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# **APPENDIX E**

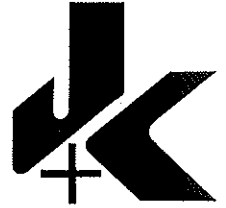
## **GEOTECHNICAL REPORT**

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**GEOTECHNICAL INVESTIGATION REPORT BY JEFFREY AND KATAUSKAS (J&K)  
IN APRIL 2010 REF: 23922ZNRPT**

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# REPORT

TO

**ROZELLE VILLAGE PTY LTD**

ON

**GEOTECHNICAL INVESTIGATION**

FOR

**PROPOSED REDEVELOPMENT OF  
BALMAIN LEAGUES CLUB**

AT

**VICTORIA ROAD, ROZELLE, NSW**

16 April 2010

Ref: 23922ZNrpt

**Jeffery and Katauskas Pty Ltd**  
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS



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PREVIOUS INVESTIGATION (REF: 19319WRPT DATED 8 APRIL 2005).



## 1 INTRODUCTION

This report presents the results of a geotechnical investigation for the proposed redevelopment of Balmain Leagues Club at Victoria Road, Rozelle, NSW. The investigation was commissioned by returned Acceptance of Proposal signed by David Randerson of dKO Architecture dated 6 April 2010, on behalf of Rozelle Village Pty Ltd. The investigation was carried out generally in accordance with our proposal (Ref: P32159ZN2email4) dated 31 March 2010.

From the supplied dKO Architecture drawings (Project No. 00010423, Dwg Nos DA.02 to DA.06 Revision C, DA.07, DA.08 Revision D, DA.09 to DA.12 Revision C, DA.13 to DA.21 Revision D and DA.22 to DA.31 Revision C) we understand that it is proposed to construct a number of multi storey commercial and residential buildings over five common basement levels on the above site. The proposed basement levels will extend to the eastern, western and southern site boundaries, and to the northern site boundary along the majority of the northern side of the site. The proposed lowest basement level is to have a finished floor reduced level (RL) at around 17.0m and is anticipated to require excavation to a maximum depth of about 22m.

As no structural loads have been supplied, typical loads for this type of development, in the high range, have been assumed.

Jeffery and Katauskas have previously completed a geotechnical investigation on the site for Balmain Leagues Club Ltd and the results were presented in our report (Ref: 19319Wrpt) dated 8 April 2005. The previous borehole logs and laboratory test results have been incorporated into this report. We note that these previous boreholes were for a different development scheme, and hence were terminated above the currently proposed basement level.



A Preliminary Phase 1 Environmental Investigation has previously been carried out by Environmental Investigation Services (EIS), part of the Jeffery and Katauskas Group, for Balmain Leagues Club Ltd, the results of which are presented in their report (Ref: E19319FK-RPT) dated April 2005.

The purpose of the investigation was to obtain geotechnical information on subsurface conditions at one additional location as a basis for preliminary comments and recommendations on hydrogeological conditions, excavation conditions and techniques, retention options, retention design parameters, footings, on-grade floor slabs, additional geotechnical work required, and other geotechnical aspects of the proposed works.

## **2 INVESTIGATION PROCEDURE**

Prior to drilling commencing, the borehole location was electromagnetically scanned for buried services by a specialist subcontractor.

One borehole (BH101) was drilled to a depth of 4.24m (RL28.72m AHD) using spiral augering techniques with our track mounted JK300 drill rig. BH101 was subsequently extended to a depth of 21.50m (RL 11.46m AHD) using rotary diamond coring techniques with water flush. In the augered portion of the borehole, the strength of the sandstone bedrock was assessed by observation of the drilling resistance of a tungsten carbide (TC) bit attached to the auger, together with examination of the recovered rock chips and subsequent correlation with moisture content testing. The strength of the cored bedrock was assessed by examination of the recovered rock core and subsequent correlation with the results of Point Load Strength Index Tests ( $I_{s(50)}$ ) carried out in the laboratory on selected rock core. The results of the point load testing are summarised in Table B and on the cored borehole logs.



Groundwater observations were made both during and on completion of augering, and at the end of coring. A 50mm diameter PVC standpipe was installed to the base of BH101 to allow for the ongoing measurement of groundwater levels by others if required. We note that water is injected into the borehole during coring, and hence, the groundwater levels observed had likely not stabilised following the completion of coring. No longer term groundwater monitoring was undertaken.

Our geoscientist, Geoff Fletcher, set out the borehole location, directed electromagnetic scanning, nominated the sampling and testing locations, and prepared logs of the strata encountered. The borehole log, which includes field and laboratory test results and groundwater observations, is attached to this report together with a set of Report Explanation Notes, which describe the investigation techniques adopted and define the logging terms and symbols used.

The borehole location, as shown on the attached Borehole Location Plan (BH101), was set out from existing surface features and inferred site boundaries. The approximate surface level of BH101 was surveyed using an automatic level from a benchmark on the provided John B White Pty Ltd survey plan (Ref: 124134/2, Revision 3, dated 16 June 2005). The datum of the levels is Australian height Datum (AHD).

Selected samples were tested by Soil Test Services Pty Ltd (STS), a NATA registered laboratory, to determine moisture contents and point load index strengths. The results of the laboratory testing are summarised in Tables A and B respectively. Contamination testing of the site soils was outside the scope of this investigation.



### **3 RESULTS OF INVESTIGATION**

#### **3.1 Site Description**

The site is located within gentle hilly terrain towards the crest of a north-west sloping hillside which grades down at between about 3° and 7°. The site is bound by Victoria Road to the north, Waterloo Road to the south, and partially by Darling Street to the east. Both Victoria Road and Waterloo Road sloped down to the north-west, and Darling Street was approximately level and ran along the crest of the hill slope.

At the time of the fieldwork, the site was occupied by the Balmain Leagues Club complex which comprised a two storey brick and concrete building over the northern portion of the site, a three storey concrete carpark with a partial basement level in the western corner of the site and an asphaltic concrete surfaced at grade carpark in the southern corner of the site. The portion of the site between the asphaltic concrete carpark and Darling Street was occupied by a two storey commercial building of brick construction. Based on a cursory external inspection, the buildings on the site appeared to generally be in good condition.

To the east of the site were a number of one and two storey brick commercial and residential buildings which fronted Darling Street. To the west of the site were a number of one and two storey residential and commercial buildings. The neighbouring buildings to the east and west were located on or close to the respective site boundaries. Based on a cursory inspection from within the subject site, the neighbouring buildings appeared to be in good external condition.



### **3.2 Subsurface Conditions**

The 1:100,000 geological map indicates the site is underlain by Hawkesbury Sandstone.

The boreholes disclosed a generalised subsurface profile consisting of fill and natural clays overlying sandstone bedrock at relatively shallow to moderate depth. Reference should be made to the attached borehole logs for detailed descriptions of the subsurface conditions. The more pertinent details of the encountered subsurface profile are discussed below:

***Pavement and Fill:*** Concrete pavement 120mm thick was penetrated from the surface in BH101, and asphaltic concrete up to 80mm thick was penetrated from the surface in BH1 and BH2. Fill comprising silty sandy gravel, clayey sand, gravelly clay, or gravelly sand was encountered from immediately beneath the fill in all of the boreholes to depths between 0.6m (BH1) and 1.8m (BH2). Where tested, the fill was assessed as being poorly or moderately compacted.

***Natural Clays:*** Natural clays were encountered beneath the fill in BH1 and BH2. The clays were assessed as being of medium plasticity and ranged from firm to very stiff strength.

***Sandstone Bedrock:*** Sandstone bedrock was encountered in all of the boreholes at depths between 1.1m (BH101) and 3.1m (BH2). The upper profile of the sandstone bedrock was assessed as being extremely weathered and of extremely low or very low strength. The sandstone bedrock generally increased in strength with depth to between low and high strength. We note that some very low and extremely low strength bands were encountered in all of the boreholes together with zones of core loss in BH2. Zones of core loss are usually indicative of clay bands and/or extremely weathered bands within the bedrock. Some steeply inclined joints and weathered seams were also identified in the cores.



Assessment of the sandstone quality at and below proposed basement level indicates Class III and Class IV sandstone strata in accordance with the methodology recommended in 'Foundations on Sandstone and Shale in the Sydney Region' by Pells et al (1998).

**Groundwater:** Groundwater was present in BH1 at a depth of 3.5m and in BH2 at a depth of 3.6m on the completion of augering. On completion of coring, groundwater was present at a depth of 9.7m in BH101, 4.7m in BH1 and 2.1m in BH2. We note that groundwater is injected into the borehole during coring, and that the groundwater levels had likely not stabilised following the completion of coring.

### **3.3 Laboratory Test Results**

The moisture content tests on the recovered rock chip samples from the boreholes generally correlated well with our field assessment of the in-situ rock strength. The point load index strength tests correlated well with our field assessment of the in-situ rock strength. The estimated Unconfined Compressive Strength (UCS) value of the sandstone bedrock varied between 1MPa and 44MPa with an average estimate UCS of about 12MPa.



## 4 PRELIMINARY COMMENTS AND RECOMMENDATIONS

### 4.1 Geotechnical Constraints

The three completed boreholes are located along the southern side of the site. Based on these boreholes, we consider the main geotechnical constraints/issues for the development will comprise:

- The fill and residual soils will require retention for the proposed excavation.
- The upper weathered sandstone which was encountered at relatively shallow depth is of poor quality and will also require retention.
- The bulk of the proposed basement excavation will be within sandstone bedrock. Although rock excavation methods will be required, we anticipate that the bulk of the excavation will be relatively 'easy' rock excavation.
- Some localised stabilisation measures are likely to be required on the excavated rock faces due to the presence of adversely oriented steeply dipping joints on at least one of the faces.
- Groundwater seepage should be anticipated into the basement excavation and is likely to have an effect on any exposed more weathered, weaker sandstone seams in the long term.
- The proposed structure may be supported on conventional pad footings excavated below the basement excavation level.

We present below details of our preliminary comments and recommendations in relation to these constraints/issues.



