coffey geotechnics
SPECIALISTS MANAGING THE EARTH

PRELIMINARY GEOTECHNICAL INVESTIGATION - PROPOSED COMMERCIAL DEVELOPMENT

Bovis Lend Lease
Corner of Olympic Boulevard and Herb Elliott Avenue, Sydney Olympic Park, Homebush Bay

GEOTLCOV23048AA-AH
16 January 2007

Coffey Geotechnics Pty Ltd ABN 93 056 929 483
8/12 Mars Road Lane Cove West NSW 2066 Australia

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

16 January 2007

Bovis Lend Lease
The Bond
30 Hickson Road
Millers Point NSW 2000

Attention: Rod McCoy

Dear Sir

RE: GEOTECHNICAL INVESTIGATION - PROPOSED COMMERCIAL DEVELOPMENT CNR OYLIMPIC BOULEVARD & HERB ELLIOT AVENUE, SYDNEY OLYMPIC PARK, HOMEBUSH BAY

This report presents the results of a geotechnical investigation carried out by Coffey Geotechnics Pty Ltd (Coffey) for a site situated at the corner of Olympic Boulevard and Herb Elliot Avenue within Sydney Olympic Park, Homebush Bay.

Should you require further clarifications on any aspects of this report, please contact the undersigned on 9911 1000.

For and on behalf of Coffey Geotechnics Pty Ltd

Peter Waddell

PETER WADDELL

Principal

Distribution:	Original copy held by Coffey Geosciences Pty Ltd
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1. INTRODUCTION

This report presents the results of a preliminary geotechnical investigation carried out by Coffey Geotechnics Pty Ltd (Coffey) for the proposed commercial building to be developed at the corner of Olympic Boulevard and Herb Elliot Avenue (site 4B) within Sydney Olympic Park, Homebush Bay. Coffey was commissioned by Mr Rod McCoy of Bovis Lend Lease (BLL) to carry out the investigation work. The investigation was generally carried out in accordance with our proposal GEOTLCOV23048AA/AA, dated 4 August 2006.

We understand that the site is L-shaped and covers and area of about 5,000 m^2. A seven storey commercial office building with three basement levels is proposed. We understand excavations up to around 9m below ground level are proposed.

The objectives of the preliminary investigation were to provide information on subsurface conditions, a geotechnical model, and discussion and recommendations on significant geotechnical constraints to the proposed development and geotechnical aspects such as excavation conditions, retaining wall design parameters, suitable footing types, and foundation design parameters.

Coffey has carried out a preliminary contamination assessment for the site which is reported separately.

2. METHOD OF INVESTIGATION

2.1 Fieldwork

Fieldwork was carried out on 16 and 17 August 2006 and comprised the drilling of three boreholes (BH1 to BH3) to a depth of 12m using a truck mounted drill rig. The borehole locations are shown on Figure 1, Site Plan.

Standard Penetration Testing was carried out at regular depth intervals as drilling progressed in soils to assessment strength and to obtaining samples for logging. The boreholes were drilled to the refusal depth of a V bit and thereafter continued using a tungsten carbide bit through soil and weathered rock. The less weathered rock was cored using a triple tube core barrel. Rock cores were photographed and are presented with the borehole logs.

The field investigation was directed by a Coffey geotechnician, who located the boreholes by measuring from existing site features, recorded test results and logged the samples obtained. Ground levels at the boreholes were measured using a staff and level and were related to ground levels on the supplied topographic survey plan, which shows spot levels and contours to Australian Height Datum. Upon completion of the fieldwork, boreholes were backfilled with cuttings.

Engineering logs of the borehole are presented in Appendix A, together with Explanation Sheets defining the terms and symbols used in preparing the logs.

2.2 Laboratory Testing

Disturbed soil samples from Standard Penetration Testing and rock core samples were transported to our NATA registered laboratory. No soil testing was carried out. Representative rock core samples were designated for Point Load Strength Index (PLI) testing for estimates of rock strength. Colour photographs of the rock cores were taken and presented as part of the borehole logs in Appendix A.

3. SITE CONDITIONS

3.1 Surface Conditions

The site is predominantly occupied by an asphalt carpark used for metered and permit parking by private motor vehicles. Portions of the site along the northern and western site boundaries are landscaped and include a row of mature trees, garden beds, grassed park and public walkway. Herb Elliot Avenue and Olympic Boulevard are located to the north and to the west of the site respectively. The site is currently identified as development site (4B) and cadastal information indicates the site is comprised predominantly of Lot 60 of DP786296 and also includes a small portion of Lot 50 of DP 1045522 along the western site boundary.

The site slopes gently down from the south-east to the north-west. The surface level along the avenue of trees is about 1m lower than the surface level of the carpark.

3.2 Geology

The Sydney Geological Sheet 9130 (Edition 1983, 1:100,000 scale) indicates that Ashfield Shale underlies the site locality. The shale is described as black to dark grey shale and laminite.

3.3 Subsurface Conditions

The results of the investigation indicate that the subsurface profile at the test locations comprises topsoil / fill overlying residual soils and shale bedrock.

Based on the information obtained from the boreholes, a geotechnical model has been developed, and is presented in Table 1, together with a summary of subsurface conditions at the borehole locations. For a detailed description of the subsurface conditions encountered at the borehole locations, refer to the Engineering Logs in Appendix A, together with Explanation Sheets describing the terms and symbols used in their preparation.

TABLE 1: SUMMARY OF SUBSURFACE CONDITIONS AT BOREHOLE LOCATIONS AND INFERRED GEOTECHNICAL MODEL

Unit	Description	Depth to Base Of Unit (m)	Thickness Of Unit (m)
1. Fill	This unit is divided into two sub-classes: Unit 1A typically: • Asphalt (encountered in BH 2 only). • Road Base & Sand (encountered in BH 2 only).	0.3	0.3
	Unit 1B typically: • Silty Clay with some gravels (encountered in BH 1 & BH3 only).	0.6 to 0.7	0.6 to 0.7

Unit	Description	Depth to Base Of Unit (m)	Thickness Of Unit (m)
2. Residual Soil	Typically: • Silty / Shaly CLAY; • Medium and high plasticity; • Very Stiff to Hard consistency.	1.2 to 3.0	0.5 to 2.5
3. Shale	This unit is divided into three sub-classes: Unit 3A typically: • Extremely and highly weathered Shale; • Very low strength; • Class V Shale *	3.5 to 5	0.7 to 3.8
	Unit 3B typically: • Highly weathered Shale; • Very low and low strength • Class IV Shale *	4.8 to 6.8	1.3 to 2.2
	• Unit 3C typically: • Moderately weathered to fresh Shale; • Medium and High strength; • Class III Shale or better *.	Drilled to a depth of up to 12m	

Note:

* Rock class assessed in accordance with Pells et all (1998) “Foundations on Sandstone and Shale in the Sydney Region” Aust. Geomech. Jnl. Dec 1998.

Figure 2 shows cross sections based on the boreholes drilled for this investigation. Other boreholes held in Coffey files for the adjacent site 4A and rail tunnel indicate similar subsurface profiles to the west and north.

No groundwater was observed within the depth of augering in the boreholes. However, no long term groundwater monitoring was carried out. Previous investigations, which were carried out within the nearby areas to the west, detected two groundwater systems, namely perched aquifers, which occurred in fill and natural soils at relatively shallow depths; and a semi-confined aquifer which was observed within the shale bedrock (reference Coffey Report S9547/1-AH, dated 12 August 1991).

3.4 Laboratory Test Results

Point Load Strength Index results are presented on the engineering logs and in Appendix B.

4. DISCUSSIONS AND RECOMMENDATIONS

4.1 General

With a subsurface profile comprising relatively shallow fill and natural soil overlying rock, there should be no significant geotechnical constraints to the proposed basement excavations and foundations for multi storey development. Excavations should be able to be carried out using commonly available plant and normal basement retention systems, rock face support and footings should be able to be adopted.

4.2 Excavation Conditions

Contractors should be required to examine the engineering logs, core photographs and rock cores to make their own assessment of excavation plant and production rates.

We anticipate that the proposed basements would require excavations to depths of up to about 9m below existing ground surface. Therefore, the excavations will penetrate into the better quality Unit 3C Shale.

A hydraulic excavator or bulldozer blade and bucket should be adequate for excavation in residual soils (Unit 2) and the Class V Shale (Unit 3A). Class IV Shale in Unit 3B should be able to be ripped using a Class 300 crawler tractor (as defined in AS2868-1986). Ripping may be more difficult into the high strength shale in Unit 3C and a class 400 or 500 crawler tractor may be required for bulk excavations. An impact hammer or rock saw would be required for trimming and footing excavations.

Use of impact hammers may result in vibrations that could damage adjacent structures. A rock saw could be used to reduce the lateral transfer of vibrations. Dilapidation surveys and vibration monitoring should be considered if vibration sensitive structures lie within close proximity to excavations.

4.3 Dewatering

Our current investigation did not detect the presence of groundwater in the boreholes. Our Report S9547/1-AH, dated 12 August 1991 indicates that two groundwater systems were identified within the nearby areas to the west during our previous investigation, namely perched aquifers (which occurred in fill and natural soils at relatively shallow depths) and semi-confined aquifer (which was observed within shale bedrock).

On the basis of the groundwater levels previously observed, groundwater is likely to be encountered in excavations to depths of 9m. It is anticipated that the seepage inflow into the basement excavation should be able to be controlled by pumping from sumps.

4.4 Temporary Cut Batters and Retaining Structures

The Unit 1 Fill should be cut at 2H: 1V. Temporary unsupported cuts in the Unit 2 Residual Soil and Unit 3A should be able to be excavated at 1H: 1V above the groundwater table, provided that surcharge loads are kept well clear of the crest of batters.

4.5 Retaining Structures

Where there is insufficient room to form unsupported batters, retaining walls will be required. Shoring will be required through the Units 1, 2, 3A and 3B. We would expect that shoring piles would react refusal on medium and high strength shale such as is likely to be encountered within Unit 3C.

Retaining walls such as bored soldier piles with timber infill panels or shotcrete panels between the soldier piles could be adopted. Pile spacings of up to 3 pile diameters should be feasible, however, there is a risk that the fill may not arch between piles, particularly if saturated. Provision should be made for timber lagging and for placing mesh and shotcrete progressively as excavation proceeds, rather than leaving fill and residual soil unsupported over excavation depths of many metres.

The design of retaining walls for multi-anchored or braced walls is geotechnically complex. The relative stiffness of the wall and support system to that of the soil/rock will strongly influence the resulting earth pressure magnitude and distribution. Earth pressure coefficients adopted for design will depend on the analytical tools utilised in the design, and whether numerical analysis methods used allow for stress re-adjustment to occur with wall movements.

It is recommended that detailed soil-structure numerical analysis be undertaken to develop a cost-effective retention support system. The typical design parameters presented below can be adopted for preliminary structural design, however, for the assessment of movements and impacts on the nearby rail corridor numerical modelling using specialist geotechnical software should be undertaken.

