## Part 4: Geotechnical Requirements

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4.1 Referenced Documents

Planning and Policy

> The Christchurch City District Plan (City Plan)
> The Banks Peninsula District Plan
  www.ccc.govt.nz/CityPlan/BanksPeninsulaDistrictPlan/BDistrictPlan.asp
> Resource Management Act (1991) Section 106
> Building Act (2004) Section 36
> Chartered Professional Engineers Act of New Zealand (2002)
> Christchurch City Council Water Related Services Bylaw (2008)
> Canterbury Regional Council Natural Resources Regional Plan (NRRP)
  ec.govt.nz/our-responsibilities/regional-plans/nrrp/Pages/read-plan.aspx
> Christchurch Earthquake Recovery Authority Residential Zone Technical Categories
  cera.govt.nz/residential-green-zone-technical-categories
> Cubrinovski et al, Liquefaction Impacts on Pipe Networks. Short Term Recovery Project No. 6,
  Natural Hazards Research Platform, December 2011 University of Canterbury

Design

  environmentecology/waterwayswetlandsdrainageguide/index.aspx
> Christchurch City Council Sewage Pumping Station Design Specification
> Christchurch City Council Water Supply Wells, Pumping Station and Reservoir Design Specification
> NZS 1170 Structural Design Actions Set
> NZS 4431:1989 Code of practice for earthfill for residential purposes
> NZS 3604:2011 Timber-framed buildings
> NZS 4404:2010 Land development and subdivision infrastructure
> BS EN 1997 Eurocode 7 - Geotechnical Design
> New Zealand Transport Agency Bridge Manual
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> BRANZ (1987) *Assessment of slope stability at building sites, Study Report 4*
> European Organisation for Technical Approvals *ETAG 27 – Falling Rock Protection Kits*
> Lambert S, Nicot F. *Rockfall engineering*. Wiley, July 2011

Construction

> Christchurch City Council *Civil Engineering Construction Standard Specifications Parts 1- 7 (CSS)* www.ccc.govt.nz/doingbusiness/css/
> Institution of Professional Engineers New Zealand *Construction Monitoring Services Level CM4* www.ipenz.org.nz/ipenz/practicesupport/endorsedinfo/codes/

Where a conflict exists between any Standard and the specific requirements outlined in the Infrastructure Design Standard (IDS), the IDS takes preference (at the discretion of the Council).

4.1.1 Source documents

This Part of the IDS is based on Part 2 of NZS 4404:2004, by agreement, and with the consent of Standards New Zealand.
4.2 INTRODUCTION

This part of the IDS draws attention to the need for the assessment of land stability and the design and control of earthworks and rockfall protection structures. Such assessment assures a suitable platform for the construction of buildings, roads and other structures, as well as the minimisation or mitigation of any adverse environmental effects arising from such works. It should also include an early assessment of the site’s soils and their potential to provide for on-site stormwater systems (e.g. detention basins, infiltration basins).

This is not a geotechnical standard but sets out some, though not necessarily all, of the matters to be considered in planning and constructing a land development or geotechnical hazard management project.

4.2.1 Relevant standards

NZS 4431 applies to the construction of earthfills for residential development, including residential roading. It does not, however, deal with historic fill that has not been placed in accordance with any Standard. It does not cover natural slopes, banks, batters or reinforced earth rockfall protection barriers.

There is no Standard for earthfill for other than residential developments. Clause 4.8.3 - Compaction standards for fill material sets out the requirements in these situations.

There is currently no New Zealand or international standard for rockfall protection structures. Design rockfall protection structures in accordance with best current practice, which is evolving quite rapidly. Clause 4.7 – Rockfall Hazard Mitigation identifies some relevant examples of best current practice.

4.2.2 Statute and City or District Plan requirements

Where there is a requirement for an assessment of land stability to meet the provisions of the Resource Management Act and the Building Act, this is the responsibility of the geoprofessional. The Council relies on that assessment when granting the resource consent. The geoprofessional determines the methods used and investigations undertaken.

Special requirements apply when the land is subject to erosion, avulsion, alluvium, falling debris, subsidence, inundation or slippage. In such situations, refer to section 106 of the Resource Management Act or section 74 of the Building Act.

Specific Council requirements include:

> No earthworks are permitted for work within Christchurch City unless it complies with the provisions of the City Plan, Volume 3, Part 9, clause 5 – Filling, excavation and building adjacent to waterways or the Banks Peninsula District Plan, Chapter 38, rule 2.

> On a subdivision that has been granted resource consent no earthworks can begin prior to final engineering acceptance, unless written permission from the Council is given, detailing conditions that must be adhered to.

> The requirements for areas subject to rockfall hazards are defined in the City Plan, which recognises two Hazard Management Zones for rockfall risk management.
### 4.3 Quality Assurance Requirements and Records

Provide quality assurance records that comply with the requirements in Part 3: Quality Assurance, during design and throughout construction.

#### 4.3.1 The geoprofessional

The geoprofessional must be suitably experienced. Their experience must be to a level to permit an appropriate grade of membership in the relevant professional body. The geoprofessional may be a suitably experienced civil engineer or engineering geologist. Refer to clause 2.7.1 – Investigation and design (General Requirements) for further information.

An Approved Geoprofessional working on rockfall mitigation measures is required to be chartered under the Chartered Engineers Act of New Zealand, in the practice area of geotechnical engineering and to possess both suitable insurance policies and relevant experience. Refer to www.ccc.govt.nz/doingbusiness/approvedcontractors/ for details.

#### 4.3.2 Requirement for a geoprofessional

Engage a geoprofessional to provide geotechnical expertise where the following issues exist:

- the lack of, or limitations of, relevant Standards.
- the construction of earthworks associated with any development requires initial planning and design, to ensure that banks, embankments and slopes remain stable and that fill material is placed in such a way that it can support the future loads imposed on it.
- the assessment of ground for building foundations, roads, etc. requires specialist expertise e.g. weak ground may require special design.
- the wide range of soil types, physical conditions and environmental factors existing in different areas make it impossible to lay down precise requirements for land stability assessment or earthworks.
- the preliminary evaluation in clause 4.4 – Preliminary site evaluation raises doubt about the stability, or suitability, of the land for the proposed development.
- other geotechnical hazards are identified.
- the Council requires geotechnical expertise to assess the project.

An Approved Geoprofessional must be involved in the investigation, design, review and construction of any new development or structure involving rockfall protection structures or within a defined rockfall Hazard Management Zone.

#### 4.3.3 Responsibilities of the geoprofessional

The geoprofessional will carry out the following functions:

- Undertake a geotechnical site assessment and any preliminary site evaluation required, including investigations of sub-surface conditions and identifying
geotechnical hazards affecting the land, before the detailed planning of any development. These matters must be included with the Geotechnical Assessment Report in any assessment of environmental effects (AEE) associated with any consent application;

> Before work commences, be involved in the design or review of the drawings and specifications defining any earthworks, rockfall hazard mitigation or other construction work, and submit a written report to the Council on the foundation and slope stability aspects of the project with the application for engineering acceptance, including any required Producer Statements;

> Determine the earthwork requirements, where no standard for earthworks is applicable to the project, to conform to the IDS and to the subdivision or resource consent conditions (if any) that apply to the proposed development;

> Before work commences, and during construction, determine the extent of further geotechnical engineering services required (including investigation and geological work);

> Before and during construction, determine the methods and frequency of construction control tests to be carried out, determine the reliability of the testing, and evaluate the significance of the test results and field inspection reports in assessing the quality of the finished work;

> During construction, undertake inspections at intervals consistent with the extent and complexity of the geotechnical issues associated with the project;

> On completion, submit a written report to the Council attesting to the compliance of the earthworks and/or the rockfall hazard mitigation with the specifications and to the suitability of the development for its proposed use. If NZS 4431 is applicable, the reporting requirements of that Standard must be used as a minimum requirement. Otherwise, provide the required Producer Statements as detailed in clause 4.8.4 – Rockfall hazard mitigation construction.

Note that rockfall hazard mitigation functions may only be completed by an Approved Geoprofessional.