## 4.2 Dilapidation Reports

Prior to the commencement of excavation, detailed dilapidation reports should be completed on any neighbouring buildings or structures which fall within the zone of influence of the excavation. The zone of influence of the excavation is defined as a distance of  $2H$  back from the top of the excavation where  $H$  is the depth of the excavation in metres. The respective owners should be asked to confirm that the reports present a fair record of existing conditions. These dilapidation reports may then be used as a benchmark against which to assess possible future claims for damage arising from the works. We note that Council and the RTA may also require that dilapidation reports be completed for adjacent Council and RTA infrastructure.

## 4.3 Excavation

All excavation recommendations should be complemented by reference to the Code of Practice '*Excavation Work*', Cat 312 dated 31 March 2000 by WorkCover.

The proposed excavation will extend to a maximum depth of about 22m below existing site levels. The excavation will be through the fill and residual profile and into the weathered sandstone bedrock.

The fill, natural soil and upper poor strength sandstone would be readily excavated using conventional hydraulic excavators. For preliminary budgeting purposes, we recommend an indicative depth of about 4m be allowed below existing site levels.

Some of the underlying sandstone will be of low strength and is likely to be rippable using a ripping tyne on a large hydraulic excavator. Given the size of the site, we consider it would be feasible to use a large dozer, such as a D10 or equivalent, which would readily complete the rock excavation with light to moderate ripping. Rock breakers and/or rock saws would be required for trimming the excavation faces and detailed excavation.



We recommend that only relatively small rock breakers, such as a Krupp 600 or equivalent, should be used on the eastern and western boundaries due to proximity to the nearby existing structures. We recommend that quantitative vibration monitoring be undertaken throughout the rock excavation period due to the possible transmission of adverse vibrations. Control of the rock excavation methods would be required to minimise potential adverse vibrations. For example:

- The rock hammer should only be operated in small bursts to reduce the possibility of site amplification.
- The rock hammer should be oriented towards the cut face and should be positioned to break small wedges off the face.
- Only experienced rock excavation contractors with appropriate insurances should be used.

We note that the presence of weathered bands identified in the boreholes is likely to reduce transmission of vibrations to much lower levels than on a 'good rock' site. If vibration levels are found to be excessive, then alternative excavation techniques would be required. Suitable methods would include sawing with a large rock saw together with ripping, or line drilling and splitting.

Reference should also be made to the attached Vibration Emission Design Goals Sheet.

#### **4.4 Excavation Batters**

The proposed basement excavation will extend up to, or very close to the four site boundaries. Therefore, temporary batters through the soil and upper weathered sandstone bedrock would not be feasible. Full retention through the upper horizons will be required with installation of some elements prior to commencement of



excavation, as discussed below. The underlying better quality sandstone bedrock may be excavated vertically provided an experienced geotechnical engineer inspects each 1.5m of depth excavated prior to further deepening of the excavation to check for the presence of adversely orientated defects, weathered seams, etc which may require additional stabilisation measures to be undertaken.

We anticipate that some stabilisation, such as by the installation of rock bolts and/or shotcrete panels, will likely be required where extremely weathered bands and clay seams are encountered. For preliminary budgeting purposes, we recommend allowance be made for such 'dental' treatment of three seams, say 0.3m thick, around the basement perimeter. In addition, allowance should be made for shotcrete protection over 2m height of face around the perimeter. The purpose of the shotcrete is to provide protection to the more weathered sandstone which would otherwise undergo long term degradation if left exposed in the basement walls.

In addition, some steeply dipping joints have been identified in the rock cores. The orientation of these joints (in three dimensional space) cannot be determined from the vertical boreholes. Such joints are likely to be adversely oriented on at least one of the excavation faces, possibly two. Therefore we recommend allowance be made for additional permanent rock bolts to stabilise potentially adversely oriented blocks or wedges. For budgeting purposes, 5m long permanent rock bolts should be allowed on half of one face at a pattern of say 3m spacing in both directions. The requirements for such stabilisation works would be subject to confirmation based on the geotechnical inspections as excavation proceeds.

#### **4.5 Excavation Retention**

The fill, residual soils and upper weathered sandstone will require temporary and permanent retention. We recommend consideration be given to the installation of soldier piles at intervals of about 2m to 3m spacing around the perimeter prior to



commencement of excavation. These piles would extend into the sandstone bedrock of at least low strength. For budgeting purposes, an indicative pile depth of 6m should be allowed. The temporary and permanent support would be provided by shotcrete infill panels spanning between the anchored soldier piles. The shotcrete panels would be constructed in about 1.5m vertical increments as excavation proceeds.

Temporary support for the soldier pile and shotcrete wall would be provided by temporary anchors through the soldier piles. We anticipate that two rows of anchors would be required. Approval would be required from the adjacent landowners and authorities for such anchors. In addition, as the temporary anchors would be inclined downwards, the soldier piles will also have to carry vertical loads. We recommend that allowance be made for one permanent rock bolt to be installed below the toe of each pile so as to provide toe stability during the temporary excavation stage, and for the long term assuming some vertical load is to be carried by the piles.

We anticipate that permanent support for this perimeter retention system would be provided by the basement structure. Temporary anchors should be distressed once the permanent support is provided.

#### **4.6 Retention Loads**

The major consideration in the selection of earth pressures for the design of the retaining walls is the need to limit deformations occurring outside the excavations. The following characteristic earth pressure coefficients and subsoil parameters may be adopted for the design of temporary or permanent retention systems.

- For anchored or propped walls, where minor movements can be tolerated (such as along the northern and southern street frontages, provided there are no buried movement sensitive services present within the road reserve), we recommend



the use of rectangular lateral earth pressure distribution of  $6H$  (kPa) for the soil profile and extremely weathered sandstone bedrock, where  $H$  is the retained height in metres.

- For anchored or propped walls, supporting areas which are relatively sensitive to movement (such as along the eastern and western site boundaries), a rectangular earth pressure distribution of  $8H$  (kPa) should be adopted for the soil profile and extremely weathered sandstone bedrock, where  $H$  is the retained height in metres. We note that some movement/settlement of the ground (and structures) behind the retaining walls may still occur even when designed using these higher lateral earth pressures.
- Any surcharge affecting the walls (eg traffic loading, construction loads, nearby buildings, etc) should be allowed in the design using an 'at rest' earth pressure coefficient,  $K_0$ , of 0.55.
- The retaining walls should be designed as drained and measures taken to induce complete and permanent drainage of the ground behind the wall. Strip drains incorporating a geofabric to act as a filter against subsoil erosion would be appropriate for soldier pile walls. Should seepage volumes be higher than anticipated, it may be necessary to change to a blanket drain incorporating a geofabric to act as a filter against subsoil erosion.
- If rock anchors are to run below adjoining properties, then permission of the owners must be obtained before installation. Also, the presence of neighbouring basements and their levels must be confirmed prior to finalising anchor design.
- Anchors should preferably have their bond length within sandstone bedrock of at least low strength. For the design of anchors bonded into such sandstone bedrock, an allowable bond stress of 250kPa is provisionally recommended, subject to the following conditions:
  - Anchor bond length of at least 3m behind the 'active' zone of the excavation (taken as a  $45^\circ$  zone above the base of the excavation).
  - Overall stability, including anchor group interaction, is satisfied.



- All anchors are proof loaded to at least 1.3 times the design working load before being locked off at working load.

#### **4.7 Potential Ground Movements**

For the excavation through the sandstone bedrock, some ground movements should be anticipated due to stress relief effects. These effects occur due to the locked in horizontal stresses, which are present within the bedrock mass, being released during the excavation process. Movements of about 10mm to 20mm (both horizontal and vertical) may be expected based on past experience. However, due to the poor quality, more weathered nature of the sandstone, we anticipate the movements would more likely be at the lower end of the above range. Such ground movements may affect nearby existing buildings with the zone of influence potentially extending up to twice the excavation depth back from the excavated face.

#### **4.8 Footings**

We anticipate that structural loads will be carried down to the excavated basement level. Design bearing values for pad footings below basement level would be limited by the presence of weathered weaker seams as indicated in the cored boreholes. We recommend that allowance be made for an average allowable bearing pressure of 3.5MPa for initial design purposes. We note that this bearing pressure has been based on serviceability (settlement) criteria.

Adoption of this design bearing pressure is subject to further investigations and proving by spoon test holes or additional cored boreholes during construction. Some areas of poor quality sandstone may be encountered requiring either deepening of footing excavations or adoption of lower bearing pressures. Alternatively, the further investigations may justify the use of higher allowable bearing pressures.



#### **4.9 Groundwater**

Groundwater seepage inflows can be anticipated from the excavated faces. We recommend that allowance be made for a perimeter spoon drain and subsoil drains below the basement floor slabs. These drains would lead to a sump and pump system. Weepholes and subsurface drains may also be required in areas of shotcrete and 'dental' treatment of weathered seams.

If possible, we recommend that consideration be given to ventilation plenum spaces being located along the eastern side. The advantage of this arrangement is that any long term seepage from this uphill face will not be within the exposed basement area, but rather within the plenum space. In addition, access to the plenum would allow for maintenance inspection and cleaning of spoon drains, etc.

#### **4.10 Additional Investigations**

We recommend that further deep cored boreholes be drilled to confirm the uniformity of the subsurface conditions across the site area. For a development of this size, an indicative borehole spacing of about 30m to 40m should be considered. We note that completion of these boreholes is only likely to be possible after demolition. We would be pleased to provide our proposals for such additional investigations.

#### **4.11 Further Geotechnical input**

We summarise below the previously recommended additional work that needs to be carried out:

- Additional geotechnical investigation work as outlined above following the completion of demolition of the existing buildings on site.
- Dilapidation survey reports on the neighbouring buildings.
- Geotechnical inspections of rock faces during excavation.
- Vibration monitoring during rock excavation.



- Witnessing the proof stressing of temporary anchors.
- Geotechnical inspection of footing excavations.
- Spoon testing footing excavations.
- Groundwater monitoring into the bulk excavation.