Site retention piles should be socketed into the rock, penetrating into the Class III or better Shale. Allowance should be made for high capacity piling rigs operated by an experienced piling contractor. Unsupported excavation faces may be feasible and result if piles terminate above the bulk excavation level in high strength Unit 3C. Toe anchors may be required to restrain the retention system pile toes. The exposed rock should be inspected by a geotechnical engineer to assess whether adverse joint features exist which require rock bolting. In the long term the shale is likely to deteriorate and a layer of mesh reinforced shotcrete should be applied to protect the shale.

Basement retaining walls will generally require props comprising rows of temporary anchors in the short term and floor slabs in the permanent case. Where the walls are cantilevered or supported by a single row of anchors and some wall movements can be tolerated, retaining walls can be designed assuming a triangular earth pressure distribution using an active earth pressure coefficient of 0.35. A bulk unit weight of 20kN/m^3 should be assumed for residual soils and weathered rock.

Where ground anchors restrain retaining wall movement, or where significant movements cannot be tolerated, an earth pressure coefficient of 0.5 should be adopted. However, it should be understood that walls designed for this higher coefficient will still undergo some lateral movements, depending on the nature of the wall and the construction sequences.

The preliminary design of the retaining walls that are anchored or strutted at several levels could be based on a trapezoidal earth pressure distribution as shown in Table 2.

Table 2: Trapezoidal Pressure Distribution

Depth (m)	Horizontal Pressure (kPa)
0	K.ps
0.25 H	K (0.8.γ.H + ps)
0.75 H	K (0.8.γ.H + ps)
H	K.ps

Where:

K = earth pressure coefficient which depends upon material type; whether movement needs to be limited; whether temporary or permanent

ps = design surcharge pressure (kPa)

H = thickness of layer being retained (m)

γ = 20kN/m^3

Hydrostatic pressures should be added to earth pressures unless walls can be provided with effective drainage, and pressures due to adjacent footings will also need to be taken into account. The above pressures assume level ground above the retaining wall. Surcharge loads should be added to earth pressures, as appropriate.

If fully drained walls are to be constructed, vertical geocomposite drains should be installed at appropriate intervals, extending for the full depth of the excavation. All vertical drains should be connected to a geofabric wrapped perimeter drain provided at the toe of the final excavation, which should discharge to the site stormwater system to provide long term drainage behind excavation walls. Flushing points should be incorporated into the design of the perimeter drain to allow periodic maintenance. Nevertheless a typical allowance of potential water pressure build-up equivalent to one-third the wall height is considered to be prudent with such drainage measures installed.

Rock anchors should generally be specified in terms of performance requirements and constructed by contractors experienced in ground anchor technology. Temporary and permanent ground anchors may be designed using the allowable bond values given in Table 3.

Table 3: Allowable Bond Stress for Ground Anchor Design

Stratigraphic Unit	Allowable Bond Stress (kPa)
Unit 3A – Class V Shale	50
Unit 3B – Class IV Shale	150
Unit 3C – Class III or better Shale	350

The above values are given on the proviso that the anchor bond lengths are at least 3m and not more than 7m long, and each anchor is proof loaded to 1.3 times (temporary anchors) and 1.5 times (permanent anchors) prior to locking off at the required working load.

Anchor designs should be based on allowing effective bonding to be developed behind an ‘active zone’ determined by drawing a line at 45^o from the base of the wall to intersect the ground surface behind the excavated face.

Installation of ground anchors beyond the site boundaries will require permission to be obtained from relevant authorities and adjacent property owners.

4.6 Excavation Induced Ground Movements

Ground movements are likely to occur due to the proposed excavation. In the retained section of the excavation, lateral and vertical ground movements will be dependent on the design and construction of the retention system. For example, the use of higher earth pressure coefficients, tie-back anchor loads and stiffer walls will reduce lateral deflections.

For preliminary estimate purposes, published data suggests that lateral movements of an adequately designed and installed retention system in stiff clay will be between 0.2% and 0.5% of the retained height for adequately engineered walls. Vertical movements could be expected to be of a similar order to the lateral movements. The extent of the horizontal movement behind the excavation face is typically between 1.5 and 3 times the excavated height.

Where structures sensitive to ground movements lie close to the site, dilapidation surveys should be carried out prior to excavation and numerical analysis should be carried out to assess the potential ground movement and interaction with the shoring wall design to control deflections to tolerable limits. Survey monitoring should also be carried out to confirm that movements are within the predicted range.

Once preliminary structural designs of the retention system are available Coffey recommends that soil structure interaction analysis be carried out to assess ground movements that could impact on the adjacent rail tunnels.

4.7 Foundations

We recommend that building loads be supported on rock. If excavations extend to 9m Unit 3C shale should be exposed. Relatively high allowable bearing pressure should be able to be adopted on the class III or better shale. Open bored piles or CFA piles should prove practical for the retention system. Open bored piles may require temporary liners through fill or if groundwater seepage occurs

For strip, pad footings and bored piles, our recommendations for design parameters are provided in Table 4 below. The use of the recommended allowable bearing pressures would be expected to result in pile settlements less than about 1% of pile diameters.

Table 4: PRELIMINARY FOOTING Design Parameters

Stratigraphic Unit	Allowable End Bearing Pressures (kPa)(1)	Allowable Shaft Adhesion (kPa) (2), (3)
Unit 3A – Class V Shale	700	50
Unit 3B – Class IV Shale	1,000	100
Unit 3C – Class III Shale	3,500	250
– Class II Shale	6,000	500

Note:

1. Assumes minimum socket of 0.3m into the nominated unit.
2. Piles that rely on shaft adhesion should be dewatered, cleaned and concreted within 12 hours of excavation to reduce the risk of softening of the pile shaft.
3. Shaft adhesion should only be adopted for piers that have a minimum embedment of at least 3 pier diameters into rock and a rough socket (at least grooves of depth 1mm to 4mm and width greater than 5mm at spacing of 50mm to 200mm). The socket should be cleaned and roughened by a suitable scraper such as a tooth, orientated perpendicular to the auger shaft.

For uplift capacity, the shaft adhesion value should be multiplied by 0.6. In addition to shaft adhesion, the uplift capacity should be checked for a cone pullout failure mode assuming a cone angle of 70o considering the submerged weight of the soil or rock and adopting a factor of safety of 1.0 against pullout.

An experienced geotechnical engineer should observe boring of the piles in order to assess the rock levels and to confirm that the rock is suitable for the adopted design parameters.

Footing inspection and assessment requirements are provided in Table 5. Where the required serviceability bearing pressure is greater than 2MPa, footing assessment should also include spoon testing (or cored boreholes) to assess whether defects below the base of the footing are within tolerable limits for the respective rock class.

Table 5: Footing Inspection and Assessment Requirements

Rock Unit	Testing Requirements
Unit 3A and Unit 3B – Class V and IV Shale	• Visual inspection of pad footings. • Observation of piling and correlation with borehole information.
Unit 3C Class III or better Shale	• Visual inspection; and • Initial allowance for spoon testing 1/3 of all pad footings or coring of pier locations. • May be reduced if consistent conditions are exposed in early testing or if rock below founding levels can be inspected in lift shaft excavations.

5. LIMITATIONS

The geotechnical model and recommendations presented in this report are based on a limited number of boreholes with limited site coverage. Variations in ground conditions can occur over relatively short distances and further investigations are required to assess the uniformity of subsurface conditions across the site for detailed design.

A suitably qualified geotechnical engineer should be engaged during construction to assess whether exposed conditions are consistent with design assumptions. The attached document entitled “Important Information about your Coffey Report” presents additional information on the uses and limitation of this report.

For and on behalf of Coffey Geotechnics Pty Ltd

Peter Waddell

PETER WADDELL

Principal

Important information about your **Coffey** Report

As a client of Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Coffey and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Coffey to be advised how time may have impacted on the project.

Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

Important information about your **Coffey** Report

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey to work with other project design professionals who are affected by the report. Have Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

Data should not be separated from the report*

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way.

Logs, figures, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment.
Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Coffey for information relating to geoenvironmental issues.

Rely on Coffey for additional assistance

Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction, speak with Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Coffey to other parties but are included to identify where Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey closely and do not hesitate to ask any questions you may have.

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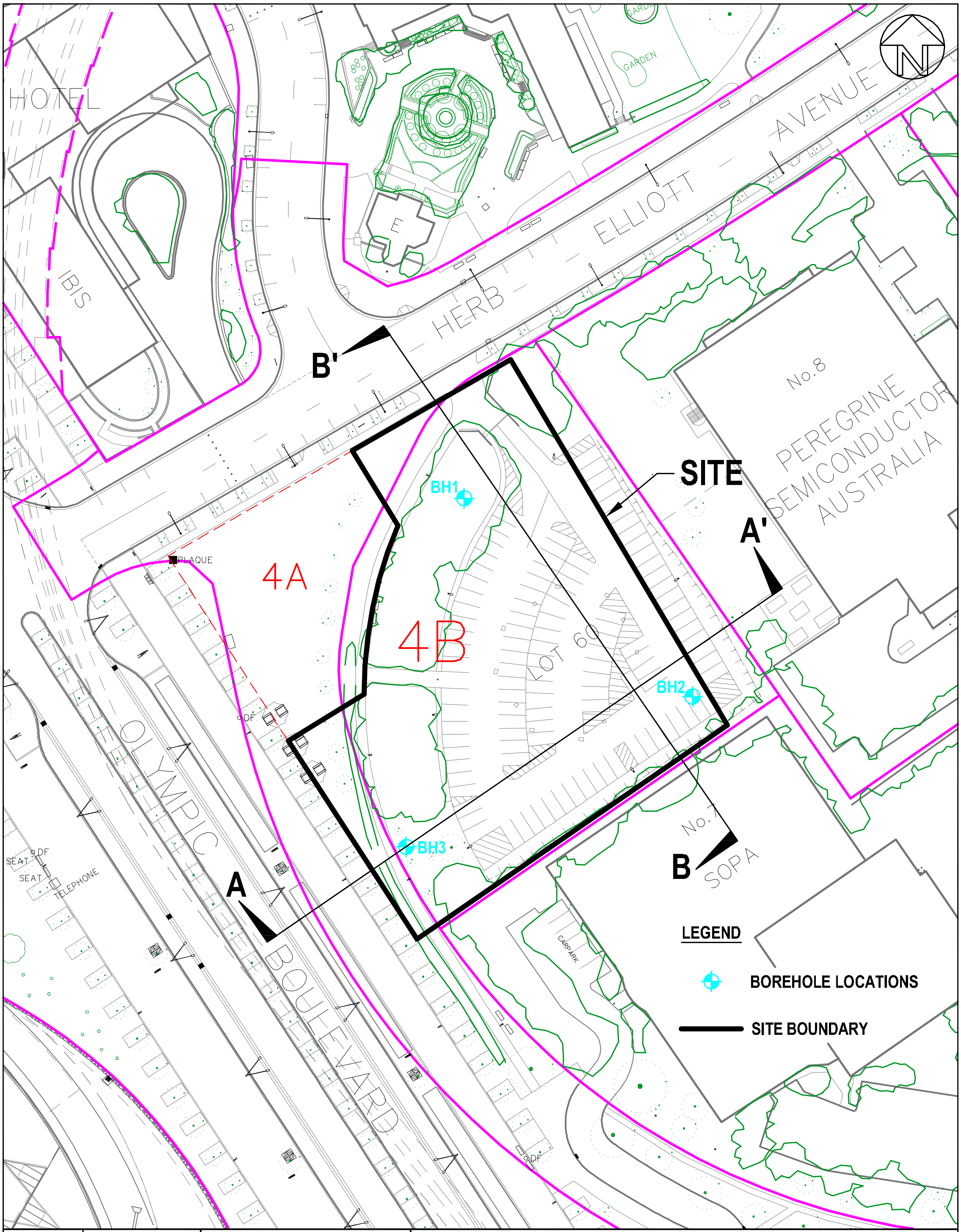
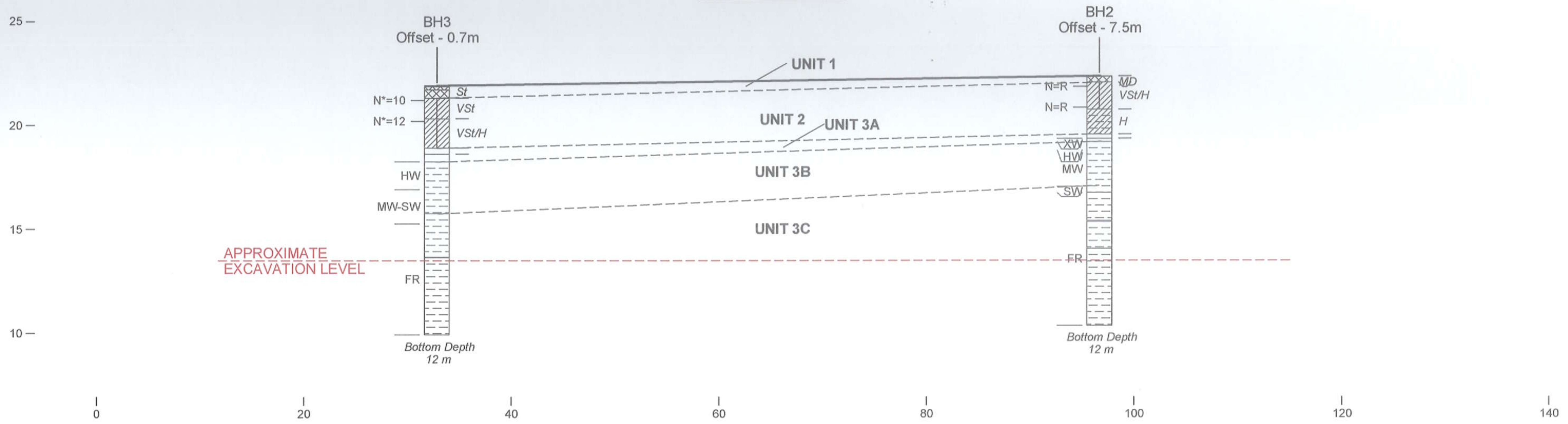
* For further information on this aspect reference should be made to "Guidelines for the Provision of Geotechnical information in Construction Contracts" published by the Institution of Engineers Australia, National headquarters, Canberra, 1987.

