LEWISHAM ESTATE PTY LTD

MIXED RETAIL AND RESIDENTIAL DEVELOPMENT

78 -90 OLD CANTERBURY ROAD,
LEWISHAM. NSW

PRELIMINARY GEOTECHNICAL ASSESSMENT

Environmental Investigations
Report No. E1195.1 GA

10th June, 2010

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EI Ref: *E1195.1 GA*
Date: *10th June, 2010*

Mr Charlie Demian
c/- Lewisham Estate Pty Ltd
Level 2,
7 Charles Street,
PARRAMATTA NSW 2150

RE: MIXED RETAIL AND RESIDENTIAL DEVELOPMENT, 78 - 90 OLD CANTERBURY ROAD, LEWISHAM PRELIMINARY GEOTECHNICAL ASSESSMENT

Environmental Investigations (EI) has pleasure in submitting this report on the geotechnical Assessment of the above site.

This report was conducted on behalf of Environmental Investigations by Asset Geotechnical Engineering Pty Ltd to assess the surface and subsurface conditions of the site and to provide comments and recommendations relating to the current proposed development.

Should you require further information or clarification regarding any aspect of this report, please contact the undersigned.

For and on behalf of,
ENVIRONMENTAL INVESTIGATIONS

ERIC GERGES
Project Manager

1485-A
10 June 2010

Environmental Investigations
17/1A Coulson Street
ERSKINEVILLE NSW 2043

Attention: Mr Eric Gerges

Dear Sir,

MIXED RETAIL AND RESIDENTIAL DEVELOPMENT, 78–90 OLD CANTERBURY ROAD, LEWISHAM
PRELIMINARY GEOTECHNICAL ASSESSMENT

1. INTRODUCTION

1.1 General

This report presents the results of a preliminary geotechnical assessment for the above project. This work was commissioned by Mr Eric Gerges of Environmental Investigations. The work was carried out in accordance with a proposal by Asset Geotechnical Engineering Pty Ltd dated 4 May 2010, reference P1589.

It is understood that a masterplan strategy has been prepared for a mixed retail and residential development of the site. The masterplan is for buildings ranging in height from 4 stories adjacent to Canterbury Road up to 9 stories adjacent to a rail corridor, and a basement level for retail.

The Director General (Department of Planning) has issued a list of requirements for an environmental assessment for the development, including geotechnical requirements, as follows:

Key Issues – 11. Rail Impacts

> *The applicant shall prepare a Geotechnical and Structural report, and Excavation methodology consistent with RailCorp's requirements. In addition, cross sectional drawings showing ground surface, rail tracks, subsoil profile, proposed basement excavation and structural design adjacent to the rail corridor are required.*

Plans and Documents – 5. Other Plans (Geotechnical Report)

> *Geotechnical Report – prepared by a recognised professional which assesses the risk of geotechnical failure on the site and identifies design solutions and works to be carried out to ensure the stability of the land and structures and safety of persons.*

The objective of the preliminary geotechnical assessment is to address the geotechnical requirements as per above.

1.2 Scope of Work

In order to achieve the project objectives, the following scope of work was carried out:

- Review of available reports and maps held within our files, including an Environmental Site Assessment by Environmental Investigations (Ref E1074-1 AF dated 7 October 2009).
- Walkover observations of site conditions, carried out by the undersigned on 13 May 2010.
- It is noted that the investigation by EI included drilling of 25 boreholes across the site, generally to tungsten-carbide tipped refusal within sandstone bedrock, to depths of up to 3.25m. For the purposes of the preliminary geotechnical assessment, further drilling was not carried out.
- Engineering assessment and reporting.

This report must be read in conjunction with the attached Information Sheets. Particular attention is drawn to the limitations inherent in site investigations and the importance of verifying the subsurface conditions inferred herein.

3. SITE DESCRIPTION

The site is located on the western side of Canterbury Road in Lewisham, as shown in the attached Figure 1. It is approximately 13,130 m^2 plan area and is bounded by Canterbury Road to the east, Hudson Street to the south, the Rozelle railway freight line to the west, and Longport Street to the north. The main western rail line is located on the northern side of and runs parallel to Longport Street.

The regional topography comprises gently undulating low hills with local relief of approximately 40m. Regional ground surface slopes are generally less than about 5°.

The site is located within a gently sloping open depression which is part of a natural drainage depression that continues to the north. Ground surface slopes across the site are generally less than about 3°. Slope directions are generally to the northeast from the southern boundary, to the southwest from the northern boundary, and to the west/northwest from the eastern boundary.