We also recommend a meeting at the commencement of construction to discuss the primary geotechnical issues and inspection requirements.

## **5 GENERAL COMMENTS**

The recommendations presented in this report include specific issues to be addressed during the construction phase of the project. In the event that any of the construction phase recommendations presented in this report are not implemented, the general recommendations may become inapplicable and Jeffery and Katauskas Pty Ltd accept no responsibility whatsoever for the performance of the structure where recommendations are not implemented in full and properly tested, inspected and documented.

Occasionally, the subsurface conditions between and away from the completed boreholes may be found to be different (or may be interpreted to be different) from those expected. Variation can also occur with groundwater conditions, especially after climatic changes. If such differences appear to exist, we recommend that you immediately contact this office.

This report provides advice on geotechnical aspects for the proposed civil and structural design. As part of the documentation stage of this project, Contract Documents and Specifications may be prepared based on our report. However, there may be design features we are not aware of or have not commented on for a variety of reasons. The designers should satisfy themselves that all the necessary advice has been obtained. If required, we could be commissioned to review the



geotechnical aspects of contract documents to confirm the intent of our recommendations has been correctly implemented.

A waste classification will need to be assigned to any soil excavated from the site prior to offsite disposal. Subject to the appropriate testing, material can be classified as Virgin Excavated Natural Material (VENM), General Solid, Restricted Solid or Hazardous Waste. If the natural soil has been stockpiled, classification of this soil as Excavated Natural Material (ENM) can also be undertaken, if requested. However, the criteria for ENM are more stringent and the cost associated with attempting to meet these criteria may be significant. Analysis takes seven to 10 working days to complete, therefore, an adequate allowance should be included in the construction program unless testing is completed prior to construction. If contamination is encountered, then substantial further testing (and associated delays) should be expected. We strongly recommend that this issue is addressed prior to the commencement of excavation on site.

If there is any change in the proposed development described in this report then all recommendations should be reviewed.

This report has been prepared for the particular project described and no responsibility is accepted for the use of any part of this report in any other context or for any other purpose. Copyright in this report is the property of Jeffery and Katauskas Pty Ltd. We have used a degree of care, skill and diligence normally exercised by consulting engineers in similar circumstances and locality. No other warranty expressed or implied is made or intended. Subject to payment of all fees due for the investigation, the client alone shall have a licence to use this report. The report shall not be reproduced except in full.



Should you have any queries regarding this report, please do not hesitate to contact the undersigned.

A handwritten signature in black ink, appearing to read 'N. Smith', written over a light grey grid background.

**Nicholas Smith**  
Senior Geotechnical Engineer

A handwritten signature in black ink, appearing to read 'A. Zenon', written over a light grey grid background.

**Agi Zenon**  
Senior Associate  
For and on behalf of  
JEFFERY AND KATAUSKAS PTY LTD.

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Ref No: 23922ZN  
Table A: Page 1 of 1

**TABLE A**  
**SUMMARY OF MOISTURE CONTENT TEST RESULTS**

AS 1289	TEST METHOD	2.1.1
BOREHOLE NUMBER	DEPTH	MOISTURE CONTENT
	m	%
101	1.50-1.55	11.4
101	2.50-3.00	9.4
101	4.00-4.20	5.7

Ref No: 23922ZN  
 TABLE B Page 1 of 1

**TABLE B**  
**SUMMARY OF POINT LOAD STRENGTH INDEX TEST RESULTS**

BOREHOLE NUMBER	DEPTH	$I_{s(50)}$	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH
	m	MPa	(MPa)
101	4.51-4.55	0.5	10
	5.13-5.17	0.4	8
	5.85-8.90	0.3	6
	6.55-6.59	0.3	6
	7.44-7.48	0.5	10
	8.67-8.70	0.3	6
	9.15-9.18	0.3	6
	9.83-9.86	0.7	14
	10.80-10.83	0.3	6
	11.16-11.20	0.9	18
	11.82-11.86	1.0	20
	12.78-12.82	0.1	2
	13.22-13.25	2.2	44
	14.29-14.32	0.4	8
	14.87-14.91	0.5	10
	15.45-15.49	1.3	26
	16.27-16.30	0.9	18
	17.28-17.31	0.8	16
	17.87-17.90	0.8	16
	18.43-18.47	0.8	16
19.58-19.61	1.4	28	
20.31-20.34	1.4	28	
20.96-21.00	0.9	18	
21.11-21.15	0.7	14	

**NOTES:**

1. In the above table testing was completed in the Axial direction.
2. The above strength tests were completed at the 'as received' moisture content.
3. Test Method: RTA T223.
4. The Estimated Unconfined Compressive Strength was calculated from the point load Strength Index by the following approximate relationship and rounded off to the nearest whole number :  

$$U.C.S. = 20 I_{s(50)}$$



Borehole No.

**101**

1/4

## BOREHOLE LOG

**Client:** ROZELLE VILLAGE PTY LTD  
**Project:** PROPOSED REDEVELOPMENT OF BALMAIN LEAGUES CLUB  
**Location:** VICTORIA ROAD, ROZELLE, NSW

**Job No.** 23922ZN      **Method:** SPIRAL AUGER      **R.L. Surface:** 32.96m  
**Date:** 8-4-10      JK300      **Datum:** AHD  
**Logged/Checked by:** G.F./

Groundwater Record	SAMPLES			Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	ES	U50	DB									
DRY ON COMPLETION OF AUGERING					0		-	CONCRETE: 120mm.t	D	-	-	NO OBSERVED REINFORCEMENT
					1		-	FILL: Silty sandy gravel, fine to coarse grained angular igneous and sub rounded alluvial gravel, fine to medium grained sand, brown. FILL: Clayey sand, fine to medium grained, brown, dark grey and red brown, with a trace of fine to medium grained sub angular ironstone and sandstone gravel and fine to medium grained angular igneous gravel.	M			
				SPT 10/50mm REFUSAL	2		-	SANDSTONE: fine to medium grained, light grey and orange brown.	XW/DW	EL/VL		VERY LOW 'TC' BIT RESISTANCE
					3		-	SANDSTONE: fine to coarse grained, light grey, red brown and orange brown.	DW	L-M		LOW RESISTANCE
					4							
					5			REFER TO CORED BOREHOLE LOG				
					6							
					7							

# JEFFERY & KATAUSKAS PTY LTD

JOB No: 23922ZN, BH 101, START CORING AT 4.24m

4

5

6

7

8

9

10

11

12





Borehole No.  
**101**  
2/4

# CORED BOREHOLE LOG

**Client:** ROZELLE VILLAGE PTY LTD  
**Project:** PROPOSED REDEVELOPMENT OF BALMAIN LEAGUES CLUB  
**Location:** VICTORIA ROAD, ROZELLE, NSW

**Job No.** 23922ZN      **Core Size:** NMLC      **R.L. Surface:** 32.96m  
**Date:** 8-4-10      **Inclination:** VERTICAL      **Datum:** AHD  
**Drill Type:** JK300      **Bearing:** -      **Logged/Checked by:** G.F./

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX I <sub>s</sub> (50)	DEFECT DETAILS									
								DEFECT SPACING (mm)					DESCRIPTION				
								EL	VL	L	M	H	VH	EH	500	300	100
		3															
		4		START CORING AT 4.24m													
		5		SANDSTONE: fine to coarse grained, light grey, orange brown and red brown, with darker laminae, bedded at 0-10°.	DW	L-M											- XWS, 0°, 10mm.t
		5		SANDSTONE: fine to coarse grained, light grey, with light orange brown with light red brown staining.	XW	EL											
		5			DW	L-M											
		6															
		7															- XWS, 0°, 50mm.t
		7		SANDSTONE: fine to coarse grained, light grey.													- XWS, 0°, 25mm.t
		8															
		9		SANDSTONE: fine to coarse grained, dark red brown, light grey and orange brown, with iron indurated bands.													- XWS/CS, 0°, 70mm.t
		9				VL											- Be, 0°, P, S, IS
		9				L-M											- CR, 0°, 30mm.t
		9		SANDSTONE: as below.													- XWS, 0°, 20mm.t

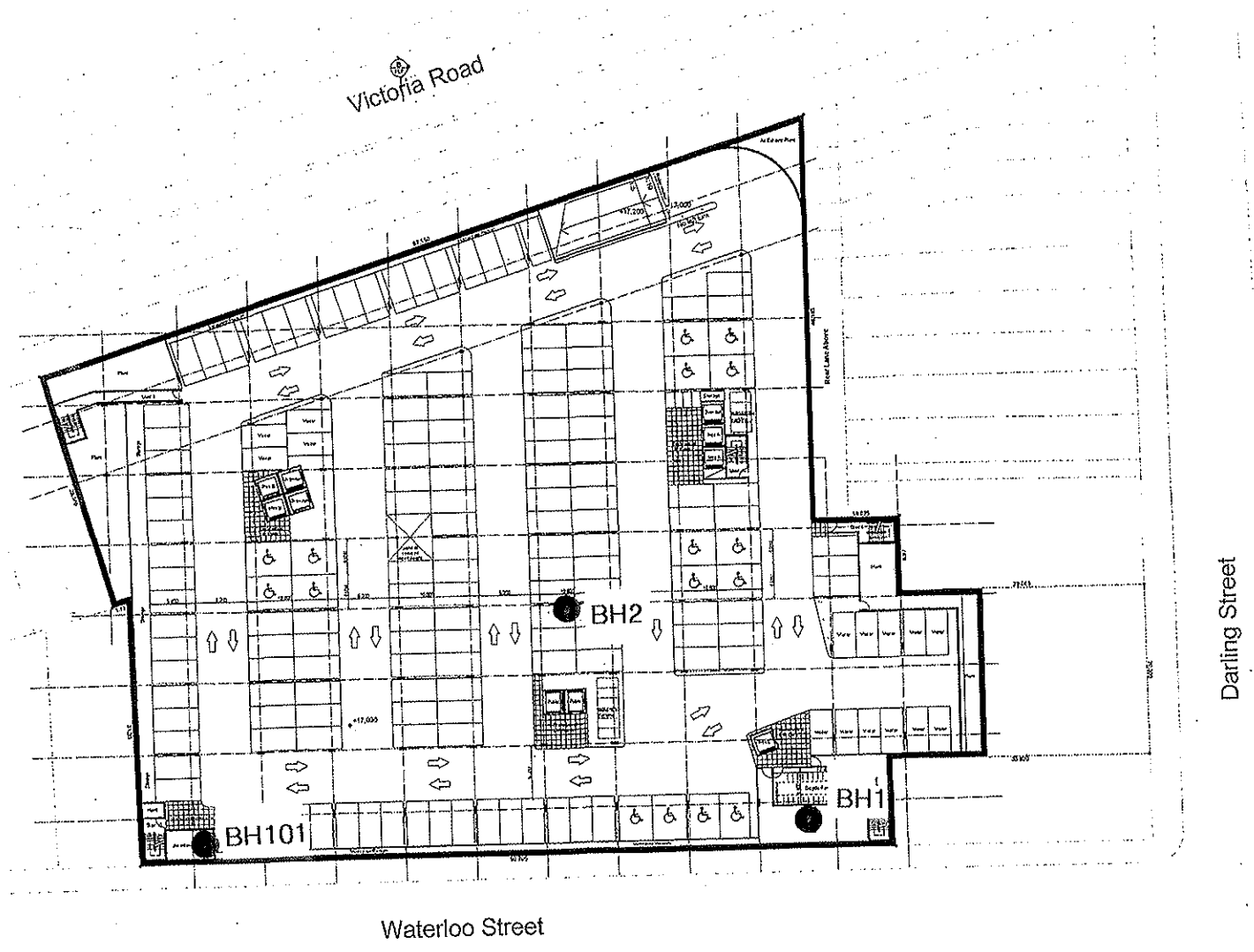
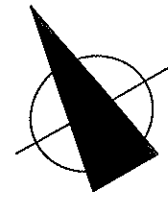
FULL RETURN