Figures

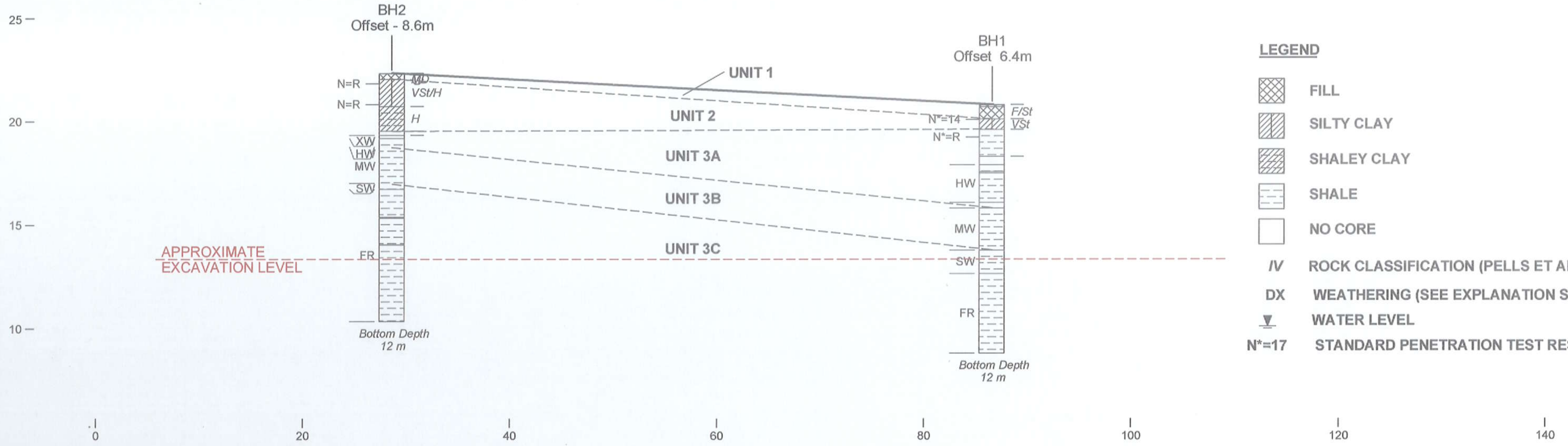


drawn	SH/AW	coffey geotechnics SPECIALISTS MANAGING THE EARTH	client: BOVIS LEND LEASE
approved	PJW		project: GEOTECHNICAL INVESTIGATION PROPOSED COMMERCIAL DEVELOPMENT - CORNER OF OLYMPIC BOULEVARD & HERB ELLIOTT AVENUE (SITE 4B), HOMEBUSH BAY
date	16/01/07		
scale	1:1000		title: SITE LAYOUT PLAN FEATURING BOREHOLE LOCATIONS
original size	A4		project no: GEOTLCOV23048AA figure no: FIGURE 1

SECTION A-A'



SECTION B-B'



LEGEND

▩	FILL
▨	SILTY CLAY
▨	SHALEY CLAY
▤	SHALE
☐	NO CORE
IV	ROCK CLASSIFICATION (PELLS ET AL, 1998)
DX	WEATHERING (SEE EXPLANATION SHEETS)
▼	WATER LEVEL
N*=17	STANDARD PENETRATION TEST RESULT

revision	description	drawn	approved	date

4 0 20
Horizontal Scale (metres)

2 0 10
Vertical Scale (metres)

drawn	SH/SW
approved	PJW
date	16/01/07
scale	AS SHOWN
original size	A3

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

client: **BOVIS LEND LEASE**

project: **GEOTECHNICAL INVESTIGATION**
PROPOSED COMMERCIAL DEVELOPMENT CNR OF
OLYMPIC BOULEVARD & HERB ELLIOTT AVENUE
(SITE 4B), HOMEBUSH BAY

title: **GEOTECHNICAL SECTIONS A-A' & B-B'**

project no: **GEOTLCOV23048AA**
figure no: **FIGURE 2**

Appendix A

Engineering Borehole Logs, Core Photographs and Explanation Sheets

Soil Description Explanation Sheet (1 of 2)

DEFINITION:

In engineering terms soil includes every type of uncemented or partially cemented inorganic or organic material found in the ground. In practice, if the material can be remoulded or disintegrated by hand in its field condition or in water it is described as a soil. Other materials are described using rock description terms.

CLASSIFICATION SYMBOL & SOIL NAME

Soils are described in accordance with the Unified Soil Classification (UCS) as shown in the table on Sheet 2.

PARTICLE SIZE DESCRIPTIVE TERMS

NAME	SUBDIVISION	SIZE
Boulders		>200 mm
Cobbles		63 mm to 200 mm
Gravel	coarse	20 mm to 63 mm
	medium	6 mm to 20 mm
	fine	2.36 mm to 6 mm
Sand	coarse	600 µm to 2.36 mm
	medium	200 µm to 600 µm
	fine	75 µm to 200 µm

MOISTURE CONDITION

Dry	Looks and feels dry. Cohesive and cemented soils are hard, friable or powdery. Uncemented granular soils run freely through hands.
Moist	Soil 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.

CONSISTENCY OF COHESIVE SOILS

TERM	UNDRAINED STRENGTH s_u (kPa)	FIELD GUIDE
Very Soft	<12	A finger can be pushed well into the soil with little effort.
Soft	12 - 25	A finger can be pushed into the soil to about 25mm depth.
Firm	25 - 50	The soil can be indented about 5mm with the thumb, but not penetrated.
Stiff	50 - 100	The surface of the soil can be indented with the thumb, but not penetrated.
Very Stiff	100 - 200	The surface of the soil can be marked, but not indented with thumb pressure.
Hard	>200	The surface of the soil can be marked only with the thumbnail.
Friable	–	Crumbles or powders when scraped by thumbnail.

DENSITY OF GRANULAR SOILS

TERM	DENSITY INDEX (%)
Very loose	Less than 15
Loose	15 - 35
Medium Dense	35 - 65
Dense	65 - 85
Very Dense	Greater than 85

MINOR COMPONENTS

TERM	ASSESSMENT GUIDE	PROPORTION OF MINOR COMPONENT IN:
Trace of	Presence just detectable by feel or eye, but soil properties little or no different to general properties of primary component.	Coarse grained soils: <5% Fine grained soils: <15%
With some	Presence easily detected by feel or eye, soil properties little different to general properties of primary component.	Coarse grained soils: 5 - 12% Fine grained soils: 15 - 30%

SOIL STRUCTURE

ZONING		CEMENTING	
Layers	Continuous across exposure or sample.	Weakly cemented	Easily broken up by hand in air or water.
Lenses	Discontinuous layers of lenticular shape.	Moderately cemented	Effort is required to break up the soil by hand in air or water.
Pockets	Irregular inclusions of different material.		

GEOLOGICAL ORIGIN

WEATHERED IN PLACE SOILS

Extremely weathered material	Structure and fabric of parent rock visible.
Residual soil	Structure and fabric of parent rock not visible.

TRANSPORTED SOILS

Aeolian soil	Deposited by wind.
Alluvial soil	Deposited by streams and rivers.
Colluvial soil	Deposited on slopes (transported downslope by gravity).
Fill	Man made deposit. Fill may be significantly more variable between tested locations than naturally occurring soils.
Lacustrine soil	Deposited by lakes.
Marine soil	Deposited in ocean basins, bays, beaches and estuaries.