4.3.4 Geotechnical Assessment Report

The Geotechnical Assessment Report is presented with the resource or building consent application. The report shall include, as applicable:

> Details of and the results of site inspections, evaluations and field investigations.

> Documentation of rock and soil types, distribution and properties.

> A liquefaction and lateral spread assessment.

> An assessment of rockfall, cliff collapse and slippage hazards, including those resulting from seismic activity.
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> An assessment of the slope stability confirming the location and appropriateness of building sites.
> An assessment of ground bearing capacity.
> Recommendations for measures to avoid, remedy or mitigate any geotechnical hazards on the land subject to the application. These shall be in accordance with the provisions of Section 106 of the Resource Management Act 1991 where they are supporting a resource consent application.
> A statement of professional opinion as set out in Appendix II – Statement of Professional Opinion on the Suitability of Land for Subdivision.

The Guidelines for the investigation and assessment of subdivisions provide guidance on the extent of the assessment required in areas prone to liquefaction.

4.3.5 Design Report

Detail the key achievement criteria and assumptions in the Design Report, such as the chosen factors of safety, for the geotechnical aspects of the engineering design.

Wherever building sites on natural ground have soil strengths less than 100 kPa, or exhibit other specific characteristics that may require specific foundation design, note them in the report, along with any recommendations for strengthened or piled foundations for residential buildings or other works.

Provide the following design records, as appropriate, to support the Design Report:

> the site inspection and evaluation
> the foundation aspects of the project including proposed mitigation measures
> the consideration of slope stability including displacements, rockfall and/or cliff collapse hazards
> the extent of further geoprofessional inputs required (including investigation and geological work)
> the methods and frequency of construction control tests to be carried out
> the extent of further construction monitoring by the geoprofessional to confirm design assumptions

4.3.6 Geotechnical Completion Report

For all developments where a geoprofessional is engaged, the geoprofessional must submit a Geotechnical Completion Report, accompanied by a statement of professional opinion as set out in Appendix I – Statement of Professional Opinion on the Suitability of Land for Building Construction. The report must, as applicable:

> Identify any specific design requirements that necessitate the design of the development to deviate from the relevant New Zealand standard.
> Describe the extent of inspection, the results of testing and include all geotechnical reports prepared for the development.
> Indicate the degree of compliance of the development with the design or standards set by the geoprofessional.

> Include documentation on both the testing of the soils for compaction and for soil strength and type, clearly showing the areas to which the tests relate.

> Include areas where compaction complied with the required Standards, any areas requiring re-testing and areas which did not comply with the Standards.

> Include documentation of rock types, distribution and properties (if rock is present on the site).

> Detail the rockfall protection works undertaken and any ongoing maintenance requirements necessary to protect the site in perpetuity. Note that this may only be completed by an Approved Geoprofessional.

For simple developments where there are no earthworks, the Geotechnical Completion Report will consist of the Geotechnical Assessment Report. For large or more complex developments where there may have been several stages of geotechnical reporting, include all relevant geotechnical information in the Geotechnical Completion Report.

4.3.7 As-Built records
Prepare as-built records and maintenance manuals, which comply with Part 12: As-Builts. Present the as-built records in conjunction with the Geotechnical Completion Report and tabulated results.

4.4 Preliminary Site Evaluation
Consider the total surroundings of the site, without being influenced by details of land tenure, territorial or other boundary considerations.

Locate and review any historic geotechnical investigations or reports (including subsurface investigations) that may help to identify the key geotechnical issues for the site.

In simple cases, a visual appraisal may be sufficient. In other cases, depending on the nature of the project, its locality, the scale of development proposed and individual site characteristics, consider the following matters before preparing a proposal for development.

4.4.1 Existing landforms
Study the general nature and shape of the ground and take particular note of:

> the geological nature and distribution of soils and rock

> existing and proposed surface and subsurface drainage conditions and the likely effects on groundwater and on surface runoff
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> the previous history of ground movements in similar soils in the area
> the previous history of rockfalls in the area
> where earthworks are involved, the performance of comparable cuts and fills (if any) in adjacent areas
> air photography and other sources of information that should be reviewed and incorporated into any slope stability assessment

4.4.2 Surface and subsurface drainage
Identify the existing natural surface and subsurface drainage pattern of any area, and locate any natural springs or seepage. Wherever any natural surface or subsurface drainage paths may be interfered with or altered by earthworks, assess the wider implications e.g. the impact on springs in nearby waterways. Sealing areas to preserve these drainage paths may be preferable to providing alternative drainage paths. Consider also the stormwater needs of the site and erosion and sedimentation control during development.

4.4.3 Slope stability and slippage potential
When assessing the stability of slopes and earthfills, refer to criteria applicable to land development in New Zealand that are published or recommended by the New Zealand Geotechnical Society, including Geotechnical Issues in Land Development.

Some natural slopes exist in a state of only marginal stability and relatively minor works such as trenching, excavation for streets or building platforms, removal of scrub and vegetation, or the erection of buildings, can lead to failure. Look for signs of instability, such as cracked or hummocky surfaces, crescent-shaped depressions, crooked fences, trees or power poles leaning uphill or downhill, uneven surfaces, swamps or wet ground in elevated positions, plants such as rushes growing down a slope and water seeping from the ground.

Incorporate the special requirements that are needed for Port Hill developments in dispersive loess soils. Refer to the Assessment of slope stability at building sites, WWDG and Soil Conservation Guidelines for the Port Hills for further guidance.

4.4.4 Rockfall and cliff collapse hazards
In some circumstances, a potential hazard from rockfall or cliff collapse may exist on a proposed development site or above an existing structure. In most cases the rockfall source will be beyond the site boundaries, sometimes at a considerable distance. Engage an Approved Geoprofessional to assess the risk for any proposed development and evaluate possible protective structures within the rockfall Hazard Management Area as defined in the City Plan.

The GNS reports Pilot study for assessing life-safety risk from rockfalls (boulder rolls) and Pilot study for assessing life-safety risk from cliff collapse contain information on rockfall and cliff collapse hazards on the Port Hills under seismic conditions.
Provide, as a minimum:

- details of source areas of rockfall or cliff collapse
- a full geological description of potential hazard sources
- an assessment of likely run-out distances and the level of damage that a rockfall or cliff collapse may induce
- an assessment of the likely kinetic energy of boulders at the site
- an assessment of the feasibility and/or suitability of possible mitigation measures

4.4.5 Foundation stability

Study the general topography of the site and its surroundings for indications of areas that have previously been built up; either as a result of natural ground movement or by the deliberate placing of fill material. Unless such fill has been placed and compacted under proper control, long-term differential settlement could occur, causing damage to superimposed structures, roads, services or other structures.

Test those areas of natural ground on planned subdivisions or developments that are not proposed to be filled or excavated, for soil strength and type.

4.4.6 Unsuitable historic fill

Council records may (or may not) indicate that a site has been filled with unsuitable, uncontrolled or contaminated material. Discuss any remediation proposals for such fillings with the Council at an early stage of the investigation.

4.4.7 Contaminated sites

Sites known to be, or subsequently found to be, contaminated as a result of previous activities may require the services of a specialist environmental scientist for a site evaluation. Ascertain, at an early stage, the extent of any contamination and gain a reasonably accurate picture of the cleanup needed to meet the required standards. Refer to Contaminated Land Management Guidelines for information on reporting requirements.

4.4.8 Local conditions

Consider the range of soil types which exist within Christchurch and Banks Peninsula e.g. expansive soils, volcanic soils, dispersive soils, soft alluvial sediments and compressible soils. The Council and Canterbury Regional Council (Environment Canterbury) may have information on the soil types of particular areas.
4.4.9 Liquefaction

Liquefaction is the loss of strength of a liquefied soil and can result in any of the following types of damage: ground surface disruption including surface cracking, dislocation, ground distortion and slumping; permanent deformations such as large settlements and lateral spreads; and sand boils. Use the Guideline for the identification, assessment and mitigation of liquefaction hazards when determining areas at risk of liquefaction.

