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REPORT ON GEOTECHNICAL ASSESSMENT

for

PROPOSED NEW RESIDENCE

at

106A WAKEHURST PARKWAY, ELANORA HEIGHTS, NSW

Prepared For

Geoff Davis

Project No.: 2019-207

December, 2019

Document Revision Record

Issue No	Date	Details of Revisions
0	3rd December 2019	Original issue

GEOTECHNICAL RISK MANAGEMENT POLICY FOR PITTWATER

FORM NO. 1 – To be submitted with Development Application

Development Application for ________________________________
Name of Applicant
Address of site ___ _106A Wakehurst Parkway, Elanora Heights

Declaration made by geotechnical engineer or engineering geologist or coastal engineer (where applicable) as part of a geotechnical report

I, ***__Troy Crozier__________*** *on behalf of* ***___Crozier Geotechnical Consultants*** 3rd December 2019 certify that I am a ~~geotechnical engineer or~~ engineering geologist ~~or coastal engineer~~ as defined by the Geotechnical Risk Management Policy for Pittwater - 2009 and I am authorised by the above ~~organisation/~~company to issue this document and to certify that the ~~organisation/~~company has a current professional indemnity policy of at least $2million.

I:

☐ have prepared the detailed Geotechnical Report referenced below in accordance with the Australia Geomechanics Society's Landslide Risk Management Guidelines (AGS 2007) and the Geotechnical Risk Management Policy for Pittwater - 2009

■ am willing to technically verify that the detailed Geotechnical Report referenced below has been prepared in accordance with the Australian Geomechanics Society's Landslide Risk Management Guidelines (AGS 2007) and the Geotechnical Risk Management Policy for Pittwater - 2009

☐ have examined the site and the proposed development in detail and have carried out a risk assessment in accordance with Section 6.0 of the Geotechnical Risk Management Policy for Pittwater - 2009. I confirm that the results of the risk assessment for the proposed development are in compliance with the Geotechnical Risk Management Policy for Pittwater - 2009 and further detailed geotechnical reporting is not required for the subject site.

☐ have examined the site and the proposed development/alteration in detail and I am of the opinion that the Development Application only involves Minor Development/Alteration that does not require a Geotechnical Report or Risk Assessment and hence my Report is in accordance with the Geotechnical Risk Management Policy for Pittwater - 2009 requirements.

☐ have examined the site and the proposed development/alteration is separate from and is not affected by a Geotechnical Hazard and does not require a Geotechnical Report or Risk Assessment and hence my Report is in accordance with the Geotechnical Risk Management Policy for Pittwater - 2009 requirements.

☐ have provided the coastal process and coastal forces analysis for inclusion in the Geotechnical Report

Geotechnical Report Details:

Report Title: Geotechnical Report for Proposed New Residence	
Report Date: 3rd December 2019	**Project No.:** 2019-207
Author: Jun Yan & Troy Crozier	
Author's Company/Organisation: Crozier Geotechnical Consultants	

Documentation which relate to or are relied upon in report preparation:

• Architectural drawing by Thodey Design, Dated: 15/11/2019
• Survey Plan by Geographic Solutions Surveyors, Ref. No.: 3949, Dated: 23/10/2019

I am aware that the above Geotechnical Report, prepared for the abovementioned site is to be submitted in support of a Development Application for this site and will be relied on by Pittwater Council as the basis for ensuring that the Geotechnical Risk Management aspects of the proposed development have been adequately addressed to achieve an "Acceptable Risk Management" level for the life of the structure, taken as at least 100 years unless otherwise stated and justified in the Report and that reasonable and practical measures have been identified to remove foreseeable risk.

Signature ....

Name ...**Troy Crozier**..............................

Chartered Professional Status ...**RPGeo (AIG)**..............................

Membership No.: ...**10197**..............................

Company... **Crozier Geotechnical Consultants**

REGISTERED PROFESSIONAL GEOSCIENTIST
AUSTRALIAN INSTITUTE OF GEOSCIENTISTS
TROY CROZIER
10,197

GEOTECHNICAL RISK MANAGEMENT POLICY FOR PITTWATER

FORM NO. 1(a) - Checklist of Requirements For Geotechnical Risk Management Report for Development Application

Development Application for ____

Name of Applicant

Address of site ___106A Wakehurst Parkway, Elanora Heights _________________

The following checklist covers the minimum requirements to be addressed in a Geotechnical Risk Management Geotechnical Report. This checklist is to accompany the Geotechnical Report and its certification (Form No. 1).

Geotechnical Report Details:

Report Title: Geotechnical Report for Proposed New Residence
Report Date: 3rd December 2019 **Project No.:** 2019-207
Author: Jun Yan & Troy Crozier
Author's Company/Organisation: Crozier Geotechnical Consultants

Please mark appropriate box

■ Comprehensive site mapping conducted ____22nd November 2019___________
(date)
■ Mapping details presented on contoured site plan with geomorphic mapping to a minimum scale of 1:200 (as appropriate)
☐ Subsurface investigation required
- ■ No Justification ……………..
- ☐ Yes Date conducted ………………………………………………

☐ Geotechnical model developed and reported as an inferred subsurface type-section
■ Geotechnical hazards identified
- ☐ Above the site
- ■ On the site
- ☐ Below the site
- ☐ Beside the site

■ Geotechnical hazards described and reported
■ Risk assessment conducted in accordance with the Geotechnical Risk Management Policy for Pittwater - 2009
- ■ Consequence analysis
- ■ Frequency analysis

■ Risk calculation
■ Risk assessment for property conducted in accordance with the Geotechnical Risk Management Policy for Pittwater - 2009
■ Risk assessment for loss of life conducted in accordance with the Geotechnical Risk Management Policy for Pittwater - 2009
■ Assessed risks have been compared to "Acceptable Risk Management" criteria as defined in the Geotechnical Risk Management Policy for Pittwater - 2009
■ Opinion has been provided that the design can achieve the "Acceptable Risk Management" criteria provided that the specified conditions are achieved.
■ Design Life Adopted:
- ■ 100 years
- ☐ Other ………………………
specify

☐ Geotechnical Conditions to be applied to all four phases as described in the Geotechnical Risk Management Policy for Pittwater - 2009 have been specified
■ Additional action to remove risk where reasonable and practical have been identified and included in the report.
☐ Risk assessment within Bushfire Asset Protection Zone.

I am aware that Pittwater Council will rely on the Geotechnical Report, to which this checklist applies, as the basis for ensuring that the geotechnical risk management aspects of the proposal have been adequately addressed to achieve an "Acceptable Risk Management" level for the life of the structure, taken as at least 100 years unless otherwise stated and justified in the Report and that reasonable and practical measures have been identified to remove foreseeable risk.

Signature ……………………………………………………

Name …**Troy Crozier**……………………………………

Chartered Professional Status: **RPGeo (AIG)**……………

Membership No. …**10197**……………………………

Company… **Crozier Geotechnical Consultants**

CROZIER
GEOTECHNICAL CONSULTANTS

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APPENDICES

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GEOTECHNICAL REPORT FOR PROPOSED NEW RESIDENCE
106A WAKEHURST PARKWAY, ELANORA HEIGHTS, NSW

1. INTRODUCTION:

This report details the results of a geotechnical assessment carried out for a proposed new residence at 106A Wakehurst Parkway, Elanora Heights, NSW. The assessment was undertaken by Crozier Geotechnical Consultants (CGC) at the request of the client Geoff Davis.