Existing site development includes a number of two-story industrial buildings, a single-story residential building, a two-story double brick residential building, and two vacant areas. Associated site development includes various paved areas. Vegetation is patchy and comprises a few scattered trees and bushes and some garden areas, and grasses over the vacant areas.

4. SUBSURFACE CONDITIONS

4.1 Geology

The 1:100,000 Penrith Geological Map indicates the site is underlain by Ashfield Shale, with Quaternary alluvium to the west, as shown in the attached Figure 2. The alluvium is likely associated with a drainage depression or previous creek. The shale bedrock typically weathers to form residual clay soils of medium to high plasticity.

4.2 Stratigraphy

The subsurface investigation carried out by Environmental Investigations indicated a generalized subsurface profile comprising:

- Filling materials of grey / brown to grey and yellow, red and orange gravel, silt, sand with rootlets, moderate plasticity, ranging in thickness between 0.35m and 1.6m below ground level; overlying
- Natural light grey silty sand/sandy clay, fine to medium grain/medium plasticity; overlying
- Natural orange/red/grey highly weathered sandstone, medium grained (encountered in 17 of the 25 boreholes drilled). The depth to the top of sandstone in the 17 boreholes ranged from 0.2m to 3.1m (average 1.2m) and these holes encountered refusal of the tungsten carbide tipped auger at depths ranging from 0.5m to 3.25m (average 1.5m). TC refusal is assessed to be on Class 4 or possibly Class 3 Sandstone[1].

The boreholes were left open for approximately two hours after drilling and shallow groundwater/seepage were not observed.

5. DISCUSSIONS & RECOMMENDATIONS

5.1 Excavation

Excavation for the proposed development will be required for the basement level and also for other buildings outside of the basement level which require a level building platform. Installation of buried services would also require excavation. s

Based on the subsurface information described above, excavation will likely be through a range of soils as encountered in the boreholes and into sandstone bedrock.

The building constructions on adjacent properties, including the railway land to the west, are sensitive to vibrations above certain threshold levels (regarding potential for cracking). Close controls by the excavation contractor over the rock excavation are recommended, so that excessive vibration effects are not generated.

Excavation methods should be adopted which limit ground vibrations at the adjoining developments to not more then 10mm/sec. Vibration monitoring will be required to verify that this is achieved. However, if the contractor adopts methods and / or equipment in accordance with the recommendations in Table 1 for a ground vibration limit of 5mm/sec, vibration monitoring may not be required.

The limits of 5mm/sec and 10mm/sec are expected to be achievable if rock breaker equipment or other excavation methods are restricted as indicated in Table 1 as follows:

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[1] Pells, P.J.N., Mostyn, G. & Walker, B.F., *Foundations on Sandstone and Shale in the Sydney Region*, Australian Geomechanics Journal, December 1998

Table 1 – Recommendations for Rock Breaking Equipment

Distance from adjoining structure (m)	Maximum Peak Particle Velocity 5mm/sec		Maximum Peak Particle Velocity 10mm/sec*	
	Equipment	Operating Limit (% of Maximum Capacity)	Equipment	Operating Limit (% of Maximum Capacity)
1.5 to 2.5	Hand operated jackhammer only	100	300 kg rock hammer	50
2.5 to 5.0	300 kg rock hammer	50	300 kg rock hammer or 600 kg rock hammer	100 50
5.0 to 10.0	300 kg rock hammer Or 600 kg rock hammer	100 50	600 kg rock hammer or 900 kg rock hammer	100 50

* Vibration monitoring is recommended for 10mm/sec vibration limit.

At all times, the excavation equipment must be operated by experienced personnel, according to the manufacturer's instructions, and in a manner consistent with minimising vibration effects.

Use of other techniques (e.g. chemical rock splitting, rock sawing), although less productive, would reduce or possibly eliminate risks of damage to adjoining property through vibration effects transmitted via the ground. Such techniques may be considered if an alternative to rock breaking is necessary. If rock sawing is carried out around excavation boundaries in not less than 1m deep lifts, a 900 kg rock hammer could be used at up to 100% maximum operating capacity with an assessed peak particle velocity not exceeding 5 mm/sec, subject to observation and confirmation by a geotechnical engineer at the commencement of excavation.

It should be noted that vibrations that are below threshold levels for building damage may be experienced at adjoining developments.

5.2 Batter Slopes

Recommended maximum slopes for permanent and temporary batters are presented in Table 2 below:

Table 2 – Recommended Maximum Batter Slopes

Unit	Maximum Batter Slope (H : V)	
	Permanent	Temporary
Fill soils, natural sands and clays, maximum cut height 2.5m	2 : 1	1 : 1
Sandstone (above TC refusal)	1.5 : 1	0.75 : 1
Sandstone (at or below TC refusal)	vertical *	vertical *

Vertical excavations should be inspected by a geotechnical engineer and remedial works carried out as required (e.g. shotcrete, rock bolting). Inspections should be carried out at every 2m maximum lift.

