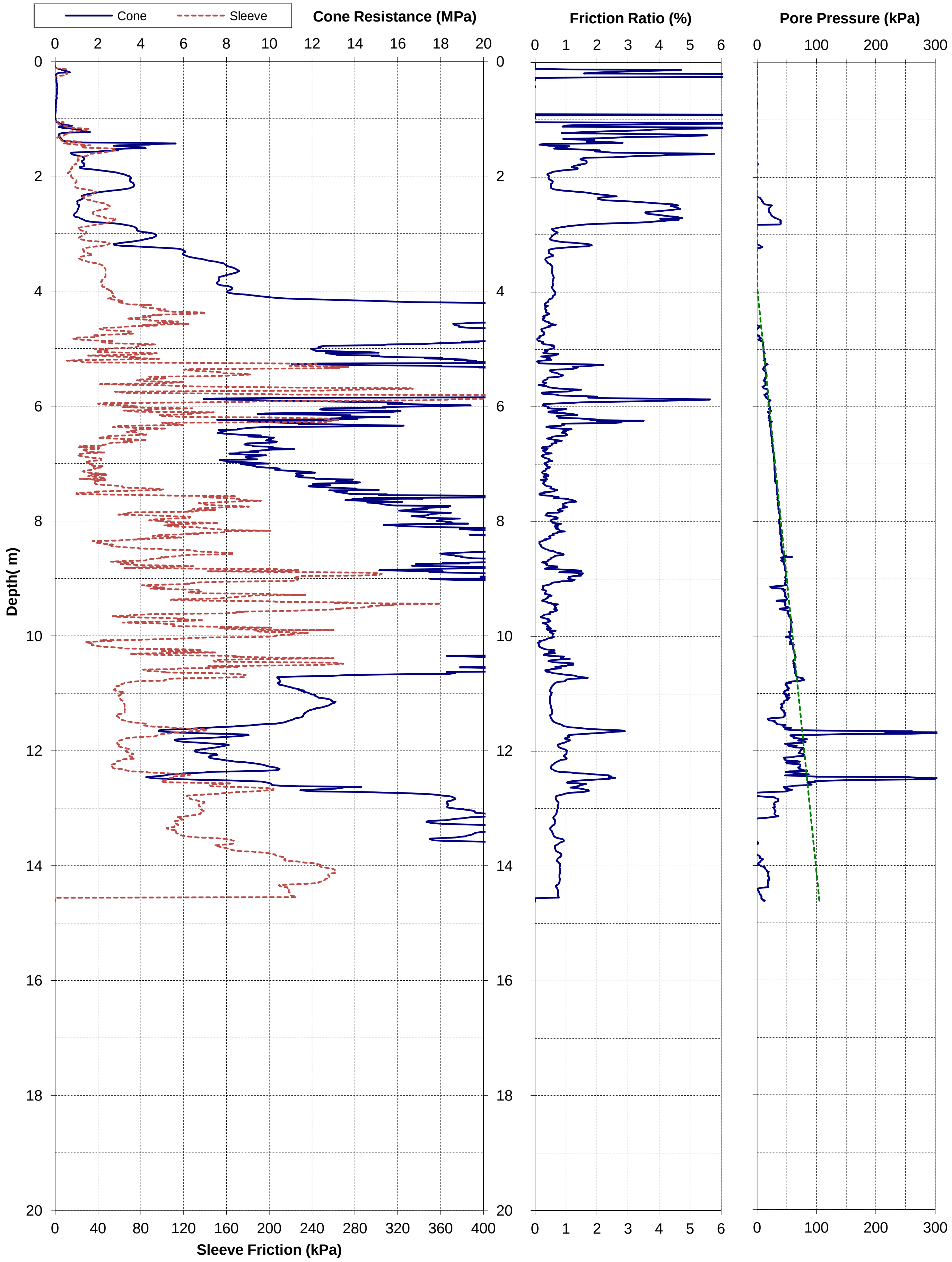
Date : **5-12-2011**

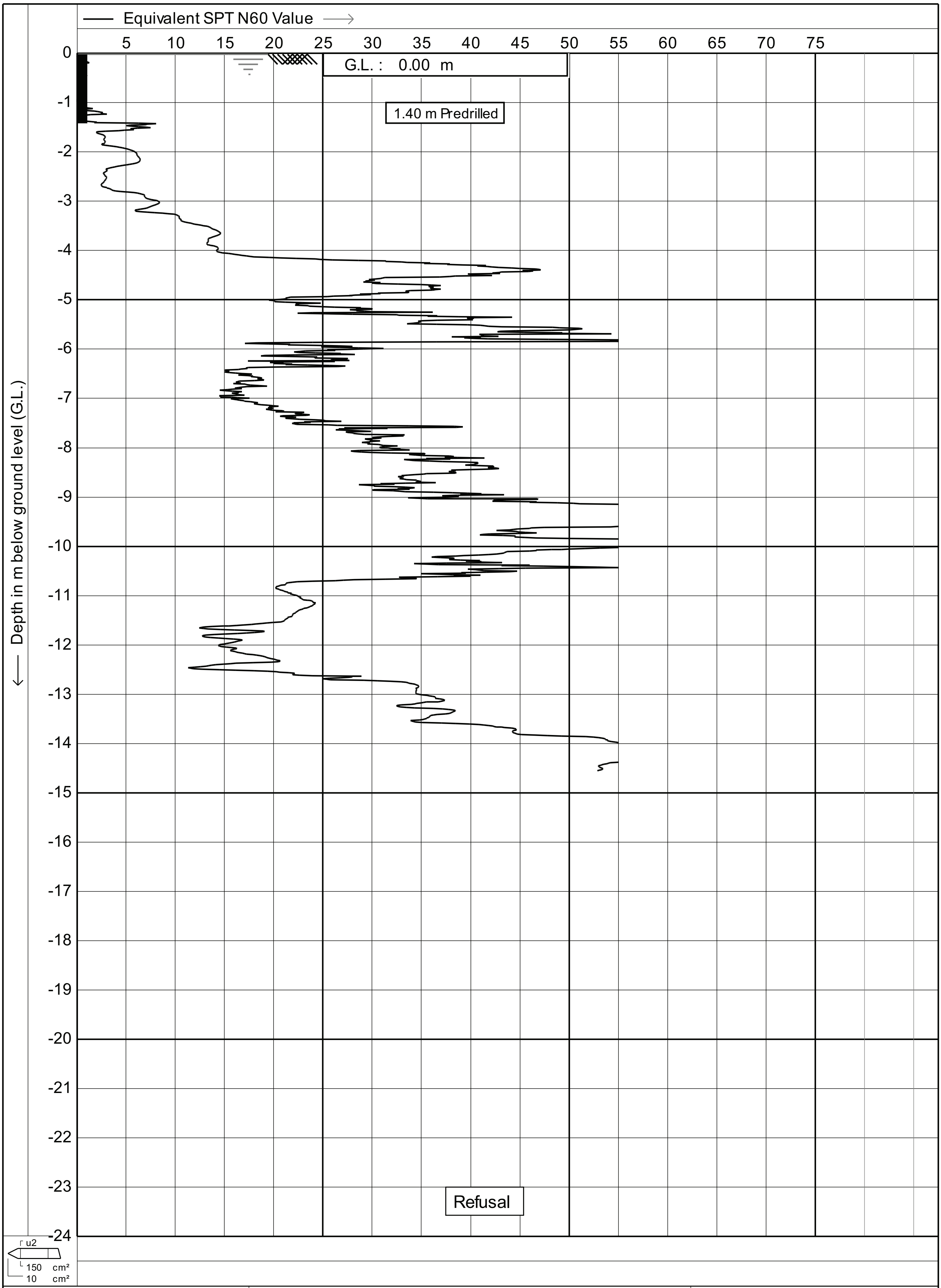
Cone no. : **C10CFIIP.F56**

Project no. : **01TT26**

CPT no. : **CBD-50a**

Project:	Christchurch 2011 Earthquake - CCC Ground Investigations		**Page:** 1 of 1		**CPT-CBD-59**
Test Date:	14-Sep-2011	**Location:**	Central City	**Operator:**	Perry
Pre-Drill:	1.5m	**Assumed GWL:**	3.9mBGL	**Located By:**	Survey GPS
Position:	2480648.1mE	5741625.9mN	5.91mRL	**Coord. System:**	NZMG & MSL
Other Tests:				**Comments:**	





CPTask V1.31

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GEO PROBE
A division of Perry Group
Ground Drilling and Environmental Specialists