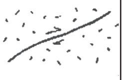
Soil Description Explanation Sheet (2 of 2)

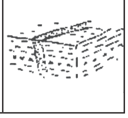
SOIL CLASSIFICATION INCLUDING IDENTIFICATION AND DESCRIPTION

FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 60 mm and basing fractions on estimated mass)							USC	PRIMARY NAME
COARSE GRAINED SOILS More than 50% of materials less than 63 mm is larger than 0.075 mm	(A 0.075 mm particle is about the smallest particle visible to the naked eye)	GRAVELS More than half of coarse fraction is larger than 2.0 mm	CLEAN GRAVELS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.			GW	GRAVEL
				Predominantly one size or a range of sizes with more intermediate sizes missing.			GP	GRAVEL
			GRAVELS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below)			GM	SILTY GRAVEL
				Plastic fines (for identification procedures see CL below)			GC	CLAYEY GRAVEL
		SANDS More than half of coarse fraction is smaller than 2.0 mm	CLEAN SANDS (Little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate sizes missing			SW	SAND
				Predominantly one size or a range of sizes with some intermediate sizes missing.			SP	SAND
			SANDS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below).			SM	SILTY SAND
				Plastic fines (for identification procedures see CL below).			SC	CLAYEY SAND
FINE GRAINED SOILS More than 50% of material less than 63 mm is smaller than 0.075 mm				IDENTIFICATION PROCEDURES ON FRACTIONS <0.2 mm.				
				DRY STRENGTH	**DILATANCY**	**TOUGHNESS**		
		SILTS & CLAYS Liquid limit less than 50		None to Low	Quick to slow	None	ML	SILT
				Medium to High	None	Medium	CL	CLAY
				Low to medium	Slow to very slow	Low	OL	ORGANIC SILT
		SILTS & CLAYS Liquid limit greater than 50		Low to medium	Slow to very slow	Low to medium	MH	SILT
				High	None	High	CH	CLAY
				Medium to High	None	Low to medium	OH	ORGANIC CLAY
HIGHLY ORGANIC SOILS				Readily identified by colour, odour, spongy feel and frequently by fibrous texture.			Pt	PEAT

- Low plasticity – Liquid Limit W_L less than 35%. • Modium plasticity – W_L between 35% and 50%.

COMMON DEFECTS IN SOIL

TERM	DEFINITION	DIAGRAM
PARTING	A surface or crack across which the soil has little or no tensile strength. Parallel or sub parallel to layering (eg bedding). May be open or closed.	
JOINT	A surface or crack across which the soil has little or no tensile strength but which is not parallel or sub parallel to layering. May be open or closed. The term 'fissure' may be used for irregular joints <0.2 m in length.	
SHEARED ZONE	Zone in clayey soil with roughly parallel near planar, curved or undulating boundaries containing closely spaced, smooth or slickensided, curved intersecting joints which divide the mass into lenticular or wedge shaped blocks.	
SHEARED SURFACE	A near planar curved or undulating, smooth, polished or slickensided surface in clayey soil. The polished or slickensided surface indicates that movement (in many cases very little) has occurred along the defect.	

TERM	DEFINITION	DIAGRAM
SOFTENED ZONE	A zone in clayey soil, usually adjacent to a defect in which the soil has a higher moisture content than elsewhere.	
TUBE	Tubular cavity. May occur singly or as one of a large number of separate or inter-connected tubes. Walls often coated with clay or strengthened by denser packing of grains. May contain organic matter	
TUBE CAST	Roughly cylindrical elongated body of soil different from the soil mass in which it occurs. In some cases the soil which makes up the tube cast is cemented.	
INFILLED SEAM	Sheet or wall like body of soil substance or mass with roughly planar to irregular near parallel boundaries which cuts through a soil mass. Formed by infilling of open joints.	

Rock Description Explanation Sheet (1 of 2)

The descriptive terms used by Coffey are given below. They are broadly consistent with Australian Standard AS1726-1993.

DEFINITIONS: Rock substance, defect and mass are defined as follows:

Rock Substance	In engineering terms roch substance is any naturally occurring aggregate of minerals and organic material which cannot be disintegrated or remoulded by hand in air or water. Other material is described using soil descriptive terms. Effectively homogenous material, may be isotropic or anisotropic.
Defect	Discontinuity or break in the continuity of a substance or substances.
Mass	Any body of material which is not effectively homogeneous. It can consist of two or more substances without defects, or one or more substances with one or more defects.

SUBSTANCE DESCRIPTIVE TERMS:

ROCK NAME	Simple rock names are used rather than precise geological classification.
PARTICLE SIZE	Grain size terms for sandstone are:
Coarse grained	Mainly 0.6mm to 2mm
Medium grained	Mainly 0.2mm to 0.6mm
Fine grained	Mainly 0.06mm (just visible) to 0.2mm
FABRIC	Terms for layering of penetrative fabric (eg. bedding, cleavage etc.) are:
Massive	No layering or penetrative fabric.
Indistinct	Layering or fabric just visible. Little effect on properties.
Distinct	Layering or fabric is easily visible. Rock breaks more easily parallel to layering of fabric.

CLASSIFICATION OF WEATHERING PRODUCTS

Term	Abbreviation	Definition
Residual Soil	**RS**	Soil derived from the weathering of rock; the mass structure and substance fabric are no longer evident; there is a large change in volume but the soil has not been significantly transported.
Extremely Weathered Material	**XW**	Material is weathered to such an extent that it has soil properties, ie, it either disintegrates or can be remoulded in water. Original rock fabric still visible.
Highly Weathered Rock	**HW**	Rock strength is changed by weathering. The whole of the rock substance is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Some minerals are decomposed to clay minerals. Porosity may be increased by leaching or may be decreased due to the deposition of minerals in pores.
Moderately Weathered Rock	**MW**	The whole of the rock substance is discoloured, usually by iron staining or bleaching , to the extent that the colour of the fresh rock is no longer recognisable.
Slightly Weathered Rock	**SW**	Rock substance affected by weathering to the extent that partial staining or partial discolouration of the rock substance (usually by limonite) has taken place. The colour and texture of the fresh rock is recognisable; strength properties are essentially those of the fresh rock substance.
Fresh Rock	**FR**	Rock substance unaffected by weathering.

Notes on Weathering:

1. AS1726 suggests the term "Distinctly Weathered" (DW) to cover the range of substance weathering conditions between XW and SW. For projects where it is not practical to delineate between HW and MW or it is judged that there is no advantage in making such a distinction. DW may be used with the definition given in AS1726.
2. Where physical and chemical changes were caused by hot gasses and liquids associated with igneous rocks, the term "altered" may be substituted for "weathering" to give the abbreviations XA, HA, MA, SA and DA.

ROCK SUBSTANCE STRENGTH TERMS

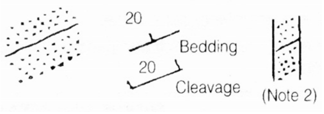
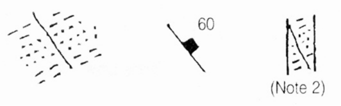
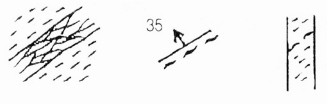
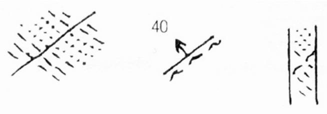
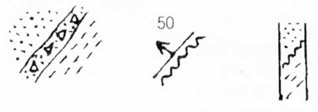
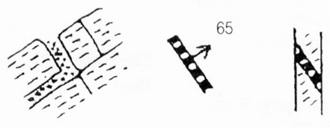
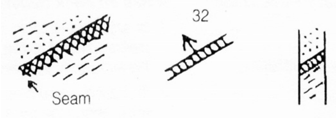
Term	Abbrev-iation	Point Load Index, I_S50 (MPa)	Field Guide
Very Low	**VL**	Less than 0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with a knife; pieces up to 30mm thick can be broken by finger pressure.
Low	**L**	0.1 to 0.3	Easily scored with a knife; indentations 1mm to 3mm show with firm bows of a pick point; has a dull sound under hammer. Pieces of core 150mm long by 50mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
Medium	**M**	0.3 to 1.0	Readily scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty.
High	**H**	1 to 3	A piece of core 150mm long by 50mm can not be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.
Very High	**VH**	3 to 10	Hand specimen breaks after more than one blow of a pick; rock rings under hammer.
Extremely High	**EH**	More than 10	Specimen requires many blows with geological pick to break; rock rings under hammer.

Notes on Rock Substance Strength:

1. In anisotropic rocks the field guide to strength applies to the strength perpendicular to the anisotropy. High strength anisotropic rocks may break readily parallel to the planar anisotropy.
2. The term "extremely low" is not used as a rock substance strength term. While the term is used in AS1726-1993, the field guide therein makes it clear that materials in that strength range are soils in engineering terms.
3. The unconfined compressive strength for isotropic rocks (and anisotropic rocks which fall across the planar anisotropy) is typically 10 to 25 times the point load index (Is50). The ratio may vary for different rock types. Lower strength rocks often have lower ratios than higher strength rocks.

Rock Description Explanation Sheet (2 of 2)

COMMON DEFECTS IN ROCK MASSES

Term	Definition	Diagram	Map Symbol	Graphic Log (Note 1)
Parting	A surface or crack across which the rock has little or no tensile strength. Parallel or sub parallel to layering (eg bedding) or a planar anisotropy in the rock substance (eg, cleavage). May be open or closed.			
Joint	A surface or crack across which the rock has little or no tensile strength. but which is not parallel or sub parallel to layering or planar anisotropy in the rock substance. May be open or closed.			
Sheared Zone (Note 3)	Zone of rock substance with roughly parallel near planar, curved or undulating boundaries cut by closely spaced joints, sheared surfaces or other defects. Some of the defects are usually curved and intersect to divide the mass into lenticular or wedge shaped blocks.			
Sheared Surface (Note 3)	A near planar, curved or undulating surface which is usually smooth, polished or slickensided.			
Crushed Seam (Note 3)	Seam with roughly parallel almost planar boundaries, composed of disoriented, usually angular fragments of the host rock substance which may be more weathered than the host rock. The seam has soil properties.			
Infilled Seam	Seam of soil substance usually with distinct roughly parallel boundaries formed by the migration of soil into an open cavity or joint, infilled seams less than 1mm thick may be described as veneer or coating on joint surface.			
Extremely Weathered Seam	Seam of soil substance, often with gradational boundaries. Formad by weathering of the rock substance in place.			

DEFECT SHAPE	TERMS
Planar	The defect does not vary in orientation
Curved	The defect has a gradual change in orientation
Undulating	The defect has a wavy surface
Stepped	The defect has one or more well defined steps
Irregular	The defect has many sharp changes of orientation

Note: The assessment of defect shape is partly influenced by the scale of the observation.

ROUGHNESS TERMS

Slickensided	Grooved or striated surface, usually polished
Polished	Shiny smooth surface
Smooth	Smooth to touch. Few or no surface irregularities
Rough	Many small surface irregularities (amplitude generally less than 1mm). Feels like fine to coarse sand paper.
Very Rough	Many large surface irregularities (amplitude generally more than 1mm). Feels like, or coarser than very coarse sand paper.

COATING TERMS

Clean	No visible coating
Stained	No visible coating but surfaces are discoloured
Veneer	A visible coating of soil or mineral, too thin to measure; may be patchy
Coating	A visible coating up to 1mm thick. Thicker soil material is usually described using appropriate defect terms (eg, infilled seam). Thicker rock strength material is usually described as a vein.

BLOCK SHAPE TERMS

Blocky	Approximately equidimensional
Tabular	Thickness much less than length or width
Columnar	Height much greate than cross section

Notes on Defects:

1. Usually borehole logs show the true dip of defects and face sketches and sections the apparent dip.
2. Partings and joints are not usually shown on the graphic log unless considered significant.
3. Sheared zones, sheared surfaces and crushed seams are faults in geological terms.