Reference to Pittwater Councilôs LEP 2014 Geotechnical Risk Management Map (GTH_016), the site has been classified as being partly within the H1 (highest category) landslip hazard zone therefore the site requires a Geotechnical Landslip Risk Assessment to be conducted in support of a Development Application. This report therefore includes a detailed description of the field work, assessment of proposed works, site specific risk assessment where landslip hazards are identified and recommendations for construction to maintain the óAcceptable Risk Managementô criteria.

The investigation and reporting were undertaken as per the Tender P19-448, Dated: 19th November 2019.

The investigation comprised:

a) A detailed geotechnical inspection and mapping of the site and adjacent properties by a Geotechnical Engineer.
b) Review of Ortho Photomaps and Aerial Photography of the site.

The following plans and diagrams were supplied for the work:

- Architectural drawing by Thodey Design, unreferenced drawings, Revision: B, Dated: 15/11/2019.
- Survey Plan by Geographic Solutions Surveyors, Ref. No.: 3949, Dated: 23/10/2019.
- Geotechnical Advice by JK Geotechnics, Ref No. 18498ZRlet10, Dated: 11 January 2018.

1.1. Proposed Development:

It is understood that the proposed works involve the construction of a two and three storey residential house with plunge pool and deck to the rear. The new house will be constructed partially into the existing slope which will require excavations up to 2.50m depth for the garage and pool. The excavations will extend to within 1.0m of the east and west boundaries.

2. SITE FEATURES:

2.1. Description:

The property is a rectangular shaped block located on the high north side of Wakehurst Parkway with Right of Access along the east side of the property to the south (No. 106). It has a front south boundary of 15.2m, side west boundary of 75.5m and side east boundary of 77.2m as referenced from the provided survey plan. The rear north boundary was not included in the survey plan.

An aerial photograph of the site and its surrounds is provided below, as sourced from NSW Government Six Map spatial data, as Photograph 1.

Photograph: 1 – Aerial photo of site and surrounds

2.2. Geology:

Reference to the Sydney 1:100,000 Geological Series sheet (9130) indicates that the site is located at the boundary of Hawkesbury Sandstone (Rh) and Newport Formation (Rnn) rocks. The rock unit of Hawkesbury Sandstone which is of Triassic Age typically comprises medium to coarse grained quartz sandstone with minor lenses of shale and laminite. The Newport Formation rocks which are of middle Triassic Age typically comprise interbedded laminite, shale and quartz to lithic quartz sandstones and pink clay pellet sandstones. Sandstone was identified in cliff/outcrop and boulders within the site and adjacent properties.

3. FIELD WORK:

3.1. Methods:

The field work comprised a walk over inspection and mapping of the site and adjacent properties on the 22nd November 2019 by a Geotechnical Engineer. It included a photographic record of the site conditions as well as geological/geomorphological mapping of the site and adjacent land with examination of bedrock and boulder outcrops, soil slopes and neighbouring properties.

3.2. Field Observations:

The site is situated at the high north side of Wakehurst Parkway. It contains an east striking outcropping sandstone cliff approximately 20m in height across the middle of the block. The site was inspected from the front boundary to the cliff face with the top of the cliff not accessible.

The front of the site contains a concrete driveway leading to a flat parking area which were excavated into the slope to the north. The excavated slope was retained by a concrete block retaining wall up to 1.70m in height to the north of the concrete driveway, whilst a steep batter slope (>70º) was formed to the north of the flat area across the western half. From the batter surface, it appears the slope is underlain by colluvium comprised of gravelly sand with cobbles and boulders.

The rest of the site up to the base of the cliff contains a steep (-26º) south dipping slope with sandstone boulders and outcrops across the slope.

Most of the boulders are buried in soil and are generally stable at present. However, it was identified that Boulder 1 and Boulder 2 as shown in Photograph 2 and 3 below and marked in Figure 1 appeared situated on top of other boulders along defects of >30º. Therefore, these boulders are prone to instability when the foundation is disturbed or under extreme weather conditions.

The cliff line at the middle of the property comprised detached sections/boulders directly overlying the bedrock and other boulders. It appears that these boulders have not recently moved and are situated on sub-horizontal bedding defects. A column of detached boulders at the front of the cliff face have been previously stabilised as shown in Photograph 4 below. A few boulders were identified at the cliff crest and were overhanging..

Photograph: 2 – Boulder 1 situated along unfavourable defect, facing east

Photograph: 3 – Boulder 2 situated along unfavourable defect, facing west

Photograph: 4 – A column of detached rock sections bolted, facing north

The neighbouring properties to the west and east (No. 1 Elanora Road and No. 104A Wakehurst Parkway) contain blocks of vacant land similar to the site. The cliff line and slope at the base extend through the properties with the blocks having a similar ground level along the common boundary and a similar topography.

The neighbouring property to the south (No. 106) contains a one storey clad cottage located at the centre of the property. The structure appears in a good condition with no signs of significant cracking or settlement on the external walls. The property is at a similar ground level as the site along the common boundary with the remainder of the block located in gently south dipping topography. The structure is located within 17.0m of the common boundary.

4. COMMENTS:

4.1. Geotechnical Assessment:

The inspection and assessment identified a steep south dipping slope within the south half of the site with an east striking cliff located at the centre of the site. Several boulders were identified buried across the soil slope, whilst detached sections/boulders were identified along the edge of the cliff and above the cliff crest. A column of detached rock sections was identified that has been previously stabilised. No obvious surface stormwater flow or excess seepage/wet areas were identified.

It is understood that the proposed works involve the construction of a two and three storey residential house with plunge pool and deck to the rear. The new house will be constructed partially into the existing slope which will require excavations up to 2.50m depth for the garage and pool. The excavations will extend to within 1.0m of the east and west boundaries.

The excavation is expected to intersect sandy colluvial soils and potential residual soils only. As such, safe batter slopes may not be achievable along the east side of the excavation. Where safe batters cannot be constructed, support prior to excavation will be required to maintain boundary stability as per Section 177 of the NSW Conveyancing Act ï 1919. However, at the time of reporting the adjacent properties did not contain structures within the influence zone of the proposed excavation.

The boulders buried across the soil slope are likely creeping with soil. Excavation adjacent to these boulders is likely to disturb and cause instability of the boulders. Therefore, monitoring and stabilising or removal of the boulders adjacent to the proposed excavations are recommended.

Within the slope, boulders directly overlying other boulders along unfavourable defects were identified and are considered relatively unstable. Stabilising measures or the removal of these boulders are recommended, whilst stabilising measures to other boulders can be determined based on the proposed development design. All footings are recommended to be founded to bedrock. As such, a geotechnical investigation is required to confirm bedrock levels.

A soft landscaping space is proposed above the largest boulder in the middle of the slope. This boulder can be utilized as footing. However, it will be very difficult to confirm the entire founding condition for any boulder and therefore there is a potential risk related boulder settlement or movement under footing loads. Lower footing loads and flexible structures will reduce but not eliminate this risk. Footings founded on the boulders should be geotechnically inspected at mark-out and initial excavation to assess the need to move or alter the footing layout.

A column of detached boulders at the front of the cliff have been previously stabilised. It is understood that the permanent stabilisation measures were undertaken from 19 April 2006 to 8 January 2008 and have been certified by JK Geotechnics (letter dated 11th January, 2018). The stabilisation measures involved underpinning the base of the rock column, installing rock bolts to ópinô the column of rock to the cliff face, infilling of lightweight backfill at the rear of the top of the column and installing of rock bolts to secure two unstable floaters at the cliff crest. Considering design life of the new development along with the risk levels related to further movement/rotation of the column, assessments of the bolts at a 20-year interval from installation are recommended. This should be undertaken by a specialist contractor that assesses bolt integrity and load capacity.