Appendix IV - Liquefaction Resistance Index (Zoning) of Christchurch at Water Table Depth indicates areas where underground reticulation could be affected by liquefaction. This map is based on the observed liquefaction and seismic demand on the underground reticulation and indicates liquefaction resistance relative to zone 1 i.e. zone 3 has a liquefaction resistance three times that of zone 1. For further details on the development of this map, please see the report Liquefaction Impacts on Pipe Networks.

Use the Guidelines for the investigation and assessment of subdivisions when reporting on developments on land prone to liquefaction. The Residential Zone Technical Categories maps provide information on residential land likely to require special consideration. These maps are based on observed performance of the land under recent seismic events.

4.4.10 Peer review

If the risk to the land is assessed as being medium to very high, obtain a peer review of the geotechnical assessment for the proposed development before development. An independent geoprofessional must carry this out. Peer Review: Reviewing the work of another Engineer provides guidance on this process. Refer to clause 3.3.2 – Design report (Quality Assurance) for further information.
Where a rockfall or cliff collapse hazard is identified, the peer review must be undertaken by an Approved Geoprofessional.

Consider using the following to aid in the risk assessment:

- Landslide Risk Management
- Pilot study for assessing life-safety risk from rockfalls (boulder rolls)
- Pilot study for assessing life-safety risk from cliff collapse

The Resource Consent Application must make reference to, and give an evaluation of, these matters.

### 4.5 Ground Investigations

Make sufficient borings, probings or open cuts to:

- classify the soil strata by field and visual methods.
- evaluate the likely extent and variation in depths of the principal soil types.
- establish the natural long-term seasonal groundwater levels.
- characterise the natural ground water environment.

Obtain an indication of the seasonal variation in groundwater levels from a review of historical data held by the Council or Canterbury Regional Council, or by an extended period of monitoring. At least one year’s readings may be required wherever groundwater levels are critical, or could have a long-term effect on the development.

### 4.5.1 Geotechnical data

In addition to the general assessment of the suitability of the site for its intended use (buildings, roads), obtain sufficient geotechnical (rock or soil) test data to characterise the ground data for areas that are intended to:

- form in-situ bases for fills
- yield material for construction of fills
- be exposed as permanent batters
- remain as permanent slopes or cut areas
- be used for stormwater disposal to ground

Special consideration of erosion potential is required wherever excavation and filling is made in Port Hills loess soils, because of their highly dispersive properties.
The **Guidelines for the investigation and assessment of subdivisions** provide guidance on the extent and type of investigation required in land prone to liquefaction.

For consistency in the reporting of soils to the Council, use the *Field Description of Soil and Rock* and Appendix III - Soil Log and Descriptions.

### 4.5.2 Further investigation

The geotechnical information thus obtained forms the basis for:

- further sampling and testing which may be required on representative soil or rock types
- relating subsequent soil or rock test properties to relevant strata over the site
- assessment of, or calculations for, slope stability
- assessment of, or calculations for, foundations suitable for the finished site
- assessment of, or calculations for, road pavements

Determine the test data that is appropriate for different areas.

### 4.5.3 Special soil types

Wherever special soil types are known to exist in a locality or are identified, advise on appropriate measures for incorporation of these soils into a development. Where the presence of coal tar contamination has been identified, detail the proposed on-site treatment.

Special soil types include, but are not limited to:

- soils with high shrinkage and expansion
- compressible soils
- volcanic soils
- soils subject to liquefaction
- soils prone to dispersion (e.g. loess)
- marine or estuarine soils

Contact the Council for information on hazard rating and on special soil types in the locality additional to those referenced above, if unfamiliar with the area.

### 4.5.4 Rockfall engineering data

Assess potential rockfall block sizes from mapping of the source area and boulder distribution on the slope. Evaluate block size distribution in relation to the distance from the source to assess gravity sorting and fragmentation effects. Assess all this information in relation to the block size information in the Council GIS database to arrive at the best estimate for the site-specific boulders.
Other special requirements for investigations for rockfall engineering may include:

- Basic rock material properties (e.g., uniaxial compressive strength, point load strength, Schmidt hammer rebound value)
- Detailed topographical sections along potential rockfall trajectories
- Assessment of slope characteristics affecting rockfall behaviour (restitution coefficients, roughness, vegetation etc)
- Previous rockfall history in this area e.g. size and distribution of boulders on the slope

### 4.6 Planning and Design

#### 4.6.1 Suitability of landform

The choice of a suitable landform is dependent on many factors that may be specific to a particular site. Refer to clause 2.5.4 – Balancing landform choices (General Requirements) for these factors.

Avoid unnecessary earthworks, aim to protect original soils and drainage patterns and to minimise disturbance, compaction, earthworks and the importation of topsoil, although earthworks may be justified in the following circumstances:

- to minimise the risk of property damage through ground movement in the form of rockfall, debris slides, slips, subsidence, creep, erosion or settlement.
- to minimise the risk of property damage through flooding, surface water run-off or groundwater modification.
- to lessen tunnel gully erosion within Port Hill developments.
- to develop a more desirable roading pattern with improved accessibility to and within the site, and to create a better sense of orientation and identity for the area as a whole.
- to increase the efficiency of overall land use, including the quality of individual sites and amenity areas around buildings, the economics of providing engineering services and the standard of roading and on-site vehicular access.
4.6.2 Seismic considerations

Consider the seismic effects on earthfills, foundations, major or critical infrastructure, slopes, rockfall sources and liquefiable ground, and take these into account in the design and construction of any development. These effects could include liquefaction, lateral spread, rockfall, cliff collapse and slippage.

Preliminary estimations of importance levels for major infrastructure required by Structural Design Actions, from which exceedance probabilities for seismic events are determined, may be obtained from the following documents:

- Bridge Manual
- Sewage Pumping Station Design Specification
- Water Supply Wells, Pumping Station and Reservoir Design Specification.

Council may also provide these levels, for example to reflect local lifeline routes. Piped infrastructure is not generally designed for a particular seismic event but rather for optimum resilience under seismic loading. This resilience can be achieved through material selection, reticulation location and detailing.

Appendix IV - Liquefaction Resistance Index (Zoning) of Christchurch at Water Table Depth indicates likely seismically generated settlements and displacements affecting underground reticulation. These values are applicable to infrastructure installed between 0-5m below the watertable and exclude lateral displacement. In the areas shaded grey there were no liquefaction observations. The Liquefaction Impacts on Pipe Networks report suggests that the possible ground performance in these areas could be extrapolated from the underground network performance, with consideration of network and ground characteristics.

The Residential Zone Technical Categories webpage contains information on special considerations for residential building platforms.
4.6.3 Peat

Ensure the geotechnical design in peat or organic compressible material areas will achieve the infrastructure design life required by all other parts of the IDS. Preserve the flow of groundwater through the peat at pre-development levels.

Special care is required in any development over peat areas to:

> maintain uninterrupted groundwater flow;
> preserve existing natural groundwater levels to avoid area wide settlement;
> avoid settlement of any surface works or structures;
> ensure the continued operation of infrastructural services and service connections to buildings throughout their design life.

4.6.4 Debris slides

Confirm that any proposed building platform is unlikely to be affected by debris slides. Refer to WWDG Part B clause 20.4.5 for further information.

4.6.5 Reducing waste

When designing the development, consider ways in which waste can be reduced.

> Design to reduce waste during construction e.g. minimise earthworks, reuse excavated material elsewhere.
> Use materials with a high recycled content e.g. recycled concrete subbase. Proposed recycled materials will need approval from the Council to ensure that environmental contamination does not occur.
See the Resource Efficiency in the Building and Related Industries (REBRI) website www.rebri.org.nz/ for guidelines on incorporating waste reduction in your project.

4.7 Rockfall Hazard Mitigation

There is no single document that provides a comprehensive guide to the design of rockfall mitigation measures under New Zealand’s and Port Hill’s seismic conditions. The following publications provide examples of good current practice in rockfall engineering:

- Landslides: Analysis and control
- Rockfalls: Characterisation and control
- Rockfall engineering
- Interdisciplinary workshop on rockfall protection.