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Borehole No.	***BH1***
Sheet	1 of 3
Project No:	***GEOTLCOV23048.AA***

Engineering Log - Borehole

Client:	***Bovis Lend Lease***	Date started:	***16.8.2006***
Principal:		Date completed:	***16.8.2006***
Project:	***Proposed Commercial Development***	Logged by:	***FS***
Borehole Location:	***Corner of Olympic Bvd and Herbs Elliot Ave, Homebush***	Checked by:	***PJW***

drill model and mounting:	EDSON 3000 TRUCK MOUNTED	Easting:	92	slope:	-90°	R.L. Surface:	20.83
hole diameter:	125 mm	Northing	146	bearing:		datum:	AHD

drilling information / material substance

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetro-meter kPa 100 200 300 400	structure and additional observations
ADV									**FILL** Woodchip and topsoil	< Wp	F/St		FILL
									FILL: SILTY CLAY, medium plasticity, dark brown.				
				SPT 3,6,8 N*=14					**FILL**: SILTY CLAY, medium plasticity, brown to dark brown, mottled orange, some gravels, with trace of fine grained ironstone gravels.				
					20	1		CL/CH	**SILTY CLAY**: Medium to high plasticity, brown mottled red and grey, trace of fine grained ironstone gravels, with some fine grained shale gravels.	= Wp	VSt		RESIDUAL
				SPT 16,-,- N*=R	19	2			**SHALE**: Extremely weathered, brown and grey, very low strength, locally clay bands.				SHALE
ADT													V-bit refusal at 2 m
			NONE OBSERVED		18	3			Borehole BH1 continued as cored hole				
					17	4							
					16	5							
					15	6							
					14	7							
					13	8							

method

AS	auger screwing*
AD	auger drilling*
RR	roller/tricone
W	washbore
CT	cable tool
HA	hand auger
DT	diatube
B	blank bit
V	V bit
T	TC bit

*bit shown by suffix
e.g. ADT

support

M mud N nil
C casing

penetration
1 2 3 4
no resistance ranging to refusal

water
10/1/98 water level on date shown
water inflow
water outflow

notes, samples, tests

U_{50}	undisturbed sample 50mm diameter
U_{63}	undisturbed sample 63mm diameter
D	disturbed sample
N	standard penetration test (SPT)
N*	SPT - sample recovered
Nc	SPT with solid cone
V	vane shear (kPa)
P	pressuremeter
Bs	bulk sample
E	environmental sample
R	refusal

classification symbols and soil description
based on unified classification system

moisture

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

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Cored Borehole

Borehole No.	**BH1**
Sheet	2 of 3
Project No:	**GEOTLCOV23048.AA**
Date started:	**16.8.2006**
Date completed:	**16.8.2006**
Logged by:	**FS**
Checked by:	**PJW**

Client: *Bovis Lend Lease*

Principal:

Project: *Proposed Commercial Development*

Borehole Location: *Corner of Olympic Bvd and Herbs Elliot Ave, Homebush*

drill model & mounting: EDSON 3000 TRUCK MOUNTED
Easting: 92
slope: -90°
R.L. Surface: 20.83
hole diameter: 125 mm
Drilling fluid: Water
Northing: 146
bearing:
datum: AHD

drilling information / material substance / rock mass defects

method: NMLC
water: NONE OBSERVED

RL	depth metres
20	1
19	2
18	3
17	4
16	5
15	6
14	7
13	8

Continued from non-cored borehole

material: rock type; grain characteristics, colour, structure, minor components	weathering alteration	Is(50) MPa D- diametral A- axial	RQD %
NO CORE: 0.41m (2.5-2.91 m)			
SHALE: Orange-brown, mottled grey, distinctly laminated at 0º, iron staining in bands, clay infill up to 70 mm thick.	HW		0
NO CORE: 0.06m (3.24-3.3m)			
SHALE: Orange-brown, mottled grey, distinctly laminated at 0º, iron staining in bands, clay infill up to 70 mm thick.			0
NO CORE: 0.275m (4.725-5m)			
SHALE: Brown and dark grey, mottled orange, distinctly laminated at 0º, iron staining in bands parallel to lamination.	MW	D 0.01 A 0.09	20
SHALE: Dark grey, distinctly laminated at 0º, iron staining in bands parallel to lamination, lenses of sand lamination up to 3 mm thick.	SW	D 0.82 A 0.76	

estimated strength: VL L M H VH EH

defect spacing mm: 30 100 300 1000 3000

defect description: type, inclination, planarity, roughness, coating, thickness — particular / general

NO CORE 2.5-2.91m
Closely spaced partings 2.91-3.14m
SM,0º,(5-mm clay)
CS,0º,PL,SO,VN (5-10mm clay)
NO CORE 3.24 - 3.3m
Closely spaced partings 3.3-3.40m
Crushed Seam 3.52-3.58m (40-50mm clay)
Seam 3.63-3.70m (60-70mm clay)
CS,0º,PL,SO,VN (3-5mm clay)
SM,0º (5-mm clay)
Crushed Seam 3.875-3.91m (30-40mm clay)
Seam 3.94-4.05m (5-6mm clay)
SM,0º (5-6mm clay)
FRACTURED SHALE 4.155-4.2m
SM,0º (6-7mm clay)
SM,0º (5-6mm clay)
CS,0º,PL,SO,VN (10mm clay)
JT,85º,PL,SO,SN
CS,0º (5-6mm clay)
CS,0º (2-3mm clay)
JT,80º,PL,SO,SN
Seam 4.62-4.645m (20mm clay)
FRACTURED SHALE 4.645-4.725m
NO CORE 4.725-5m
CS,0º (10-15mm clay)
PT,30º,PL,SO,SN
JT,80º,PL,SO,VN (50mm long)
JT,80º,PL,RO,CN (60mm long)
JT,60º,PL,SO,VN
JT,85º,PL,SO,SN
PT,30º,PL,SO,SN
SM,5º (5-10mm clay)
PT,30º,CU,SO,SN
CS,0º,PL,SO,VN (2-3mm clay)
CS,0º (3-5mm thick clay seam)
PT,0º,UN,SO,CN
PT,0º,UN,SO,SN
PT,0º,ST,SO,SN

ALL DEFECTS ARE PT, 0º-5º, PL,CU , SO, SN, CN, VN UNLESS OTHERWISE STATED

method
DT diatube
AS auger screwing
AD auger drilling
RR roller/tricone
CB claw or blade bit
NMLC NMLC core
NQ, HQ, PQ wireline core

core-lift
casing used
barrel withdrawn

graphic log/core recovery
core recovered - graphic symbols indicate material
no core recovered

water
10/1/98 water level on date shown
water inflow
partial drill fluid loss
complete drill fluid loss
25 water pressure test result (lugeons) for depth interval shown

weathering
FR fresh
SW slightly weathered
MW moderately weathered
HW highly weathered
XW extremely weathered
DW distinctly weathered (covers MW and HW)

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

defect type
JT joint
PT parting
SM seam
SZ sheared zone
SS sheared surface
CS crushed seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR irregular

roughness
VR very rough
RO rough
SO smooth
SL slickensided

coating
CN clean
SN stained
VN veneer
CO coating

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Engineering Log - Cored Borehole

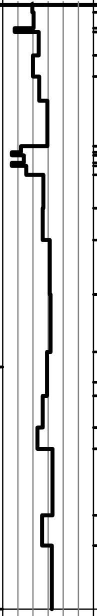
Borehole No. **BH1**
Sheet 3 of 3
Project No: **GEOTLCOV23048.AA**

Client: ***Bovis Lend Lease***
Principal:
Project: ***Proposed Commercial Development***
Borehole Location: ***Corner of Olympic Bvd and Herbs Elliot Ave, Homebush***

Date started: **16.8.2006**
Date completed: **16.8.2006**
Logged by: **FS**
Checked by: **PJW**

drill model & mounting: EDSON 3000 TRUCK MOUNTED
Easting: 92
slope: -90°
R.L. Surface: 20.83
hole diameter: 125 mm
Drilling fluid: Water
Northing: 146
bearing:
datum: AHD

drilling information					material substance					rock mass defects			
method	core-lift	water	RL	depth metres	graphic log core recovery	material: rock type; grain characteristics, colour, structure, minor components	weathering alteration	estimated strength VL L M H VH EH	Is(50) MPa D- diametral A- axial	RQD %	defect spacing mm 30 100 300 1000 3000	defect description: type, inclination, planarity, roughness, coating, thickness — particular	general
NMLC		NONE OBSERVED					SW		D A 0.54 0.86			JT,85º,PL,SO,CN (75mm long) SM,0º (3-4mm clay)	
			12	9		**SHALE**: Dark grey, distinctly laminated at 0º, lenses of sand lamination up to 2 mm thick.	FR			79		PT,0º,ST,SO,CN JT,75º,PL,RO,SN	
			11	10								JT,90º,PL,SO,CN (105mm long)	
			10	11					D A 0.52 0.68	100		FRACTURED SHALE 10.5-10.55m CS,30º (5-10mm clay)	
									D A 0.65 1.02				
			9	12									
						BH1 terminated at 12m							
			8	13									
			7	14									
			6	15									
			5	16									



method

DT	diatube
AS	auger screwing
AD	auger drilling
RR	roller/tricone
CB	claw or blade bit
NMLC	NMLC core
NQ, HQ, PQ	wireline core

core-lift

casing used

barrel withdrawn

graphic log/core recovery

core recovered - graphic symbols indicate material

no core recovered

water

▼ 10/1/98 water level on date shown

► water inflow

◁ partial drill fluid loss

◀ complete drill fluid loss

25 water pressure test result (lugeons) for depth interval shown

weathering

FR	fresh
SW	slightly weathered
MW	moderately weathered
HW	highly weathered
XW	extremely weathered
DW	distinctly weathered (covers MW and HW)

strength

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

defect type

JT	joint
PT	parting
SM	seam
SZ	sheared zone
SS	sheared surface
CS	crushed seam

roughness

VR	very rough
RO	rough
SO	smooth
SL	slickensided

planarity

PL	planar
CU	curved
UN	undulating
ST	stepped
IR	irregular

coating

CN	clean
SN	stained
VN	veneer
CO	coating

CORED BOREHOLE GEOTLC~1.GPJ COFFEY.GDT 23.1.07

Form GEO 5.5 Issue 3 Rev. 3

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Engineering Log - Borehole

Borehole No.	*BH2*
Sheet	1 of 3
Project No:	*GEOTLCOV23048.AA*
Date started:	*16.8.2006*
Date completed:	*17.8.2006*
Logged by:	*FS*
Checked by:	*PJW*

Client: ***Bovis Lend Lease***

Principal:

Project: ***Proposed Commercial Development***

Borehole Location: ***Corner of Olympic Bvd and Herbs Elliot Ave, Homebush***

drill model and mounting:	EDSON 3000 TRUCK MOUNTED	Easting:	137	slope:	-90°	R.L. Surface:	22.36
hole diameter:	125 mm	Northing	106.5	bearing:		datum:	AHD

drilling information / **material substance**

method	penetration 1 2 3	support	water	**notes** samples, tests, etc	RL	depth metres	graphic log	classification symbol	**material** soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetro-meter kPa 100 200 300 400	**structure and additional observations**
ADT									**FILL**: Asphalt.	< Wp	MD		FILL
					22				**FILL**: GRAVELLY CLAYEY SAND, fine-grained, brown/mottled grey, with some fine to medium grained gravels.				FILL OF ROAD BASE
				SPT 10 for 20mm,-,- N=R				CL	**SILTY CLAY**: Medium plasticity, brown, some gravels, trace of ironstone.		VSt/H		RESIDUAL
						1							
					21								
ADV				SPT 15 for 30mm,-,- N=R				CL	**SHALY CLAY**: Medium plasticity, grey and brown, trace of gravel.	< Wp	H		
						2							
					20								
ADT													V-bit refusal at 2.6 m
						3			**SHALE**: Extremely weathered, grey and brown, very low strength.				SHALE
			NONE OBSERVED						Borehole BH2 continued as cored hole				
					19								
						4							
					18								
						5							
					17								
						6							
					16								
						7							
					15								
						8							

method

AS	auger screwing*
AD	auger drilling*
RR	roller/tricone
W	washbore
CT	cable tool
HA	hand auger
DT	diatube
B	blank bit
V	V bit
T	TC bit

*bit shown by suffix
e.g. ADT

support

M	mud	N	nil
C	casing		

penetration
1 2 3 4
no resistance ranging to refusal

water

▼ 10/1/98 water level on date shown

► water inflow

◄ water outflow

notes, samples, tests

U_{50}	undisturbed sample 50mm diameter
U_{63}	undisturbed sample 63mm diameter
D	disturbed sample
N	standard penetration test (SPT)
N*	SPT - sample recovered
Nc	SPT with solid cone
V	vane shear (kPa)
P	pressuremeter
Bs	bulk sample
E	environmental sample
R	refusal

classification symbols and soil description
based on unified classification system

moisture

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

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

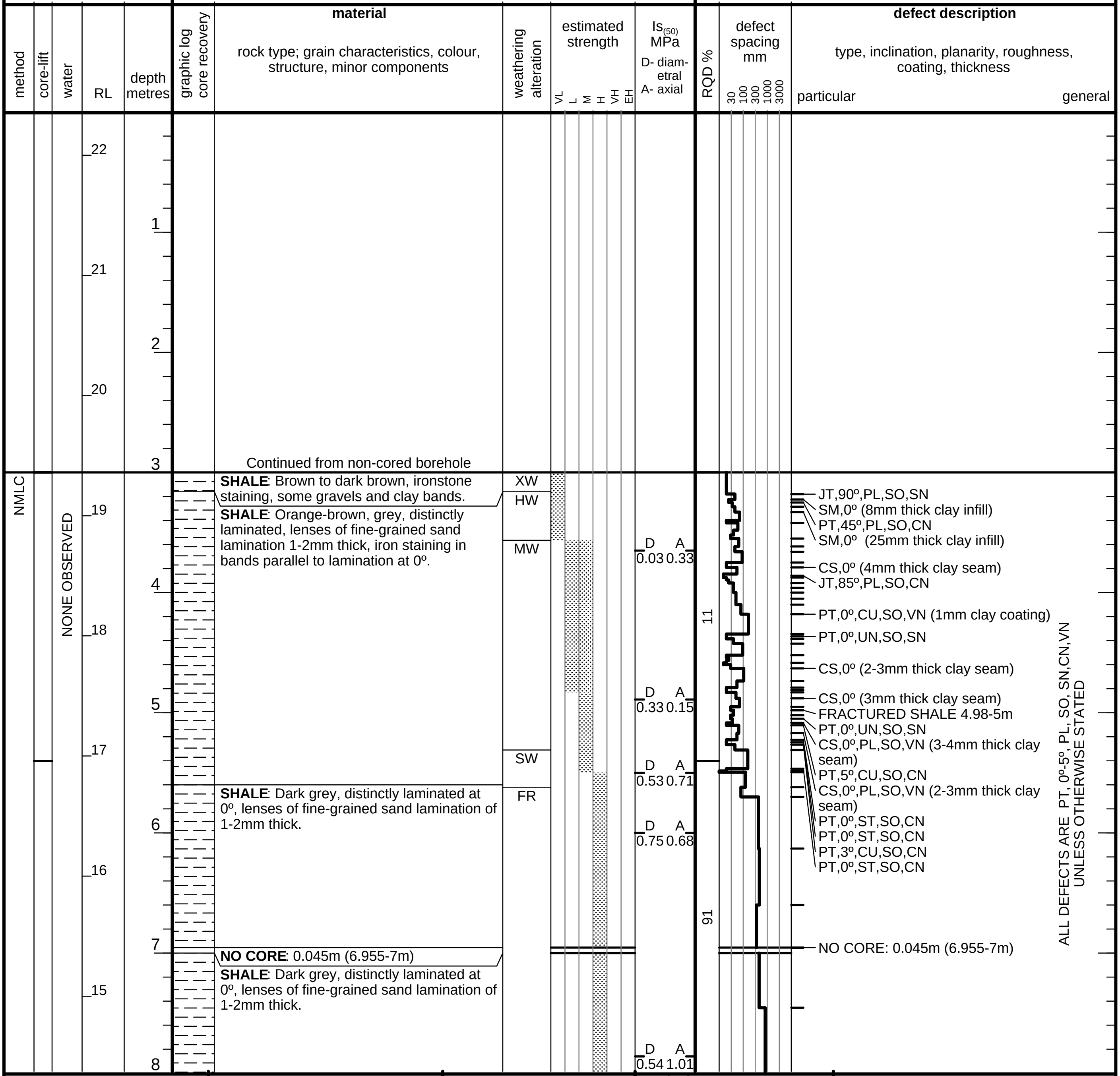
coffey geotechnics

Engineering Log - Cored Borehole

Borehole No.	**BH2**
Sheet	2 of 3
Project No:	**GEOTLCOV23048.AA**
Client:	**Bovis Lend Lease**
Principal:	
Project:	**Proposed Commercial Development**
Borehole Location:	**Corner of Olympic Bvd and Herbs Elliot Ave, Homebush**
Date started:	**16.8.2006**
Date completed:	**17.8.2006**
Logged by:	**FS**
Checked by:	**PJW**

drill model & mounting:	EDSON 3000 TRUCK MOUNTED	Easting:	137	slope:	-90°	R.L. Surface:	22.36
hole diameter:	125 mm Drilling fluid: Water	Northing:	106.5	bearing:		datum:	AHD

drilling information | material substance | rock mass defects



depth (m)	material: rock type; grain characteristics, colour, structure, minor components	weathering alteration	Is(50) MPa
0–3	Continued from non-cored borehole		
3	**SHALE**: Brown to dark brown, ironstone staining, some gravels and clay bands.	XW	
	SHALE: Orange-brown, grey, distinctly laminated, lenses of fine-grained sand lamination 1-2mm thick, iron staining in bands parallel to lamination at 0º.	HW MW	D 0.03 A 0.33 D 0.33 A 0.15
		SW	D 0.53 A 0.71
	SHALE: Dark grey, distinctly laminated at 0º, lenses of fine-grained sand lamination of 1-2mm thick.	FR	D 0.75 A 0.68
6.955–7	**NO CORE**: 0.045m (6.955-7m)		
7–8	**SHALE**: Dark grey, distinctly laminated at 0º, lenses of fine-grained sand lamination of 1-2mm thick.		D 0.54 A 1.01

defect description (type, inclination, planarity, roughness, coating, thickness)

particular:

JT,90º,PL,SO,SN
SM,0º (8mm thick clay infill)
PT,45º,PL,SO,CN
SM,0º (25mm thick clay infill)
CS,0º (4mm thick clay seam)
JT,85º,PL,SO,CN
PT,0º,CU,SO,VN (1mm clay coating)
PT,0º,UN,SO,SN
CS,0º (2-3mm thick clay seam)
CS,0º (3mm thick clay seam)
FRACTURED SHALE 4.98-5m
PT,0º,UN,SO,SN
CS,0º,PL,SO,VN (3-4mm thick clay seam)
PT,5º,CU,SO,CN
CS,0º,PL,SO,VN (2-3mm thick clay seam)
PT,0º,ST,SO,CN
PT,0º,ST,SO,CN
PT,3º,CU,SO,CN
PT,0º,ST,SO,CN
NO CORE: 0.045m (6.955-7m)

general:

ALL DEFECTS ARE PT, 0º-5º, PL, SO, SN,CN,VN UNLESS OTHERWISE STATED

method

DT	diatube
AS	auger screwing
AD	auger drilling
RR	roller/tricone
CB	claw or blade bit
NMLC	NMLC core
NQ, HQ, PQ	wireline core

core-lift

casing used
barrel withdrawn

graphic log/core recovery

core recovered - graphic symbols indicate material
no core recovered

water

10/1/98 water level on date shown
water inflow
partial drill fluid loss
complete drill fluid loss
25 water pressure test result (lugeons) for depth interval shown

weathering

FR	fresh
SW	slightly weathered
MW	moderately weathered
HW	highly weathered
XW	extremely weathered
DW	distinctly weathered (covers MW and HW)