5.3 Temporary and Permanent Retaining

Where the above temporary and/or permanent batter slopes cannot be accommodated in the development or are not desired, temporary shoring and/or retaining walls will be required.

Design of retaining walls will need to consider both long–term (i.e. permanent) and short–term (i.e. during construction) loading conditions, as well as the possible impact on adjoining developments.

In the long–term, the basement floor slab will provide bracing at the top of the wall and the basement floor slab will provide bracing at the bottom of the wall. Therefore, the basement retaining wall should be designed as a braced wall for the long–term loading condition.

In the short–term (i.e. during construction), where temporary excavations could be adopted for the site, the permanent retaining walls could be constructed without temporary shoring. However, where temporary shoring is required and is incorporated into the permanent basement support, the design of the basement retaining wall will depend on the method of construction adopted. It is likely that bottom–up construction would be adopted for the site. Bottom–up construction typically involves:

- constructing the perimeter wall as either contiguous bored piles, cast–insitu wall (e.g. geocast), or conventional soldiers installed in concreted pile sockets;
- options for wall design include cantilever, anchored ("deadman", soil, or rock anchors), and propped (internal props);
- excavating to basement subgrade level (installing horizontal walers and timber lagging if solider pile wall construction is adopted);
- pouring the ground floor slab and proceeding upwards.

If bottom-up construction is considered, we recommend the use of internal propped walls where the retained height is 2m or more, and either internal propped walls or cantilever walls where the retained height is less than 2m.

Cantilever retaining walls may be designed for a lateral earth pressure coefficient (K_a) of 0.3 where they retained soils and where adjacent structures or buried services are located below the "zone of influence" of excavations. The "zone of influence" is defined as a line extending outwards and upwards at 45° from the base of the excavation or the top of the assessed Class 4 or better sandstone. Where adjacent structures and buried services are located above the "zone of influence", a K_a value of 0.5 is recommended. Piles for cantilever walls should be socketed below bulk excavation level by a depth at least equal to the retained height.

Braced retaining walls may be designed for a uniform lateral earth pressure of $0.65 * \gamma * H * K_a$ where γ = unit weight of retained soil (say 18kN/m^3), H = height of wall, and K_a = earth pressure coefficient (0.3 or 0.5 as per above). Piles for braced walls should be socketed at least 0.75m below basement subgrade level to provide toe "kick-in" resistance until the slab can be poured.

5.4 Risk of Slope Instability

A limited, preliminary level, risk assessment has been carried out for this site with regard to slope instability, using the methods of the AGS publication *"Landslide Risk Management"*[2]. In view of the early stages of the proposed development, only a generalised slope instability risk assessment is possible. This assessment should be re-evaluated during design development.

The basis of the preliminary assessment undertaken for this site and important factors relating to slope conditions and the impacts of the development that commonly influence the risks of slope instability are discussed in the attached "Important Information about your Slope Instability Risk Assessment". Further information is provided in Reference 2 as per the footnote.

[2] *Landslide Risk Management, Australian Geomechanics, Vol 42, No. 1, March 2007.*

The preliminary assessment has been carried out by:

- Consideration of the likely slope failure mechanisms and the likely initiating circumstances that could affect the elements at the site.
- **Risk to Property.** For each slope failure mechanism, the likely consequences with respect to future development have been considered. The current assessed probability of occurrence of each event has been estimated on a qualitative basis. The consequences and probability of occurrence have been combined for each case to provide the risk assessment.
- **Risk to Life.** The lack of project detail precludes a sensible quantitative assessment of the risk to life. A qualitative assessment only has been carried out at this stage.

For the proposed development, slope instability risk arises due to the proposed excavations. The general potential hazards / events identified for this site include slumping of soil excavations, and wedge failure of rock excavations.

Where the proposed basement excavations and other excavations are designed and constructed in accordance with the general recommendations provided in this report, it is envisaged that the outcome of such a development would be a **Low risk** with respect to property, and an **Acceptable risk** with respect to life. These risk levels would normally be acceptable to regulatory authorities.

Further geotechnical input is required during design development and construction, to ensure that these risk levels are not exceeded.

6. STATEMENT – RAIL CORRIDOR

Where the proposed development is designed and constructed in accordance with the general recommendations provided above, it is considered that the impact on the adjoining rail corridor will be insignificant.

❖ ❖ ❖ ❖ ❖

Please contact us if you have any questions regarding this report or if you require further assistance.

