WAIMAKARIRI
DISTRICT COUNCIL

ENGINEERING CODE OF PRACTICE

PART FOUR

GEOTECHNICAL REQUIREMENTS (EARTHWORKS AND LAND STABILITY)

April 2009

Part 4: Geotechnical Requirements

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4.1 INTRODUCTION

This part of the Engineering Code of Practice draws attention to the need for the assessment of land stability and the design and control of earthworks. Such assessment ensures 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.

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 project.

Part 4: Geotechnical Requirements

4.2 CONSENT AND COMPLIANCE ISSUES

The consent and compliance information set out in Part 2: *General Requirements* applies to all works within the Waimakariri District, with the addition of the clauses below.

4.2.1 Legislation

The Resource Management Act (RMA) 1991 and amendments is the principal statute that controls land development, including earthmoving and land-use aspects.

NZS 4431:1989 applies to the construction of earthfills for residential development, including residential roading. It does not, however, deal with historical fill that has not been undertaken in accordance with any Standard and it does not cover natural slopes, banks and batters.

There is no Standard for earthfill for other than residential developments. Clause 4.7.3 - Compaction standards for fill material sets out the requirements in these situations.

4.2.2 Statute and District 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 geotechnical engineer. The Council relies on that assessment when granting the resource consent. The geotechnical engineer 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 and, for subsequent building work, section 74 of the Building Act.

Specific Council requirements include:

- No earthworks permission for work within Waimakariri District unless it complies with the provisions of the District Plan.
- No earthworks beginning on a subdivision that has been granted resource consent prior to final engineering acceptance, unless written permission from the Council is given, detailing conditions that must be adhered to.

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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 Requirement for a Geotechnical Engineer

Engage a geotechnical engineer (or suitably experienced civil engineer) to provide geotechnical expertise where the following issues exist:

- The lack of, and limitations of, relevant Standards.
- The assessment of land stability requires specialist expertise.
- The construction of earthworks associated with any development requires initial planning and design, to ensure that banks and batters 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 raises doubt about the stability, or suitability, of the ground for the proposed development.
- Other geotechnical hazards are identified.
- The Council requires geotechnical expertise to assess the project.

The geotechnical engineer will carry out the following functions:

- Undertake a site inspection 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 in any assessment of environmental effects (AEE) associated with any consent application;
- Before work commences, be involved in the design or review the drawings and specifications defining any earthworks or other construction work, and submit a written report to the Council on the foundation and stability aspects of the project with the application for engineering acceptance;
- Set earthwork requirements, where no standard for earthworks is applicable to the project, to conform to the CoP and to 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 regular inspections consistent with the extent of geotechnical issues associated with the project;
- On completion, submit a written report to the Council attesting to the compliance of the earthworks with the specifications and 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.

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Where a development proposal has been submitted without geotechnical input and where, in the opinion of the Council, such input is required, the Council may direct that such advice is obtained before proceeding further with the proposal.

4.3.2 Design Report

Detail the key achievement criteria in the Design Report for the geotechnical aspects of the engineering design.

Provide the following design records to support the engineering drawings and Design Report, as a minimum:

- The site inspection and evaluation;
- The foundation and stability aspects of the project;
- The extent of further geotechnical engineering services required (including investigation and geological work);
- The methods and frequency of construction control tests to be carried out.

4.3.3 Construction Records

Provide the information detailed in CoP Part 3: *Quality Assurance* and the CCC *Construction Standard Specifications (CSS)*, including where applicable:

- Material specification compliance test results;
- Subgrade test results and corresponding recalculations of metalcourse depths;
- Compaction test results;

4.3.4 Post-Construction Records

Provide the information detailed in CoP Part 3: *Quality Assurance*, Part 12: *As-Builts*, and the CCC *CSS*, including where applicable:

- Design report
- Completion certificates;
- Producer statements – design, construction, construction review
- Completion report, including all test results
- As-built plans and records

4.3.5 Geotechnical Completion Report

For all developments where a geotechnical engineer is engaged, the geotechnical engineer must submit a Geotechnical Completion Report, accompanied by a statement of professional opinion as set out in QP-C813-AA (attached as Appendix A).