ON COMPLETION OF CORING

COPYRIGHT

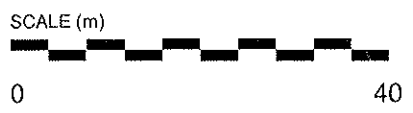






NOTE: BH1 and BH2 from previous Jeffery and Katauskas Geotechnical Investigation (Ref: 19319W dated 8 April 2005).

## BOREHOLE LOCATION PLAN



**Jeffery and Katauskas Pty Ltd**  
CONSULTING GEOTECHNICAL & ENVIRONMENTAL ENGINEERS



Report No. 23922ZN Figure No. 1



## REPORT EXPLANATION NOTES

### INTRODUCTION

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

The ground is a product of continuing natural and man-made processes and therefore exhibits a variety of characteristics and properties which vary from place to place and can change with time. Geotechnical engineering involves gathering and assimilating limited facts about these characteristics and properties in order to understand or predict the behaviour of the ground on a particular site under certain conditions. This report may contain such facts obtained by inspection, excavation, probing, sampling, testing or other means of investigation. If so, they are directly relevant only to the ground at the place where and time when the investigation was carried out.

### DESCRIPTION AND CLASSIFICATION METHODS

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726, the SAA Site Investigation Code. In general, descriptions cover the following properties – soil or rock type, colour, structure, strength or density, and inclusions. Identification and classification of soil and rock involves judgement and the Company infers accuracy only to the extent that is common in current geotechnical practice.

Soil types are described according to the predominating particle size and behaviour as set out in the attached Unified Soil Classification Table qualified by the grading of other particles present (eg sandy clay) as set out below:

Soil Classification	Particle Size
Clay	less than 0.002mm
Silt	0.002 to 0.06mm
Sand	0.06 to 2mm
Gravel	2 to 60mm

Non-cohesive soils are classified on the basis of relative density, generally from the results of Standard Penetration Test (SPT) as below:

Relative Density	SPT 'N' Value (blows/300mm)
Very loose	less than 4
Loose	4 – 10
Medium dense	10 – 30
Dense	30 – 50
Very Dense	greater than 50

Cohesive soils are classified on the basis of strength (consistency) either by use of hand penetrometer, laboratory testing or engineering examination. The strength terms are defined as follows.

Classification	Unconfined Compressive Strength kPa
Very Soft	less than 25
Soft	25 – 50
Firm	50 – 100
Stiff	100 – 200
Very Stiff	200 – 400
Hard	Greater than 400
Friable	Strength not attainable – soil crumbles

Rock types are classified by their geological names, together with descriptive terms regarding weathering, strength, defects, etc. Where relevant, further information regarding rock classification is given in the text of the report. In the Sydney Basin, 'Shale' is used to describe thinly bedded to laminated siltstone.

### SAMPLING

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

Disturbed samples taken during drilling provide information on plasticity, grain size, colour, moisture content, minor constituents and, depending upon the degree of disturbance, some information on strength and structure. Bulk samples are similar but of greater volume required for some test procedures.

Undisturbed samples are taken by pushing a thin-walled sample tube, usually 50mm diameter (known as a U50), into the soil and withdrawing it with a sample of the soil contained in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Details of the type and method of sampling used are given on the attached logs.

### INVESTIGATION METHODS

The following is a brief summary of investigation methods currently adopted by the Company and some comments on their use and application. All except test pits, hand auger drilling and portable dynamic cone penetrometers require the use of a mechanical drilling rig which is commonly mounted on a truck chassis.



**Test Pits:** These are normally excavated with a backhoe or a tracked excavator, allowing close examination of the insitu soils if it is safe to descend into the pit. The depth of penetration is limited to about 3m for a backhoe and up to 6m for an excavator. Limitations of test pits are the problems associated with disturbance and difficulty of reinstatement and the consequent effects on close-by structures. Care must be taken if construction is to be carried out near test pit locations to either properly recompact the backfill during construction or to design and construct the structure so as not to be adversely affected by poorly compacted backfill at the test pit location.

**Hand Auger Drilling:** A borehole of 50mm to 100mm diameter is advanced by manually operated equipment. Premature refusal of the hand augers can occur on a variety of materials such as hard clay, gravel or ironstone, and does not necessarily indicate rock level.

**Continuous Spiral Flight Augers:** The borehole is advanced using 75mm to 115mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling and insitu testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface by the flights or may be collected after withdrawal of the auger flights, but they can be very disturbed and layers may become mixed. Information from the auger sampling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively lower reliability due to mixing or softening of samples by groundwater, or uncertainties as to the original depth of the samples. Augering below the groundwater table is of even lesser reliability than augering above the water table.

**Rock Augering:** Use can be made of a Tungsten Carbide (TC) bit for auger drilling into rock to indicate rock quality and continuity by variation in drilling resistance and from examination of recovered rock fragments. This method of investigation is quick and relatively inexpensive but provides only an indication of the likely rock strength and predicted values may be in error by a strength order. Where rock strengths may have a significant impact on construction feasibility or costs, then further investigation by means of cored boreholes may be warranted.

**Wash Boring:** The borehole is usually advanced by a rotary bit, with water being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from "feel" and rate of penetration.

**Mud Stabilised Drilling:** Either Wash Boring or Continuous Core Drilling can use drilling mud as a circulating fluid to stabilise the borehole. The term 'mud' encompasses a range of products ranging from bentonite to polymers such as Revert or Biogel. The mud tends to mask the cuttings and reliable identification is only possible from intermittent intact sampling (eg from SPT and U50 samples) or from rock coring, etc.

**Continuous Core Drilling:** A continuous core sample is obtained using a diamond tipped core barrel. Provided full core recovery is achieved (which is not always possible in very low strength rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation. In rocks, an NMLC triple tube core barrel, which gives a core of about 50mm diameter, is usually used with water flush. The length of core recovered is compared to the length drilled and any length not recovered is shown as CORE LOSS. The location of losses are determined on site by the supervising engineer; where the location is uncertain, the loss is placed at the top end of the drill run.

**Standard Penetration Tests:** Standard Penetration Tests (SPT) are used mainly in non-cohesive soils, but can also be used in cohesive soils as a means of indicating density or strength and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, "Methods of Testing Soils for Engineering Purposes" – Test F3.1.

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

The test results are reported in the following form:

- In the case where full penetration is obtained with successive blow counts for each 150mm of, say, 4, 6 and 7 blows, as

$$N = 13 \\ 4, 6, 7$$

- In a case where the test is discontinued short of full penetration, say after 15 blows for the first 150mm and 30 blows for the next 40mm, as

$$N > 30 \\ 15, 30/40\text{mm}$$

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

Occasionally, the drop hammer is used to drive 50mm diameter thin walled sample tubes (U50) in clays. In such circumstances, the test results are shown on the borehole logs in brackets.

A modification to the SPT test is where the same driving system is used with a solid 60° tipped steel cone of the same diameter as the SPT hollow sampler. The solid cone can be continuously driven for some distance in soft clays or loose sands, or may be used where damage would otherwise occur to the SPT. The results of this Solid Cone Penetration Test (SCPT) are shown as "N<sub>c</sub>" on the borehole logs, together with the number of blows per 150mm penetration.



**Static Cone Penetrometer Testing and Interpretation:** Cone penetrometer testing (sometimes referred to as a Dutch Cone) described in this report has been carried out using an Electronic Friction Cone Penetrometer (EFCP). The test is described in Australian Standard 1289, Test F5.1.

In the tests, a 35mm diameter rod with a conical tip is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with an hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the frictional resistance on a separate 134mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are electrically connected by wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck.

As penetration occurs (at a rate of approximately 20mm per second) the information is output as incremental digital records every 10mm. The results given in this report have been plotted from the digital data.

The information provided on the charts comprise:

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

The ratios of the sleeve resistance to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1% to 2% are commonly encountered in sands and occasionally very soft clays, rising to 4% to 10% in stiff clays and peats. Soil descriptions based on cone resistance and friction ratios are only inferred and must not be considered as exact.

Correlations between EFCP and SPT values can be developed for both sands and clays but may be site specific.