Determine possible protection and/or remedial measures to mitigate the assessed risk for any proposed development. Provide results by appraisal of bounce height and kinetic energy for the likely rock sizes as assessed in clause 4.4.4 - Rockfall and cliff collapse. Calibrate the bounce height and kinetic energy appraisals against previous rockfall behaviour at the specific or similar locations.

Rockfall mitigation measures could include any combination of:

- a proprietary rockfall protection system
- reinforced earth embankment barriers
- in-situ fixing anchorage solutions such as rock anchors, cables or mesh
- benching or bunding
- establishment and retention of an effective vegetation barrier (not a suitable short term solution and best used in combination with other measures)

All mitigation measures must be designed by an Approved Geoprofessional and will require both a building consent and a resource consent.

Design barrier systems (e.g. reinforced earth embankment barriers or rockfall fences) to:

- protect the dwelling or structure from impact by the 95th percentile boulder for the site source area and
- protect the dwelling or structure from impact by boulders at the 95th percentile total kinetic energy level for the barrier location and
- be designed to withstand multiple impacts (at least two impacts of the 95th percentile boulder at the 95th percentile total kinetic energy level) without significant loss of capacity or height.

The residual height of the barrier after two impacts of the design boulder at 95th percentile energies at the specific location being considered (i.e. the dwelling or structure) must be one diameter greater than the 95th percentile bounce height at the barrier location.
Design anchorage solutions (such as grouted steel ground anchors, rock bolts, rock mesh etc) and foundation systems for dynamic rockfall barriers to the following codes of practice:

- Eurocode 7 · Geotechnical Design
- Anchor requirements of the Bridge Manual

Any rockfall protection system shall:

- be accessible for inspection, rock removal and repair without compromising the safety of downhill property or life;
- not be compromised where gates or accessways are provided;
- be and remain effective over their design life.

Ensure the design addresses erosion potential and the impact on any natural surface and subsurface flow.

### 4.7.1 In-situ anchorage

In-situ anchorage solutions such as rock bolts, cables, mesh, nets and drape systems may be used for protective works in rock source areas.

Design above-ground structures and easily replaced components (such as posts and mesh but excluding components such as ground anchors or rock bolts) with a design life of no less than 15 years.

Include the design loads and the manufacturer’s testing certificates for the properties of the supplied materials, to support the design life in the design report.

### 4.7.2 Low energy rockfall protection systems

Council defines a low energy rockfall protection system as one required to handle impact energies of less than 100kJ.

### 4.7.3 Proprietary rockfall protection systems

Council strongly recommends the adoption of a proprietary system for all dynamic structures where the estimated impact energy is greater than 100kJ. Dynamic rockfall barrier systems are not considered an appropriate protection measure against falling rock masses with very high (>1500kJ) energy levels.

Design proprietary rockfall protection systems with a design life of not less than 15 years, when maintained in accordance with the manufacturer’s requirements. The manufacture of any proprietary rockfall protection system shall comply with Table 1.
Table 1 Minimum standards for proprietary rockfall protection systems

<table>
<thead>
<tr>
<th>Maximum Energy Level</th>
<th>Minimum Standard Applicable</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 - 500kJ</td>
<td>Manufacturer certification</td>
<td>Manufacturer shall both certify and warrant the performance of the protection system to the required impact energy and for the design life of the structure.</td>
</tr>
<tr>
<td>&gt; 500kJ</td>
<td>Manufacturer certification including full scale testing in accordance with ETAG 27 – Falling Rock Protection Kits</td>
<td>Full scale testing shall be in accordance with the provisions of ETAG 27 – Falling Rock Protection Kits.</td>
</tr>
</tbody>
</table>

Note 1: Maximum energy level (MEL) as defined by ETAG 27 for 95th percentile boulder

The required capacity of the foundation and tie back systems shall be provided by the manufacturer of the rockfall protection system. Design the foundations and tie backs in accordance with the manufacturer’s requirements, to comply with the conditions of the building consent.

### 4.7.4 Hybrid and attenuator rockfall protection systems

Hybrid and attenuator rockfall protection systems are a combination of rockfall protection drapes or nettings and flexible rockfall protection barriers without bottom supporting ropes. Hybrid barriers refer to systems installed on slopes steeper than 65 degrees and are generally used to guide rocks down the slope face so that they come to rest near the toe of the slope. Attenuator systems are installed on slopes flatter than 65 degrees and generally serve to reduce the energy of rocks as they roll down-slope. These types of system generally act to control rather than to arrest falling rock.

These systems are relatively new and there is currently little design guidance and no certification methodology similar to ETAG. Consequently, Council does not consider them to be generally appropriate as the sole means of protection.

The approach to the ‘design’ of these systems should be no different to that of a dynamic rockfall barrier, and should consider:

- the rock energy and bounce height. The maximum energy level (MEL) design approach can be considered given the lower energy demands on the system components in comparison to a similarly sized dynamic barrier system;
- the estimated translational and rotational energy of the falling rock and its effect on the type, weight and durability of the material used for the drape/netting;
- For attenuator systems, slope angle at the installation site and its effect on the selected drape material and tail length.
The ‘skeleton’ structure (posts, base plates, ropes, and other accessories except the main drape panel and lower longitudinal rope) should be the same as that of an ETAG approved catch fence for a similar energy category.

### 4.7.5 Reinforced earth embankment barriers

Reinforced earth embankment barriers (also known as reinforced soil bunds) are able to withstand extremely high energy levels without any appreciable deformation or extraordinary maintenance. Current experience of the manufacturers of proprietary systems allows the design and construction of embankments up to 20m high, with a resistance of not less than 20,000 kJ total kinetic (impact) energy.

Because reinforced earth embankment barriers permit both high energy levels and multiple impacts to be controlled, and the maintenance requirements are relatively minor, Council prefers these as the first choice rockfall protection system in all situations where the total kinetic (impact) energy is greater than 1500kJ.

There is currently no certification methodology similar to ETAG for reinforced earth embankment barriers. Consider the following in the design:

- the stability of the embankment and the slope (bearing capacity of the foundations, sliding and tilting, seismic loads);
- the internal stability of the embankment (tensile and pull-out strength of the reinforcing elements);
- an evaluation to ensure that the structure can sustain the dynamic impact without launching fragments during the impact, without being passed over by rolling blocks and without collapsing due to block penetration and/or sliding of the soil layers. This may be demonstrated by full-scale testing or by finite element method (FEM) analysis.

Consider a catch fence installed on top of a bund when there is a concern for rocks or rock fragments flying over the reinforced soil bund.

### 4.7.6 Designer requirements

The designer of the protection system’s foundations including ground anchors shall be an Approved Geoprofessional, who shall provide a Producer Statement PS1 - Design, as set out in Appendix V - Producer Statement PS1 – Design.

The design shall be reviewed by an Approved Geoprofessional, who shall provide a Producer Statement PS2a – Design Review, as set out in Appendix VI - Producer Statement PS2a – Design Review.

Design amendments shall also be reviewed by the Approved Geoprofessional, who shall provide a Producer Statement PS2b – Design Review Amendment, as set out in Appendix VII - Producer Statement PS2a – Design Review Amendment.
4.8  Construction

4.8.1  Underrunners and springs
In hill catchments, underrunners are often encountered. Where practicable and considered necessary, intercept these and bring them to the surface, with a free outfall into the stormwater system wherever possible. If possible, locate the source and redirect or eliminate the underrunner.

4.8.2  Control testing
A testing laboratory, or a competent person under the control of the geoprofessional, must carry out the construction control testing. The testing laboratory must have recognised registration or quality assurance qualifications.

4.8.3  Compaction standards for fill material
The standard of compaction and method of determination is as set out in NZS 4431, except where NZS 4431 is not applicable. For example, reinforced earth embankment barriers, industrial and commercial developments often have specialised requirements for fill materials and compaction. Specify the fill and compaction standards, procedures and methods of determination for the development in these cases. Use NZS 4431 as a basis where appropriate.

4.8.4  Rockfall hazard mitigation construction
The contractor shall verify the construction complies with the manufacturer’s requirements and with the design by providing a Completion Certificate complying with Part 3: Quality Assurance, Appendix VIII.