The report must identify any specific design requirements that necessitate the building design to deviate from NZS 3604 and NZS 4229. Describe the extent of inspection, the results of testing and include all geotechnical reports prepared for the development.

The professional opinion must indicate the degree of compliance of the development with the design or standards set by the geotechnical engineer.

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

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 met the required Standards, any areas requiring re-testing and areas which did not meet the Standards.

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.

4.3.6 Acceptance Criteria

All basecourse, topsoil and other integral components must be tested before acceptance and/or comply with *CSS*.

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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.

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 Drainage

Identify the existing natural 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 sedimentation control during development.

4.4.2 Slope Stability

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, dispersive soils, swamps or wet ground in elevated positions, plants such as rushes growing down a slope and water seeping from the ground.

4.4.3 Rock Fail Potential

In some circumstances, a potential hazard from rock fall within or beyond the site boundaries may exist. Assess the risk for any proposed development on such sites. Provide:

- Details of source areas of rock fall hazard;
- A full geological description of potential sources of rock;
- Likely rock sizes.

4.4.4 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, potentially causing damage to superimposed structures, roads, services or other structures.

4.4.5 Unsuitable Historical 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.

4.4.6 Contaminated Site

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 the remediation needed to meet the required standards.

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4.4.7 Local Conditions

Consider the range of soil types which exist within the Waimakariri District e.g. expansive soils, volcanic soils, dispersive soils, soft alluvial sediments and compressible soils. Also consider the liquefaction of saturated non-cohesive soils. The Council and Canterbury Regional Council (Environment Canterbury) may have information on the soil types of particular areas.

4.4.8 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 geotechnical engineer must carry this out. *The Role of Peer Review* provides guidance on this process.

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

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4.5 GROUND INVESTIGATIONS

Field-testing shall be undertaken to determine the existing site conditions, subgrade strength, other soil characteristics, ground stability and any other foundation conditions that may exist at the proposed site.

Field testing should include, but not be limited to, the following:

- Benkelman beam tests to determine subgrade or existing pavement strength
- Scala penetrometer subgrade testing to 1m minimum depth below finished subgrade level
- Soil profile logs
- Hand auger tests to 2m minimum depth below finished subgrade level
- Additional tests as required assessing, for example, slope stability and ground water
- Densometer testing

Sufficient borings, probings or open cuts shall be carried out 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.

An indication of the seasonal variation in groundwater levels shall be obtained 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 Soil Data

Obtain soil 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.

Special consideration of erosion potential is required wherever excavation and filling is made in loess soils, because of their highly dispersive properties.

For consistency in the reporting of soils to the Council, use the Soil Description Method in QP-C813-AB (attached as Appendix B) and the *Field Description of Soil and Rock*.

4.5.2 Further Investigation

The soil information thus obtained forms the basis for:

- Further sampling and testing which may be required on representative soil types.
- Relating subsequent soil 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.

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4.5.3 Stability Criteria

When making an assessment of the stability of slopes and earthfills, use accepted criteria and analysis methods. Stability criteria applicable to land development in New Zealand are published or recommended by the New Zealand Geotechnical Society. Refer to *Geotechnical Issues in Land Development*.

4.5.4 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.

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 hazard maps and information on special soil types in the locality if unfamiliar with the area.

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4.6 PLANNING AND DESIGN

4.6.1 Balancing Landform Choices

The final choice of landform is dependent on many factors, which may be specific to the development. These include the:

- Relationship with surrounding landscapes.
- Natural drainage patterns.
- Size of the development.
- Proposed and existing roading patterns.
- Preservation of natural features.
- Enhancement of natural features where compromised by fragmentation or reduction due to the development.
- Stability of the land.
- Function and purpose of the development.
- Potential for flooding, erosion and other natural events.

The order of importance of these factors will vary from project to project.

The final choice of landform must represent the most desirable compromise between the development requirements, the preservation of natural features including the existing soil profile, and the natural quality of the landscape. Preservation aspects include retaining natural watercourses, and excluding any development from natural gullies (refer to the *District Plan*).

4.6.2 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 for guidelines on incorporating waste reduction in your project (www.rebri.org.nz/).

4.6.3 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 drainage conditions and the likely effects on groundwater.
- The previous history of ground movements in similar soils 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.