Interpretation of EFCP values can be made to empirically derive modulus or compressibility values to allow calculation of foundation settlements.

Stratification can be inferred from the cone and friction traces and from experience and information from nearby boreholes etc. Where shown, this information is presented for general guidance, but must be regarded as interpretive. The test method provides a continuous profile of engineering properties but, where precise information on soil classification is required, direct drilling and sampling may be preferable.

**Portable Dynamic Cone Penetrometers:** Portable Dynamic Cone Penetrometer (DCP) tests are carried out by driving a rod into the ground with a sliding hammer and counting the blows for successive 100mm increments of penetration.

Two relatively similar tests are used:

- Cone penetrometer (commonly known as the Scala Penetrometer) – a 16mm rod with a 20mm diameter cone end is driven with a 9kg hammer dropping 510mm (AS1289, Test F3.2). The test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various Road Authorities.
- Perth sand penetrometer – a 16mm diameter flat ended rod is driven with a 9kg hammer, dropping 600mm (AS1289, Test F3.3). This test was developed for testing the density of sands (originating in Perth) and is mainly used in granular soils and filling.

## LOGS

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

The attached explanatory notes define the terms and symbols used in preparation of the logs.

Interpretation of the information shown on the logs, and its application to design and construction, should therefore take into account the spacing of boreholes or test pits, the method of drilling or excavation, the frequency of sampling and testing and the possibility of other than "straight line" variations between the boreholes or test pits. Subsurface conditions between boreholes or test pits may vary significantly from conditions encountered at the borehole or test pit locations.

## GROUNDWATER

Where groundwater levels are measured in boreholes, there are several potential problems:

- Although groundwater may be present, in low permeability soils it may enter the hole slowly or perhaps not at all during the time it is left open.
- A localised perched water table may lead to an erroneous indication of the true water table.
- Water table levels will vary from time to time with seasons or recent weather changes and may not be the same at the time of construction.
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must be washed out of the hole or 'reverted' chemically if water observations are to be made.



More reliable measurements can be made by installing standpipes which are read after stabilising at intervals ranging from several days to perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from perched water tables or surface water.

#### **FILL**

The presence of fill materials can often be determined only by the inclusion of foreign objects (eg bricks, steel etc) or by distinctly unusual colour, texture or fabric. Identification of the extent of fill materials will also depend on investigation methods and frequency. Where natural soils similar to those at the site are used for fill, it may be difficult with limited testing and sampling to reliably determine the extent of the fill.

The presence of fill materials is usually regarded with caution as the possible variation in density, strength and material type is much greater than with natural soil deposits. Consequently, there is an increased risk of adverse engineering characteristics or behaviour. If the volume and quality of fill is of importance to a project, then frequent test pit excavations are preferable to boreholes.

#### **LABORATORY TESTING**

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

#### **ENGINEERING REPORTS**

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

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

- Unexpected variations in ground conditions – the potential for this will be partially dependent on borehole spacing and sampling frequency as well as investigation technique.
- Changes in policy or interpretation of policy by statutory authorities.
- The actions of persons or contractors responding to commercial pressures.

If these occur, the company will be pleased to assist with investigation or advice to resolve any problems occurring.

#### **SITE ANOMALIES**

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

#### **REPRODUCTION OF INFORMATION FOR CONTRACTUAL PURPOSES**

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

Copyright in all documents (such as drawings, borehole or test pit logs, reports and specifications) provided by the Company shall remain the property of Jeffery and Katauskas Pty Ltd. Subject to the payment of all fees due, the Client alone shall have a licence to use the documents provided for the sole purpose of completing the project to which they relate. License to use the documents may be revoked without notice if the Client is in breach of any objection to make a payment to us.

#### **REVIEW OF DESIGN**

Where major civil or structural developments are proposed or where only a limited investigation has been completed or where the geotechnical conditions/ constraints are quite complex, it is prudent to have a joint design review which involves a senior geotechnical engineer.

#### **SITE INSPECTION**

The company will always be pleased to provide engineering inspection services for geotechnical aspects of work to which this report is related.

Requirements could range from:

- i) a site visit to confirm that conditions exposed are no worse than those interpreted, to
- ii) a visit to assist the contractor or other site personnel in identifying various soil/rock types such as appropriate footing or pier founding depths, or
- iii) full time engineering presence on site.

# GRAPHIC LOG SYMBOLS FOR SOILS AND ROCKS

SOIL		ROCK		DEFECTS AND INCLUSIONS	
	FILL		CONGLOMERATE		CLAY SEAM
	TOPSOIL		SANDSTONE		SHEARED OR CRUSHED SEAM
	CLAY (CL, CH)		SHALE		BRECCIATED OR SHATTERED SEAM/ZONE
	SILT (ML, MH)		SILTSTONE, MUDSTONE, CLAYSTONE		IRONSTONE GRAVEL
	SAND (SP, SW)		LIMESTONE		ORGANIC MATERIAL
	GRAVEL (GP, GW)		PHYLLITE, SCHIST		
	SANDY CLAY (CL, CH)		TUFF		
	SILTY CLAY (CL, CH)		GRANITE, GABBRO		
	CLAYEY SAND (SC)		DOLERITE, DIORITE		CONCRETE
	SILTY SAND (SM)		BASALT, ANDESITE		BITUMINOUS CONCRETE, COAL
	GRAVELLY CLAY (CL, CH)		QUARTZITE		COLLUVIUM
	CLAYEY GRAVEL (GC)				
	SANDY SILT (ML)				
	PEAT AND ORGANIC SOILS				

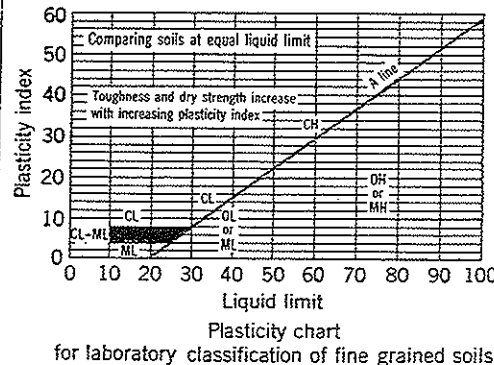


# UNIFIED SOIL CLASSIFICATION TABLE

Field Identification Procedures (Excluding particles larger than 75 μm and basing fractions on estimated weights)				Group Symbols	Typical Names	Information Required for Describing Soils	Laboratory Classification Criteria				
Coarse-grained soils More than half of material is larger than 75 μm sieve size (The 75 μm sieve size is about the smallest particle visible to naked eye)	Gravels More than half of coarse fraction is larger than 4 mm sieve size	Clean gravels (little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes	GW	Well graded gravels, gravel-sand mixtures, little or no fines	Give typical name; indicate approximate percentages of sand and gravel; maximum size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbols in parentheses  For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics  Example: <i>Silty sand, gravelly</i> ; about 20% hard, angular gravel particles 12 mm maximum size; rounded and subangular sand grains coarse to fine, about 15% non-plastic fines with low dry strength; well compacted and moist in place; alluvial sand; (SM)	$C_u = \frac{D_{60}}{D_{10}} \text{ Greater than 4}$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} \text{ Between 1 and 3}$ Not meeting all gradation requirements for GW				
			Predominantly one size or a range of sizes with some intermediate sizes missing	GP	Poorly graded gravels, gravel-sand mixtures, little or no fines						
		Gravels with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures see ML below)	GM	Silty gravels, poorly graded gravel-sand-silt mixtures			Atterberg limits below "A" line, or PI less than 4  Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols			
	Plastic fines (for identification procedures, see CL below)		GC	Clayey gravels, poorly graded gravel-sand-clay mixtures	Atterberg limits above "A" line, with PI greater than 7						
									Wide range in grain sizes and substantial amounts of all intermediate particle sizes	SW	Well graded sands, gravelly sands, little or no fines
	Sands More than half of coarse fraction is smaller than 4 mm sieve size	Clean sands (little or no fines)	Predominantly one size or a range of sizes with some intermediate sizes missing	SP	Poorly graded sands, gravelly sands, little or no fines			Atterberg limits below "A" line or PI less than 5  Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols			
Nonplastic fines (for identification procedures, see ML below)			SM	Silty sands, poorly graded sand-silt mixtures	Atterberg limits below "A" line with PI greater than 7						
		Plastic fines (for identification procedures, see CL below)				SC	Clayey sands, poorly graded sand-clay mixtures				
Fine-grained soils More than half of material is smaller than 75 μm sieve size (The 75 μm sieve size is about the smallest particle visible to naked eye)	Identification Procedures on Fraction Smaller than 380 μm Sieve Size										
	Silt and clays liquid limit less than 50	Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	Give typical name; indicate degree and character of plasticity, amount and maximum size of coarse grains; colour in wet condition, odour if any, local or geologic name, and other pertinent descriptive information, and symbol in parentheses	For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture and drainage conditions  Example: <i>Clayey silt, brown</i> ; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; (ML)			
									None to slight	Quick to slow	None
									Medium to high	None to very slow	Medium
	Silt and clays liquid limit greater than 50	Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture and drainage conditions  Example: <i>Clayey silt, brown</i> ; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; (ML)				
								Slight to medium	Slow	Slight	
								Slight to medium	Slow to none	Slight to medium	
	Silt and clays liquid limit greater than 50	Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture and drainage conditions  Example: <i>Clayey silt, brown</i> ; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; (ML)				
								High to very high	None	High	
								Medium to high	None to very slow	Slight to medium	
Silt and clays liquid limit greater than 50	Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)	CH	Inorganic clays of high plasticity, fat clays	For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture and drainage conditions  Example: <i>Clayey silt, brown</i> ; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; (ML)					
							High to very high	None	High		
							Medium to high	None to very slow	Slight to medium		
Highly Organic Soils	Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)	Pt	Peat and other highly organic soils	For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture and drainage conditions  Example: <i>Clayey silt, brown</i> ; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; (ML)					
							High to very high	None	High		
							Medium to high	None to very slow	Slight to medium		

Determine percentages of gravel and sand from grain size curve. Depending on percentage of fines (fraction smaller than 75 μm sieve size) coarse grained soils are classified as follows:  
Less than 5% GW, GP, SW, SP  
More than 5% GM, GC, SM, SC  
Borderline cases requiring use of dual symbols

Use grain size curve in identifying the fractions as given under field identification



NOTE: 1) Soils possessing characteristics of two groups are designated by combinations of group symbols (e.g. GW-GC, well graded gravel-sand mixture with clay fines).  
2) Soils with liquid limits of the order of 35 to 50 may be visually classified as being of medium plasticity.



