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(Incorporating Keown & Drummond Pty. Ltd.)

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8230 P.C.

REF. NO.

19 March 2004

Pittwater Council
11/5 Vuko Place
WARRIEWOOD 2102

Att. Jo Marshall
Planning

**Re: D.I.P.N.R./Uniting Church rezoning & D.A. proposal
Ingleside Road & Wesley Street, Ingleside
Application by Ingham Planning**

Dear Jo

We have worked with Ingham Planning on a joint proposal for the subject land. David Winley asked that we forward a Geotechnical Stability Assessment for D.I.P.N.R.'s land to support the applications.

Please note:

- (i) the "dwelling zone" on D.I.P.N.R.'s land is on flat land about 50 metres west of the cliff line.
- (ii) the location of the Right of Way proposed through lots 2 to 5 above the escarpment is flexible and would be subject to more detailed geotechnical assessment at design stage. It has already been suggested that the Right of Way should be relocated more to the west i.e. away from the escarpment and closer to the "Dwelling Zone". The Bushfire consultants have no problem with this relocation and it certainly is worth considering.
- (iii) fine tuning of the lot layout has occurred since the geotechnical assessment including nomination of dwelling zones which would clearly lessen any geotechnical constraint.

We enclose a copy of Douglas Partners Stability Assessment.

Yours faithfully

DRUMMOND PARMENTER PTY. LTD.


MALCOLM DRUMMOND



LOT 3 SECF DP 11784
LOTS 74,79,83,84,85,
SECB DP 11784

LOT 62 DP 30255
LOT 70 DP 32253

D.P. 366659

ROAD

7
23.16ha

12
5.72

WHERE IFE'S ARE CRITICAL THEY SHOULD BE

371A PITT STREET, SYDNEY
AUSTRALIA 2000

D452HC3

PLAN SHOWING DEPT OF INFRASTRUCTURE
PLANNING & NATURAL RESOURCES LAND AND
UNTING CHURCH LAND AT WESLEY STREET
AND INGLESIDE ROAD, INGLESIDE

94524CJ-031203



Douglas Partners

Geotechnics • Environment • Groundwater

**REPORT
on
STABILITY ASSESSMENT**

**PART LOT 3 - SECTION F
D.P. 11784 INGLESIDE ROAD, INGLESIDE**

**Prepared for
DEPARTMENT OF URBAN AFFAIRS AND PLANNING**

**Project 30181A
December 2001**

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Landslide Risk Management Notes

PLATE 1

GRW:pc
Project 30181A
5 December 2001

REPORT ON STABILITY ASSESSMENT
PART LOT 3 – SECTION F - D.P.11784 INGLESIDE ROAD, INGLESIDE

1. INTRODUCTION

This report presents the results of a stability assessment carried out as part of a pre-purchase due-diligence process for Part Lot 3 – Section F – D.P.11784 Ingleside Road, Ingleside. The work was requested by Drummond Parmenter Pty Ltd acting on behalf of the Department of Urban Affairs and Planning (DUAP).

It is understood that, if purchased, DUAP intends to subdivide a 2 ha section along the western boundary into five 4000 m² (minimum) rural/residential lots (designated Lots 1 – 5) and dedicate the remaining 25 ha as open space reserve.

The stability assessment comprised a review of published mapping followed by geological inspection of the lot and adjacent areas. Details are given in the report, together with comments relating to development and construction practice relevant to the landforms, subsurface conditions and assessed risk of instability observed within the study area.

Douglas Partners Pty Ltd, as part of the pre-purchase due diligence process, has also carried out a separate Stage 1 (preliminary) contamination assessment. The results of that assessment are reported separately (Project 30181), but reference is made to the assessment where appropriate.

Site sketches showing broad topographic features and the proposed development scheme were supplied by the client for use in the investigation.

