PART 4: GEOTECHNICAL REQUIREMENTS

CONTENTS

FIGURES

4.1 REFERENCED DOCUMENTS

Planning and Policy

- Resource Management Act (1991) Section 106
- Building Act (2004) Section 36
- Chartered Professional Engineers Act of New Zealand (2002)

Design

- NZS 1170 *Structural Design Actions Set*
- NZS 4431:2022 *Engineered fill for construction of lightweight structures*
- NZS 3604:2011 *Timber-framed buildings*
- New Zealand Transport Agency *Bridge Manual*
- Canterbury Regional Council *Erosion and sediment control toolbox*
- Auckland Regional Council Guideline Document 1, *Stormwater Management Devices in the Auckland Region* (2017)
- Ministry for the Environment *Hazardous Activities and Industries List (HAIL)*
- Ministry for the Environment *Contaminated Land Management Guidelines No. 1 – Reporting on Contaminated Sites in New Zealand* (2011)
- Ministry of Business, Innovation and Employment *Rockfall: Design considerations for passive protection structures.*
- Ministry of Business, Innovation and Employment and New Zealand Geotechnical Society *Earthquake Geotechnical Engineering Practice Series Modules 1 to 6*
- New Zealand Geotechnical Society *Geotechnical Issues in Land Development*, Proceedings of NZ Geotechnical Society Symposium, Hamilton (1996)
- New Zealand Geotechnical Society *NZ Ground Investigation Specification*
- New Zealand Geotechnical Society *Field Description of Soil and Rock* (December 2005)
- New Zealand Geotechnical Society *Application of the New South Wales RMS "A Guide to Slope Risk Analysis" for NZTA Projects*.
- Australian Geomechanics Society Practice Note 2007 (and commentary) *Landslide Risk Management*, Australian Geomechanics Volume 42 No 1 (March 2007) www.australiangeomechanics.org/
- Engineering NZ Practice Notes & Guidelines
- Transport Research Board. *Landslides: Investigation and Mitigation,* Special Report No. 247 National Academy of Sciences. 1996
- Ministry of Business, Innovation and Employment. *Rockfall: Design considerations for passive protection structures.* Oct 2016
- Understanding the potential for Liquefaction in Timaru District
- Timaru District Growth Management Strategy 2017
- Liquefaction Hazard in Timaru District

Construction

- Engineering NZ Construction Monitoring Services

- Ministry of Business, Innovation and Employment *Part D* – *Guidelines for the geotechnical investigation and assessment of subdivisions in the Canterbury Region* Dec 2012

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 4404:2010, 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 suitability and includes:

- site and ground investigations;
- surface and subsurface drainage and erosion control;
- liquefaction (including lateral spreading);
- contaminated sites;
- unsuitable historic fill;
- foundation stability;
- slope stability (including the design of rockfall protection structures); and
- control of earthworks.

The *District Plan* sets out planning rules, which may include the provision of geotechnical and natural hazards requirements.

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 part 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.

As Timaru District does have liquefaction prone areas and is susceptible to tectonic activity, consideration of earthquake effects must be taken into account, particularly in the higher risk areas.

4.2.1 Relevant standards

NZS 4431:2022 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 4.7.3 - Compaction standards for fill material sets out the requirements in these situations.

4.2.2 Statute and 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 applicant's 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:

- 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.

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 or geotechnical engineer, engineering or environmental geologist or a hydrologist. Refer to clause 2.7.1 – Investigation and design (General Requirements) for further information.

The Geoprofessional must possess both suitable insurance policies with a minimum of $1,000,000 of public liability/indemnity coverage and relevant experience.

4.3.2 Requirement for a Geoprofessional

Engage a Geoprofessional or other Suitably Qualified Experienced Practioner to provide geotechnical, soil contaminant and geohydrological expertise where the following issues exist:

- the construction of earthworks associated with any development requires initial planning and design, to ensure that fill, 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 and rock 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 Geoprofessional expertise to assess the project.

4.3.3 Responsibilities of the Geoprofessional

The Geoprofessional will carry out the following functions:

- Undertake a site assessment and any preliminary site evaluation required, including investigations of sub-surface conditions and identifying geotechnical, natural and environmental hazards affecting the land, before the detailed planning of any development. Consider hazards located outside but which may pose a risk to the site. 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 recommendations, natural hazard risk 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 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.

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 landslide (mass movement) hazards, including those resulting from seismic activity.

- An assessment of the slope stability confirming the location and appropriateness of building sites.
- An assessment on drainage of the subject site and disposal of surface water.
- 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 I – Statement of Professional Opinion on the Suitability of Land for Subdivision.