For and on behalf of
Asset Geotechnical Engineering Pty Ltd

Mark Bartel

Mark Bartel
BE MEngSc MIEAust CPEng
Principal Geotechnical Engineer

Encl: Information Sheets
Important Information about Your Slope Instability Risk Assessment
Figure 1 – Site Locality
Figure 2 – Regional Geology
Figure 3 – Test Locations

Important Information

SCOPE OF SERVICES

The geotechnical report ("the report") has been prepared in accordance with the scope of services as set out in the contract, or as otherwise agreed, between the Client and Asset Geotechnical Engineering Pty Ltd ("Asset"). The scope of work may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

RELIANCE ON DATA

Asset has relied on data provided by the Client and other individuals and organizations, to prepare the report. Such data may include surveys, analyses, designs, maps and plans. Asset has not verified the accuracy or completeness of the data except as stated in the report. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations ("conclusions") are based in whole or part on the data, Asset will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to Asset.

GEOTECHNICAL ENGINEERING

Geotechnical engineering is based extensively on judgment and opinion. It is far less exact than other engineering disciplines. Geotechnical engineering reports are prepared for a specific client, for a specific project and to meet specific needs, and may not be adequate for other clients or other purposes (e.g. a report prepared for a consulting civil engineer may not be adequate for a construction contractor). The report should not be used for other than its intended purpose without seeking additional geotechnical advice. Also, unless further geotechnical advice is obtained, the report cannot be used where the nature and/or details of the proposed development are changed.

LIMITATIONS OF SITE INVESTIGATION

The investigation programme undertaken is a professional estimate of the scope of investigation required to provide a general profile of subsurface conditions. The data derived from the site investigation programme and subsequent laboratory testing are extrapolated across the site to form an inferred geological model, and an engineering opinion is rendered about overall subsurface conditions and their likely behaviour with regard to the proposed development. Despite investigation, the actual conditions at the site might differ from those inferred to exist, since no subsurface exploration program, no matter how comprehensive, can reveal all subsurface details and anomalies.

The engineering logs are the subjective interpretation of subsurface conditions at a particular location and time, made by trained personnel. The actual interface between materials may be more gradual or abrupt than a report indicates.

SUBSURFACE CONDITIONS ARE TIME DEPENDENT

Subsurface conditions can be modified by changing natural forces or man-made influences. The report is based on conditions that existed at the time of subsurface exploration. Construction operations adjacent to the site, and natural events such as floods, or ground water fluctuations, may also affect subsurface conditions, and thus the continuing adequacy of a geotechnical report. Asset should be kept appraised of any such events, and should be consulted to determine if any additional tests are necessary.

VERIFICATION OF SITE CONDITIONS

Where ground conditions encountered at the site differ significantly from those anticipated in the report, it is a condition of acceptance of the report that Asset be notified of any variations and be provided with an opportunity to review the recommendations of this report. Recognition of change of soil and rock conditions requires experience and it is recommended that a suitably experienced geotechnical engineer be engaged to visit the site with sufficient frequency to detect if conditions have changed significantly.

REPRODUCTION OF REPORTS

This report is the subject of copyright and shall not be reproduced either totally or in part without the express permission of this Company. Where information from the accompanying report is to be included in contract documents or engineering specification for the project, the entire report should be included in order to minimize the likelihood of misinterpretation from logs.

REPORT FOR BENEFIT OF CLIENT

The report has been prepared for the benefit of the Client and no other party. Asset assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of Asset or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Other parties should not rely upon the report or the accuracy or completeness of any conclusions and should make their own inquiries and obtain independent advice in relation to such matters.

OTHER LIMITATIONS

Asset will not be liable to update or revise the report to take into account any events or emergent circumstances or fact occurring or becoming apparent after the date of the report.

Abbreviations, Notes & Symbols

METHOD

borehole logs

AS	auger screw *
AD	auger drill *
RR	roller / tricone
W	washbore
CT	cable tool
HA	hand auger
D	diatube
B	blade / blank bit
V	V-bit
T	TC-bit

* bit shown by suffix e.g. ADV

excavation logs

NE	natural excavation
HE	hand excavation
BH	backhoe bucket
EX	excavator bucket
DZ	dozer blade
R	ripper tooth

coring

NMLC, NQ, PQ, HQ

SUPPORT

borehole logs

N	nil
M	mud
C	casing
NQ	NQ rods

excavation logs

N	nil
S	shoring
B	benched

CORE—LIFT

casing installed

barrel withdrawn

NOTES, SAMPLES, TESTS

D	disturbed
B	bulk disturbed
U50	thin-walled sample, 50mm diameter
HP	hand penetrometer (kPa)
SV	shear vane test (kPa)
DCP	dynamic cone penetrometer (blows per 100mm penetration)
SPT	standard penetration test
N*	SPT value (blows per 300mm) * denotes sample recovered
Nc	SPT with solid cone
R	refusal of DCP or SPT