It is recommended that loose soils and unstable boulders be removed in the area of the proposed development prior to a more detailed inspection. Unstable boulders within a 1.0V:1.5H influence zone of excavation are recommended to be removed or secured by way of rock bolts and/or grout underpinning prior to any excavation on site. This will help to prevent potential movement both during and after excavation works. It is also recommended that further investigation be undertaken to confirm subsurface condition and depth to bedrock. All new footings should be inspected by a geotechnical professional.

The recommendations and conclusions in this report are based on a walkover inspection and mapping. The results of the assessment provide a reasonable basis for the Development Application analysis and subsequent preliminary design of the proposed works.

4.2. Slope Stability & Risk Assessment:

Based on our assessment we have identified the following credible geological/geotechnical hazard which needs to be considered in relation to the existing site and the proposed works. The hazards are:

A. Collapse (Rocktopple <$30m^3$) of detached sections/boulders on cliff face due to rock bolt failure
B. Landslip (Rockslide/topple <$10m^3$) of boulder due to disturbance
C. Landslip (Soil <$3m^3$) of earth around perimeter of excavation for proposed excavation for garage and pool

A qualitative assessment of risk to life and property related to this hazard is presented in Table A and B, Appendix: 3, and is based on methods outlined in Appendix: C of the Australian Geomechanics Society (AGS) Guidelines for Landslide Risk Management 2007. AGS terms and their descriptions are provided in Appendix: 4.

The **Risk to Life** from **Hazard A**, **B** and **C** was estimated to be up to **1.88×10^{-4}** for a single person, whilst the **Risk to Property** was considered to be **'Very High'** from **Hazard A**.

Although the óVery Highô Risk to Property for Hazard A is considered to be óUnacceptableô, the assessments were based on excavations with no support or planning and the existing bolted column remaining unchecked until bolt failure following house construction. Provided the recommendations of this report are implemented including regular detailed geotechnical mapping of the excavation and installation of determined support systems in timely manner the likelihood of any failure becomes óRareô and as such the consequences reduce and risk becomes within óAcceptableô levels when assessed against the criteria of the AGS. As such the project is considered suitable for the site provided the recommendations of this report are implemented.

4.3. Design Life of Future Development:

We have interpreted the design life requirements specified within Councils Risk Management Policy to refer to structural elements designed to support the adjacent slope, control stormwater and maintain the risk of instability within óAcceptableô limits. Specific structures and features that may affect the maintenance and stability of the site in relation to the proposed development are considered to comprise:

- stormwater and subsoil drainage systems,
- retaining walls and soil slope erosion and instability,
- maintenance of trees/vegetation on this and adjacent properties,

Man-made features should be designed and maintained for a design life consistent with surrounding structures (as per AS2870 ï 2011 (50 years)). In order to attain an ñAcceptable Risk Management Criteriaò for a design life of 100 years as detailed by the Councils Risk Management Policy, it will be necessary for the property owner to adopt and implement a maintenance and inspection program. It is considered that the existing house will have a design life of 50 years from its upgrade following the proposed works.

If a maintenance and inspection schedule are not implemented the ñAcceptableò risk levels for the design life of the property may not be attained. A recommended program is given in Table: 1 below and should also include the following guidelines:

- The conditions on the block donôt change from those present at the time this report was prepared, except for the changes due to new development.
- There is no change to the property due to an extraordinary event external to this site, and the property is maintained in good order and in accordance with the guidelines set out in;
  a) CSIRO sheet BTF 18
  b) Australian Geomechanics ñLandslide Risk Managementò Volume 42, March 2007.
  c) AS 2870 ï 2011, Australian Standard for Residential Slabs and Footings

Table 1: Recommended Maintenance and Inspection Program for Future Developments

Structure	**Maintenance/ Inspection Item**	**Frequency**
Stormwater Drains.	Owner to inspect to ensure that the drains and pipes are free of debris & sediment build-up. Clear surface grates and litter.	Every year or following each major rainfall event
Retaining Walls or remedial measures	Owner to inspect walls for deviation from as constructed condition or for excess deterioration/rotation or signs of soil settlement/erosion or significant cracking adjacent to crest.	Every two years or following major rainfall events.
Large Trees on or adjacent to site	Arbourist to check condition of trees and remove branches and dead trees as required	Every five years
Rock Bolts	Specialist contractor that assesses bolt integrity and load capacity	Every twenty years (from bolt installation)

N.B. Provided the above schedule is maintained the design life of the property should conform AS2870 and Councils 100 years stability criteria

Where changes to site conditions are identified during the maintenance and inspection program, reference should be made to relevant professionals (e.g. structural engineer, geotechnical engineer or Council). It is assumed that Pittwater Council will control development on neighbouring properties, carry out regular inspections and maintenance of the road verge, stormwater systems and large trees on public land adjacent to the site so as to ensure that stability conditions do not deteriorate with potential increase in risk level to the site. Also individual Government Departments will maintain public utilities in the form of power lines, water and sewer mains to ensure they donꞌt leak and increase either the local groundwater levels or landslide potential.

5. CONCLUSION:

The inspection and assessment identified boulders within the steep slope at the front of the site pose a landslide hazard to the proposed excavation. Stabilising measures or the removal of these boulders is recommended to ensure stability during and after excavation.

It is understood that permanent stabilisation measurements were undertaken 11 years ago to secure a column of detached rock sections on the cliff face. Considering design life of the new development and risks related to collapse of the rock column, assessments of the bolts integrity are required at a 20-year interval.

It is understood that the proposed works involve the construction of a two and three storey residential house with plunge pool and deck to the rear. The new house will be constructed partially into the existing slope which will require excavations up to 2.50m depth for the garage and pool. The excavations will extend to within 1.0m of the east and west boundaries.

Based on the separation distance between the proposed excavation and boundaries, support measures may be required along the east boundary to maintain stability.

It is expected that the site is underlain by colluvium. However, an investigation is required to assess bedrock levels and to provide retention parameters. All footings are recommended to be founded to bedrock to avoid settlement and/or creep movement. All footings should be inspected by an experienced geotechnical professional before concrete or steel are placed to verify their bearing capacity and the in-situ nature of the founding strata.

Provided the recommendations of this report are implemented in the design and construction phases of the development, it is considered that the works can be carried out with negligible impact to the site and neighbouring properties and as such are considered suitable for the site.

It is considered that the site will meet the óAcceptableô risk management criteria for the design life of the development taken as 100 years from the proposed works provided the property is maintained as per the recommendations of this report.

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Geotechnical Engineer

Reviewed By:
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6.0. REFERENCES:

1. Australian Geomechanics Society 2007, ñLandslide Risk Assessment and Managementò, Australian Geomechanics Journal Vol 42, No 1, March 2007.
2. Geotechnical Risk Management Policy for Pittwater, 2009.

Appendix 1

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NOTES RELATING TO THIS REPORT

Introduction

These notes have been provided to amplify the geotechnical report in regard to classification methods, specialist field procedures and certain matters relating to the Discussion and Comments section. Not all, of course, are necessarily relevant to all reports.