2. SITE DESCRIPTION AND GEOLOGY

The site for assessment comprised an irregular, approximately L-shaped area of approximately 2 ha (proposed Lots 1 – 5) at the western margin of Part Lot 3 – Section F – D.P.11784 (Plate 1). It includes a 40 m frontage to Ingleside Road at the northern end of the site and has maximum plan dimensions of approximately 310 m (north-south) and 170 m (east-west).

The site lies between approximate RL 108 at the Ingleside Road frontage to about RL 95 at the eastern boundary. The surface slopes gently (about 4°) to the east and northeast over the most of the lots, steepening progressively within a cliff top zone which ranges from about 2 m to 20 m in width. The height of the cliff line beyond increases from north to south and, where access permitted observation, generally ranged from about 3 m to 10 m in height. Isolated sections may extend to about 15 m in height.

The site is densely covered by shrubs and trees with the exception of localised sandstone outcrops or cliff faces and cleared, grass-covered areas about the southern margin of the proposed Lot 1 and western margin of the proposed Lot 2.

An access driveway servicing the adjacent developed residential lot has been constructed along the southern margin of the proposed Lot 1. The remains of an overgrown access track are also present along the northern boundary of the proposed Lots 1 and 2.

Reference to the Sydney 1:100 000 Geological Sheet 9130 indicate that the site is underlain by Hawkesbury Sandstone of Triassic age. This formation comprises predominantly quartz sandstone with minor shale or shale breccia bands. Within the local area, the strata are near-horizontally bedded.

The Sydney 1:100 000 Soil Landscape Series Sheet 9130 indicates that the shallow soils developed on the Hawkesbury Sandstone in the local area are classified as shallow Earthy Sands, Yellow Earths, Siliceous Sands/Lithosols, Leached Sands, Grey Earths and Gleyed Podzolic Soils.

3. FIELD WORK

The field work comprised an inspection on 21 November 2001 by a senior engineering geologist for site orientation, geological inspection and stability assessment purposes. Heavy rainfall had occurred prior to and continued during the inspection. The dense vegetation cover restricted access to sections of the site and location on site was determined by reference to fenced and pegged property boundaries, boundaries shown on the supplied site sketches or to features shown on the Terry Hills 1:10 000 Orthophotomap U1867, an extract of which is included in Plate 1.

Notes defining classification methods and descriptive terms are included in Appendix A.

Items of geotechnical note observed during the inspection and subsurface sampling undertaken as part of the preliminary contamination assessment were that:

- the gently sloping sections of the hillslope were characterised by sparse outcrop of medium to high strength sandstone. The soil profile overlying the bedrock ranged from less than 0.1 m to approximately 1 m in depth and comprised a grey, slightly organic, silty sand topsoil and a leached, light grey sandy subsoil profile.
- the ground surface was water-logged with surface runoff as sheet and rill flow occurring during the inspection. There areas of upland marsh grasses suggesting that water-logging may periodically affect the shallow soil profile and indicate a very low permeability of the underlying bedrock.
- a stepped surface profile including 0.5 m to 1 m high near-vertical faces was commonly observed in the cliff top zone and was controlled by open near-vertical joints parallel to sub-parallel to the cliff line.
- the cliff base included large fallen sandstone joint blocks, however no disruption of the current vegetation cover by block fall was noted. The cliff line includes over-hanging ledges to the order of 1 m to 2 m and larger overhangs may also be present in inaccessible areas.
- filling comprising crushed shale and terracotta tiles and some bricks has been placed to form an access driveway and to provide site leveling extends up to 5 m into the proposed Lots 1 and 2.

4. COMMENTS

4.1 Proposed Development

It is understood that, if purchased, DUAP intends to subdivide a 2 ha section along the western boundary into five 4000 m² (minimum) rural/residential lots (designated Lots 1 – 5, Plate 1) and dedicate the remaining 25 ha as open space reserve. An approximately 6 m to 7 m wide access right-of-way to service the lots is proposed along the northern boundary of Lots 1 and 2, thence continuing along the cliff top before returning to Ingleside Road near the southern corner of Lot 5.