strength

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

defect type

JT	joint
PT	parting
SM	seam
SZ	sheared zone
SS	sheared surface
CS	crushed seam

planarity

PL	planar
CU	curved
UN	undulating
ST	stepped
IR	irregular

roughness

VR	very rough
RO	rough
SO	smooth
SL	slickensided

coating

CN	clean
SN	stained
VN	veneer
CO	coating

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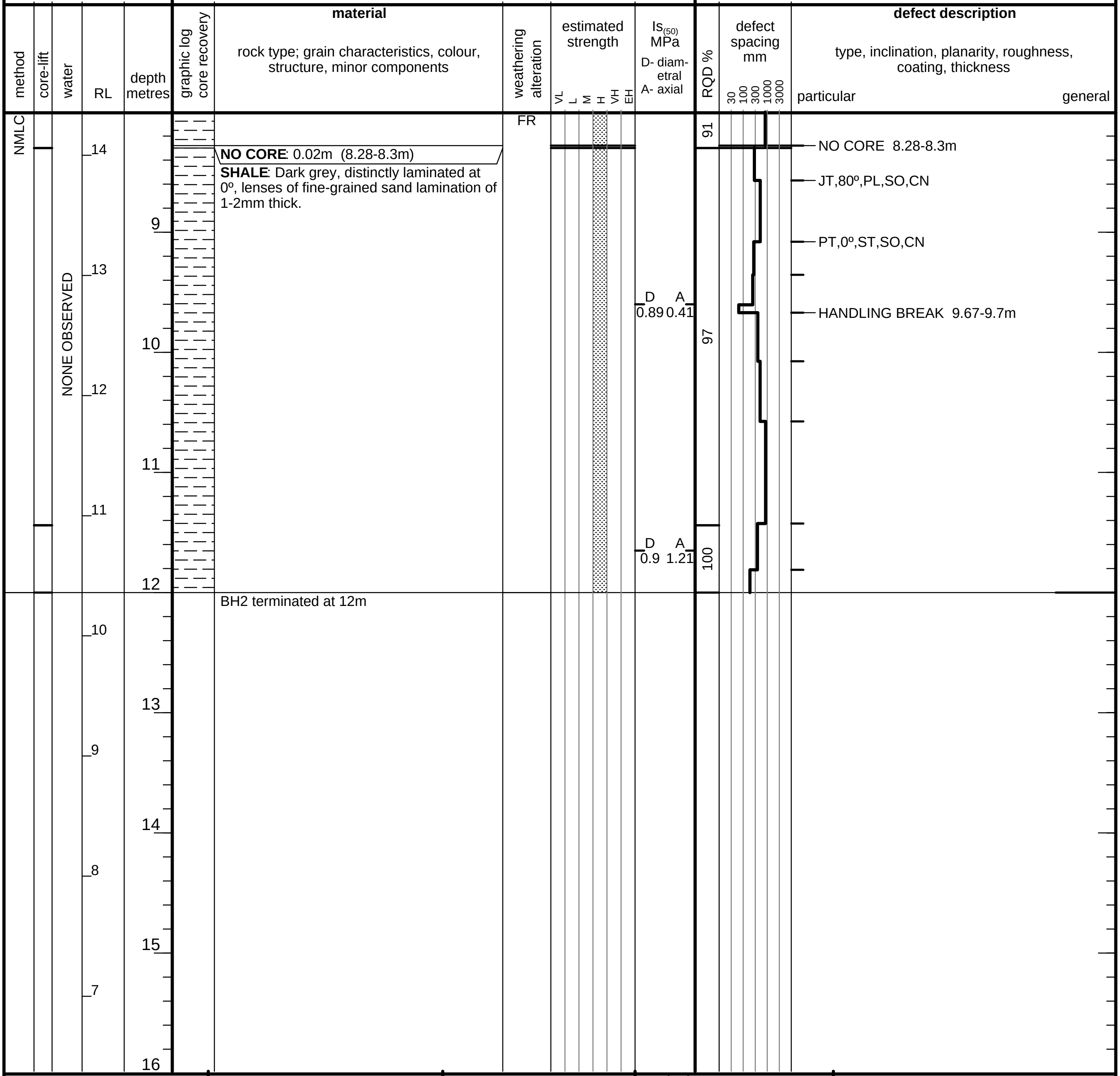
Engineering Log - Cored Borehole

Borehole No.	**BH2**
Sheet	3 of 3
Project No:	**GEOTLCOV23048.AA**
Client:	**Bovis Lend Lease**
Date started:	**16.8.2006**
Principal:	
Date completed:	**17.8.2006**
Project:	**Proposed Commercial Development**
Logged by:	**FS**
Borehole Location:	**Corner of Olympic Bvd and Herbs Elliot Ave, Homebush**
Checked by:	**PJW**

drill model & mounting:	EDSON 3000 TRUCK MOUNTED	Easting:	137	slope:	-90°	R.L. Surface:	22.36
hole diameter:	125 mm Drilling fluid: Water	Northing:	106.5	bearing:		datum:	AHD

drilling information | **material substance** | **rock mass defects**



NO CORE: 0.02m (8.28-8.3m)

SHALE: Dark grey, distinctly laminated at 0º, lenses of fine-grained sand lamination of 1-2mm thick.

BH2 terminated at 12m

NO CORE 8.28-8.3m

JT,80º,PL,SO,CN

PT,0º,ST,SO,CN

HANDLING BREAK 9.67-9.7m

method

DT	diatube
AS	auger screwing
AD	auger drilling
RR	roller/tricone
CB	claw or blade bit
NMLC	NMLC core
NQ, HQ, PQ	wireline core

core-lift

- casing used
- barrel withdrawn

graphic log/core recovery

- core recovered - graphic symbols indicate material
- no core recovered

water

- 10/1/98 water level on date shown
- water inflow
- partial drill fluid loss
- complete drill fluid loss
- 25 water pressure test result (lugeons) for depth interval shown

weathering

FR	fresh
SW	slightly weathered
MW	moderately weathered
HW	highly weathered
XW	extremely weathered
DW	distinctly weathered (covers MW and HW)

strength

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

defect type

JT	joint
PT	parting
SM	seam
SZ	sheared zone
SS	sheared surface
CS	crushed seam

roughness

VR	very rough
RO	rough
SO	smooth
SL	slickensided

planarity

PL	planar
CU	curved
UN	undulating
ST	stepped
IR	irregular

coating

CN	clean
SN	stained
VN	veneer
CO	coating

CORED BOREHOLE GEOTLC~1.GPJ COFFEY.GDT 23.1.07

Form GEO 5.5 Issue 3 Rev. 3

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Borehole No.	***BH3***
Sheet	1 of 3
Project No:	***GEOTLCOV23048.AA***

Engineering Log - Borehole

Client:	***Bovis Lend Lease***	Date started:	***17.8.2006***
Principal:		Date completed:	***17.8.2006***
Project:	***Proposed Commercial Development***	Logged by:	***FS***
Borehole Location:	***Corner of Olympic Bvd and Herbs Elliot Ave, Homebush***	Checked by:	***PJW***

drill model and mounting:	EDSON 3000 TRUCK MOUNTED	Easting:	80.5	slope:	-90°	R.L. Surface:	21.92
hole diameter:	125 mm	Northing	76	bearing:		datum:	AHD

drilling information | **material substance**

method	penetration 1 2 3	support	water	**notes** samples, tests, etc	RL	depth metres	graphic log	classification symbol	**material** soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetro-meter kPa 100 200 300 400	**structure and additional observations**
ADV									**FILL**: Woodchip and topsoil	= Wp	St		FILL
									FILL: SILTY CLAY, low to medium plasticity, dark brown, some root fibres.				FILL
				SPT 3,4,6 N*=10					**FILL**: SILTY CLAY, medium to high plasticity, brown to dark brown, some fine grained ironstone gravels.				
					21	1		CL	**SILTY CLAY**: Medium plasticity, brown to grey mottling, red, some gravels.	< Wp	VSt		RESIDUAL
				SPT 3,7,5 N*=12				CH	**SILTY CLAY**: High plasticity, brown and grey mottling, trace of fine-grained ironstone gravels, with some fine-grained shale gravels.	< Wp	VSt/H		
					20	2							
					19	3							V-bit refusal at 2.9 m
ADT									**SHALE**: Extremely weathered, brown and grey, ironstone staining, very low strength.				SHALE
			NONE OBSERVED						Borehole BH3 continued as cored hole				
					18	4							
					17	5							
					16	6							
					15	7							
					14	8							

method

AS	auger screwing*
AD	auger drilling*
RR	roller/tricone
W	washbore
CT	cable tool
HA	hand auger
DT	diatube
B	blank bit
V	V bit
T	TC bit

*bit shown by suffix
e.g. ADT

support

M	mud	N	nil
C	casing		

penetration
1 2 3 4
no resistance ranging to refusal

water
10/1/98 water level on date shown
water inflow
water outflow

notes, samples, tests

U_{50}	undisturbed sample 50mm diameter
U_{63}	undisturbed sample 63mm diameter
D	disturbed sample
N	standard penetration test (SPT)
N*	SPT - sample recovered
Nc	SPT with solid cone
V	vane shear (kPa)
P	pressuremeter
Bs	bulk sample
E	environmental sample
R	refusal

classification symbols and soil description
based on unified classification system

moisture

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

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

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Engineering Log - Cored Borehole

Borehole No. **BH3**
Sheet 2 of 3
Project No: **GEOTLCOV23048.AA**

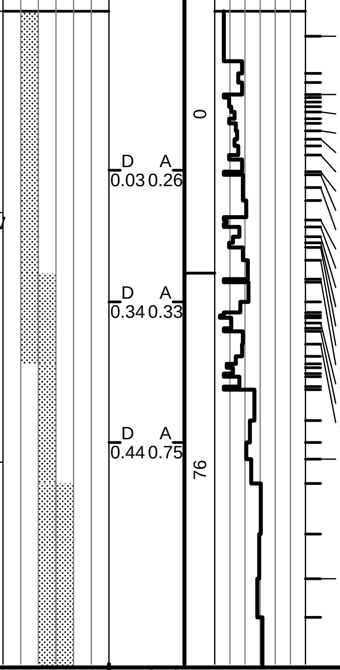
Client: **Bovis Lend Lease**
Principal:
Project: **Proposed Commercial Development**
Borehole Location: **Corner of Olympic Bvd and Herbs Elliot Ave, Homebush**

Date started: **17.8.2006**
Date completed: **17.8.2006**
Logged by: **FS**
Checked by: **PJW**

drill model & mounting: EDSON 3000 TRUCK MOUNTED
Easting: 80.5
slope: -90°
R.L. Surface: 21.92
hole diameter: 125 mm
Drilling fluid: Water
Northing: 76
bearing:
datum: AHD

drilling information / material substance / rock mass defects

method	core-lift	water	RL	depth metres	material: rock type; grain characteristics, colour, structure, minor components	weathering alteration	Is(50) MPa (D- diametral, A- axial)	RQD %	defect description: particular	defect description: general
			21	1						
			20	2						
			19	3	Continued from non-cored borehole					
NMLC		NONE OBSERVED			**NO CORE**: 0.37m (3.3-3.67m)				NO CORE 3.3-3.67m	ALL DEFECTS ARE PT, 0º-5º, PL, SO, SN, CN, VN UNLESS OTHERWISE STATED
			18	4	**SHALE**: Orange-brown, mottled grey, distinctly laminated at 0º, lenses of fine-grained sand up to 5mm thick.	HW		0	Closely spaced partings 3.67-4m SM,0º (2.5mm thick clay seam) SM,0º (2.5mm thick clay infill) PT,5º,CU,SO,SN SM,0º (45mm thick clay seam) SM,0º (30mm thick clay seam) SM,0º (2-3mm thick clay infill)	
			17	5		MW-SW	D 0.03 A 0.26		SM,0º (2mm thick clay infill) PT,0º,ST,SO,VN JT,80º,PL,SO,CN Closely spaced seams 5.08-5.11m SM,5º (4mm thick clay infill)	
			16	6			D 0.34 A 0.33	76	SM,0º (2mm thick clay infill) PT,0º,PL,RO,SN SM,0º (3mm thick clay infill) JT,90º,PL,SO,CN JT,85º,ST,SO,CN SM, 0º (5-10mm thick clay infill) JT,90º,CU,SO,CN	
			15	7	**SHALE**: Dark grey, distinctly laminated at 0º, lenses of fine-grained sand up to 5mm thick.	FR	D 0.44 A 0.75		PT,0º,UN,SO,CN PT,0º,UN,SO,CN	
			14	8						



method

DT	diatube
AS	auger screwing
AD	auger drilling
RR	roller/tricone
CB	claw or blade bit
NMLC	NMLC core
NQ, HQ, PQ	wireline core

core-lift

casing used
barrel withdrawn

graphic log/core recovery

core recovered - graphic symbols indicate material
no core recovered

water

10/1/98 water level on date shown
water inflow
partial drill fluid loss
complete drill fluid loss
25 water pressure test result (lugeons) for depth interval shown

weathering

FR	fresh
SW	slightly weathered
MW	moderately weathered
HW	highly weathered
XW	extremely weathered
DW	distinctly weathered (covers MW and HW)