Geotechnical reports are based on information gained from limited subsurface test boring and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Description and classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726, Geotechnical Site Investigation Code. In general, descriptions cover the following properties - strength or density, colour, structure, soil or rock type and inclusions.

Soil types are described according to the predominating particle size, qualified by the grading of other particles present (eg. Sandy clay) on the following bases:

Soil Classification	Particle Size
Clay	less than 0.002 mm
Silt	0.002 to 0.06 mm
Sand	0.06 to 2.00 mm
Gravel	2.00 to 60.00mm

Cohesive soils are classified on the basis of strength either by laboratory testing or engineering examination. The strength terms are defined as follows:

Classification	Undrained Shear Strength kPa
Very soft	Less than 12
Soft	12 - 25
Firm	25 – 50
Stiff	50 – 100
Very stiff	100 - 200
Hard	Greater than 200

Non-cohesive soils are classified on the basis of relative density, generally from the results of standard penetration tests (SPT) or Dutch cone penetrometer tests (CPT) as below:

Relative Density	SPT “N” Value (blows/300mm)	CPT Cone Value (Qc – MPa)
Very loose	less than 5	less than 2
Loose	5 – 10	2 – 5
Medium dense	10 – 30	5 -15
Dense	30 – 50	15 – 25
Very dense	greater than 50	greater than 25

Rock types are classified by their geological names. Where relevant, further information regarding rock classification is given on the following sheet.

Sampling

Sampling is carried out during drilling to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling to allow information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Drilling Methods

The following is a brief summary of drilling methods currently adopted by the company and some comments on their use and application.

Test Pits – these are excavated with a backhoe or a tracked excavator, allowing close examination of the insitu soils if it is safe to descent into the pit. The depth of penetration is limited to about 3m for a backhoe and up to 6m for an excavator. A potential disadvantage is the disturbance caused by the excavation.

Large Diameter Auger (eg. Pengo) – the hole is advanced by a rotating plate or short spiral auger, generally 300mm or larger in diameter. The cuttings are returned to the surface at intervals (generally of not more than 0.5m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube sampling.

Continuous Sample Drilling – the hole is advanced by pushing a 100mm diameter socket into the ground and withdrawing it at intervals to extrude the sample. This is the most reliable method of drilling soils, since moisture content is unchanged and soil structure, strength, etc. is only marginally affected.

Continuous Spiral Flight Augers – the hole is advanced using 90 – 115mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or insitu testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are very disturbed and may be contaminated. Information from the drilling (as distinct from specific sampling by SPT's or undisturbed samples) is of relatively lower reliability, due to remoulding, contamination or softening of samples by ground water.

Non-core Rotary Drilling - the hole is advanced by a rotary bit, with water being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from 'feel' and rate of penetration.

Rotary Mud Drilling – similar to rotary drilling, but using drilling mud as a circulating fluid. The mud tends to mask the cuttings and reliable identification is again only possible from separate intact sampling (eg. From SPT).

Continuous Core Drilling – a continuous core sample is obtained using a diamond-tipped core barrel, usually 50mm internal diameter. Provided full core recovery is achieved (which is not always possible in very weak rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation.

Standard Penetration Tests

Standard penetration tests (abbreviated as SPT) are used mainly in non-cohesive soils, but occasionally also in cohesive soils as a means of determining density or strength and also of obtaining a relatively undisturbed sample. The test procedures is described in Australian Standard 1289, "Methods of Testing Soils for Engineering Purposes" – Test 6.3.1.

The test is carried out in a borehole by driving a 50mm diameter split sample tube under the impact of a 63kg hammer with a free fall of 760mm. It is normal for the tube to be driven in three successive 150mm increments and the 'N' value is taken as the number of blows for the last 300mm. In dense sands, very hard clays or weak rock, the full 450mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150mm of say 4, 6 and 7 as 4, 6, 7 then N = 13
- In the case where the test is discontinued short of full penetration, say after 15 blows for the first 150mm and 30 blows for the next 40mm then as 15, 30/40mm.

The results of the test can be related empirically to the engineering properties of the soil. Occasionally, the test method is used to obtain samples in 50mm diameter thin wall sample tubes in clay. In such circumstances, the test results are shown on the borelogs in brackets.

Cone Penetrometer Testing and Interpretation

Cone penetrometer testing (sometimes referred to as Dutch Cone – abbreviated as CPT) described in this report has been carried out using an electrical friction cone penetrometer. The test is described in Australia Standard 1289, Test 6.4.1.

In tests, a 35mm diameter rod with a cone-tipped end is pushed continually into the soil, the reaction being provided by a specially designed truck or rig which is fitted with an hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the friction resistance on a separte 130mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are connected buy electrical wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck.

As penetration occurs (at a rate of approximately 20mm per second) their information is plotted on a computer screen and at the end of the test is stored on the computer for later plotting of the results.

The information provided on the plotted results comprises: -

- Cone resistance – the actual end bearing force divided by the cross-sectional area of the cone – expressed in MPa.
- Sleeve friction – the frictional force on the sleeve divided by the surface area – expressed in kPa.
- Friction ratio - the ratio of sleeve friction to cone resistance, expressed in percent.

There are two scales available for measurement of cone resistance. The lower scale (0 – 5 MPa) is used in very soft soils where increased sensitivity is required and is shown in the graphs as a dotted line. The main scale (0 – 50 MPa) is less sensitive and is shown as a full line. The ratios of the sleeve friction to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios 1% - 2% are commonly encountered in sands and very soft clays rising to 4% - 10% in stiff clays.

In sands, the relationship between cone resistance and SPT value is commonly in the range: -

Q_c (MPa) = (0.4 to 0.6) N blows (blows per 300mm)

In clays, the relationship between undrained shear strength and cone resistance is commonly in the range: -

Q_c = (12 to 18) C_u

Interpretation of CPT values can also be made to allow estimation of modulus or compressibility values to allow calculations of foundation settlements.

Inferred stratification as shown on the attached reports is assessed from the cone and friction traces and from experience and information from nearby boreholes, etc. This information is presented for general guidance, but must be regarded as being to some extent interpretive. The test method provides a continuous profile of engineering properties, and where precise information on soil classification is required, direct drilling and sampling may be preferable.

Dynamic Penetrometers

Dynamic penetrometer tests are carried out by driving a rod into the ground with a falling weight hammer and measuring the blows for successive 150mm increments of penetration. Normally, there is a depth limitation of 1.2m but this may be extended in certain conditions by the use of extension rods.

Two relatively similar tests are used.

- Perth sand penetrometer – a 16mm diameter flattened rod is driven with a 9kg hammer, dropping 600mm (AS1289, Test 6.3.3). The test was developed for testing the density of sands (originating in Perth) and is mainly used in granular soils and filling.
- Cone penetrometer (sometimes known as Scala Penetrometer) – a 16mm rod with a 20mm diameter cone end is driven with a 9kg hammer dropping 510mm (AS 1289, Test 6.3.2). The test was developed initially for pavement sub-grade investigations, and published correlations of the test results with California bearing ratio have been published by various Road Authorities.

Laboratory Testing

Laboratory testing is generally carried out in accordance with Australian Standard 1289 "Methods of Testing Soil for Engineering Purposes". Details of the test procedure used are given on the individual report forms.

Borehole Logs

The bore logs presented herein are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable, or possible to justify on economic grounds. In any case, the boreholes represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes, the frequency of sampling and the possibility of other than 'straight line' variations between the boreholes.