USCS SYMBOLS

GW	Well graded gravels and gravel-sand mixtures, little or no fines.
GP	Poorly graded gravels and gravel-sand mixtures, little or no fines.
GM	Silty gravels, gravel-sand-silt mixtures.
GC	Clayey gravels, gravel-sand-clay mixtures.
SW	Well graded sands and gravelly sands, little or no fines.
SP	Poorly graded sands and gravelly sands, little or no fines.
SM	Silty sand, sand-silt mixtures.
SC	Clayey sand, sand-clay mixtures.
ML	Inorganic silts of low plasticity, very fine sands, rock flour, silty or clayey fine sands.
CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays.
OL	Organic silts and organic silty clays of low plasticity.
MH	Inorganic silts of high plasticity.
CH	Inorganic clays of high plasticity.
OH	Organic clays of medium to high plasticity.
PT	Peat muck and other highly organic soils.

MOISTURE CONDITION

D	dry
M	moist
W	wet
Wp	plastic limit
Wl	liquid limit

CONSISTENCY

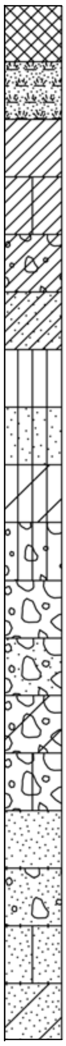
VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable

DENSITY INDEX

VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

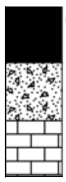
GRAPHIC LOG

Soil

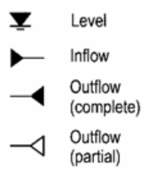


Rock

Other



Water



Boundaries

known — probable — possible

WEATHERING

XW	extremely weathered
HW	highly weathered
MW	moderately weathered
SW	slightly weathered
FR	fresh

STRENGTH

EL	extremely low
VL	very low
L	low
M	medium
H	high
VH	very high
EH	extremely high

RQD (%)

$$= \frac{\text{sum of intact core pieces} > 2 \times \text{diameter}}{\text{total length of section being evaluated}} \times 100$$

DEFECTS

type

JT	joint
PT	parting
SZ	shear zone
SM	seam

coating

cl	clean
st	stained
ve	veneer
co	coating

shape

pl	planar
cu	curved
un	undulating
st	stepped
ir	irregular

roughness

po	polished
sl	slickensided
sm	smooth
ro	rough
vr	very rough

inclination

measured above axis and perpendicular to core

AS1726-1993

Soils and rock are described in the following terms, which are broadly in accordance with AS1726-1993.

SOIL

MOISTURE CONDITION

Term	Description
Dry	Looks and feels dry. Cohesive and cemented soils are hard, friable or powdery. Uncemented granular soils run freely through the hand.
Moist	Feels cool and darkened in colour. Cohesive soils can be moulded. Granular soils tend to cohere.
Wet	As for moist, but with free water forming on hands when handled.

Moisture content of cohesive soils may also be described in relation to plastic limit (W_P) or liquid limit (W_L) [>> much greater than, > greater than, < less than, << much less than].

CONSISTENCY OF COHESIVE SOILS

Term	Su (kPa)	Term	Su (kPa)
Very soft	< 12	Very Stiff	100 – 200
Soft	12 – 25	Hard	> 200
Firm	25 – 50	Friable	–
Stiff	50 – 100		

DENSITY OF GRANULAR SOILS

Term	Density Index(%)	Term	Density Index (%)
Very Loose	< 15	Dense	65 – 85
Loose	15 – 35	Very Dense	>85
Medium Dense	35 – 65		

PARTICLE SIZE

Name	Subdivision	Size (mm)
Boulders		> 200
Cobbles		63 – 200
Gravel	coarse	20 – 63
	medium	6 – 20
	fine	2.36 – 6
Sand	coarse	0.6 – 2.36
	medium	0.2 – 0.6
	fine	0.075 – 0.2
Silt & Clay		< 0.075

MINOR COMPONENTS

Term	Proportion by Mass	
	coarse grained	fine grained
Trace	≤ 5%	≤ 15%
Some	5 – 2%	15 – 30%

SOIL ZONING

Layers	Continuous exposures.
Lenses	Discontinuous layers of lenticular shape.
Pockets	Irregular inclusions of different material.

SOIL CEMENTING

Weakly	Easily broken up by hand.
Moderately	Effort is required to break up the soil by hand.