## LOG SYMBOLS

LOG COLUMN	SYMBOL	DEFINITION	
Groundwater Record		Standing water level. Time delay following completion of drilling may be shown.	
		Extent of borehole collapse shortly after drilling.	
		Groundwater seepage into borehole or excavation noted during drilling or excavation.	
Samples	ES	Soil sample taken over depth indicated, for environmental analysis.	
	U50	Undisturbed 50mm diameter tube sample taken over depth indicated.	
	DB	Bulk disturbed sample taken over depth indicated.	
	DS	Small disturbed bag sample taken over depth indicated.	
	ASB	Soil sample taken over depth indicated, for asbestos screening.	
	ASS	Soil sample taken over depth indicated, for acid sulfate soil analysis.	
	SAL	Soil sample taken over depth indicated, for salinity analysis.	
Field Tests	N = 17 4, 7, 10	Standard Penetration Test (SPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration. 'R' as noted below.	
	N <sub>c</sub> =	5	Solid Cone Penetration Test (SCPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration for 60 degree solid cone driven by SPT hammer. 'R' refers to apparent hammer refusal within the corresponding 150mm depth increment.
		7	
		3R	
VNS = 25 PID = 100	Vane shear reading in kPa of Undrained Shear Strength. Photoionisation detector reading in ppm (Soil sample headspace test).		
Moisture Condition (Cohesive Soils)  (Cohesionless Soils)	MC > PL	Moisture content estimated to be greater than plastic limit.	
	MC ≈ PL	Moisture content estimated to be approximately equal to plastic limit.	
	MC < PL	Moisture content estimated to be less than plastic limit.	
	D	DRY - runs freely through fingers.	
	M	MOIST - does not run freely but no free water visible on soil surface.	
W	WET - free water visible on soil surface.		
Strength (Consistency) Cohesive Soils	VS	VERY SOFT - Unconfined compressive strength less than 25kPa	
	S	SOFT - Unconfined compressive strength 25-50kPa	
	F	FIRM - Unconfined compressive strength 50-100kPa	
	St	STIFF - Unconfined compressive strength 100-200kPa	
	VSt	VERY STIFF - Unconfined compressive strength 200-400kPa	
	H	HARD - Unconfined compressive strength greater than 400kPa	
	( )	Bracketed symbol indicates estimated consistency based on tactile examination or other tests.	
Density Index/ Relative Density (Cohesionless Soils)	VL	Density Index (I <sub>d</sub> ) Range (%)                      SPT 'N' Value Range (Blows/300mm) Very Loose                      < 15    0-4	
	L	Loose                                      15-35    4-10	
	MD	Medium Dense                      35-65    10-30	
	D	Dense                                      65-85    30-50	
	VD	Very Dense                                      > 85    > 50	
	( )	Bracketed symbol indicates estimated density based on ease of drilling or other tests.	
Hand Penetrometer Readings	300	Numbers indicate individual test results in kPa on representative undisturbed material unless noted otherwise.	
	250		
Remarks	'V' bit	Hardened steel 'V' shaped bit.	
	'TC' bit	Tungsten carbide wing bit.	
	T 60	Penetration of auger string in mm under static load of rig applied by drill head hydraulics without rotation of augers.	



## LOG SYMBOLS

### ROCK MATERIAL WEATHERING CLASSIFICATION

TERM	SYMBOL	DEFINITION
Residual Soil	RS	Soil developed on extremely weathered 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 rock	XW	Rock is weathered to such an extent that it has "soil" properties, ie it either disintegrates or can be remoulded, in water.
Distinctly weathered rock	DW	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by ironstaining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Slightly weathered rock	SW	Rock is slightly discoloured but shows little or no change of strength from fresh rock.
Fresh rock	FR	Rock shows no sign of decomposition or staining.

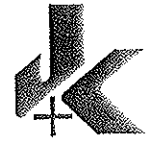
### ROCK STRENGTH

Rock strength is defined by the Point Load Strength Index (Is 50) and refers to the strength of the rock substance in the direction normal to the bedding. The test procedure is described by the International Journal of Rock Mechanics, Mining, Science and Geomechanics, Abstract Volume 22, No 2, 1985.

TERM	SYMBOL	Is (50) MPa	FIELD GUIDE
Extremely Low:	EL	0.03	Easily remoulded by hand to a material with soil properties.
Very Low:	VL	0.1	May be crumbled in the hand. Sandstone is "sugary" and friable.
Low:	L	0.3	A piece of core 150mm long x 50mm dia. may be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling.
Medium Strength:	M	1	A piece of core 150mm long x 50mm dia. can be broken by hand with difficulty. Readily scored with knife.
High:	H	3	A piece of core 150mm long x 50mm dia. core cannot be broken by hand, can be slightly scratched or scored with knife; rock rings under hammer.
Very High:	VH	10	A piece of core 150mm long x 50mm dia. may be broken with hand-held pick after more than one blow. Cannot be scratched with pen knife; rock rings under hammer.
Extremely High:	EH		A piece of core 150mm long x 50mm dia. is very difficult to break with hand-held hammer. Rings when struck with a hammer.

### ABBREVIATIONS USED IN DEFECT DESCRIPTION

ABBREVIATION	DESCRIPTION	NOTES
Be	Bedding Plane Parting	Defect orientations measured relative to the normal to the long core axis (ie relative to horizontal for vertical holes)
CS	Clay Seam	
J	Joint	
P	Planar	
Un	Undulating	
S	Smooth	
R	Rough	
IS	Ironstained	
XWS	Extremely Weathered Seam	
Cr	Crushed Seam	
60t	Thickness of defect in millimetres	



## VIBRATION EMISSION DESIGN GOALS

German Standard DIN 4150 – Part 3: 1986 provides guideline levels of vibration velocity for evaluating the effects of vibration in structures. The limits presented in this standard are generally recognised to be conservative.

The DIN 4150 values (maximum levels measured in any direction at the foundation, OR, maximum levels measured in (x) or (y) horizontal directions, in the plane of the uppermost floor), are summarised in Table 1 below.

It should be noted that peak vibration velocities higher than the minimum figures in Table 1 for low frequencies may be quite “safe”, depending on the frequency content of the vibration and the actual condition of the structure.

It should also be noted that these levels are “safe limits”, up to which no damage due to vibration effects has been observed for the particular class of building. “Damage” is defined by DIN 4150 to include even minor non-structural effects such as superficial cracking in cement render, the enlargement of cracks already present, and the separation of partitions or intermediate walls from load bearing walls. Should damage be observed at vibration levels lower than the “safe limits” then it may be attributed to other causes. DIN 4150 also states that when vibration levels higher than the “safe limits” are present, it does not necessarily follow that damage will occur. Values given are only a broad guide.

**Table 1 DIN 4150 – Structural Damage – Safe Limits for Building Vibration**

Group	Type of Structure	Peak Vibration Velocity in mm/s			
		At Foundation Level At a Frequency of			Plane of Floor of Uppermost Storey
		Less than 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz	All Frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design.	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use.	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Group 1 and 2 and have intrinsic value (eg buildings that are under a preservation order).	3	3 to 8	8 to 10	8

**Note:** For frequencies above 100 Hz, the higher values in the 50 Hz to 100 Hz column should be used.

**APPENDIX A:**

**SUMMARY OF LABORATORY TEST RESULTS AND  
BOREHOLE LOGS FROM PREVIOUS INVESTIGATION**

**(REF: 19319WRPT DATED 8 APRIL 2005).**

Ref No: 19319W  
Table A: Page 1 of 1

**TABLE A**  
**SUMMARY OF MOISTURE CONTENT TEST RESULTS**

AS 1289	TEST METHOD	2.1.1
BOREHOLE NUMBER	DEPTH	MOISTURE CONTENT
	m	%
1	3.00-3.50	8.6
1	5.00-5.50	5.4
2	3.80-4.50	6.1
2	5.00-5.40	6.0

**TABLE B**  
**SUMMARY OF POINT LOAD STRENGTH INDEX TEST RESULTS**

BOREHOLE NUMBER	DEPTH	$I_{s(50)}$	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH	
	m	MPa	(MPa)	
1	5.89-5.93	0.7	14	
	6.43-6.47	0.2	4	
	7.22-7.25	0.5	10	
	7.76-7.80	0.5	10	
	8.52-8.56	0.6	12	
	9.57-9.60	0.3	6	
	10.39-10.43	0.5	10	
	12.07-12.10	0.02	<1	
	12.86-12.89	1.4	28	
	13.34-13.38	0.5	10	
	14.26-14.29	0.5	10	
	2	5.85-5.88	0.3	6
		6.26-6.29	0.1	2
7.24-7.28		0.2	4	
7.54-7.57		0.3	6	
8.52-8.55		0.3	6	
9.64-9.68		0.7	14	
10.35-10.38		0.1	2	
10.51-10.54		0.1	2	
11.46-11.49		1.2	24	
12.58-12.61		1.1	22	
13.38-13.42		1.0	20	
14.23-14.27	0.7	14		

**NOTES:**

1. In the above table testing was completed in the Axial direction.
2. The above strength tests were completed at the 'as received' moisture content.
3. Test Method: RTA T223.
4. The Estimated Unconfined Compressive Strength was calculated from the point load Strength Index by the following approximate relationship and rounded off to the nearest whole number :  

$$U.C.S. = 20 I_{s(50)}$$



Borehole No.