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4.6.4 Suitability

The choice of a suitable landform is dependent on many factors that may be specific to a particular site. Avoid unnecessary earthworks, aim to protect original soils and drainage patterns and to minimise disturbance, compaction, earthworks and 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 rock fall, slips, subsidence, creep, erosion or settlement.
- To minimise the risk of property damage through flooding, or surface water run-off.
- To lessen tunnel gully erosion within hillside 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.
- To create, where needed, suitably graded areas for playing fields and other community facilities.
- To enhance the general environmental character of the area by softening the landscape or by artificially creating or emphasizing landforms of visual significance, particularly on flat sites or on areas devoid of landscape features.

Note that some hillside developments require soil conservation measures such as plantings and revegetation of areas liable to tunnel gully erosion, sheet erosion, slips and existing stream bank/bed erosion. Refer to the *Soil Conservation Guidelines for the Port Hills* for guidance on erosion prone areas and measures to prevent or control erosion. Refer to CoP Part 10 clause 10.5.2.4 – *Revegetation, Restoration and Connection of Habitats* for an explanation of revegetation.

4.6.5 Seismic Considerations

Consider the seismic effects on earthfills, slopes and liquefiable ground, and take these into account in the design and construction of any development.

4.6.6 Rockfall Hazard Mitigation

Determine possible protection and/or remedial measures to mitigate the assessed risk for any proposed development. Provide results by analysis of bounce height and velocity for typical annual events and 100 year events for the likely rock sizes as assessed in clause 4.4.3 – Rock Fail Potential.

Mitigation could include:

- Catch fences or other forms of protective barriers;
- Benching, bunding, excavation or filling;
- Planting of vegetation.

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Determine the rock energy in kilojoules and demonstrate how the protective barrier will arrest them. Protective barriers must:

- Have a 50 year design life;
- Be accessible for inspection, rock removal and repair;
- Not be compromised where gates or accessways are included;
- Be designed by suitably experienced designers;
- Be and remain effective over their design life.

State the growth time until vegetation is an effective barrier and the vegetation's life expectancy.

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

4.6.7 Peat

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

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4.7 CONSTRUCTION

4.7.1 Underrunners and Springs

In hill catchments, underrunners are often encountered. 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.

4.7.2 Control Testing

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

4.7.3 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, industrial and commercial developments often have specialised requirements for fill materials and compaction.

Set the fill and compaction standards, procedures and methods of determination for the development in these cases. Use NZS 4431 as a basis where appropriate.

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4.8 EROSION, SEDIMENT AND DUST CONTROL

4.8.1 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 CCC *CSS: Part 1*.

4.8.2 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 one week before any works 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.

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).

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The ESCP must comply with the following standards:

- ECan *Erosion and sediment control guidelines*
- ECan *Erosion and sediment control guidelines for small sites*;
- ARC90: *Erosion and sediment control: guidelines for land disturbing activities in the Auckland Region*.

4.8.3 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 CCC *Stormwater treatment devices: design guideline manual*.

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.

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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.

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4.9 AS-BUILT INFORMATION

Prepare as-built records, which comply with CoP Part 12: *As-Builts*. Present the as-built drawings in conjunction with the Geotechnical Completion Report and tabulated results.

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4.10 ASSOCIATED DOCUMENTS

Appendix A Statement of Professional Opinion on the Suitability of Land for Building Construction (QP-C813-AA)

Appendix B WDC Soil Description Method (QP-C813-AB)

Appendix C WDC Soil Log (QP-C813-AC)

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

ISSUED BY: _____
(Engineer)

OF: _____
(Name and address of firm)

TO: _____
(Developer)

TO BE SUPPLIED TO: _____
(Territorial Authority)

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

AT: _____

_____
(Address)

I hereby confirm that:

1. I am a suitably qualified and experienced geotechnical engineer and was retained by the developer as the geotechnical engineer 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 Geotechnical Assessment 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 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 in accordance with the provisions of Section 106 of the Resource Management Act 1991 provided that:

(i) _____

(ii) _____

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

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

4. This professional opinion is furnished to the territorial authority and the 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 certificate shall be read in conjunction with my 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. I / My practice holds professional indemnity insurance in the sum of $ _____ (Minimum amount of insurance shall be commensurate with the current amounts recommended by IPENZ, ACENZ, TNZ, INGENIUM.)