USCS SYMBOLS

Symbol	Description
GW	Well graded gravels and gravel-sand mixtures, little or no fines.
GP	Poorly graded gravels and gravel-sand mixtures, little or no fines.
GM	Silty gravels, gravel-sand-silt mixtures.
GC	Clayey gravels, gravel-sand-clay mixtures.
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OL	Organic silts and organic silty clays of low plasticity.
MH	Inorganic silts of high plasticity.
CH	Inorganic clays of high plasticity.
OH	Organic clays of medium to high plasticity.
PT	Peat muck and other highly organic soils.

ROCK

SEDIMENTARY ROCK TYPE DEFINITIONS

Rock Type	**Definition** (more than 50% of rock consists of …..)
Conglomerate	… gravel sized (>2mm) fragments.
Sandstone	… sand sized (0.06 to 2mm) grains.
Siltstone	… silt sized (<0.06mm) particles, rock is not laminated.
Claystone	… clay, rock is not laminated.
Shale	… silt or clay sized particles, rock is laminated.

LAYERING

Term	Description
Massive	No layering apparent.
Poorly Developed	Layering just visible. Little effect on properties.
Well Developed	Layering distinct. Rock breaks more easily parallel to layering.

STRUCTURE

Term	Spacing (mm)	Term	Spacing
Thinly laminated	<6	Medium bedded	200 – 600
Laminated	6 – 20	Thickly bedded	600 – 2,000
Very thinly bedded	20 – 60	Very thickly bedded	> 2,000
Thinly bedded	60 – 200		

STRENGTH

Term	Is50 (MPa)	Term	Is50 (MPa)
Extremely Low	<0.03	High	1.0 – 3.0
Very low	0.03 – 0.1	Very High	3.0 – 10.0
Low	0.1 – 0.3	Extremely High	>10.0
Medium	0.3 – 1.0		

NOTE: Is50 = Point Load Strength Index

WEATHERING

Term	Description
Residual Soil	Soil derived from weathering of rock; the mass structure and substance fabric are no longer evident.
Extremely …..	Rock is weathered to the extent that it has soil properties (either disintegrates or can be remoulded). Fabric of original rock is still visible.
Highly …..	Rock strength usually highly changed by weathering; rock may be highly discoloured.
Moderately …..	Rock strength usually moderately changed by weathering; rock may be moderately discoloured.
Slightly …..	Rock is slightly discoloured but shows little or no change of strength from fresh rock.
Fresh	Rock shows no signs of decomposition or staining.

DEFECT DESCRIPTION

Type

Joint	A surface or crack across which the rock has little or no tensile strength. May be open or closed.
Parting	A surface or crack across which the rock has little or no tensile strength. Parallel or sub-parallel to layering/ bedding. May be open or closed.
Sheared Zone	Zone of rock substance with roughly parallel, near planar, curved or undulating boundaries cut by closely spaced joints, sheared surfaces or other defects.
Seam	Seam with deposited soil (infill), extremely weathered insitu rock (XW), or disoriented usually angular fragments of the host rock (crushed).

Shape

Planar	Consistent orientation.
Curved	Gradual change in orientation.
Undulating	Wavy surface.
Stepped	One or more well defined steps.
Irregular	Many sharp changes in orientation.

Roughness

Polished	Shiny smooth surface.
Slickensided	Grooved or striated surface, usually polished.
Smooth	Smooth to touch. Few or no surface irregularities.
Rough	Many small surface irregularities (amplitude generally <1mm). Feels like fine to coarse sandpaper.
Very Rough	Many large surface irregularities, amplitude generally >1mm. Feels like very coarse sandpaper.

Coating

Clean	No visible coating or discolouring.
Stained	No visible coating but surfaces are discoloured.
Veneer	A visible coating of soil or mineral, too thin to measure; may be patchy
Coating	Visible coating ≤1mm thick. Thicker soil material described as seam.

Important Information about your Slope Instability Risk Assessment

1. BASIS OF THE ASSESSMENT

This assessment is based on a visual inspection of the property and also the immediate adjoining land. Limited subsurface investigation may also have been undertaken as part of this appraisal. Slope monitoring has not been carried out within or adjacent to the property for the purposed of this appraisal. The opinions expressed in this report are based on our relevant local experience.

Our conclusions on the stability of the land are presented in the framework of the Australian Geomechanics Society's risk classification system, which is described in the attachments to the report.

The property is within an area where landslip and/or subsidence have occurred, or where there are risks that slope instability may occur. Important factors relating to slope conditions and the impact of development which commonly influence the risks of slope instability are discussed herein.