1

1/3

# BOREHOLE LOG

**Client:** BALMAIN LEAGUES CLUB  
**Project:** PROPOSED BALMAIN LEAGUES CLUB REDEVELOPMENT  
**Location:** BALMAIN LEAGUES CLUB, VICTORIA ROAD, ROZELLE, NSW

**Job No.** 19319W      **Method:** SPIRAL AUGER JK350      **R.L. Surface:** ≈ 37.9m  
**Date:** 14-3-05      **Datum:** AHD

**Logged/Checked by:** L.A./ *AW*

Groundwater Record	SAMPLES			Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/Weathering	Strength/Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	ES	USO	DB									
					0		-	ASPHALTIC CONCRETE: 50mm.t FILL: Gravelly clay, low plasticity, dark brown.	MC<PL			APPEARS MODERATELY COMPACTED
				N = 7 1,2,5	1		CL	FILL: Clayey sand, fine grained, orange brown, with a trace of rounded medium grained ironstone gravel. SILTY CLAY: medium plasticity, orange, with a trace of fine grained sand and ironstone bands.	D-M MC>PL	F-St	90 110	POSSIBLE FILL
				SPT 5/100mm REFUSAL	2		-	SANDSTONE: fine grained, light grey, with ironstone bands.	XW	EL-VL		NO 'TC' BIT RESISTANCE WITH MODERATE BANDS
					3		-		DW	VL-L		
					4		-	SANDSTONE: fine to medium grained, light grey, with occasional ironstained bands.				LOW RESISTANCE
					5		-					LOW TO MODERATE RESISTANCE
					6		-	REFER TO CORED BOREHOLE LOG				
					7		-					

▽  
ON  
COMPLETION OF  
AUGERING

▽  
ON  
COMPLETION OF  
CORING



Jeffery and Katauskas Pty Ltd

CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

19319W BH1 START CORING AT 5.77m

5

6

7

8

9

10

11

12

13





Borehole No.

1

2/3

# CORED BOREHOLE LOG

<b>Client:</b>	BALMAIN LEAGUES CLUB	
<b>Project:</b>	PROPOSED BALMAIN LEAGUES CLUB REDEVELOPMENT	
<b>Location:</b>	BALMAIN LEAGUES CLUB, VICTORIA ROAD, ROZELLE, NSW	
<b>Job No.</b> 19319W	<b>Core Size:</b> NMLC	<b>R.L. Surface:</b> ≈ 37.9m
<b>Date:</b> 14-3-05	<b>Inclination:</b> VERTICAL	<b>Datum:</b> AHD
<b>Drill Type:</b> JK350	<b>Bearing:</b> -	<b>Logged/Checked by:</b> L.A./SPD

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX I <sub>s</sub> (50)	DEFECT DETAILS											
								DEFECT SPACING (mm)										DESCRIPTION Type, inclination, thickness, planarity, roughness, coating.	
								EL	VL	L	M	H	VH	EH	500	300	100	50	20
		5		START CORING AT 5.77m															
		6		SANDSTONE: fine to medum grained, light grey, bedded at 10°.	DW	L-M	X												
		7			XW	EL-VL	X												
		8		DW	L-M	X													
		9		XW	EL-VL	X													
		10		DW	L-M	X													
		11		XW	EL-VL	X													

75% RETURN

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General Contractors and Environmental Services

14



Borehole No.

1

3/3

# CORED BOREHOLE LOG

<b>Client:</b>	BALMAIN LEAGUES CLUB	
<b>Project:</b>	PROPOSED BALMAIN LEAGUES CLUB REDEVELOPMENT	
<b>Location:</b>	BALMAIN LEAGUES CLUB, VICTORIA ROAD, ROZELLE, NSW	
<b>Job No.</b> 19319W	<b>Core Size:</b> NMLC	<b>R.L. Surface:</b> ≈ 37.9m
<b>Date:</b> 14-3-05	<b>Inclination:</b> VERTICAL	<b>Datum:</b> AHD
<b>Drill Type:</b> JK350	<b>Bearing:</b> -	<b>Logged/Checked by:</b> L.A./BAO

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX I <sub>s</sub> (50)	DEFECT DETAILS	
								DEFECT SPACING (mm)	DESCRIPTION Type, inclination, thickness, planarity, roughness, coating.
								EL VL L M H VH EH	Specific General
75% RET URN		13		SANDSTONE: fine to medium grained, light grey, bedded at 10°.	XW	EL-VL			<ul style="list-style-type: none"> <li>- J, 90°, P, S</li> <li>- Be, 10°, P, S, IRONSTONE COATED</li> <li>- J, 45-90°, P, R</li> <li>- J, 70°, P, S, IS</li> <li>- J, 80°, Un, R, IS</li> <li>- XWS, 40mm.l</li> <li>- XWS, 20mm.l</li> <li>- J, 0-35°, Un, R, IS</li> <li>- Be, 20°, P, S, IS</li> <li>2xJ, 15°, Un, R, IS</li> <li>- Be, 0°, Un, S, IS</li> <li>- J, 30°, Un, R, IS</li> <li>- Be, 10°, Un, R, IS</li> <li>- Be, 0°, CLAY COATED</li> </ul>
				as above, but with orange and red brown bands and bedded at 10-20°.	DW	M	X		
				as above, but with medium grained quartz gravel inclusions.		L-M	X		
		14		END OF BOREHOLE AT 14.55m					
		15							
		16							
		17							
		18							



Borehole No.

2

1/3

# BOREHOLE LOG

**Client:** BALMAIN LEAGUES CLUB  
**Project:** PROPOSED BALMAIN LEAGUES CLUB REDEVELOPMENT  
**Location:** BALMAIN LEAGUES CLUB, VICTORIA ROAD, ROZELLE, NSW

**Job No.** 19319W      **Method:** SPIRAL AUGER JK350      **R.L. Surface:** ≈ 35.0m  
**Date:** 15-3-05      **Datum:** AHD

**Logged/Checked by:** L.A./BFW

Groundwater Record	SAMPLES			Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	ES	U30	DB									
					0		-	ASPHALTIC CONCRETE: 80mm.t FILL: Gravelly sand, medium grained, dark grey, with some medium grained slag.	D	-	-	APPEARS MODERATELY COMPACTED
				N = 8 6,5,3	1		-	FILL: Gravelly sand, medium grained, orange brown, with brick fragments.  FILL: Clayey sand, fine to medium grained, dark brown, with medium to coarse grained angular sandstone gravel.	D-M			APPEARS POORLY COMPACTED
				N = 5 1,2,3	2		CL	SANDY CLAY: medium plasticity, orange brown, with fine to medium grained ironstone gravel.	MC>PL	St	100 140	
ON COMPLETION OF CORING					3			as above, but with ironstone bands.				OCCASIONAL MODERATE RESISTANCE BANDS
ON COMPLETION OF AUGERING					4		-	SANDSTONE: fine to medium grained, light grey, with occasional ironstone bands and clay seams.	XW	EL-VL		VERY LOW 'TC' BIT RESISTANCE WITH MODERATE BANDS
					5			SANDSTONE: fine to medium grained, light grey, with occasional red brown seams.	DW	VL-L		LOW RESISTANCE
					6			SANDSTONE: medium to coarse grained, red brown, with orange brown bands.		L-M		MODERATE RESISTANCE
					7			REFER TO CORED BOREHOLE LOG				MODERATE TO HIGH RESISTANCE



Jeffery and Katauskas Pty Ltd  
CORING CONTRACTORS AND EQUIPMENT HIRE

19319W BH2 START CORING AT 5.78m

5

6

CORE LOSS 0.68m

7

8

9

10

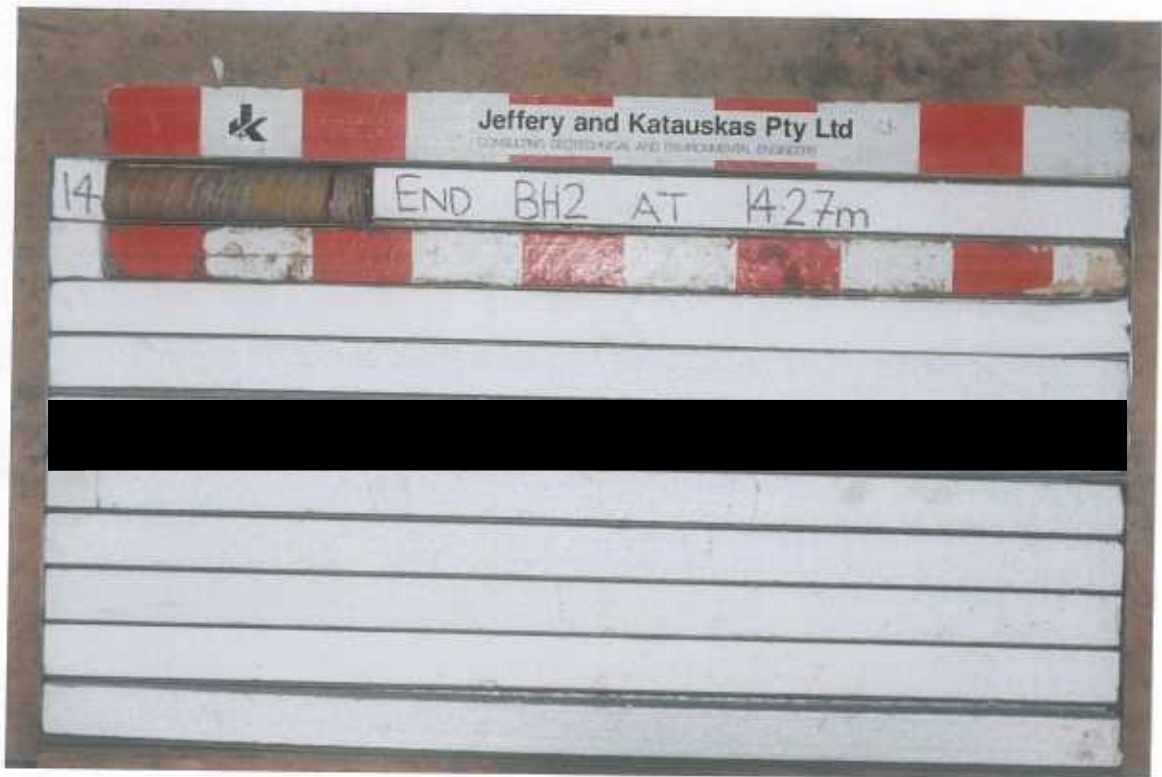
CORE LOSS 0.23m

11

12

13







Borehole No.