Test according A.S.T.M. Standard D 5778-07

Project : **Site Investigations**

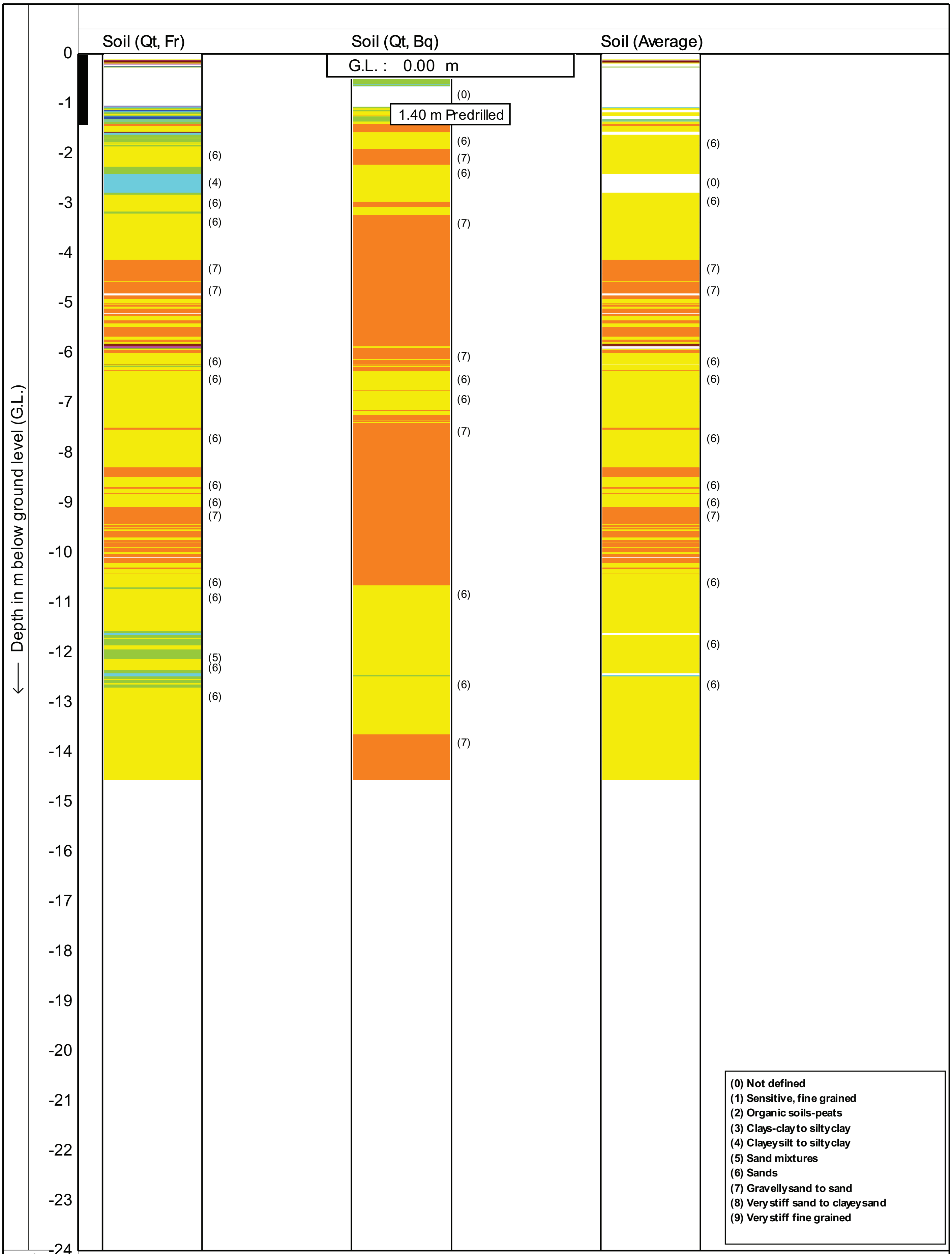
Location: **CBD - Christchurch City**

Date : **14-9-2011**

Cone no. : **C10CFIIP.G23**

Project no. : **01TT26**

CPT no. : **CBD-59** **12/14**



Soil behaviour type classification after Robertson 1990

u2
150 cm²
10 cm²

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Ground Drilling and Environmental Specialists