The designer (the Approved Geoprofessional who designed the mitigation) shall review the construction and provide a Producer Statement PS4 – Construction Review, as set out in Appendix VII - Producer Statement PS4 – Construction Review. The minimum construction monitoring requirement shall be Construction Monitoring Services Level CM4.

4.9  Erosion, Sediment and Dust Control

4.9.1  Minimisation of effects
Design and construct earthworks to minimise soil erosion and sediment discharge. Where necessary, make permanent provision to control erosion and sediment discharge from the area of the earthworks.

At the planning and design phase, consider the generation of dust during and after the earthworks operation. If necessary, incorporate specific measures to control dust.

Requirements for erosion, sediment and dust control will be set in the resource consent conditions for the project. Refer to these conditions and take into account in the early stages of planning a project. Refer also to the requirements of CSS: Part 1.
4.9.2 Site-specific erosion and sediment control plan requirements

For all developments where erosion could result in contaminants in sediments entering the groundwater, surface waters or the Council’s stormwater system, provide a site-specific Erosion and Sediment Control Plan (ESCP) to the Council at least four weeks before any works start on site. Note that, even where the Council has accepted an ESCP, the developer remains entirely responsible for all adverse effects associated with the site development.

Develop the ESCP to eliminate or reduce the following issues:

- ecological damage to waterways;
- channel infilling;
- disturbed or uncompacted surfaces and potential sediment yield;
- contaminated runoff;
- sediment discharges from dewatering;
- potential contamination from bituminous materials.

The ESCP must include the following assessment factors:

- a description of the pre-development surface water runoff regime;
- the development area (hectares);
- the catchment area passing through the site (hectares) marked on drawing;
- a plan of the development area, identifying discharge points to waterways or pipelines;
- calculated flow rates, and velocities through from the site (dry weather, two-year flood and typical water levels);
- a site plan showing the proposed earthwork strategy;
- the earthworks engineering drawings;
- a statement on how the exposed soil surface will be minimised;
- a statement (with sketches as appropriate) on how sediment runoff will be trapped and disposed of;
- a statement on potential tracking of soils on and off site by machinery;
- a statement on other contaminants and how they will be controlled;
- a statement on how ground water will be treated and discharged (if required).
The ESCP must comply with the standards:

- as specified by Canterbury Regional Council e.g. *Erosion and sediment control guidelines*;
- *Water Related Services Bylaw*;
- *Soil Conservation Guidelines for the Port Hills*.

### 4.9.3 Protection measures

Take the following protection measures, unless incompatible with Canterbury Regional Council resource consent conditions:

- Construct stabilised construction entrances and detail proposed remedial works to mitigate contaminants moving off site e.g. mud on streets or silt in existing sumps in streets.
- Construct sediment traps and retention ponds where necessary. These should be cleaned out, as required, to ensure that adequate sediment storage is maintained.
- Use temporary barriers, or silt fences using silt control geotextiles, to reduce flow velocities and to trap sediment.
- Leave sections of natural ground unstripped to act as grass (or other vegetation) filters for run-off from adjacent areas.
- Construct temporary drains at the top and toe of steep slopes to intercept surface run-off and to lead drainage away to a stable watercourse or piped stormwater system.
- Slope benches in batter faces back and grade (both longitudinally and transversely), to reduce spillage of stormwater over the batter wherever surface water could cause erosion of batters, or internal instability through infiltration into the soil.
- Prevent surface water from discharging over batter faces by constructing open interceptor drains in permanent materials formed to intercept surface run-off and discharge via stable channels or pipes, preferably into stable watercourses or piped stormwater systems.
- Grade the surfaces of fills and cuts to prevent ponding.
- Shape and compact the upper surface of intermediate fills with rubber-tyred or smooth-wheeled plant when rain is impending or when the site is to be left unattended, to minimise water infiltration.
- Topsoil and grass the completed battered surfaces of fills to reduce run-off velocities.
- Re-topsoil and grass (or hydroseed) all earthwork areas as soon as possible after completion of the earthworks and drainage works.
> Use planting, environmental matting, hydroseeding, drainage channels or similar measures at an early stage in the earthworks construction phase as a permanent control of erosion and sediment discharge.

> To control dust or encourage early vegetation growth, water the site frequently during construction.

> Establish the permanent surface at an early stage of the construction phase.

Possible treatment methods are provided in the *Stormwater treatment devices: design guideline manual*.

Earthworks for developments on hillside land are not to be undertaken between 1 May and 31 August in any year, without the express written permission of the Council. This may be in the form of either conditions of subdivision, building or resource consent.

Ensure a satisfactory grass strike is obtained on all completed earthworks surfaces as soon as practicable. The intention is to provide early vegetative cover, particularly before the onset of winter, to minimise erosion and sedimentation. Suitable irrigation methods may be required to assist grass growth in the summer months.

Prevent water from stormwater systems flowing into a fill or into natural ground near the toe or sides of a fill. Do not construct stormwater or wastewater soakage systems in a fill, which could impair the fill’s stability. Take into account the effect of utility services laid within the fill.
APPENDIX I

Statement of Professional Opinion on the Suitability of Land for Subdivision

ISSUED BY: ________________________________________________________________

(Geotechnical engineering firm or suitably qualified engineer)

TO: ________________________________________________________________

(Territorial authority)

TO BE SUPPLIED TO: _______________________________________________________

(Owner/Developer)

IN RESPECT OF: __________________________________________________________

(Description of infrastructure/land development)

AT: ________________________________________________________________

(Address)

I ____________________________ on behalf of ________________________________

(Geoprofessional)

(Geotechnical engineering firm)

hereby confirm:

1. I am a suitably qualified and experienced geoprofessional employed by ____________________________
   and the geotechnical firm named above was retained by the owner/developer as the geoprofessional on
   the above proposed development.

2. The geotechnical assessment report, dated ______________________ has been carried out in accordance with the
   Ministry of Business, Innovation and Employment Guidelines for geotechnical investigation and assessment
   of subdivisions and the Christchurch City Council Infrastructure Design Standard – Part 4: Geotechnical
   Requirements and includes:

   (i) Details of and the results of my/the site investigations.

   (ii) A liquefaction and lateral spread assessment.

   (iii) An assessment of rockfall and slippage, including hazards resulting from seismic activity.

   (iv) An assessment of the slope stability and ground bearing capacity confirming the location and
       appropriateness of building sites.

   (v) Recommendations proposing measures to avoid, remedy or mitigate any potential hazards on the
       land subject to the application, in accordance with the provisions of Section 106 of the Resource
3. In my professional opinion, not to be construed as a guarantee, I consider that Council is justified in granting consent incorporating the following conditions:

(i) _____________________________________________________________________

(ii) _____________________________________________________________________

4. This professional opinion is furnished to the territorial authority and the owner/developer for their purposes alone, on the express condition that it will not be relied upon by any other person and does not remove the necessity for the normal inspection of foundation conditions at the time of erection of any building. It is limited to those items referred to in clause 2 only.

5. This statement shall be read in conjunction with the geotechnical report referred to in clause 2 above, and shall not be copied or reproduced except in conjunction with the full geotechnical completion report.

6. Liability under this statement accrues to the geotechnical firm only and no liability shall accrue to the individual completing this statement.

7. The geotechnical engineering firm issuing this statement holds a current policy of professional indemnity insurance of no less than $______________

(Minimum amount of insurance shall be commensurate with the current amounts recommended by IPENZ, ACENZ, NZTA, INGENIUM.)

____________________________________________________________________________ Date:________________________

(Signature of engineer, for and on behalf of ________________________________________________________________________________)

Qualifications and experience

____________________________________________________________________________

____________________________________________________________________________

This form is to accompany Form 9 – Resource Management Act 1991 (Application for a Resource Consent (Subdivision))
APPENDIX II

Statement of Professional Opinion on the Suitability of Land for Building Construction

ISSUED BY: ____________________________
(Geotechnical engineering firm or suitably qualified engineer)

TO: ____________________________
(Owner/Developer)

TO BE SUPPLIED TO: ____________________________
(Territorial authority)

IN RESPECT OF: ____________________________
(Description of infrastructure/land development)

AT: ____________________________

(Address)

I ____________________________ on behalf of ____________________________
(Geoprofessional)

(Geotechnical engineering firm)

hereby confirm:

1. I am a suitably qualified and experienced geoprofessional and was retained by the owner/developer as the geoprofessional on the above development.