strength

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

defect type

JT	joint
PT	parting
SM	seam
SZ	sheared zone
SS	sheared surface
CS	crushed seam

roughness

VR	very rough
RO	rough
SO	smooth
SL	slickensided

planarity

PL	planar
CU	curved
UN	undulating
ST	stepped
IR	irregular

coating

CN	clean
SN	stained
VN	veneer
CO	coating

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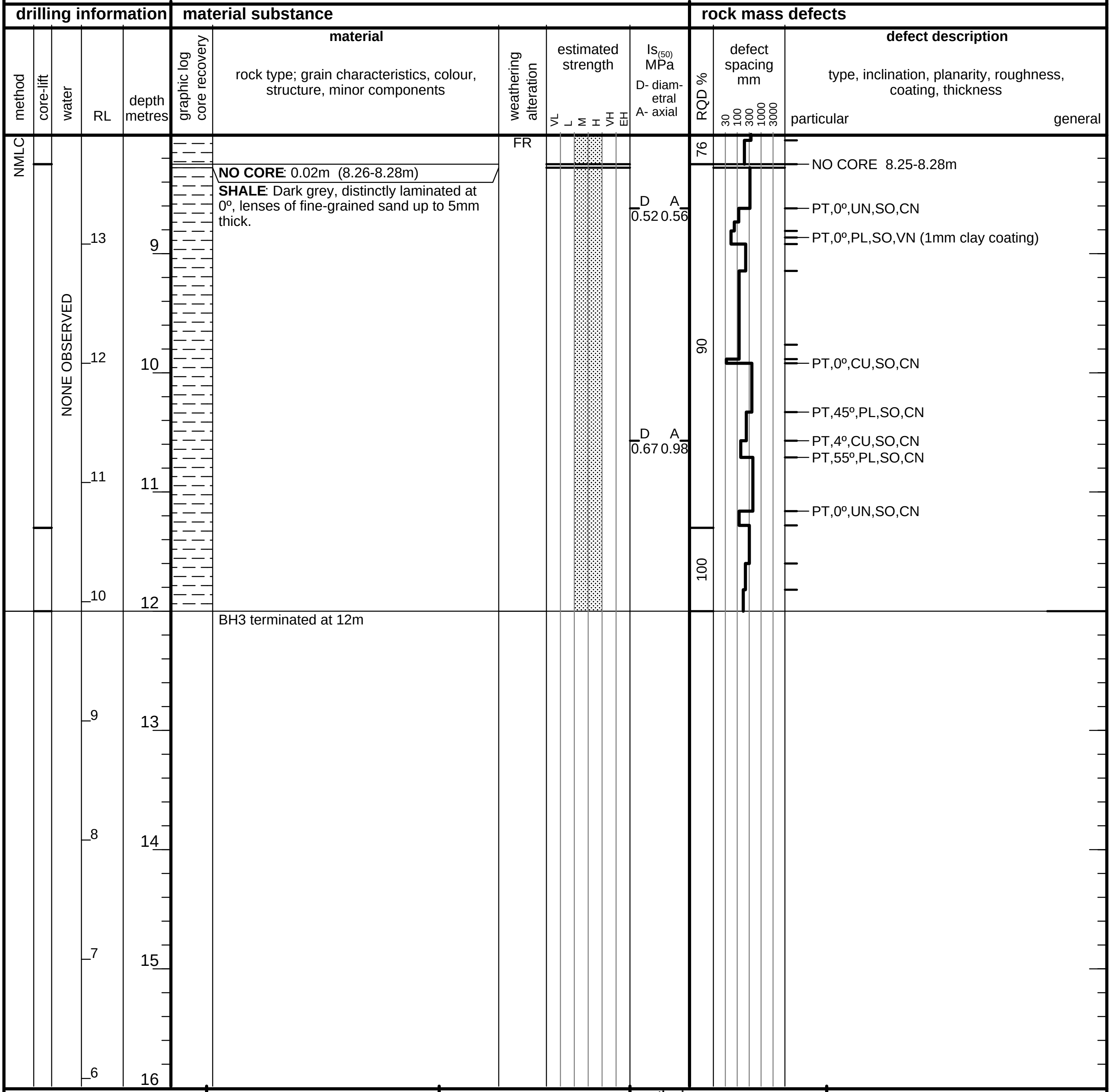
Engineering Log - Cored Borehole

Client:	*Bovis Lend Lease*	Borehole No.	***BH3***
Principal:		Sheet	3 of 3
Project:	***Proposed Commercial Development***	Project No:	***GEOTLCOV23048.AA***
Borehole Location:	***Corner of Olympic Bvd and Herbs Elliot Ave, Homebush***	Date started:	***17.8.2006***
		Date completed:	***17.8.2006***
		Logged by:	***FS***
		Checked by:	***PJW***

drill model & mounting: EDSON 3000 TRUCK MOUNTED   Easting: 80.5   slope: -90°   R.L. Surface: 21.92

hole diameter: 125 mm   Drilling fluid: Water   Northing: 76   bearing: datum: AHD



NO CORE: 0.02m (8.26-8.28m)

SHALE: Dark grey, distinctly laminated at 0º, lenses of fine-grained sand up to 5mm thick.

BH3 terminated at 12m

NO CORE 8.25-8.28m

PT,0º,UN,SO,CN

PT,0º,PL,SO,VN (1mm clay coating)

PT,0º,CU,SO,CN

PT,45º,PL,SO,CN

PT,4º,CU,SO,CN

PT,55º,PL,SO,CN

PT,0º,UN,SO,CN

method

DT	diatube
AS	auger screwing
AD	auger drilling
RR	roller/tricone
CB	claw or blade bit
NMLC	NMLC core
NQ, HQ, PQ	wireline core

core-lift

casing used

barrel withdrawn

graphic log/core recovery

core recovered - graphic symbols indicate material

no core recovered

water

10/1/98 water level on date shown

water inflow

partial drill fluid loss

complete drill fluid loss

25 water pressure test result (lugeons) for depth interval shown

weathering

FR	fresh
SW	slightly weathered
MW	moderately weathered
HW	highly weathered
XW	extremely weathered
DW	distinctly weathered (covers MW and HW)

strength

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

defect type

JT	joint
PT	parting
SM	seam
SZ	sheared zone
SS	sheared surface
CS	crushed seam

roughness

VR	very rough
RO	rough
SO	smooth
SL	slickensided

planarity

PL	planar
CU	curved
UN	undulating
ST	stepped
IR	irregular

coating

CN	clean
SN	stained
VN	veneer
CO	coating

GEOTLCOV23048.AA
Bovis Lend Lease
Proposed Commercial Development


coffey
geotechnics
SPECIALISTS MANAGING THE EARTH
Job Number: GEOTLCOV23048AA
BH3
Depth: 3.30m-12.00m
3m GEOTLCOV 23048.AA BH3 START AT 3.3m
NO CORE 0.37m
4m
5m
6m
7m
8m
9m
10m
11m

Appendix B

Laboratory Test Results

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SPECIALISTS MANAGING THE EARTH

Job No **GEOTLCOV 23048AA**

Sheet **1** of **1**

Point Load Strength Index Test Results

Client **Bovis Lend Lease**

Office **SYDNEY**

Principal

Date **21/8/2006**

Project **Proposed Commercial Development**

By **FS**

Location **Corner of Olympic Boulevard and Herbs Elliot Ave (SITE 4B), Homebush Bay**

Checked

Test Method *AS 4133.4.1 - 1993 Methods of Testing Rocks for Engineering Purposes, Determination of Point Load Strength Index*

Test Machine *GSA (bench-mounted)*

Calibration Date *8/9/2000*

Sampling Technique *NMLC triple tube diamond coring*

Storage History *Lab*

Moisture Condition *Natural*

Loading Rate *< 30 seconds*

Sampling Date *16-17/8/06*

Testing Date *19/8/2006*

Tested By *FS*

Rock Type	Location	Depth (m)	Diametral Tests					Axial, Block, and Irregular Lump Tests							Strength Classification
			D (mm)	L (mm)	P (kN)	$I_{s(50)}$ (MPa)	Failure Mode	W (mm)	D (mm)	L (mm)	P (kN)	I_s (MPa)	$I_{s(50)}$ (MPa)	Failure Mode	
Shale	**BH1**	**5.11**	50	80	0.03	**0.01**	*Parallel to bedding*	50	26	-	0.16	0.1	**0.09**	*Through substance*	**VL**
Shale	**BH1**	**7.50**	50	155	2.04	**0.82**	*Parallel to bedding*	50	35	-	1.74	0.78	**0.76**	*Through substance*	**M**
Shale	**BH1**	**8.06**	50	95	1.35	**0.54**	*Parallel to bedding*	50	34	-	1.93	0.89	**0.86**	*Through substance*	**M**
Shale	**BH1**	**10.80**	50	130	1.29	**0.52**	*Parallel to bedding*	50	33	-	1.49	0.71	**0.68**	*Through substance*	**M**
Shale	**BH1**	**11.37**	50	195	1.63	**0.65**	*Parallel to bedding*	50	37	-	2.43	1.03	**1.02**	*Through substance*	**M / H**
Shale	**BH2**	**3.65**	50	60	0.08	**0.03**	*Parallel to bedding*	50	20	-	0.49	0.38	**0.33**	*Through substance*	**VL / M**
Shale	**BH2**	**4.89**	50	92	0.83	**0.33**	*Parallel to bedding*	50	40	-	0.38	0.15	**0.15**	*Through substance*	**L / M**
Shale	**BH2**	**5.50**	50	75	1.32	**0.53**	*Parallel to bedding*	50	30	-	1.44	0.75	**0.71**	*Through substance*	**M**
Shale	**Bh2**	**6.00**	50	120	1.87	**0.75**	*Parallel to bedding*	50	30	-	1.38	0.72	**0.68**	*Through substance*	**M**
Shale	**BH2**	**7.86**	50	115	1.36	**0.54**	*Parallel to bedding*	50	35	-	2.31	1.04	**1.01**	*Through substance*	**M / H**
Shale	**BH2**	**9.60**	50	65	2.23	**0.89**	*Parallel to bedding*	50	30	-	0.83	0.43	**0.41**	*Through substance*	**M**
Shale	**BH2**	**11.65**	50	175	2.24	**0.9**	*Parallel to bedding*	50	44	-	3.31	1.18	**1.21**	*Through substance*	**M / H**
Shale	**BH3**	**4.72**	51	110	0.08	**0.03**	*Parallel to bedding*	51	20	-	0.39	0.3	**0.26**	*Through substance*	**VL / L**
Shale	**BH3**	**5.59**	51	70	0.88	**0.34**	*Parallel to bedding*	51	31	-	0.69	0.34	**0.33**	*Through substance*	**M**
Shale	**BH3**	**6.52**	51	100	1.14	**0.44**	*Parallel to bedding*	51	30	-	1.55	0.8	**0.75**	*Through substance*	**M**
Shale	**BH3**	**8.62**	51	110	1.33	**0.52**	*Parallel to bedding*	51	30	-	1.15	0.59	**0.56**	*Through substance*	**M**
Shale	**BH3**	**10.57**	51	135	1.72	**0.67**	*Parallel to bedding*	51	30	-	2.02	1.04	**0.98**	*Through substance*	**M**

F:\1.PROJECTS\GEOTLCOV230\23048AA BLL Olympic Park\Point Load Test (Sampling Date 16-17 Aug 06)\[BLL_Point Load Data.xls]Result Sheet (1 of 3)