Test according A.S.T.M. Standard D 5778-07

Project : **Site Investigations**

Location: **CBD - Christchurch City**

Date : **14-9-2011**

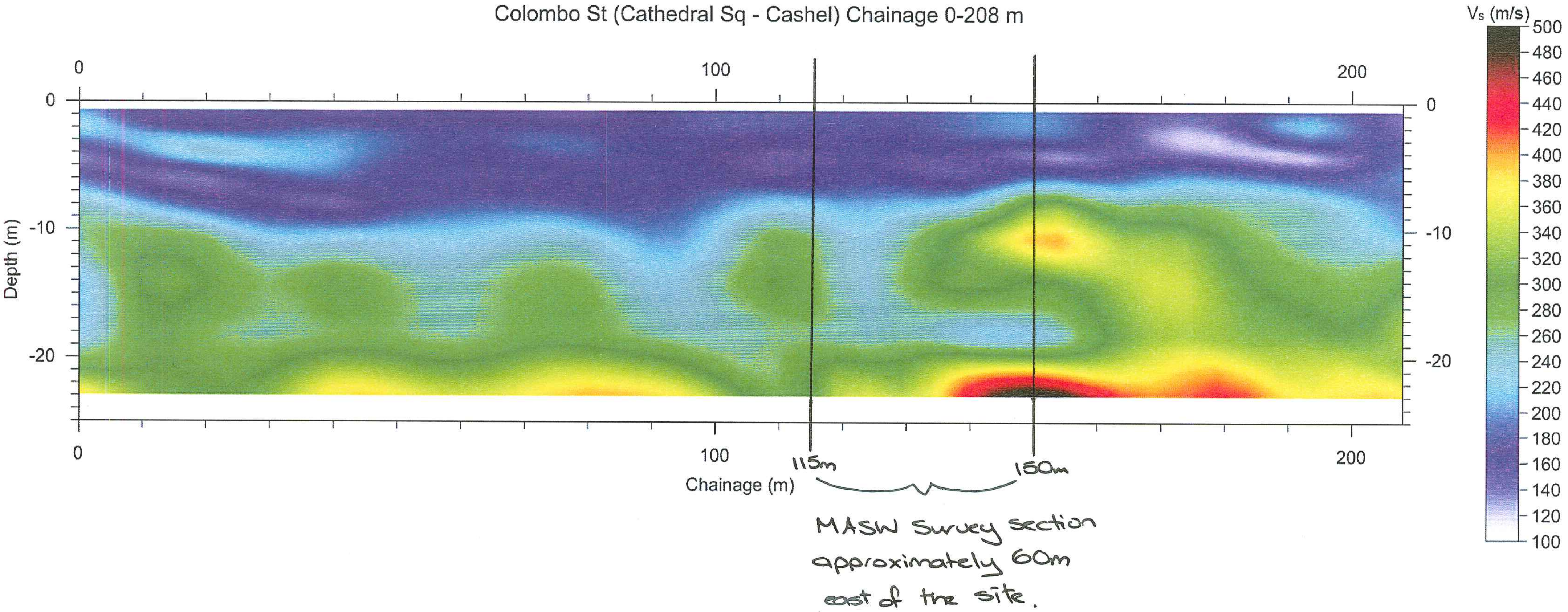
Cone no. : **C10CFIIP.G23**

Project no. : **01TT26**

CPT no. : **CBD-59**

13/14

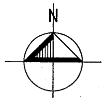
CPTask V1.31

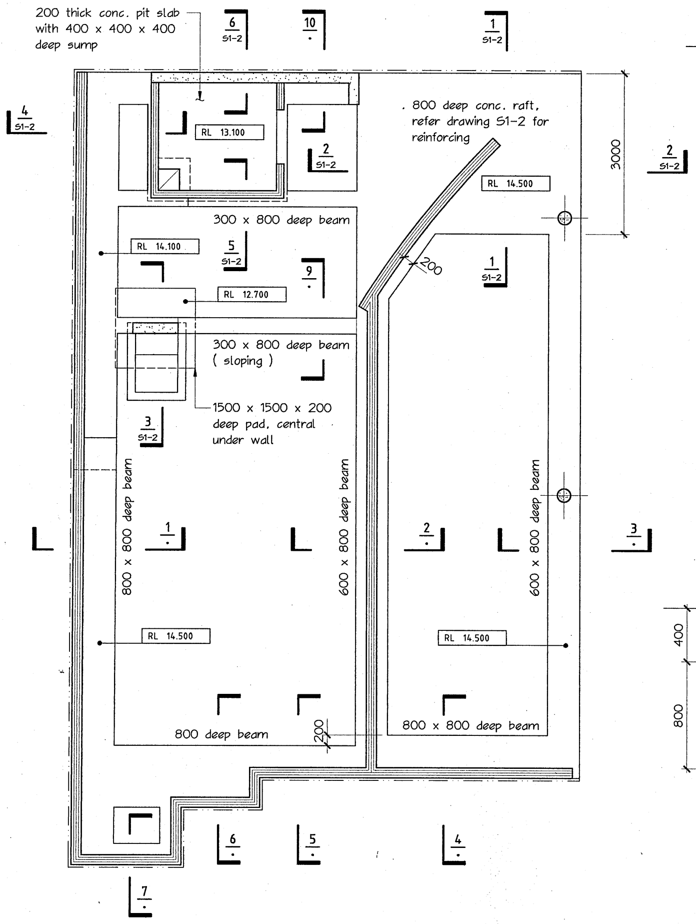


MASW Survey section approximately 60m east of the site.

APPENDIX C

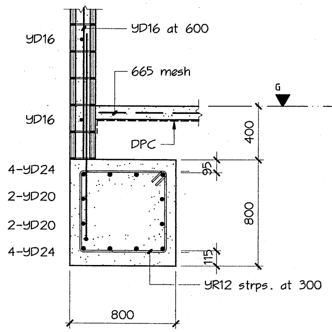
Extract from Structural Drawings



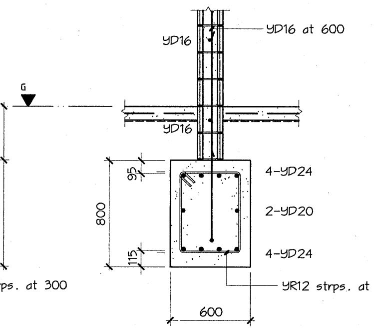


foundation plan

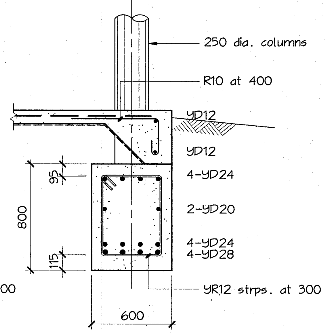
. refer wall elevations (S3 series) for foundation beam reinforcing.