The following sections indicate the principal geotechnical constraints identified at the site and provide comments in relation to appropriate development methods to address these constraints. The assessment is based on surface observations, limited probing of the subsurface soil profile and company experience with construction on Hawkesbury Sandstone terrain, particularly adjacent to cliff lines within the Sydney area.

4.2 Slope Instability Assessment

Aspects included in the assessment of slope instability are the bedrock geology, observed or anticipated soil depth, steepness of slope relative to historical or ancient slope failures in similar materials, the disturbance of soil and vegetation cover during development, the influence of groundwater or surface saturation, and the effects of earthquake forces.

The inspection did not indicate evidence of landslide or recent cliff line collapse. It is however noted that the valley slopes of the Mullett Creek catchment have been formed by the process of weathering and erosion that continue to result in the slow retreat of existing cliff lines over geological time. The slow, on-going regression of the cliff faces at this site is evidenced by the presence of joint blocks at the toes of cliff lines, the rotation outward and downward of individual joint blocks and open joints extending back behind sections of the cliff lines. Previous

investigations of steep cliff lines within the Sydney area have indicated joint opening extending 10 m to 15 m (and more) behind cliff faces.

The principal mechanism of cliff line failures at the site is assessed as a combination of stress relief and gravity induced joint opening, weathering along open joints/bedding planes and the build up of water pressure within steeply dipping joints. Failures would most likely occur when undercutting of a weathering resistant bed exposes jointing paralleling or sub-parallel the cliff face.

The cliff line appears to have been generally stable over the life span of the current vegetation cover that includes mature trees without evident disruption of normal growth patterns. The boulder fields along bases of the cliff lines however, suggests rock falls in the geologically recent past, if not the historical past.

Most of the proposed lot areas comprise gently sloping, east-facing hillslopes mantled by skeletal to shallow sandy soils with scattered sandstone outcrops. When assessed in accordance with the current *"Landslip Risk Management Concepts and Guidelines"* (Australian Geomechanics Society Sub-Committee on Landslide Risk Management, March 2000), these area may be classified as having a very low risk of instability. Within the cliff top zone generally extending to less than 20 m from the cliff face, the steeper, soil covered and/or open-joint affected sandstone surface may be classified as ranging from having a medium to high risk of instability.

4.3 Geotechnical Constraints to Development

The soil type and depth, together with the presence of the cliff line impose only minor to moderate geotechnical constraints to residential development.

4.3.1 Slope Instability

As indicated in Section 4.2, slope instability is only likely to be a constraint to the alignment and construction of the proposed cliff top right-of-way servicing the lots. The need to manage the assessed risk levels, in particular within the zone of medium to high risk of instability leads to the following suggested options for the proposed development:

- relocation of the proposed access footprint further upslope.
- the trimming of loose joint blocks and construction of retaining structures founded on intact bedrock.
- the stabilisation of relevant rock face sections by a combination of bolting, anchoring and drainage of open-jointed areas where the access cannot be practically or economically relocated.

4.3.2 Soil Erodibility

The soil profile comprises a skeletal organic layer underlain by relatively thin colluvial and residual sandy soils. Reference to the notes accompanying the Sydney 1:100 000 Soil Landscape Series Sheet 9130 indicates that soil erosion hazard for non-concentrated flows is usually very high but ranges from low to extreme and that calculated soil losses for the first 12 months of urban development range up to 17 tonnes/ha for topsoil and 197 tonnes/ha for exposed subsoils. The soil erosion hazard from channelised flow is extreme.

Management options should include:

- orientation of access driveways, residential structures and services to minimise requirements for excavation and possible retaining structures.
- the maximisation and/or replacement of tree cover.
- the programming of development, particularly construction roadworks, which would be the main activity to expose potentially erodible colluvial and residual soils, to minimise time of exposure and also the inclusion of techniques (e.g. spray coating, silt fences, hay bales) to minimise erosion.
- improvement of the soil fertility by use of select fertilisers to enhance plant growth, particularly in disturbed areas.