_____ Date: _____

(Signature of engineer)

Qualifications and experience

_____

_____

Soil Description Methods

As:

Moisture		Strength		Colour		Soil Type		Grading		Organics
	+		+		+		+		+	

1. MOISTURE

Moisture		Description
1	Dry	Cohesive soils usually hard or powdery Granular soils run freely through hands
2	Moist	Some moisture present – usually darkens the colour
3	Wet	Strong squeezing in the hand will drive some water out
4	Saturated	Squeezing will drive water out

2. STRENGTH

Cohesive Soil Consistency		Characteristic
1	Very soft	Exudes between figures
2	Soft	Easily moulded by fingers
3	Stiff	Impossible to mould with fingers, but will change shape with heel pressure
4	Very stiff	As for stiff, but considerable heel pressure is required
5	Hard	Brittle, very tough
Non-Cohesive Soil Density		**Characteristic**
6	Very loose	Very easy to excavate by hand
7	Loose	Easy to excavate by hand
8	Medium dense	Between loose and dense
9	Very dense	Very difficult to excavate by hand
0	Cemented	Particles bound together

3. COLOUR

Adjective1	Adjective2	Main Colour
1. Light	1. Pinkish	1. Pink
2. Dark	2. Reddish	2. Red
	3. Yellowish	3. Yellow
	4. Brownish	4. Brown
	5. Olive	5. Olive
	6. Greenish	6. Green
	7. Bluish	7. Blue
	8. Greyish	8. White
		9. Grey
		0. Black

Soil Description Methods

4. SOIL TYPE

Lesser Fraction		Dominant Fraction			Minor Fraction	
20-50% volume		> 50% volume			< 20% volume	
Soil Type Term		Soil Type term	Particle size (mm)	Graphic Symbol	With some	
		0. Boulders	>200		0. Boulders	
1. Coarse	gravelly	1. Coarse*	60-200		1. Coarse	gravel
2. Medium	gravelly	2. Medium	20-60		2. Medium	gravel
3. Fine	gravelly	3. Fine	2-20		3. Fine	gravel
4. Coarse	sandy	4. Coarse	0.6-2.0		4. Coarse	sand
5. Medium	sandy	5. Medium	0.2-0.6		5. Medium	sand
6. Fine	sandy	6. Fine	0.06-0.2		6. Fine	sand
7. Silty		7. Silt	0.002-0.06		7. Silt	
8. Clayey		8. Clay	<0.002		8. Clay	
9. Peaty		9. Peat	N/A		9. Peat	

* also referred to as cobbles

5. SAND/GRAVEL GRADING

1. well graded
2. poorly graded

6. ORGANIC CONTENT

Adjective	Organic Type
1. Trace	1. Fibrous
2. Little	2. Wood pieces
3. Some	3. Root fibres
4. And	4. Vegetation

Soil Log

WAIMAKARIRI DISTRICT COUNCIL

Project: Project No: Bore ID:

Client:

Bore Depth: GL: Recorded by: Date:

Location: WT Depth:

Elevation	Depth	Lithology	Material Description	Soil Code 1	2	3	4	5	6	7	8	9	10	11	Scala Penetrometer (mm/blow) 0	10	20	30	40	50	60	70	80	90	100	Depth
	0																									0
	0.1																									0.1
	0.2																									0.2
	0.3																									0.3
	0.4																									0.4
	0.5																									0.5
	0.6																									0.6
	0.7																									0.7
	0.8																									0.8
	0.9																									0.9
	1																									1
	1.1																									1.1
	1.2																									1.2
	1.3																									1.3
	1.4																									1.4
	1.5																									1.5
	1.6																									1.6
	1.7																									1.7
	1.8																									1.8
	1.9																									1.9
	2																									2
	2.1																									2.1
	2.2																									2.2
	2.3																									2.3
	2.4																									2.4
	2.5																									2.5
	2.6																									2.6
	2.7																									2.7
	2.8			Moisture	Strength		Colour			Soil Type		Grading	Organics													2.8
	2.9																									2.9
	3																									3
									Safe bearing kPa->							250	155	110	80	68	57	50	44	39	36	

Locality Diagram