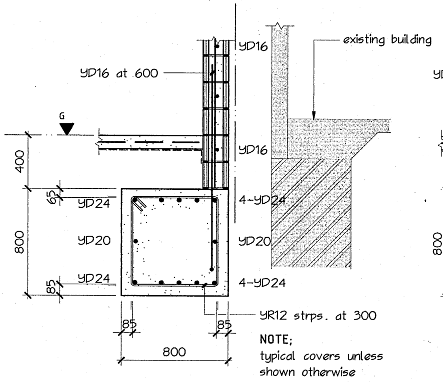
1 · 1 S2-1 1 S3-3



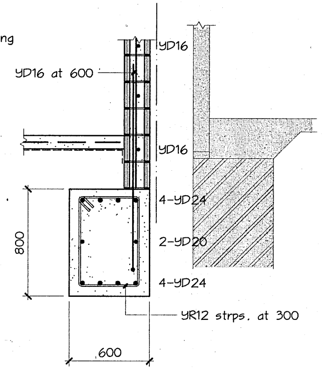
2 · 2 S2-1 2 S3-2



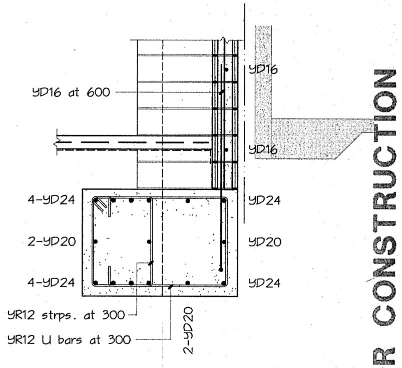
3 · 3 S2-1 3 S3-4



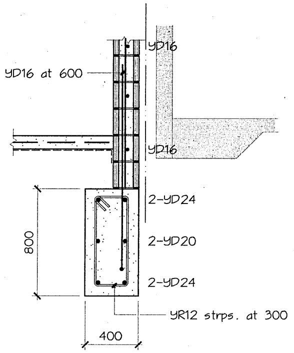
4 · 4 S2-1 4 S3-3



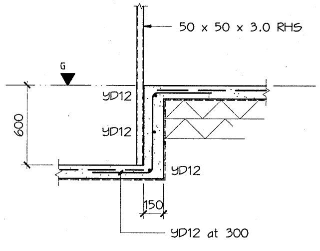
5 · 5 S2-1 5 S3-3



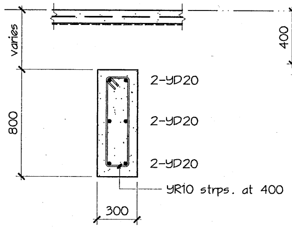
6 · 6 S2-1 6 S3-3



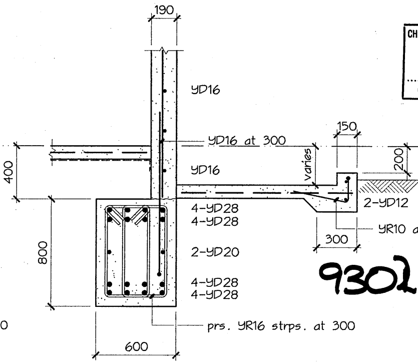
7 · 7 S2-1 7 S3-3



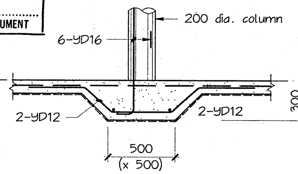
8 S2-1



9 · 9 S3-2



10 · 10 S2-1 10 S3-1



11 S2-1

9302122 ②

All building work shall comply with the New Zealand Building Code notwithstanding any inconsistencies which may occur in the drawings and specifications.

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2 JUL 1993
CONSENT DOCUMENT

note ;
. ground floor slabs shown at floor level
. refer Architect's drawings for slab setdowns for tiles, falls etc......

10/02/93 17:01

TENDER ISSUE DRAWING - NOT FOR CONSTRUCTION

ALL DIMENSIONS TO BE VERIFIED ON SITE BEFORE MAKING ANY SHOP DRAWINGS OR COMMENCING ANY WORK. THE COPYRIGHT OF THIS DRAWING REMAINS WITH HOLMES CONSULTING GROUP LTD.

notes ;

- read in conjunction with Architect's drawings for setout dimensions, penetrations, ribs, rebates etc.....
- refer other consultants drawings for electrical conduits, mechanical penetrations etc......
- refer specification for demolition notes and underpinning to adjacent existing foundations

REV	DATE	BY	REASON
1	11/2/93	RIS	Tender

Warren & Mahoney Architects Ltd
Christchurch Wellington & Auckland

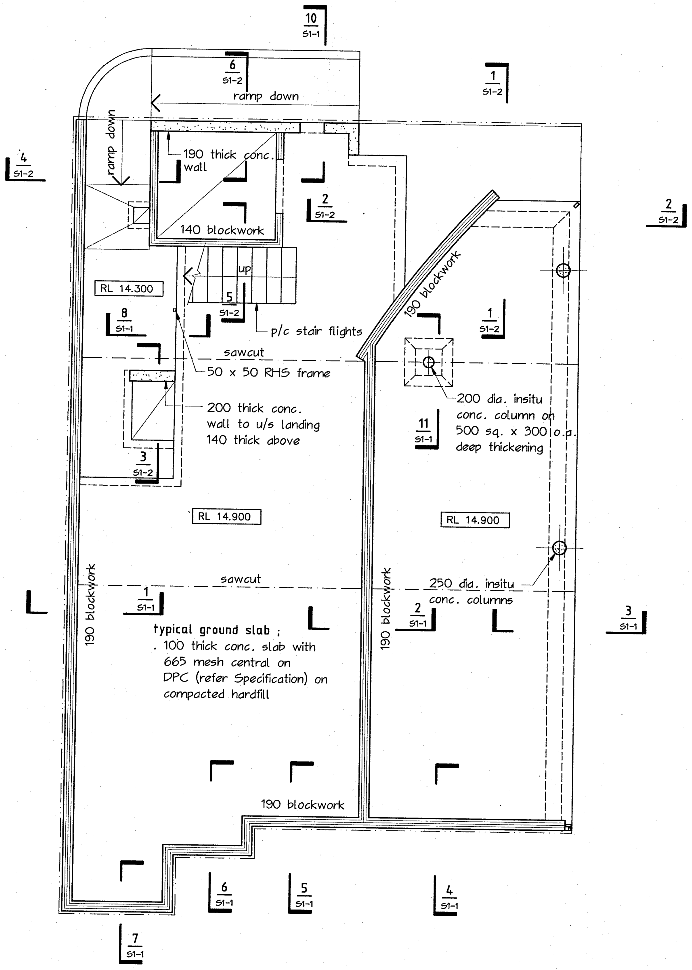
HOLMES CONSULTING GROUP
STRUCTURAL AND CIVIL ENGINEERS
Christchurch, Wellington, New Plymouth, Auckland, Sydney