Details of the type and method of sampling are given in the report and the following sample codes are on the borehole logs where applicable:

D	Disturbed Sample	E	Environmental sample	DT	Diatube
B	Bulk Sample	PP	Pocket Penetrometer Test		
U50	50mm Undisturbed Tube Sample	SPT	Standard Penetration Test		
U63	63mm " " " " "	C	Core		

Ground Water

Where ground water levels are measured in boreholes there are several potential problems:

- In low permeability soils, ground water although present, may enter the hole slowly or perhaps not at all during the time it is left open.
- A localised perched water table may lead to an erroneous indication of the true water table.
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report.
- The use of water or mud as a drilling fluid will mask any ground water inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water observations are to be made. More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be interference from a perched water table.

Engineering Reports

Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal (eg. A three-storey building), the information and interpretation may not be relevant if the design proposal is changed (eg. to a twenty-storey building). If this happens, the Company will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface condition, discussion of geotechnical aspects and recommendations or suggestions for design and construction. However, the Company cannot always anticipate or assume responsibility for:

- unexpected variations in ground conditions – the potential for this will depend partly on bore spacing and sampling frequency,
- changes in policy or interpretation of policy by statutory authorities,
- the actions of contractors responding to commercial pressures,

If these occur, the Company will be pleased to assist with investigation or advice to resolve the matter.

Site Anomalies

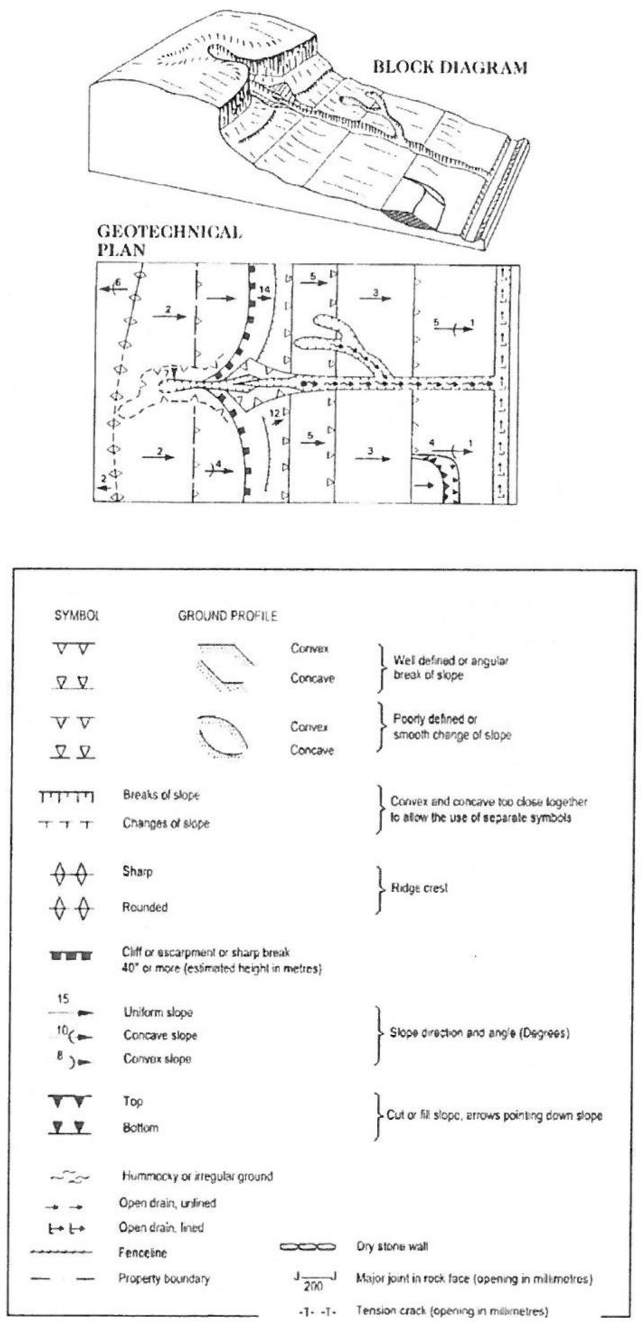
In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, the Company requests that it immediately be notified. Most problems are much more readily resolved when conditions are exposed than at some later stage, well after the event.

Reproduction of Information for Contractual Purposes

Attention is drawn to the document "Guidelines for the Provision of Geotechnical Information in Tender Documents", published by the Institution of Engineers Australia. Where information obtained from this investigation is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a special ally edited document. The Company would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

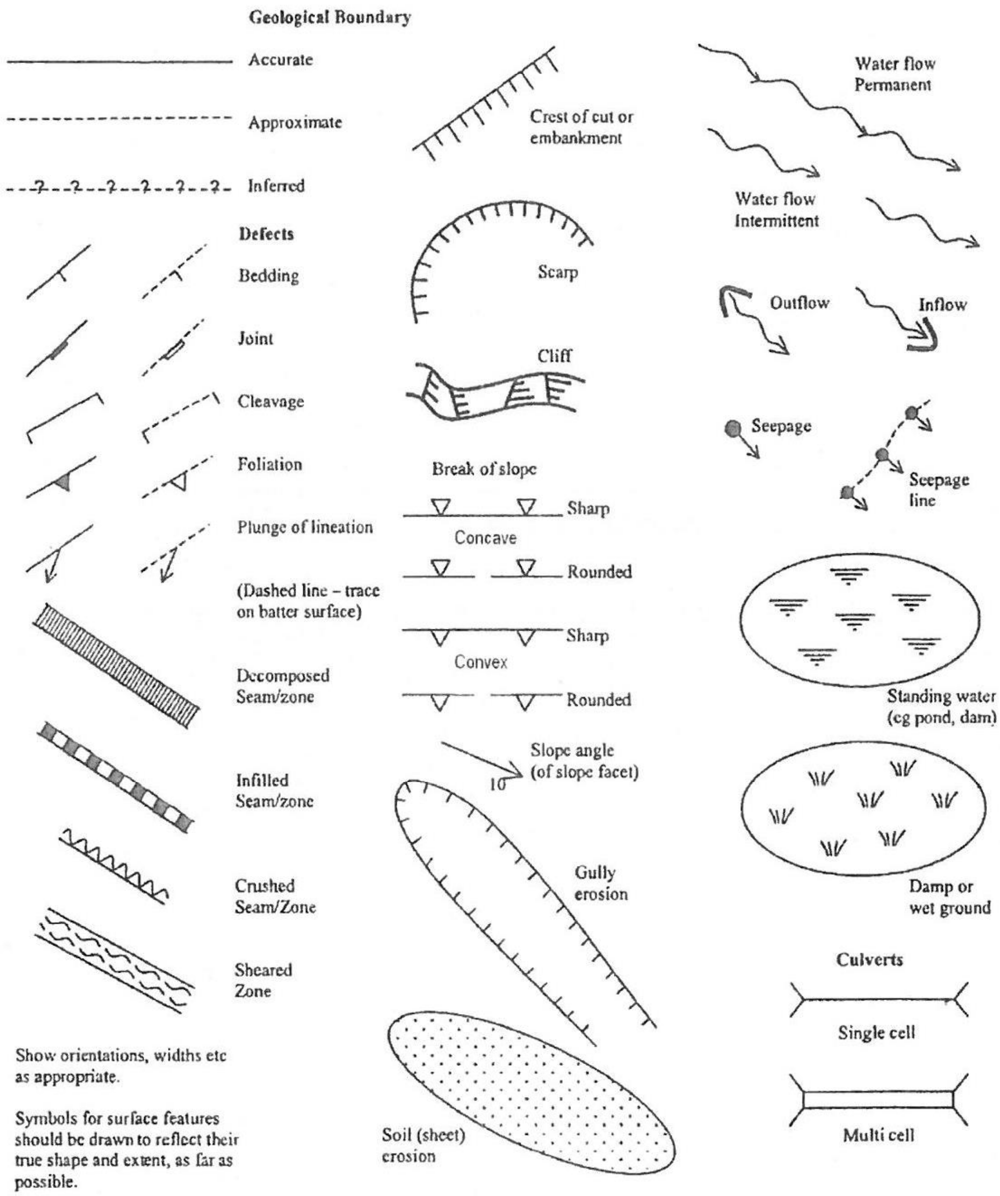
Site Inspection

The Company will always be pleased to provide engineering inspection services for geotechnical aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.