The Ministry of Business, Innovation and Employment's *Part D - Guidelines for the geotechnical investigation and assessment of subdivisions in the Canterbury region* 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 strengthening or piling 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 II – 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.

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 11: 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
- the previous history of rockfalls in the area
- 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
- aerial 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

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

Some natural slopes exist in a state of marginal stability and natural triggers like an earthquake or rainfall event may trigger failure. In addition, 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.

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, 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.

4.4.5 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.

4.4.6 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 or Suitably Qualified and Experience Practitioner for a site evaluation. *Hazardous Activities and Industries List (HAIL)* provides further detail.

Ascertain, at an early stage, the extent of any contamination and gain a reasonably accurate picture of any constraints on earthworks, including excavated material disposal. Refer to *Contaminated Land Management Guidelines* for information on reporting requirements.

4.4.7 Local conditions

Consider the range of soil types which exist within e.g. expansive soils, volcanic soils, dispersive soils, soft alluvial sediments and compressible soils. Note the presence of loess and loess colluvium as these soils have specific slope instability characteristics. The Council and Canterbury Regional Council (Environment Canterbury) may have information on the soil types of particular areas.

4.4.8 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. Refer to Figures 1 and 2 below for identifying areas of potential risk to liquefaction.

Use the Building Code Geotechnical *Guidelines Module 3: Identification, assessment and mitigation of liquefaction hazards* when determining areas at risk of liquefaction.

Use the *Part D - Guidelines for the geotechnical investigation and assessment of subdivisions in the Canterbury region* when reporting on developments on land prone to liquefaction.