2. The extent of my inspections during construction, and the results of all tests carried out are as described in my/the geotechnical completion report, dated __________

3. In my professional opinion, not to be construed as a guarantee, I consider that (delete as appropriate):

   (a) the earthfills shown on the attached Plan No __________ have been placed in compliance with the requirements of the __________ Council and my/the specification.

   (b) the completed works give due regard to land slope and foundation stability considerations.

   (c) the original ground not affected by filling is suitable for the erection thereon of buildings designed according to NZS 3604 provided that:

      (i) ____________________________

      (ii) ____________________________
(d) the filled ground is suitable for the erection thereon of buildings designed according to NZS 3604 provided that:

(i) 

(ii) 

(e) The original ground not affected by filling and the filled ground are suitable for the construction of a development/subdivision and are not subject to erosion, subsidence or slippage provided that:

(i) 

(ii) 

**NOTE:** The sub-clauses in Clause 3 may be deleted or added to as appropriate.

4. This professional opinion is furnished to the territorial authority and the owner/developer for their purposes alone, on the express condition that it will not be relied upon by any other person and does not remove the necessity for the normal inspection of foundation conditions at the time of erection of any building.

5. This statement shall be read in conjunction with my/the geotechnical report referred to in Clause 2 above, and shall not be copied or reproduced except in conjunction with the full geotechnical completion report.

6. Liability under this statement accrues to the geotechnical firm only and no liability shall accrue to the individual completing this statement.

7. The geotechnical engineering firm issuing this statement holds a current policy of professional indemnity insurance of no less than $__________________

(Minimum amount of insurance shall be commensurate with the current amounts recommended by IPENZ, ACENZ, NZTA, INGENIUM.)

___________________________________________     Date:________________________________________

(Signature of engineer, for an on behalf of ______________________)

Qualifications and experience

__________________________________________________________________________________________

__________________________________________________________________________________________
## APPENDIX III  Soil Log and Descriptions

<table>
<thead>
<tr>
<th>Elevation</th>
<th>Depth</th>
<th>Symbol</th>
<th>Material Description</th>
<th>Scala Penetrometer (mm/blow)</th>
<th>Depth</th>
</tr>
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<tbody>
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</tbody>
</table>
Material Descriptions

Examples:
- Sandy GRAVEL, with some clay
- Clayey SILT, with trace of peat, light grey, firm, moist

SOIL TYPE

<table>
<thead>
<tr>
<th>Lesser Fraction</th>
<th>Dominant Fraction</th>
<th>Minor Fraction</th>
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</thead>
<tbody>
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<td>Soil Type Term</td>
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<tr>
<td>Silt</td>
<td>0.002 - 0.06</td>
<td>Silt</td>
</tr>
<tr>
<td>Clay</td>
<td>&lt; 0.002</td>
<td>Clay</td>
</tr>
<tr>
<td>Peat</td>
<td>N/A</td>
<td>Peat</td>
</tr>
</tbody>
</table>

COLOUR

<table>
<thead>
<tr>
<th>Adjective1</th>
<th>Adjective2</th>
<th>Main Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>light</td>
<td>pinkish</td>
<td>pink</td>
</tr>
<tr>
<td>dark</td>
<td>reddish</td>
<td>red</td>
</tr>
<tr>
<td>yellowish</td>
<td>yellow</td>
<td></td>
</tr>
<tr>
<td>brownish</td>
<td>brown</td>
<td></td>
</tr>
<tr>
<td>olive</td>
<td>olive</td>
<td></td>
</tr>
<tr>
<td>greenish</td>
<td>green</td>
<td></td>
</tr>
<tr>
<td>bluish</td>
<td>blue</td>
<td></td>
</tr>
<tr>
<td>greyish</td>
<td>white</td>
<td></td>
</tr>
<tr>
<td>grey</td>
<td>black</td>
<td></td>
</tr>
</tbody>
</table>
**STRENGTH**

Cohesive Soil Consistency

<table>
<thead>
<tr>
<th>Consistency</th>
<th>Undrained Shear Strength (kPa)</th>
<th>Characteristic</th>
</tr>
</thead>
<tbody>
<tr>
<td>very soft</td>
<td>&lt; 12</td>
<td>Easily exudes between fingers</td>
</tr>
<tr>
<td>soft</td>
<td>12 - 25</td>
<td>Easily moulded by fingers</td>
</tr>
<tr>
<td>firm</td>
<td>25 - 50</td>
<td>Can be moulded with fingers with some effort</td>
</tr>
<tr>
<td>stiff</td>
<td>50 - 100</td>
<td>Impossible to mould with fingers, but will change shape with heel pressure</td>
</tr>
<tr>
<td>very stiff</td>
<td>100 - 200</td>
<td>As for stiff, but considerable heel pressure is required</td>
</tr>
<tr>
<td>hard</td>
<td>200 - 500</td>
<td>Brittle, very tough</td>
</tr>
</tbody>
</table>

Non Cohesive Soil Density

<table>
<thead>
<tr>
<th>Density</th>
<th>Characteristic</th>
</tr>
</thead>
<tbody>
<tr>
<td>very loose</td>
<td>Very easy to excavate by hand</td>
</tr>
<tr>
<td>loose</td>
<td>Easy to excavate by hand</td>
</tr>
<tr>
<td>medium dense</td>
<td>Between loose and dense</td>
</tr>
<tr>
<td>dense</td>
<td>Very difficult to excavate by hand</td>
</tr>
<tr>
<td>very dense</td>
<td>Particles bound together</td>
</tr>
</tbody>
</table>

**MOISTURE**

<table>
<thead>
<tr>
<th>Moisture</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>dry</td>
<td>Cohesive soils usually hard or powdery Granular soils run freely through hands</td>
</tr>
<tr>
<td>moist</td>
<td>Some moisture present – usually darkens the colour</td>
</tr>
<tr>
<td>wet</td>
<td>Strong squeezing in the hand will drive some water out</td>
</tr>
<tr>
<td>saturated</td>
<td>Squeezing will drive water out</td>
</tr>
</tbody>
</table>

**SAND/GRAVEL GRADING**

<table>
<thead>
<tr>
<th>Adjective</th>
<th>Organic Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>trace</td>
<td>fibrous</td>
</tr>
<tr>
<td>little</td>
<td>wood pieces</td>
</tr>
<tr>
<td>some</td>
<td>root fibres</td>
</tr>
<tr>
<td>and</td>
<td>vegetation</td>
</tr>
</tbody>
</table>

For full descriptions see: Field Description of Soil and Rock, NZ Geotechnical Society, Dec 2005
APPENDIX IV

Liquefaction Resistance Index (Zoning) Of Christchurch At Water Table Depth For Application To Underground Infrastructure Only

Based on liquefaction observations from the 2010-2011 earthquakes and water table depth information

<table>
<thead>
<tr>
<th>Zone</th>
<th>Equivalent CRR (at water table)</th>
<th>Representative LRI (at water table)</th>
<th>Estimated Ground Settlement (mm)</th>
<th>Estimated Lateral Displacement (relative; transient) (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>&lt; 0.065 - &gt; 500 &gt; 400</td>
<td>ε &gt; 5%, γ &gt; 4%, H = 5 - 10 m</td>
<td>v L</td>
<td>l</td>
</tr>
<tr>
<td>1</td>
<td>0.065 - 0.11</td>
<td>0.065</td>
<td>250 - 500</td>
<td>200 - 400</td>
</tr>
<tr>
<td>2</td>
<td>0.11 - 0.16</td>
<td>0.13</td>
<td>50 - 250</td>
<td>40 - 200</td>
</tr>
<tr>
<td>3</td>
<td>0.16 - 0.23</td>
<td>0.195</td>
<td>20 - 50</td>
<td>20 - 40</td>
</tr>
<tr>
<td>4</td>
<td>&gt; 0.23</td>
<td>&lt; 20</td>
<td>&lt; 20</td>
<td>&lt; 20</td>
</tr>
</tbody>
</table>

No Liquefaction Observations

Main Roads

Rivers

0 42 km

The LRI map and table are for preliminary use and restricted to the water / wastewater systems of Christchurch. The ground displacement values exclude effects of lateral spreading. Design should accommodate the higher value of displacement/deformation.