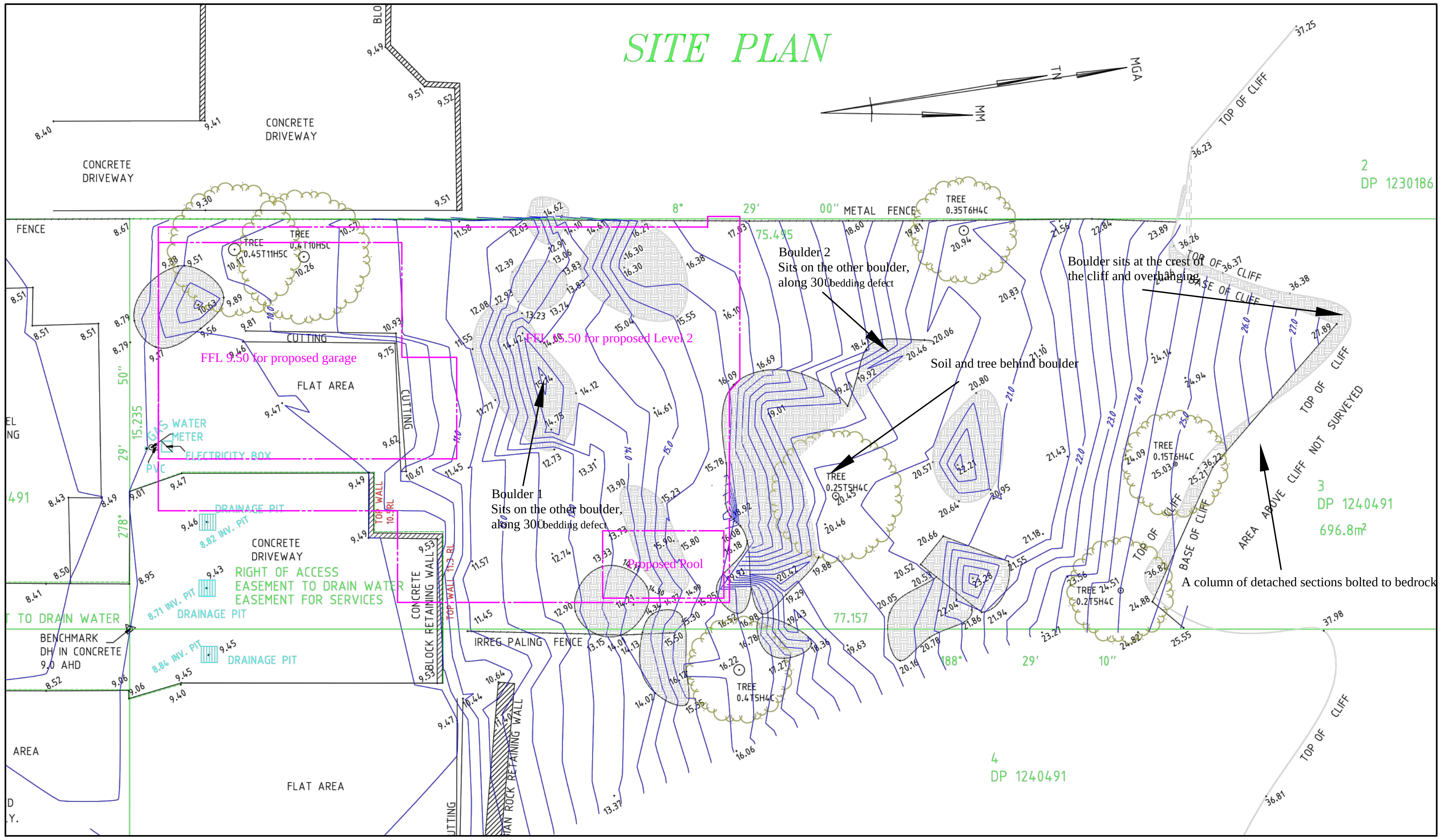
Example of Mapping Symbols
(after V Gardiner & R V Dackombe (1983).Geomorphological Field Manual. George Allen & Unwin).

APPENDIX E - GEOLOGICAL AND GEOMORPHOLOGICAL MAPPING SYMBOLS AND TERMINOLOGY



Examples of Mapping Symbols (after Guide to Slope Risk Analysis Version 3.1 November 2001, Roads and Traffic Authority of New South Wales).

Appendix 2



0 1 2 3 4 5 6 7 8 9 10

SCALE: 1:200

VL - Very Loose	VS - Very Soft	ELS - Extremely Low Strength	EW - Extremely Weathered	fg - Fine Grained
L - Loose	S - Soft	VLS - Very Low Strength	HW - Highly Weathered	mg - Medium Grained
MD - Medium Dense	F - Firm	LS - Low Strength	DW - Distinctly Weathered	cg - Coarse Grained
D - Dense	St - Stiff	MS - Medium Strength	MW - Moderately Weathered	MAS - Massive
VD - Very Dense	VSt - Very Stiff	HS - High Strength	SW - Slightly Weathered	BD - Bedded
	H - Hard	VHS - Very High Strength	FR - Fresh	OC - Outcrop

SITE PLAN & TEST LOCATIONS FIGURE 1.

CROZIER
GEOTECHNICAL CONSULTANTS

Crozier Geotechnical ABN: 96 113 453 624
Unit 12, 42-46 Wattle Road Phone: (02) 9939 1882
Brookvale NSW 2100 Fax: (02) 9939 1883
Crozier Geotechnical is a division of PJC Geo-Engineering Pty Ltd