An owner's decision to acquire, develop or build on land within an area such as this involves the understanding and acceptance of a level of risk. It is important to recognise that soil and rock movements are an ongoing geological process, which may be affected by development and land management within the site or on adjoining land. Soil and rock movements may cause visible damage to structures even where the risk of slope failure is considered low. This report is intended only to assess the risk of slope failure, apparent at the time of inspection.

Our opinion is provided on the present risk of slope instability for the land specifically referenced in the title to this report. Foundations suitable for future building development are discussed in relation to slope stability considerations. Limited foundation advice may be provided. If so, advice is intended to guide the footing design for the proposed development. However, this report is not intended as, is not suitable for, and must not be used in lieu of a detailed foundation investigation for final design and costing of foundations, retaining walls or associated structures.

2. IMPORTANT FACTORS

2.1 Limitations of the Assessment Procedure

The assessment procedures carried out for this appraisal are in accordance with the recommendations of the AGS March 2000 *Landslide Risk Management Concepts and Guidelines,* and with accepted local practice.

The following limitations must be acknowledged:-

- the assessment of the stability of natural slopes requires a great degree of judgment and personal experience, even for experienced practitioners with good local knowledge;
- the assessment must be based on development of a sound geological model; slope processes and process rates influencing land sliding or landslide potential will vary according to geomorphologic influences;
- the likelihood that land sliding may occur on a given slope is generally hard to predict and is associated with significant uncertainties;
- different practitioners may produce different assessments of risk;
- actual risk of land sliding cannot be determined; risk changes with time;
- consequences of land sliding need to be considered in a rational framework of risk acceptance;
- acceptable risk in relation to damage to property from landslide activity is subjective; it remains the
- responsibility of the owner and/or local authority to decide whether the risk is acceptable; the geotechnical practitioner can assist with this judgment;
- the extent and methods of investigation for assessment of landslide risk will be governed by experience, by the perceived risk level, and by the degree to which the risk or consequences of land sliding are accepted for a specific project;
- the assessment may be required at a number of stages of the project or development; frequently (due to time or budget constraints imposed by the client) there will be no opportunity for long-term monitoring of the slope behaviour or groundwater conditions, or for on-going opportunity for the slope processes and performance of structures to be reviewed during and after development; such limitations should be recognised as relevant to the assessment.

2.2 Slope Instability

In the Sydney Basin region, natural slope instability is mostly confined to the talus or colluvial material, but in some cases occurs in the residual clay soil overburden. The underlying bedrock on natural slopes, even in highly weathered form, is generally stable. Exceptions can occur and are known, particularly in the Illawarra and Newcastle regions.

In most of the reported slope failures in the Sydney Basin region, the cause of failure may be traced to one of the following factors:

i. interference with natural drainage features
ii. introduction of additional water to the area
iii. excavation or removal of soil or rock from the toe (bottom) of the slope
iv. addition of soil or rock to the top of the slope.

There have been some slope failures with no immediately apparent cause and it is our opinion that these failures resulted from natural changes in the groundwater conditions in the slope during or some time after very heavy or prolonged periods of rainfall.

Continuing or intermittent down slope soil movement is an on-going natural geological process. It may be modified (accelerated or slowed) by the activities of man. Such movements become of concern when their magnitude or rate has the potential to threaten the integrity of man-made improvements or threaten life or safety. A broad assessment of slope stability risk is presented in this report and it should be recognised there is always a possibility that unpredicted slope movements can occur.

Developments can be designed to tolerate, or be isolated from, the effects of minor slope movements. Geotechnical assessment and design input, and monitoring will usually be required for such purposes.

In the case of creeping hill slopes, design that isolates the structure from the effects of slope creep is preferable. For example, retaining walls should be separated from the house structure so that if they move because of soil creep or other slope influences, the movements are not transmitted to the house. Where this cannot be achieved for the design, significant strengthening of the structure and/or its foundations, or other measures to modify the potential for slope movements, or the capacity of the structure to accommodate slope movements, will be required.

2.3 Development on Slopes

2.3.1 General

Some risk of slope instability is always attached to the development of land on slopes formed on talus and colluvium, and on residual soils. Guidelines for hillside construction and examples of good practices for hillside developments are provided with the assessment undertaken and reported herewith.