4.3.3 Surface Movement Potential

The shallow sandy soils are generally considered to be stable to slightly reactive. In only isolated deeper (>1 m) clay rich soil profiles (probably developed on included shale bands) would moderately reactive conditions be anticipated.

4.3.4 Excavatability

The shallow soil profile would be readily excavated using conventional backhoe or excavator equipment. The excavation of the medium to high strength sandstone will require the use of heavy ripping and/or hydraulic rock breaking equipment to achieve bulk and detailed excavation lines for access road or residence construction.

4.3.5 Water Logging and Drainage

Seasonal water logging of the highly permeable sandy soils overlying bedrock of very low permeability can be expected over sections of the proposed lots. To improve the amenity of the lots, it is anticipated that:

- adequate surface drainage would be installed and maintained where there is significant overland flow.
- subsoil drains will be provided to protect the pavement of the proposed access right-of-way.
- the installation of subsoil drains and/or filling platforms may also be required about residences to improve surface traffickability.
- all collected stormwater, groundwater from subsoil drains and roof runoff would be discharged into a formed stormwater disposal system. The collected water should not be dispersed onto the cliff top area or the sandy soil cover as there is significant potential for accelerating erosion or spalling of the cliff face. Preferably the collected drainage should be discharged directly into the base of the headwater gully of Mullett Creek.

5. SUMMARY

Assessment of the area of the proposed 5 lot subdivision indicates that there are only minor to moderate geotechnical constraints to urban development. The principal constraints will be the risk of instability in the cliff line at the eastern boundary of the proposed lots, erodibility of exposed soils and seasonal water logging.

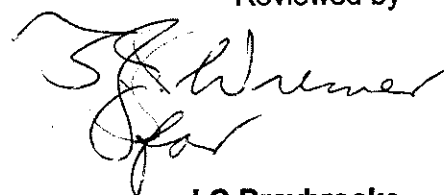
The constraints may be managed by engineered and non-engineered methods including avoidance of the cliff top area, stabilisation of cliff top sections at worst case, protection of exposed soil profiles and the installation of surface and subsoil drainage.

DOUGLAS PARTNERS PTY LTD



G R Wilson
Senior Associate

Reviewed by



J C Braybrooke
Principal

APPENDIX A
Notes Relating to this Report
Landslide Risk Management Notes



Douglas Partners

Geotechnics • Environment • Groundwater

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 Investigations 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 60.00 mm

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/300 mm)	CPT Cone Value (q_c — 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 provide 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 with 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.

Details of the type and method of sampling are given in the report.

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 in-situ soils if it is safe to descent into the pit. The depth of penetration is limited to about 3 m for a backhoe and up to 6 m 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 300 mm or larger in diameter. The cuttings are returned to the surface at intervals (generally of not more than 0.5 m) 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 100 mm diameter socket into the ground and withdrawing it at intervals to extrude the sample. This is the most reliable method of drilling in 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—115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ 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 SPTs 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 50 mm 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 procedure 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 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm 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 150 mm of say 4, 6 and 7
as 4, 6, 7
N = 13
- In the case where the test is discontinued short of full penetration, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm
as 15, 30/40 mm.

The results of the tests can be related empirically to the engineering properties of the soil.

Occasionally, the test method is used to obtain samples in 50 mm diameter thin walled sample tubes in clays. 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 Australian Standard 1289, Test 6.4.1.

In the tests, a 35 mm diameter rod with a cone-tipped end is pushed continuously 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 separate 130 mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are connected by 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 20 mm per second) the 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 of 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:—

$$q_c \text{ (MPa)} = (0.4 \text{ to } 0.6) N \text{ (blows per 300 mm)}$$

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

$$q_c = (12 \text{ to } 18) c_u$$

Interpretation of CPT values can also be made to allow estimation of modulus or compressibility values to allow calculation 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.