CRR = Cyclic Resistance Ratio, ε = volumetric strain, γ = shear strain, H = thickness of liquefied layer.

Note that the zone numbers indicate the relative liquefaction resistance, with Zone 1 being the reference zone. For example, Zone 3 has three times the liquefaction strength of the lower bound value of Zone 1.

The typical range of settlements and displacements associated with each zone shown in the above table are based on expert judgement and should be taken only as preliminary estimates. Further updates will follow based on more robust interpretation and analysis.

Please cite this map as follows:


Contact:
Professor Misko Cubrinovski, Department of Civil & Natural Resources Engineering, University of Canterbury. misko.cubrinovski@canterbury.ac.nz

Spatial Analysis & Cartography: Dr Matthew Hughes, Department of Civil & Natural Resources Engineering, University of Canterbury. matthew.hughes@canterbury.ac.nz

Notes

December 2011
APPENDIX V

Producer Statement PS1 – Design

This Producer Statement is for the design of support or protection devices for the rockfall and boulder roll hazards on and near to the Port Hills, Christchurch. It applies to construction consented by the Christchurch City Council under the Building Act 2004 and its amendments.

DESIGNED BY: ____________________________________________________________
(Approved Geoprofessional)

ISSUED BY: ______________________________________________________________
(Design Firm)

TO: _________________________________________________________________
(Purchaser)

OWNERS: _______________________________________________________________
(Registered owners shown on the Certificate of Title. Individuals, trusts, Trustees, Company Directors)

Consenting Authority – Christchurch City Council

Appointed Peer Reviewer ____________________________________________________________
(Approved Geoprofessional and signatory to a Producer Statement PS2- Peer Review)

Description of Work ___________________________________________________________

(Describe the work covered by this Producer Statement in detail)

At ________________________________________________________________ (Address)

Lot Number ____________ DP ____________  C/T Number ____________

Description of Design Services Undertaken _____________________________________________

Inputs to the Design _____________________________________________________________
(Standards and codes used)

(Rockfall Energy used and its derivation/supply)

(other)
Design Life __________________________ Expected Service Life __________________________

(To take account of the environmental setting)

Name any Proprietary System __________________________________________________________

Test Level for Proprietary System Used __________________________ Certificate Number __________

(Current test level certificate)

The works covered by this Producer Statement are described in calculations titled __________________________

All details are given on drawings titled __________________________

I __________________________ (the designer)

being a Chartered Civil Engineer under the Chartered Engineers Act of New Zealand and an Approved Geoprofessional (see note 2) believe on reasonable grounds the works designed by me, if constructed according to the details shown on the drawings, in the specification and any other accompanying documents will perform to the design intent as set down by the Christchurch City Council in a consent to construct. The work covered by this Statement will be observed as it is constructed according to:

CM4  ○  CM5  ○  Other____________________

This statement is endorsed by __________________________

(Director and/share holder)

of __________________________

(Design Firm)

and the employer of the Designer.

I/we are member(s) of ACENZ  YES  ○  NO  ○, hold Professional Indemnity insurance of no less than $5,000,000.00 and accept that liability under this statement accrues to the Design Firm only.

Signed by the Designer __________________________ (Signature)

__________________________ (Date)

Signed on behalf of the Design Firm __________________________ (Signature)

__________________________ (Date)
Notes And Requirements For Ps1 - Design

1. This Producer Statement shall provide the Christchurch City Council with reasonable grounds to issue a consent for construction of the work without the need for duplicate and independent design checking.

2. PS1 - Design is required from an Approved Geoprofessional, as defined in clause 4.3.1 – The geoprofessional.

3. The Designer shall have signing authority delegated by the Design Firm. By signing the PS1 – Design, the Designer warrants that she/he has:

   a. delegated authority from a Director of the Design Firm to undertake the design and develop the construction details;

   b. a directory role in the gathering of site data, establishing the design inputs overseeing the design process, checking the outputs from design, arranging and signing off internal verification, developing the work specification, overseeing the drawing of details and shall be fully satisfied that the documents accompanying the PS1 – Design are completed and relevant to the stabilisation of rockfall or protection of life and/or property from rockfall or boulder roll.

4. The Designer shall employ an Approved Geoprofessional to independently review the design and to provide a Producer Statement PS2a – Design Review. The costs associated with the design review shall be borne in full by the Design Firm. Issues of disputed design shall be resolved by the Designer and Design Reviewer to enable the PS1 – Design to be signed unconditionally. Council will not accept a PS1 with conditions.

5. The PI Insurance minimum stated on the PS1 shall be current at the time of submission to Christchurch City Council. A certificate of currency shall be appended by the Design firm to the Statement.

6. In the case where a Design Firm ceases to trade within 10 years of the construction of the designed work, the Director(s) shall maintain “run-on” insurance to the full value of $5,000,000 for the balance of time to 10 years from completion of construction.
APPENDIX VI

Producer Statement PS2a – Design Review

This Producer Statement is for the design review of support or protection devices for the rockfall and boulder roll hazards on and near to the Port Hills, Christchurch. It applies to construction consented by the Christchurch City Council under the Building Act 2004 and its amendments.

APPOINTED DESIGN REVIEWER: __________________________________________________________
(Approved Geoprofessional named on the Producer Statement PS1 - Design)

ISSUED BY: _________________________________________________________________________
(Design Reviewer Firm)

TO: ______________________________________________________________________________
(Designer)

OF: ______________________________________________________________________________
(Design Firm)

OWNERS: __________________________________________________________________________
(Registered owners shown on the Certificate of Title. Individuals, trusts, Trustees, Company Directors)

Consenting Authority – Christchurch City Council

Description of Work __________________________________________________________________________
(Describe the work covered by this Producer Statement in detail)

At ______________________________________________________________________________________ (Address)

Lot Number ___________ DP ___________ C/T Number ___________

I ________________________________________________ (Design Reviewer) have been engaged

by ________________________________________________ (Design Firm)

to review all of the work included by the design calculations, specification and drawings
Part 4: Geotechnical Requirements

Calculations titled ________________ dated ________________

Specification titled ________________ dated ________________

Drawings titled ________________ dated ________________

Drawing number ________________ Revision numbers ________________

I ____________________________________________________________________________
(the Design Reviewer)

being an Approved Geoprofessional (see note 2) have reviewed the design and construction documents supplied by the Designer and agree all matters of difference between the Designer and myself are satisfactorily resolved.

I believe on reasonable grounds the design work reviewed by me, if constructed according to the details shown on the drawings, in the specification and any other accompanying documents will perform to the design intent determined by the Designer as set down by the Christchurch City Council in the consent to construct.

I have sighted the signed Producer Statement PS1 and confirm that the Statement is complete and correct.

This statement is endorsed by ______________________________________________________________________
(Director and/share holder)

of _______________________________________________________________________________________

(Design Firm)

and the employer of the Designer Reviewer.

I/we are member(s) of ACENZ YES ☐ NO ☐, hold Professional Indemnity insurance of no less than $5,000,000.00 and accept that liability under this statement accrues to the Design Firm only.

Signed by the Designer ________________________________________________________________________ (Signature)
__________________________________________________________________________________________  (Date)

Signed on behalf of the Design Review Firm ____________________________________________________________________ (Signature)
__________________________________________________________________________________________  (Date)
Notes And Requirements For PS2a – Design Review

1. This Producer Statement shall provide the Christchurch City Council reasonable grounds to issue consent for construction of the work. It shall be based on an independent review of the design covered by PS1 – Design.