Figure 1: Liquefaction potential in Timaru District

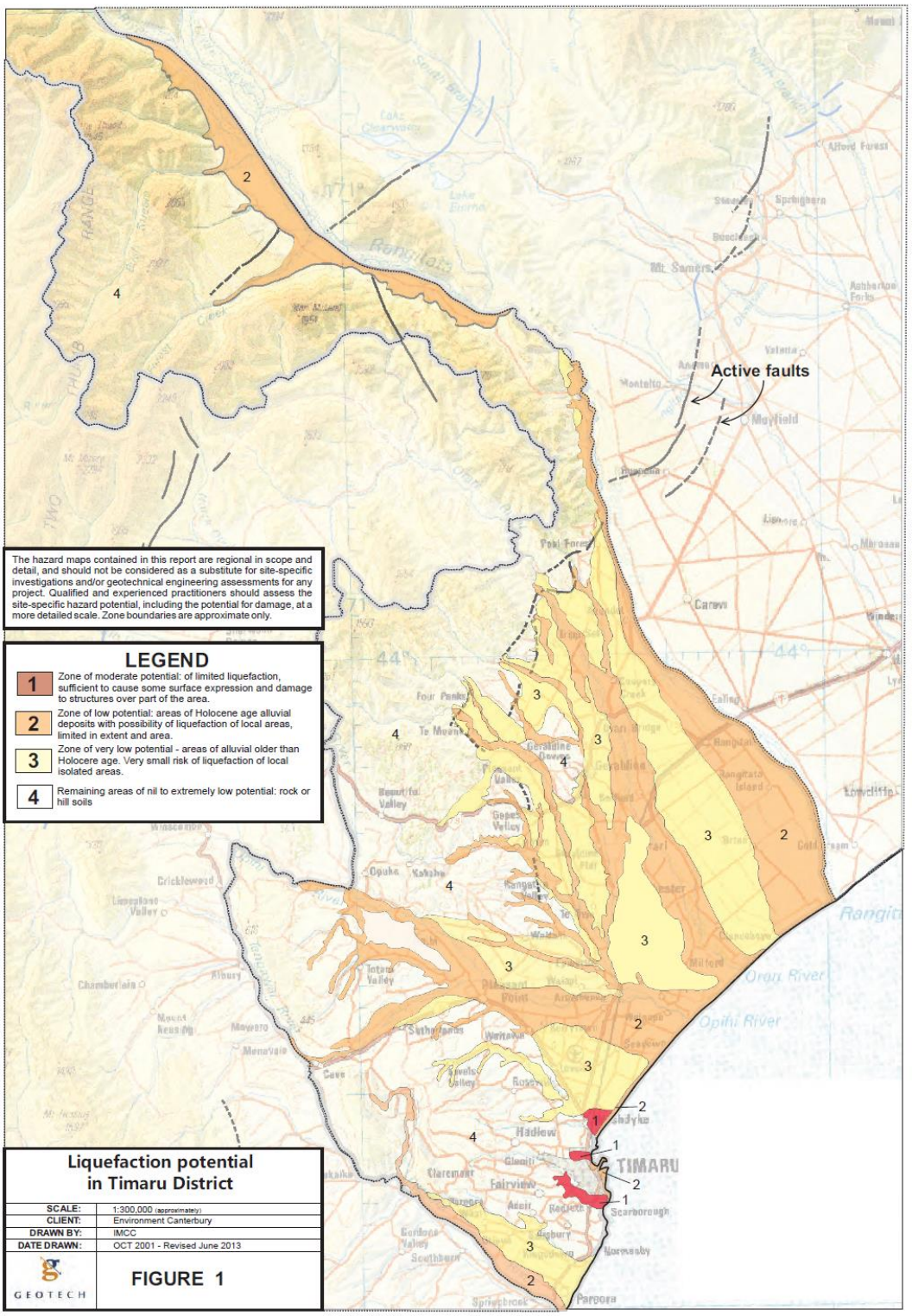
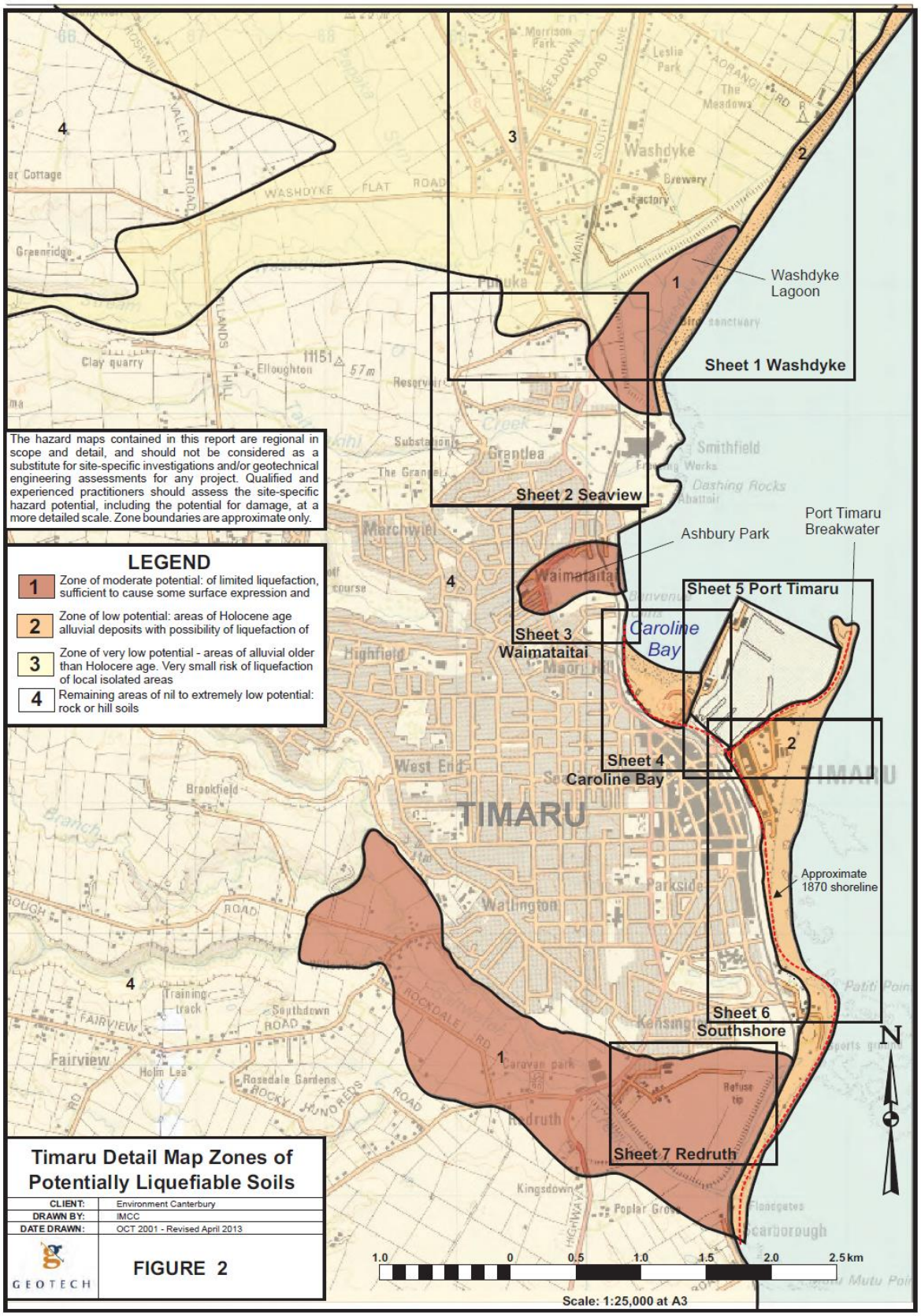


Figure 2: Timaru Detail Map Zones of Potentially Liquefiable Soils



4.4.9 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 an application for Engineering Design Acceptance. 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.