LEGEND

SCALE: 1:200 @ A3
DRAWING: FIGURE 1
DATE: 02/12/2019

PREPARED FOR:
Rick Davis Contracting

APPROVED BY: TMC
DRAWN BY: JY
PROJECT: 2019-207

ADDRESS:
106A Wakehurst Parkway, Elanora Heights

CROZIER
GEOTECHNICAL CONSULTANTS

Appendix 3

TABLE : A

Landslide risk assessment for Risk to life

HAZARD	Description	Impacting	Likelihood of Slide	Spatial Impact of Slide		Occupancy	Evacuation	Vulnerability	Risk to Life
A	Collapse (Rockslide <30m³) of detached sections/boulders on cliff face due to rock bolt failure		Rock bolts installed over 30 years ago, design life of furture development is 100 years	a) 30m steep slope between the base of cliff and future house b) 60m between the neighbouring house and the base of cliff		a) Person in house 10hrs/day avge b) Person in house 10hrs/day avge	a) Almost Certain to not evacuate b) Almost Certain to not evacuate	a) Person in building, crushed b) Person in building, crushed	
			Possible	**Prob. of Impact**	**Impacted**				
		a) future site house	0.001	0.60	0.75	0.4167	1	1.00	**1.88E-04**
		b) neighbouring house (No. 106 Wakehurst Parkway)	0.001	0.30	0.75	0.4167	1	1.00	**9.38E-05**
B	Landslip (Rockslide/topple <10m³) of boulder due to distubance		a)Boulder situated within 0.7m of proposed excavation b) Boulder adjacent to proposed pool excavation	a) 0.70m off the proposed garage level and level1, impact 20% b) boulder adjacent to the proposed pool, impact 100%		a) person in house 10hrs/day b) person in pool 2 hrs/day	a) possible to not evacuate b) Unlikely to not evacuate	a) Person in building, crushed b) Person in pool, mionr injury	
			Possible	**Prob. of Impact**	**Impacted**				
		a) future site house	0.001	1.00	0.20	0.4167	0.5	1.00	**4.17E-05**
		b) proposed pool	0.001	1.00	1.00	0.0833	0.25	0.10	**2.08E-06**
C	Landslip (Soil <3m³) of earth around perimeter of excavation for proposed excavation for garage and pool		Excavation up to 2.50m depth possible into soils (colluvium)	a) Excavation within 1.0m of the boundary, impact 2% b) Excavation within 1.0m of the boundary, impact 2%		a) person in vacant land 0.1hrs/day b) person in vacant land 0.1hrs/day	a) unlikely to not evacuate b) unlikely to not evacuate	a) Person in open space, minor injured b) Person in open space, minor injured	
			Likely	**Prob. of Impact**	**Impacted**				
		a) vacant land in neigbouring property (No. 1 Elanora Rd)	0.01	0.50	0.02	0.0042	0.25	0.10	**1.04E-08**
		b) vacant land in neighbouring property (No. 104a Wakehurst Parkway)	0.01	0.50	0.02	0.0042	0.25	0.10	**1.04E-08**

* hazards considered in current condition and/or without remedial/stabilisation measures
* likelihood of occurrence for design life of 100 years
* Spatial Impact - Probaility of Impact referes to slide impacting structure/area expressed as a % (1.00 = 100% probability of slide impacting area if it occurs), Imapcted refers to % of area/strucure impacted if slide occurred
* neighbouring houses considered for bedroom impact unless specified
* considered for person most at risk
* considered for adjacent premises/buildings founded via shallow footings unless indicated
* evacuation scale from Almost Certain to not evacuate (1.0), Likely (0.75), Possible (0.5), Unlikely (0.25), Rare to not evacuate (0.01). Based on likelihood of person knwoing of landslide and completely evacuating area prior to landslide impact.
* vulnerability assessed using Appendix F - AGS Practice Note Guidelines for Landslide Risk Management 2007

TABLE : B

Landslide risk assessment for Risk to Property

HAZARD	Description	Impacting	Likelihood		Consequences		Risk to Property
A	Collapse (Rockslide <30m^3) of detached sections/boulders on cliff face due to rock bolt failure	a) future site house	Possible	The event could occur under adverse conditions over the design life.	Catastrophic	Site structures completely destroyed, significant stabilising or MAJOR damage to neighbouring property.	Very High
		b) neighbouring house (No. 106 Wakehurst Parkway)	Possible	The event could occur under adverse conditions over the design life.	Catastrophic	Site structures completely destroyed, significant stabilising or MAJOR damage to neighbouring property.	Very High
B	Landslip (Rockslide/topple <10m^3) of boulder due to distubance	a) future site house	Possible	The event could occur under adverse conditions over the design life.	Medium	Moderate damage to some of structure or significant part of site, requires large stabilising works or MINOR damage to neighbouring property.	Moderate
		b) proposed pool	Possible	The event could occur under adverse conditions over the design life.	Medium	Moderate damage to some of structure or significant part of site, requires large stabilising works or MINOR damage to neighbouring property.	Moderate
C	Landslip (Soil <3m^3) of earth around perimeter of excavation for proposed excavation	a) vacant land in neigbouring property (No. 1 Elanora Rd)	Possible	The event could occur under adverse conditions over the design life.	Insignificant	Little Damage, no significant stabilising required or no impact to neighbouring properties.	Very Low
		b) vacant land in neighbouring property (No. 104a Wakehurst Parkway)	Possible	The event could occur under adverse conditions over the design life.	Insignificant	Little Damage, no significant stabilising required or no impact to neighbouring properties.	Very Low

* hazards considered in current condition, without remedial/stabilisation measures and during construction works.
* qualitative expression of likelihood incorporates both frequency analysis estimate and spatial impact probability estimate as per AGS guidelines.
* qualitative measures of consequences to property assessed per Appendix C in AGS Guidelines for Landslide Risk Management.
* Indicative cost of damage expressed as cost of site development with respect to consequence values: Catastrophic : 200%, Major: 60%, Medium: 20%, Minor: 5%, Insignificant: 0.5%.

TABLE: C

Recommended Maintenance and Inspection Program

Structure	Maintenance/ Inspection Item	Frequency
Stormwater drains.	Owner to inspect to ensure that the drains, and pipes are free of debris & sediment build-up. Clear surface grates and litter.	Every year or following each major rainfall event.
Retaining Walls. or remedial measures	Owner to inspect walls for deveation from as constructed condition and repair/replace. Replace poorly constructed rock walls	Every two years or following major rainfall event. As soon as practicable
Large Trees on or adjacent to site	Arbourist to check condition of trees and remove as required. Where treee within steep slopes or adjacent to structures require geotechincal inspection prior to removal	Every five years
Slope Stability	Hydraulics (stormwater) & Geotechnical Consultants to check on site stability at same time and provide report.	One year after construction is completed.

N.B. Provided the above shedule is maintained the design life of the property should conform with Councils Risk Management Policy.

Appendix 4

APPENDIX A

DEFINITION OF TERMS

INTERNATIONAL UNION OF GEOLOGICAL SCIENCES WORKING GROUP ON LANDSLIDES, COMMITTEE ON RISK ASSESSMENT

Risk – A measure of the probability and severity of an adverse effect to health, property or the environment. Risk is often estimated by the product of probability x consequences. However, a more general interpretation of risk involves a comparison of the probability and consequences in a non-product form.

Hazard – A condition with the potential for causing an undesirable consequence (*the landslide*). The description of landslide hazard should include the location, volume (or area), classification and velocity of the potential landslides and any resultant detached material, and the likelihood of their occurrence within a given period of time.

Elements at Risk – Meaning the population, buildings and engineering works, economic activities, public services utilities, infrastructure and environmental features in the area potentially affected by landslides.

Probability – The likelihood of a specific outcome, measured by the ratio of specific outcomes to the total number of possible outcomes. Probability is expressed as a number between 0 and 1, with 0 indicating an impossible outcome, and 1 indicating that an outcome is certain.

Frequency – A measure of likelihood expressed as the number of occurrences of an event in a given time. See also Likelihood and Probability.

Likelihood – used as a qualitative description of probability or frequency.

Temporal Probability – The probability that the element at risk is in the area affected by the landsliding, at the time of the landslide.

Vulnerability – The degree of loss to a given element or set of elements within the area affected by the landslide hazard. It is expressed on a scale of 0 (no loss) to 1 (total loss). For property, the loss will be the value of the damage relative to the value of the property; for persons, it will be the probability that a particular life (the element at risk) will be lost, given the person(s) is affected by the landslide.