2. PS2a - Design Review is required from the Design Reviewer who shall be an Approved Geoprofessional, as defined in clause 4.3.1 – The geoprofessional.

3. The Design Reviewer shall be a person and not a Firm and shall have signing authority delegated to him/her from a Director of the Design Reviewer’s Firm to undertake the review and sign the PS2a.

4. The Design Reviewer is engaged by the Design Firm to undertake a review of the documents representing the design work. Christchurch City Council is not responsible in any part for the commercial arrangements between the Design Firm and the Design Reviewer.

5. From time to time differences of opinion will arise between the Design Reviewer and Designer of the work. Both parties are expected to work together to resolve any difference so that the PS1 and PS2 Statements are submitted to Christchurch City Council without conditions.

6. The PI Insurance minimum stated on the PS2a shall be current at the time of submission to Christchurch City Council. A certificate of currency shall be appended by the Design Reviewer Firm to the Statement.

7. In the case where a Design Reviewer Firm ceases to trade within 10 years of the construction of the designed work, the Director(s) shall maintain “run-on” insurance to the full value of $5,000,000 for the balance of time to 10 years from completion of construction.
APPENDIX VII

Producer Statement PS2b – Design Review Amendment

This Producer Statement is a variation to PS2a to cover variation to the design content arising out of construction of rockfall support or protection devices for rockfall and boulder roll hazards on and near to the Port Hills, Christchurch. It applies to construction consented by the Christchurch City Council under the Building Act 2004 and its amendments.

APPOINTED DESIGN REVIEWER: _________________________________________________

(Approved Geoprofessional named on the Producer Statement PS1 - Design)

ISSUED BY: _________________________________________________

(Design Reviewer Firm)

TO: _________________________________________________

(Designer)

OF: _________________________________________________

(Design Firm)

OWNERS: _________________________________________________

(Registered owners shown on the Certificate of Title. Individuals, trusts, Trustees, Company Directors)

Consenting Authority – Christchurch City Council

The amendment to the work _________________________________________________

(Describe the work covered by this Producer Statement in detail)

At _________________________________________________ (Address)

Lot Number ___________ DP ___________ C/T Number ___________

I _________________________________________________ (Design Reviewer) have been engaged

by _________________________________________________ (Design Firm)

to review all of the work included by the design calculations, specification and drawings

VARIATION TO DESIGN CONTENT

> Variation No________ Description___________________________Date________________
> Variation No________ Description___________________________Date________________
> Variation No________ Description___________________________Date________________
> Variation No________ Description___________________________Date________________
being an Approved Geoprofessional (see note 2) have reviewed the amendments to the design reviewed under PS2a and viewed the variations at the place of construction.

I believe on reasonable grounds the amendments to the design work reviewed by me, as constructed, will perform to the design intent determined by the Designer as set down by the Christchurch City Council in the consent to construct.

I have sighted the signed Producer Statement PS1 and PS4 and confirm that the Statements are complete and correct.

This statement is endorsed by ____________________________________________________________

(Director and/share holder)

of __________________________________________________________

(Design Review Firm)

and the employer of the Designer Reviewer.

I/we are member(s) of ACENZ YES ☐ NO ☐, hold Professional Indemnity insurance of no less than $5,000,000.00 and accept that liability under this statement accrues to the Design Firm only.

Signed by the Design Reviewer ________________________________________________________ (Signature)

__________________________________________________________ (Date)

Signed on behalf of the Design Review Firm ___________________________________________ (Signature)

__________________________________________________________ (Date)
Notes And Requirements For PS2b – Design Review

1. This Producer Statement shall show the Christchurch City Council that variation to the content of the design work which arises out of its construction does not alter the design intent and the basis of the design review. It shall be based on an independent check of the variation to the design covered by the PS2a – Design Review.

2. PS2b - Design Review Amendment is required from the Design Amendment Reviewer and signatory to the PS2a, who shall be an Approved Geoprofessional, as defined in clause 4.3.1 – The geoprofessional.

3. The Design Amendment Reviewer shall be a person and not a Firm and shall have signing authority delegated to him/her from a Director of the Design Reviewer’s Firm to undertake the review and sign the PS2b.

4. The Design Amendment Reviewer is engaged by the Design Firm to undertake a review of the documents representing the design work. Christchurch City Council is not responsible in any part for the commercial arrangements between the Design Firm and the Design Amendment Reviewer.

5. The PI Insurance minimum stated on the PS2b shall be current at the time of submission to Christchurch City Council. A certificate of currency shall be appended by the Design Amendment Reviewer Firm to the Statement.

6. In the case where a Design Amendment Reviewer Firm ceases to trade within 10 years of the construction of the designed work, the Director(s) shall maintain “run-on” insurance to the full value of $5,000,000 for the balance of time to 10 years from completion of construction.
APPENDIX VIII

Producer Statement PS4 – Construction Review

This Producer Statement is for the construction compliance of design for support or protection devices for the rockfall and boulder roll hazards on and near to the Port Hills, Christchurch. It applies to construction consented by the Christchurch City Council under the Building Act 2004 and its amendments.

ISSUED BY: ____________________________
(Design Firm)

TO: ____________________________
(Purchaser)

OWNERS: ____________________________
(Registered owners shown on the Certificate of Title. Individuals, trusts, Trustees, Company Directors)

Consenting Authority – Christchurch City Council

Description of Work

(Describe the work covered by this Producer Statement in detail)

At ____________________________ (Address)

Lot Number ___________ DP ___________ C/T Number ___________

Designed by ____________________________ (Designer)

Construction observations made by ____________________________

Qualifications of Construction Observer

NZCE □ REA □ TIPENZ □ CPEng □ Other □

Construction observations to

CM4 □ CM5 □ Other________________

(Categories given by IPENZ)

Description of construction observations

________________________________________________________

________________________________________________________

Authorised variations to design details that are covered by PS1 and PS2a for construction

(attach all documentation to vary content of construction)

Endorsement of variation to vary content of construction by the Design Reviewer Producer Statement

PS2b is attached □ YES □ NO □

(Include copies of the communication with the Design Reviewer)
I ________________ (the designer) being a Chartered Civil Engineer under the Chartered Engineers Act of New Zealand and an Approved Geoprofessional (see note 2) have monitored the construction of the work and believe on reasonable grounds the works are constructed according to my design.

I am satisfied that variation to the work as detailed made at time of construction has not altered its expected performance and durability.

I confirm that the conditions of Consent issued by Christchurch City Council are satisfied in full by the construction.

This statement is endorsed by ________________ (Director and/share holder)

of ________________ (Design Firm)

and the employer of the Designer and Construction Observer.

I/we are member(s) of ACENZ YES ☐ NO ☐, hold Professional Indemnity insurance of no less than $5,000,000.00 and accept that liability under this statement accrues to the Design Firm only.

Signed by the Designer ________________ (Signature)

_____________________________ (Date)

Signed on behalf of the Design Firm ________________ (Signature)

_____________________________ (Date)
Notes And Requirements For PS4 – Construction Review

1. This Producer Statement shall provide the Christchurch City Council with assurance that the work as designed and amended at time of construction has been built according to the documents to which PS1, PS2a and PS2b apply and any conditions of consent to construct.

2. PS4 – Construction Review is required from an Approved Geoprofessional, as defined in clause 4.3.1 – The geoprofessional.

3. The Designer shall be a person and not a Firm and shall have signing authority delegated to him/her from a Director of the Design Firm to undertake the Construction Review and sign the PS4.

4. The Designer shall establish the frequency for inspections and shall adopt CM4 and CM5 as specified by the consent to construct. The day-to-day inspections of construction can be undertaken by other professional or sub-professional engineers who are under the direct supervision of the Designer.

5. The PI Insurance minimum stated on the PS4 shall be current at the time of submission to Christchurch City Council. A certificate of currency shall be appended by the Design Firm to the Statement.

6. In the case where a Design Firm ceases to trade within 10 years of the construction of the designed work, the Director(s) shall maintain “run-on” insurance to the full value of $5,000,000 for the balance of time to 10 years from completion of construction.