NEW TOILETS &
ASSOCIATED FACILITIES
CATHEDRAL SQUARE
CHRISTCHURCH

DRAWN: RIS
SCALE: 1 : 50 1 : 20
APPROVED:
ACAD FILENAME: SFDNPLN

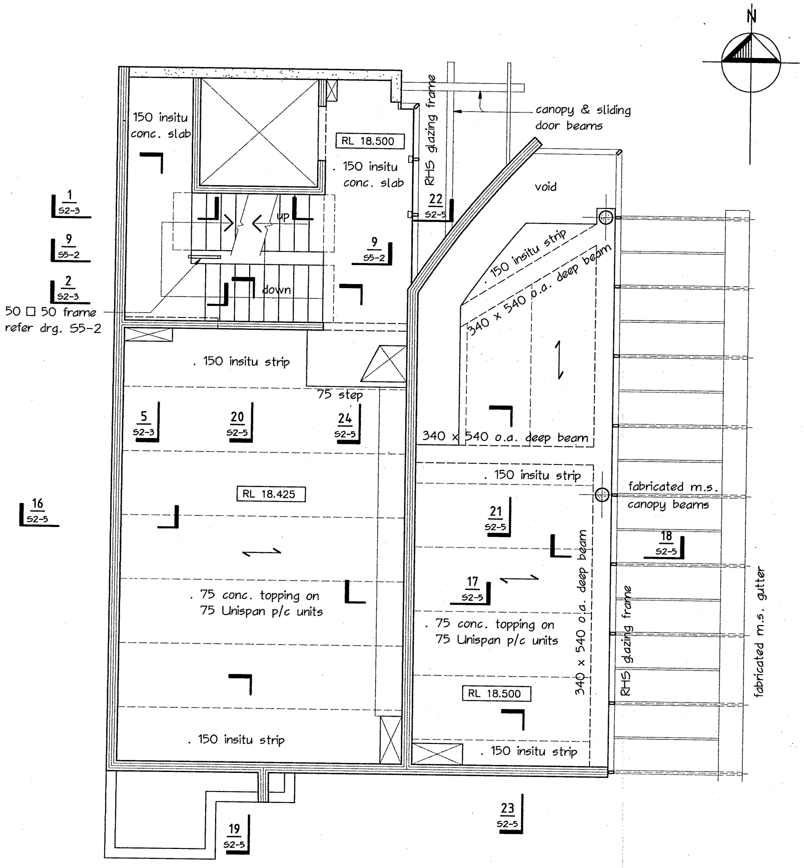
SHEET TITLE:
foundation plan & details

JOB No: 2429
SHEET No: S1-1
REV: 1



ground floor plan

NOTE ;
. refer Architect's drawings for slab setdowns for toppings, tiles etc.



first floor plan

NOTE ;
. refer drawing S2-3 for slab reinforcing

CHRISTCHURCH CITY COUNCIL
2 JUL 1993
CONSENT DOCUMENT

9302122

All building work shall comply with the New Zealand Building Code notwithstanding any inconsistencies which may occur in the drawings and specifications.

notes ;

- read in conjunction with Architect's drawings for setout dimensions, penetrations, nibs, rebates etc.....
- refer other consultants drawings for electrical conduits, mechanical penetrations etc......

REV	DATE	BY	REASON
1	11/2/93	RIS	Tender

Warren & Mahoney Architects Ltd
Christchurch Wellington & Auckland

HOLMES CONSULTING GROUP
STRUCTURAL AND CIVIL ENGINEERS
Christchurch, Wellington, New Plymouth, Auckland, Sydney

NEW TOILETS &
ASSOCIATED FACILITIES
CATHEDRAL SQUARE
CHRISTCHURCH

DRAWN: R.I.S
SCALE: 1 : 50
APPROVED:
ACAD FILENAME: SFLRPLN1

SHEET TITLE:
ground & first floor plans

JOB No: 2429
SHEET No: S2-1
REV: 1

TENDER ISSUE DRAWING - NOT FOR CONSTRUCTION

10/02/93 17:01

Appendix 2:

Quantitative Assessment

Methodology and Assumptions

A3.1. Referenced Documents

- AS/NZS 1170.0:2002, *Structural design actions, Part 0: General principles,* Standards New Zealand.
- AS/NZS 1170.1:2002, *Structural design actions, Part 1: Permanent, imposed and other actions,* Standards New Zealand.
- NZS1170.5:2004, *Structural design actions, Part 5: Earthquake actions* – New Zealand, Standards New Zealand.
- NZS 3101: Part 1:2006, *Concrete Structures Standard, The Design of Concrete Structures,* Standards New Zealand.
- NZS3101: Part 2:2006, *Concrete Structures Standard, Commentary on the Design of Concrete Structures,* Standards New Zealand.
- NZS4230: 2004, *Masonry Structures Standard, The Design of Reinforced Concrete Masonry Structures,* Standards New Zealand.
- NZSEE: 2006, *Assessment and improvement of the structural performance of buildings in earthquakes,* New Zealand Society for Earthquake Engineering.
- Engineering Advisory Group, *Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings in Canterbury, Part 2 Evaluation Procedure*, Draft Prepared by the Engineering Advisory Group, Revision 5, 19 July 2011.

A3.2. Analysis Parameters

The following parameters are used for the seismic analysis:

- Site Soil Category D (deep and soft soil);
- Seismic Hazard Factor Z = 0.3;
- Return Period Factor R_u = 1.0 (Importance Level 3 structure, 50 year design life);
- Ductility Factor $\mu = 1.25$ (Nominally Ductile Structure – in accordance with detailing requirements outlined in NZS4230:2004);
- Structural Performance Factor $S_p = 0.925$.