Consequence – The outcomes or potential outcomes arising from the occurrence of a landslide expressed qualitatively or quantitatively, in terms of loss, disadvantage or gain, damage, injury or loss of life.

Risk Analysis – The use of available information to estimate the risk to individuals or populations, property, or the environment, from hazards. Risk analyses generally contain the following steps: scope definition, hazard identification, and risk estimation.

Risk Estimation – The process used to produce a measure of the level of health, property, or environmental risks being analysed. Risk estimation contains the following steps: frequency analysis, consequence analysis, and their integration.

Risk Evaluation – The stage at which values and judgements enter the decision process, explicitly or implicitly, by including consideration of the importance of the estimated risks and the associated social, environmental, and economic consequences, in order to identify a range of alternatives for managing the risks.

Risk Assessment – The process of risk analysis and risk evaluation.

Risk Control or Risk Treatment – The process of decision making for managing risk, and the implementation, or enforcement of risk mitigation measures and the re-evaluation of its effectiveness from time to time, using the results of risk assessment as one input.

Risk Management – The complete process of risk assessment and risk control (*or risk treatment*).

Individual Risk – The risk of fatality or injury to any identifiable (named) individual who lives within the zone impacted by the landslide; or who follows a particular pattern of life that might subject him or her to the consequences of the landslide.

Societal Risk – The risk of multiple fatalities or injuries in society as a whole: one where society would have to carry the burden of a landslide causing a number of deaths, injuries, financial, environmental, and other losses.

Acceptable Risk – A risk for which, for the purposes of life or work, we are prepared to accept as it is with no regard to its management. Society does not generally consider expenditure in further reducing such risks justifiable.

Tolerable Risk – A risk that society is willing to live with so as to secure certain net benefits in the confidence that it is being properly controlled, kept under review and further reduced as and when possible.

In some situations risk may be tolerated because the individuals at risk cannot afford to reduce risk even though they recognise it is not properly controlled.

Landslide Intensity – A set of spatially distributed parameters related to the destructive power of a landslide. The parameters may be described quantitatively or qualitatively and may include maximum movement velocity, total displacement, differential displacement, depth of the moving mass, peak discharge per unit width, kinetic energy per unit area.

Note: Reference should also be made to Figure 1 which shows the inter-relationship of many of these terms and the relevant portion of Landslide Risk Management.

APPENDIX C: LANDSLIDE RISK ASSESSMENT

QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY

QUALITATIVE MEASURES OF LIKELIHOOD

Approximate Annual Probability		Implied Indicative Landslide Recurrence Interval		Description	Descriptor	Level
Indicative Value	**Notional Boundary**					
10^{-1}	$5x10^{-2}$	10 years	20 years	The event is expected to occur over the design life.	ALMOST CERTAIN	A
10^{-2}	$5x10^{-3}$	100 years	200 years	The event will probably occur under adverse conditions over the design life.	LIKELY	B
10^{-3}	$5x10^{-4}$	1000 years	2000 years	The event could occur under adverse conditions over the design life.	POSSIBLE	C
10^{-4}	$5x10^{-5}$	10,000 years	20,000 years	The event might occur under very adverse circumstances over the design life.	UNLIKELY	D
10^{-5}	$5x10^{-6}$	100,000 years	200,000 years	The event is conceivable but only under exceptional circumstances over the design life.	RARE	E
10^{-6}		1,000,000 years		The event is inconceivable or fanciful over the design life.	BARELY CREDIBLE	F

Note: (1) The table should be used from left to right; use Approximate Annual Probability or Description to assign Descriptor, not *vice versa*.

QUALITATIVE MEASURES OF CONSEQUENCES TO PROPERTY

Approximate Cost of Damage		Description	Descriptor	Level
Indicative Value	**Notional Boundary**			
200%	100%	Structure(s) completely destroyed and/or large scale damage requiring major engineering works for stabilisation. Could cause at least one adjacent property major consequence damage.	CATASTROPHIC	1
60%	40%	Extensive damage to most of structure, and/or extending beyond site boundaries requiring significant stabilisation works. Could cause at least one adjacent property medium consequence damage.	MAJOR	2
20%	10%	Moderate damage to some of structure, and/or significant part of site requiring large stabilisation works. Could cause at least one adjacent property minor consequence damage.	MEDIUM	3
5%	1%	Limited damage to part of structure, and/or part of site requiring some reinstatement stabilisation works.	MINOR	4
0.5%		Little damage. (Note for high probability event (Almost Certain), this category may be subdivided at a notional boundary of 0.1%. See Risk Matrix.)	INSIGNIFICANT	5

Notes: (2) The Approximate Cost of Damage is expressed as a percentage of market value, being the cost of the improved value of the unaffected property which includes the land plus the unaffected structures.

(3) The Approximate Cost is to be an estimate of the direct cost of the damage, such as the cost of reinstatement of the damaged portion of the property (land plus structures), stabilisation works required to render the site to tolerable risk level for the landslide which has occurred and professional design fees, and consequential costs such as legal fees, temporary accommodation. It does not include additional stabilisation works to address other landslides which may affect the property.

(4) The table should be used from left to right; use Approximate Cost of Damage or Description to assign Descriptor, not vice versa

APPENDIX C: – QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY (CONTINUED)

QUALITATIVE RISK ANALYSIS MATRIX – LEVEL OF RISK TO PROPERTY

LIKELIHOOD		CONSEQUENCES TO PROPERTY (With Indicative Approximate Cost of Damage)				
	Indicative Value of Approximate Annual Probability	1: CATASTROPHIC 200%	2: MAJOR 60%	3: MEDIUM 20%	4: MINOR 5%	5: INSIGNIFICANT 0.5%
A – ALMOST CERTAIN	10^{-1}	VH	VH	VH	H	M or **L** (5)
B - LIKELY	10^{-2}	VH	VH	H	M	**L**
C - POSSIBLE	10^{-3}	VH	H	M	M	**VL**
D - UNLIKELY	10^{-4}	H	M	**L**	**L**	**VL**
E - RARE	10^{-5}	M	**L**	**L**	**VL**	**VL**
F - BARELY CREDIBLE	10^{-6}	**L**	**VL**	**VL**	**VL**	**VL**

Notes: (5) For Cell A5, may be subdivided such that a consequence of less than 0.1% is Low Risk.

(6) When considering a risk assessment it must be clearly stated whether it is for existing conditions or with risk control measures which may not be implemented at the current time.

RISK LEVEL IMPLICATIONS

Risk Level		Example Implications (7)
VH	VERY HIGH RISK	Unacceptable without treatment. Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to Low; may be too expensive and not practical. Work likely to cost more than value of the property.
H	HIGH RISK	Unacceptable without treatment. Detailed investigation, planning and implementation of treatment options required to reduce risk to Low. Work would cost a substantial sum in relation to the value of the property.
M	MODERATE RISK	May be tolerated in certain circumstances (subject to regulator's approval) but requires investigation, planning and implementation of treatment options to reduce the risk to Low. Treatment options to reduce to Low risk should be implemented as soon as practicable.
L	LOW RISK	Usually acceptable to regulators. Where treatment has been required to reduce the risk to this level, ongoing maintenance is required.
VL	VERY LOW RISK	Acceptable. Manage by normal slope maintenance procedures.

Note: (7) The implications for a particular situation are to be determined by all parties to the risk assessment and may depend on the nature of the property at risk; these are only given as a general guide.