Hand Penetrometers

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

Two relatively similar tests are used.

- Perth sand penetrometer — a 16 mm diameter flat-ended rod is driven with a 9 kg hammer, dropping 600 mm (AS 1289, Test 6.3.3). This 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 the Scala Penetrometer) — a 16 mm rod with a 20 mm diameter cone end is driven with a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). The test was developed initially for pavement subgrade investigations, and published correlations of the test results with California bearing ratio have been published by various Road Authorities.

Laboratory Testing

Laboratory testing is 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.

Bore 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.

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 advisable in low permeability soils or where there 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 specially 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.

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APPENDIX G

LANDSLIDE RISK ASSESSMENT - EXAMPLE OF QUALITATIVE TERMINOLOGY
FOR USE IN ASSESSING RISK TO PROPERTY

Qualitative Measures of Likelihood

Level	Descriptor	Description	Indicative Annual Probability
A	ALMOST CERTAIN	The event is expected to occur	$>10^{-1}$
B	LIKELY	The event will probably occur under adverse conditions	$\approx 10^{-2}$
C	POSSIBLE	The event could occur under adverse conditions	$\approx 10^{-3}$
D	UNLIKELY	The event might occur under very adverse circumstances	$\approx 10^{-4}$
E	RARE	The event is conceivable but only under exceptional circumstances.	$\approx 10^{-5}$
F	NOT CREDIBLE	The event is inconceivable or fanciful	$<10^{-6}$

Note: "≈" means that the indicative value may vary by say ± 1 order of magnitude, or more.

Qualitative Measures of Consequences to Property

Level	Descriptor	Description
1	CATASTROPHIC	Structure completely destroyed or large scale damage requiring major engineering works for stabilisation.
2	MAJOR	Extensive damage to most of structure, or extending beyond site boundaries requiring significant stabilisation works.
3	MEDIUM	Moderate damage to some of structure, or significant part of site requiring large stabilisation works.
4	MINOR	Limited damage to part of structure, or part of site requiring some reinstatement/stabilisation works.
5	INSIGNIFICANT	Little damage.

Note: The "Description" may be edited to suit a particular case.