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

For consistency in the reporting of soils to the Council, use the *Field Description of Soil and Rock*. Appendix III provides templates and the necessary details to be supplied in Soil Logs (Figure 3) as well as the details for the Soil Description (Figure 4).

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 through the advice of a Suitably Qualified and Experienced Practitioner. 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.

4.6 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 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.

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.

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 Timaru District Council "*Stormwater Management Guidelines"* 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 CONSTRUCTION

4.7.1 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, following consent received from Council.

4.7.2 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.

4.7.3 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, 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 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 from Timaru District Council and/or Canterbury Regional Council for the project. Refer to these conditions and take into account in the early stages of planning a project.

4.8.2 Site-specific erosion and sediment control plan requirements

For all developments where erosion could result in contaminants and 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. Also refer to the SMG for guidelines as appropriate.

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 drains 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 specific design requirements triggered where dewatering is required;
- 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, Sediment Control Toolbox for Canterbury;*
- Timaru District Consolidated Bylaw 2018 Chapter 15: Water Services Bylaw

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 overland flow paths from discharging water 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 TDC SMG and Environment Canterbury *ESC Toolbox*.

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 Geoprofessional)

TO: …… *(Territorial authority)*

TO BE SUPPLIED TO: ……*(Owner/Developer)*

IN RESPECT OF: …….
(Description of proposed 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 *Part D - Guidelines for the geotechnical investigation and assessment of subdivisions in the Canterbury region* and the Timaru District 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 Management Act 1991.

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 ENGINEERING NEW ZEALAND, ACENZ, NZTA, IPWEA.)

…… 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 ENGINEERING NEW ZEALAND , ACENZ, NZTA, IPWEA.)

…… Date: ……
(Signature of engineer)

Qualifications and experience

……

……

Appendix III. SOIL LOG AND DESCRIPTIONS

Figure 3: Soil Log

Project:		Project No:	Bore ID:
Client:			
Bore Depth:	Ground Level:	Recorded by:	Date:
Location:	WaterTableDepth:		

Elevation	Depth	Symbol	Material Description Soil Type + Colour + Strength + Moisture + Grading + Organics	Scala Penetrometer (mm/blow) 0 10 20 30 40 50 60 70 80 90 100	Depth
	0.0				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
	1.0				1.0
	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
	2.0				2.0
	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				2.8
	2.9				2.9
	3.0				3.0

Locality Diagram	Other Comments:

Figure 4: Soil Descriptions

Soil Descriptions

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

SOIL TYPE

Lesser Fraction		Dominant Fraction				Minor Fraction		
20-50% volume		> 50% volume				12 - 20%	5 - 12%	< 5%
Soil Type Term		Soil Type term		Particle size (mm)	Graphic Symbol	with some	with minor	with trace
		BOULDERS		> 200		boulders		
		COBBLES		60 - 200		cobbles		
Coarse	gravelly	COARSE	GRAVEL	20 - 60		coarse		gravel
Medium	gravelly	MEDIUM	GRAVEL	6 - 20		medium		gravel
Fine	gravelly	FINE	GRAVEL	2 - 6		fine		gravel
Coarse	sandy	COARSE	SAND	0.6 - 2.0		coarse		sand
Medium	sandy	MEDIUM	SAND	0.2 - 0.6		medium		sand
Fine	sandy	FINE	SAND	0.06 - 0.2		fine		sand
Silty		SILT		0.002 - 0.06		silt		
Clayey		CLAY		< 0.002		clay		
Peaty		PEAT		N/A		peat		

COLOUR

Adjective1	*Adjective2*	*Main Colour*
light	pinkish	pink
dark	reddish	red
	yellowish	yellow
	brownish	brown
	olive	olive
	greenish	green
	bluish	blue
	greyish	white
		grey
		black

STRENGTH

Cohesive Soil Consistency

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

Non Cohesive Soil Density

Density	*Characteristic*
very loose	Very easy to excavate by hand
loose	Easy to excavate by hand
medium dense	Between loose and dense
dense	Very difficult to excavate by hand
very dense	Particles bound together

MOISTURE

Moisture	*Description*
dry	Cohesive soils usually hard or powdery Granular soils run freely through hands
moist	Some moisture present – usually darkens the colour
wet	Strong squeezing in the hand will drive some water out
saturated	Squeezing will drive water out

SAND/GRAVEL GRADING

well graded
poorly graded

ORGANIC CONTENT

Adjective	*Organic Type*
trace	fibrous
little	wood pieces
some	root fibres
and	vegetation

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