A3.3. Material Properties

Table A3.1: Analysis Material Properties

Masonry nominal compressive strength, f'_m (MPa)	12
Concrete nominal compressive strength, f'_c (MPa) (1)	45
Mild reinforcing nominal yield strength, f_y (MPa) (2)	324

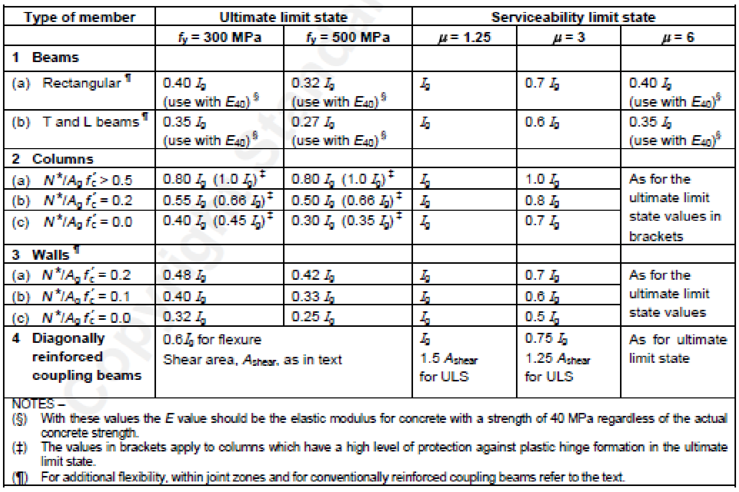
High strength reinforcing nominal yield strength, f_y (MPa) (2)	464

Notes:

1. Based on guidance from *NZSEE 2006,* probable concrete compressive strength is based on a value of 1.5 times the nominal compressive strength (Cl. 7.1.1)
2. Based on guidance from *NZSEE 2006,* probable reinforcement yield strength is based on a value of 1.08 times the nominal yield strength (Cl. 7.1.1)

A3.4. Effective Section Properties

Table A3.2: Effective Section Properties from NZS 3101:2006



Type of member	Ultimate limit state		Serviceability limit state		
	f_y = 300 MPa	f_y = 500 MPa	μ = 1.25	μ = 3	μ = 6
1 Beams					
(a) Rectangular ¶	0.40 I_g (use with E_{40}) §	0.32 I_g (use with E_{40}) §	I_g	0.7 I_g	0.40 I_g (use with E_{40})§
(b) T and L beams ¶	0.35 I_g (use with E_{40}) §	0.27 I_g (use with E_{40}) §	I_g	0.6 I_g	0.35 I_g (use with E_{40})§
2 Columns					
(a) $N^*/A_g f'_c > 0.5$	0.80 I_g (1.0 I_g) ‡	0.80 I_g (1.0 I_g) ‡	I_g	1.0 I_g	As for the ultimate limit state values in brackets
(b) $N^*/A_g f'_c = 0.2$	0.55 I_g (0.66 I_g) ‡	0.50 I_g (0.66 I_g) ‡	I_g	0.8 I_g	
(c) $N^*/A_g f'_c = 0.0$	0.40 I_g (0.45 I_g) ‡	0.30 I_g (0.35 I_g) ‡	I_g	0.7 I_g	
3 Walls ¶					
(a) $N^*/A_g f'_c = 0.2$	0.48 I_g	0.42 I_g	I_g	0.7 I_g	As for the ultimate limit state values
(b) $N^*/A_g f'_c = 0.1$	0.40 I_g	0.33 I_g	I_g	0.6 I_g	
(c) $N^*/A_g f'_c = 0.0$	0.32 I_g	0.25 I_g	I_g	0.5 I_g	
4 Diagonally reinforced coupling beams	0.6I_g for flexure Shear area, A_{shear}, as in text		I_g 1.5 A_{shear} for ULS	0.75 I_g 1.25 A_{shear} for ULS	As for ultimate limit state

NOTES –

(§) With these values the *E* value should be the elastic modulus for concrete with a strength of 40 MPa regardless of the actual concrete strength.

(‡) The values in brackets apply to columns which have a high level of protection against plastic hinge formation in the ultimate limit state.

(¶) For additional flexibility, within joint zones and for conventionally reinforced coupling beams refer to the text.

A3.5. Assessment Methodology

Equivalent Static Analysis

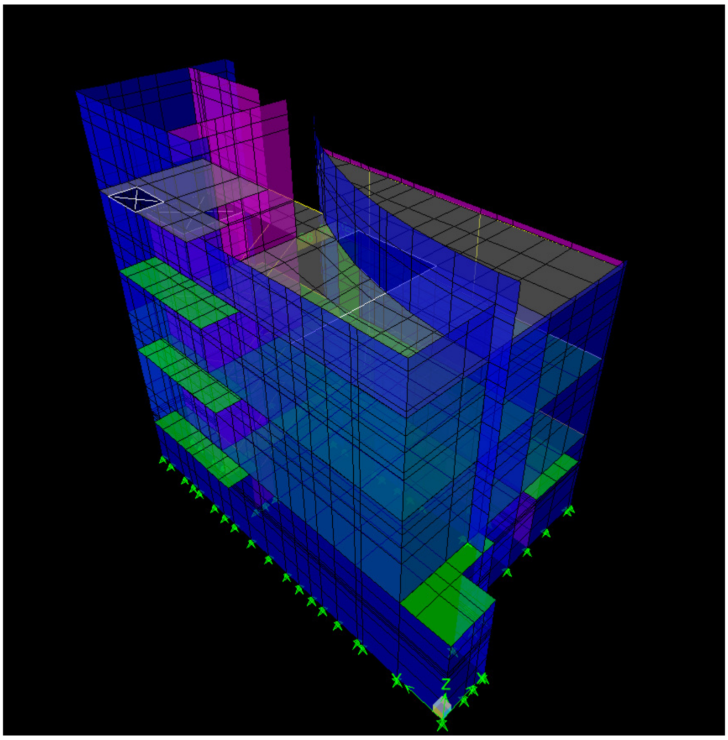


Figure A3.1: ETABS Model of the Cathedral Square Toilets

The building modes of free vibration outputted from ETABS are:

T_1 = 0.21 seconds (E/W translational mode);

T_2 = 0.14 seconds (N/S translational mode);

T_3 = 0.10 seconds (torsional mode).