2.3.2 Effects of Construction on Slope Stability

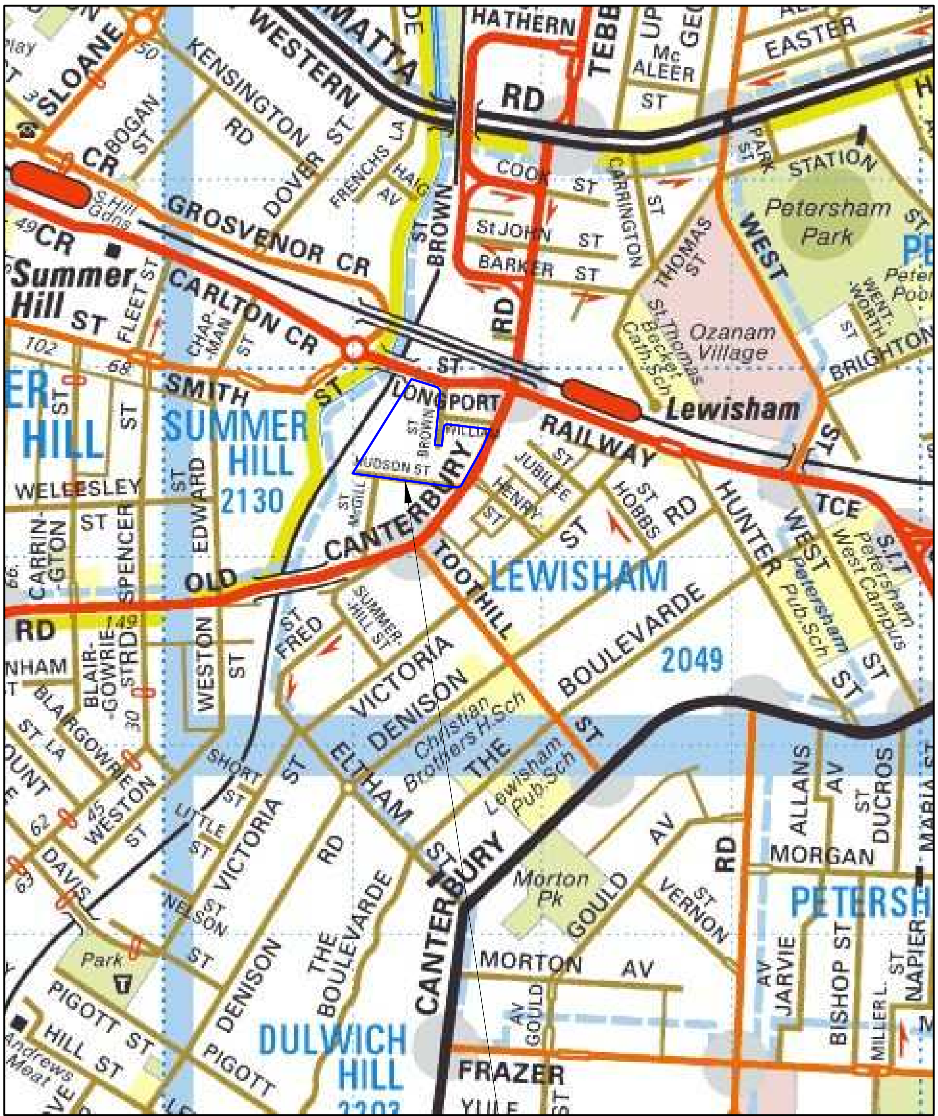
The stability of apparently stable land may be adversely affected by various activities on the land or in the vicinity, as follows:

- the diversion of surface water onto the land by new roads, houses, landscaping, or other construction activities,
- the placing of filling either above or beside the land,
- the excavation or removal of soil or rock from the area below (downhill) of the land,
- the construction of absorption areas for stormwater or effluent, or other systems whereby liquids are introduced into the soil and rock.

2.3.3 Effects of Drainage on Slope Stability

Good surface and subsurface drainage will usually improve the stability of a slope. Where a new structure, modifications to an existing structure or landscaping is proposed on a slope, it is highly likely that some form of surface or subsurface drainage will be required to maintain or improve the stability of the slope.

All proposed construction, developments or alterations on slopes should be reviewed by a geotechnical engineer to assess the effect on slope stability and to assess the required drainage.



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ENVIRONMENTAL INVESTIGATIONS

SITE LOCALITY

drawn: MAB		fig:	1
date: 1/6/10			
checked:		rev:	–
scale: 1:10,000		job no.:	1485

rev	by	date	description
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REGIONAL GEOLOGY

drawn:	MAB	**fig:**	2
date:	1/6/10		
checked:		**rev:**	–
scale:	1:20,000	**job no.:**	1485

LEGEND

- Borehole Locations
- Borehole / Monitoring Well Locations
- Approx. Site Boundaries

0 10 20 30 40 50
Approx. Scale (m)

SOURCE: ENVIRONMENTAL INVESTIGATIONS, SAMPLING LOCALITY PLAN, PROJECT E1074.1, FIG 2

rev	by	date	description
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SAMPLING LOCATION PLAN

drawn:	MAB	fig:	3
date:	1/6/10		
checked:		rev:	–
scale:	~1:1,600	job no.:	1485