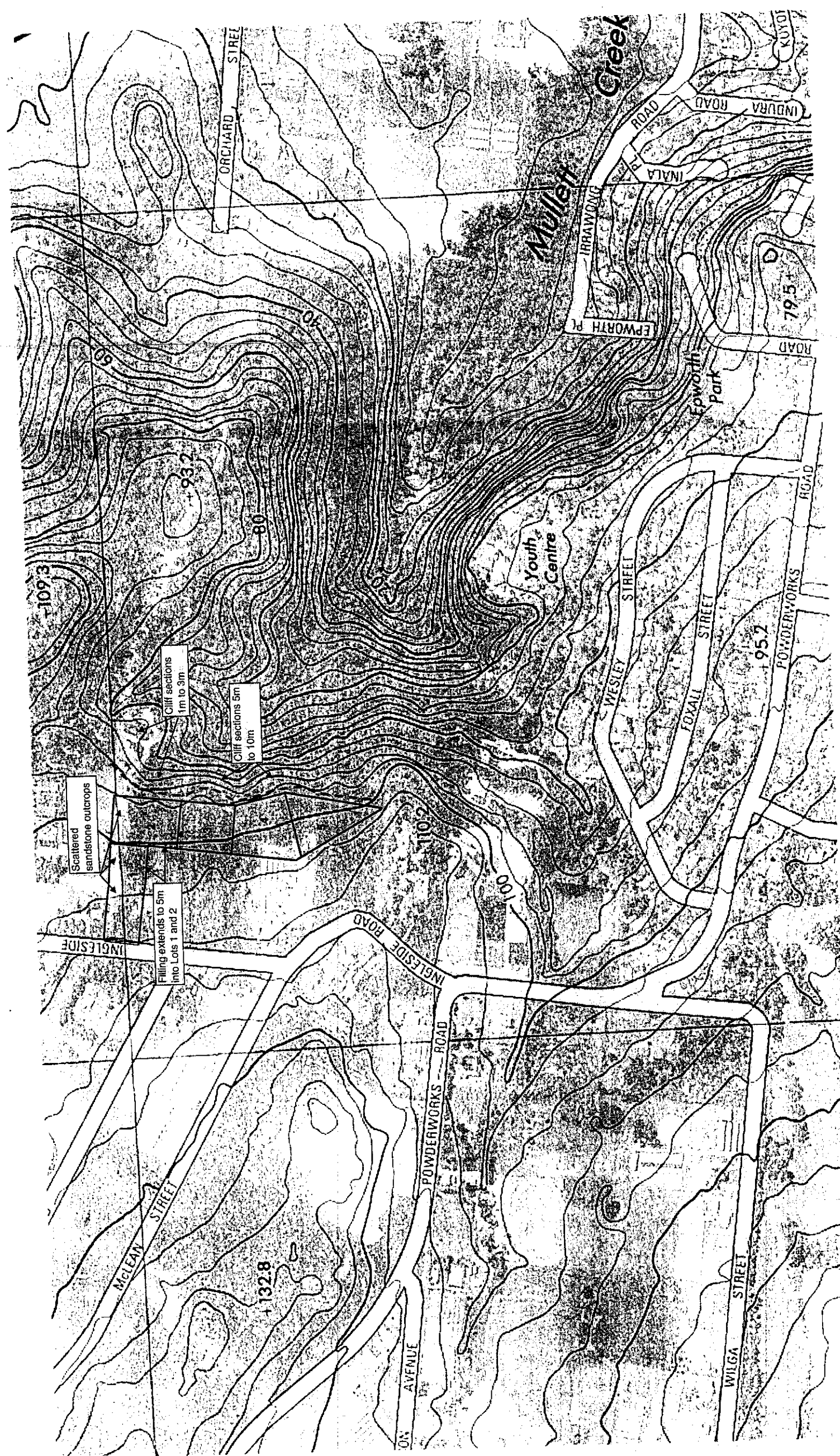
Qualitative Risk Analysis Matrix - Level of Risk to Property

LIKELIHOOD	CONSEQUENCES to PROPERTY				
	1: CATASTROPHIC	2: MAJOR	3: MEDIUM	4: MINOR	5: INSIGNIFICANT
A - ALMOST CERTAIN	VH	VH	H	H	M
B - LIKELY	VH	H	H	M	L-M
C - POSSIBLE	H	H	M	L-M	VL-L
D - UNLIKELY	M-H	M	L-M	VL-L	VL
E - RARE	M-L	L-M	VL-L	VL	VL
F - NOT CREDIBLE	VL	VL	VL	VL	VL

Risk Level Implications

Risk Level	Example Implications ⁽¹⁾
VH VERY HIGH RISK	Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to acceptable levels; may be too expensive and not practical
H HIGH RISK	Detailed investigation, planning and implementation of treatment options required to reduce risk to acceptable levels
M MODERATE RISK	Tolerable provided treatment plan is implemented to maintain or reduce risks. May be accepted. May require investigation and planning of treatment options.
L LOW RISK	Usually accepted. Treatment requirements and responsibility to be defined to maintain or reduce risk.
VL VERY LOW RISK	Acceptable. Manage by normal slope maintenance procedures.

Note: (1) The implications for a particular situation are to be determined by all parties to the risk assessment; these are only given as a general guide.
(2) Judicious use of dual descriptors for Likelihood, Consequence and Risk to reflect the uncertainty of the estimate may be appropriate in some cases.



Scale 1:5000

1000m

LEGEND

--- Drainage line - approximate

- - - Approximate crest of cliff line/escarpment

STABILITY ASSESSMENT
PART LOT 3 - SECTION F DP11784
INGLESIDE

Project 30181A	NOVEMBER 2001	Plate 1
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