The building was analysed as being nominally ductility (μ = 1.25) and the design actions were applied separately in each perpendicular direction, with 100% for the first axis plus 30% on the second axis, and then 30% on the first axis and 100% in the second axis, as required by NZS1170.5:2006 for nominally ductile and brittle structures (Clause 5.3.1.2).

Element force demands were extracted from the equivalent static analysis and compared to calculated capacities based on the material properties assumed in Table A3.3. The results of these demand to capacity checks are summarised in further detail in the report and presented as %NBS.

The flexural capacity of the critical shear wall sections were analysed using the moment curvature analysis programme spColumn, including wall boundary elements where appropriate.

Appendix 3:

CERA DEE Spreadsheet

Detailed Engineering Evaluation Summary Data

V1.11

Location

Building Name: Cathedral Square Toilets
Building Address: Unit: No: 13 Street: Cathedral Square
Legal Description:
GPS south: Degrees 43 Min 31 Sec 54.30
GPS east: Degrees 172 Min 38 Sec 9.17
Building Unique Identifier (CCC): PRK_1224_BLDG_002_EQ2

Reviewer: Alistair Boyce
CPEng No: 209860
Company: Opus International Consultants
Company project number: 6-QUCCC.42
Company phone number: 3635520
Date of submission: 20/09/2012
Inspection Date: 8/12/2011
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):
Soil Profile (if available): Sand overlaying sandy GRAVEL
If Ground improvement on site, describe:
Approx site elevation (m): 15.00

Building

No. of storeys above ground: 3 single storey = 1
Ground floor split? no
Storeys below ground
Foundation type: other (describe)
Building height (m): 14.00
Floor footprint area (approx): 100
Age of Building (years): 125

Ground floor elevation (Absolute) (m): 14.90
Ground floor elevation above ground (m): 0.00
if Foundation type is other, describe: Shallow strip footing, and raft foundation
height from ground to level of uppermost seismic mass (for IEP only) (m): 10
Date of design: 1992-2004

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

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

<u>Gravity Structure</u>

Gravity System: load bearing walls
Roof: concrete — slab thickness (mm) 200
Floors: concrete flat slab — slab thickness (mm) 150
Beams: cast-insitu concrete — overall depth x width (mm x mm) 340x540 Beams first floor
Columns: cast-insitu concrete — typical dimensions (mm x mm) 250 dia. Insitu concrete
Walls: fully filled concrete masonry — #N/A

<u>Lateral load resisting structure</u>

Note: Define along and across in detailed report!

Lateral system along: fully filled CMU — note total length of wall at ground (m): 23
Ductility assumed, μ: 1.25 — wall thickness (m): 0.19
Period along: 0.14 — 0.10 from parameters in sheet — estimate or calculation? calculated
Total deflection (ULS) (mm): 95 — estimate or calculation? calculated
maximum interstorey deflection (ULS) (mm): 2 — estimate or calculation? calculated

Lateral system across: fully filled CMU — note total length of wall at ground (m): 9
Ductility assumed, μ: 1.25 — wall thickness (m): 0.19
Period across: 0.20 — 0.35 from parameters in sheet — estimate or calculation? calculated
Total deflection (ULS) (mm): 94 — estimate or calculation? calculated
maximum interstorey deflection (ULS) (mm): 3 — estimate or calculation? calculated

<u>Separations:</u>

north (mm): — leave blank if not relevant
east (mm):
south (mm): 50
west (mm): 270

<u>Non-structural elements</u>

Stairs: other (specify) — describe Precast northern end, in-situ east end
Wall cladding: other light — describe Glazed
Roof Cladding: Other (specify) — describe In-situ conc slab
Glazing: steel frames
Ceilings: plaster, fixed
Services(list):

Available documentation

Architectural full — original designer name/date Warren&Mahoney 1993 & 1995
Structural full — original designer name/date Holmes Consulting 1993 & 1995
Mechanical partial — original designer name/date
Electrical partial — original designer name/date
Geotech report partial — original designer name/date

Damage

<u>Site:</u>
(refer DEE Table 4-2)

Site performance: — Describe damage: None observed
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):

<u>Building:</u>

Current Placard Status: yellow

Along Damage ratio: — Describe how damage ratio arrived at:
Describe (summary):

Across Damage ratio: #DIV/0!
Describe (summary):

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

Diaphragms Damage?: no — Describe:
CSWs: Damage?: yes — Describe: Soft Storey, Pounding, Built-in stairs
Pounding: Damage?: yes — Describe: Not to structure, cover flashing only
Non-structural: Damage?: yes — Describe: Broken glass panel south east corner

Recommendations

Level of repair/strengthening required: significant structural and strengthening — Describe: Shear walls to reduce torsional response
Building Consent required: yes — Describe:
Interim occupancy recommendations: full occupancy — Describe:

Along Assessed %NBS before: ##### %NBS from IEP below — If IEP not used, please detail assessment methodology: Quantitative Assessment
Assessed %NBS after: 10%

Across Assessed %NBS before: ##### %NBS from IEP below
Assessed %NBS after: 10%

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: 10m

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):	0.14	0.2
(%NBS)nom from Fig 3.3:		

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

	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:

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

%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

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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