2

3/3

# CORED BOREHOLE LOG

**Client:** BALMAIN LEAGUES CLUB  
**Project:** PROPOSED BALMAIN LEAGUES CLUB REDEVELOPMENT  
**Location:** BALMAIN LEAGUES CLUB, VICTORIA ROAD, ROZELLE, NSW

**Job No.** 19319W      **Core Size:** NMLC      **R.L. Surface:** ≈ 35.0m  
**Date:** 15-3-05      **Inclination:** VERTICAL      **Datum:** AHD  
**Drill Type:** JK350      **Bearing:** -      **Logged/Checked by:** L.A./*BF*

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$										DEFECT DETAILS				
																	DEFECT SPACING (mm)	DESCRIPTION Type, inclination, thickness, planarity, roughness, coating.			
							EL	VL	L	M	H	VH	EH	500	300	100		50	30	10	Specific
		13		but with coarse grained bands and bedded at 10-15°. SANDSTONE: coarse grained, light grey with orange brown seams and occasional grey laminae and bedded at 10	DW	M														- J, 20°, P, R	
				as above, but orange brown and bedded at 5-10°.																- FRAGMENTED SEAM, 10mm.t	
		14		as above, but light grey, with orange brown bands, bedded at 10-15°.																- Be, 0-15°, P, S, CLAY COATED	
				END OF BOREHOLE AT 14.27m																- CLAY SEAM, 5mm.t	
		15																		- Be, 0°, Un, R	
		16																			
		17																			
		18																			

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# **APPENDIX F**

## **ENVIRONMENTAL REPORT**

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**PHASE 1 PRELIMINARY ENVIRONMENTAL SITE SCREENING IN APRIL 2005 REF  
E19319FK-REP BY ENVIRONMENTAL INVESTIGATION SERVICES (EIS)**

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ENVIRONMENTAL INVESTIGATION SERVICES

**REPORT**

TO

**DG JONES AUSTRALIA**

ON

**PHASE 1 PRELIMINARY ENVIRONMENTAL SITE  
SCREENING**

FOR

**PROPOSED BALMAIN LEAGUES CLUB  
REDEVELOPMENT**

AT

**138-152 VICTORIA ROAD, ROZELLE**

**APRIL 2005**

**REF: E19319FK-RPT**

Principal: E H Fletcher BSc (Eng) ME

39 BUFFALO ROAD GLADESVILLE NSW 2111 TELEPHONE: (02) 9809 7322 (02) 9807 0200 FAX: (02) 9809 7626

EIS IS A DIVISION OF JEFFERY & KATAUSKAS PTY LTD A.B.N. 17 003 550 801 A.C.N. 003 550 801

Principals: B F Walker BE DIC MSc P Stubbs BSc MIEAust D Treweek Dip Tech



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### Important Information About Your Environmental Site Assessment:

#### Abbreviations

#### References

Table A-1:	Environmental and Heath-Based Soil Investigation Levels
Table A-2:	Chemical Contaminant Criteria For Waste Classification
Table B:	Summary Of Laboratory Test Data – Soil: Heavy Metals
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Figure 1: Site Location Plan

Figure 2: Borehole Location Plan

Appendix A:	Borehole Logs BH1 To BH2 Inclusive and Geotechnical Explanatory Notes
Appendix B:	Laboratory Reports and Chain of Custody Documents
Appendix C:	Site History Assessment Documents
Appendix D:	Sampling Protocols and QA/QC Definitions



## **1 INTRODUCTION**

DG Jones Australia Pty Ltd commissioned Environmental Investigation Services (EIS), a division of Jeffery & Katauskas Pty Ltd (J&K), to undertake a Phase 1 preliminary environmental site assessment to assess the likelihood of contamination of the subsurface soils for a proposed commercial development at 138-152 Victoria Road, Rozelle. The site is identified as Lot 1 in DP 528045 and at the time of this investigation was occupied by Balmain Leagues Club. The site location is shown in Figure 1. The investigation was confined to the site boundaries as shown on Figure 2.

The screening was undertaken generally in accordance with an EIS proposal of 2 March 2005 and written acceptance by facsimile of 22 March 2005.

The proposed development consists of alterations and extensions to the existing Balmain Leagues Club. Basement excavation of up to approximately 10m is understood to be necessary on the east side of the property and up to approximately 6m of the west side.

This report describes the investigation procedures and presents the results of the environmental site screening, together with comments, discussion and recommendations.

A geotechnical investigation was performed concurrently with the environmental site screening by J&K and the results are presented in a separate report (Ref. 19319WRPT, dated 8 April, 2004).

## **2 ASSESSMENT OBJECTIVES**

### **2.1 Investigation Objectives**

The primary objective of the investigation was to assess the soil conditions at the site in relation to the suitability of the site for the proposed land use.

### **2.2 Scope of Work**

The scope of work undertaken to achieve the objective included:

1. Assessment of historical site use, including review of historical aerial photographs, land title records search, review of the deposited plan and development applications/building approvals held by Council.
2. Review of regional geology and groundwater conditions, including the location of registered groundwater bores and major underground services in the vicinity of the site.



3. Search of WorkCover Dangerous Goods Licenses for underground fuel storage tanks (USTs), and investigation/remediation orders issued by the NSW EPA.
4. Design and implementation of a field sampling program.
5. Preparation of a report presenting the results of the assessment of potential soil contamination.

Field work for this investigation was undertaken on 15 March 2005.

### **2.3 Data Quality Objectives**

The purpose of Data Quality Objectives is to develop criteria to assess the reliability of the laboratory data. The Data Quality Objectives established for this project included review of laboratory QA/QC data (including surrogate recovery, repeat analysis, duplicates, matrix spikes and method blanks).

The success of the Data Quality Objectives is based on assessment of the data set as a whole and not on individual acceptance or exceedance within the data set.

## **3 SITE INFORMATION**

### **3.1 Site Description**

The site identification details are summarised below:

<b>Site Owner:</b>	Balmain Leagues Club Ltd
<b>Site Address:</b>	138-152 Victoria Road, Rozelle
<b>Lot &amp; Deposited Plan:</b>	Lot 1 in DP 528045
<b>Local Government Authority:</b>	Leichhardt Municipal Council
<b>Current Zoning:</b>	Business
<b>Site Area:</b>	Approximately 5400m <sup>2</sup>
<b>AHD:</b>	Approximately 35m
<b>Geographical Location (MGA):</b>	N: 6251260 E: 330530 (approximately)
<b>Site Locality Plan:</b>	Refer to Figure 1
<b>Site Layout Plan</b>	Refer to Figure 2

The site of the proposed redevelopment extends from Victoria Road on the north (site frontage) to Waterloo Street (forming the south site frontage). The full development site area is approximately 75m (north-south, truncated towards the north-western corner by Victoria Road), by 75m wide (east-west).



The site is located on a hillside that falls approximately 6° to the west. Darling Street is located approximately 40m east of the site and runs along a gentle ridgeline in an approximately north-south direction.

At the time of the investigation, the area in which the borehole was drilled was an asphaltic paved open carpark. The existing Balmain Leagues Club which is comprised of a three storey brick and concrete building was located to the north. Multi-level carparks (single basement level excavation below existing ground level) were located the west and north-west of the open carpark area.

A two storey terrace type shop and residential buildings (older style) occupied a significant amount of the area to the east of the site. One of these buildings was located immediately to the east of the carpark along the south half of the east site boundary. The north half of the east site boundary abutted a shared right-of-way to the rear of the buildings facing onto Darling Street. One and two storey dwellings and workshop buildings also of brick construction were located to the west of the site.

There were no bedrock outcrops evident on the site or the immediately adjacent areas.

### **3.2 Regional Geology and Hydrogeology**

The 1:100,000 geological map of Sydney (Map 9130, 1:100,000 Department of Mineral Resources – 1983) indicates the site to be underlain by Hawkesbury sandstone of the Wianamatta Group that is medium to coarse grained, with very minor shale and laminite lenses.

Department of Infrastructure, Planning and Natural Resources (DIPNR) were researched for the investigation and indicated that no registered groundwater bores lie within 1km of the site.

The stratigraphy of the site is expected to consist of residual clayey soils overlying relatively shallow bedrock. Based on these conditions groundwater is not considered to be a significant resource in the immediate area of the site.

## **4 SITE HISTORY ASSESSMENT**

### **4.1 Aerial Photographs**

Aerial photographs were reviewed as part of the assessment of the site history. The following information was obtained:



- 1930 - The photograph was of poor quality. The land bordered by Waterloo Road, Moodie Street, Victoria Road and Darling Street has been developed and appeared to be mixed residential and commercial.
- 1951 - The site and surrounds appeared to be a mixture of commercial/industrial and residential premises. A warehouse type building was located in the south-east section of the site.
- 1961 - The site was similar to the 1951 photograph.
- 1970 - A number of buildings had been demolished and the Balmain Leagues Club and carpark had been constructed. A service station was visible at the west end of the block. Residential areas bounded the site to the north. Commercial and retail areas bounded the site to the south. The areas extending further around the club site were a mix of commercial/industrial, retail and residential areas.
- 1978 - The site was similar to the 1970 photograph. There had been some minor alterations to the footprint of the club entrance on Victoria Road.
- 1986 - The site was similar to the 1978 photograph.
- 1994 - The site was similar to the 1986 photograph. Some of the residential buildings to the west of the Leagues Club had been demolished to make way for a carpark.
- 2002 - The site was similar to the 1994 photograph. The asphalt carpark to the west of the Leagues club had been extended due to the demolition of another building.

#### **4.2 Council Records**

A search of Development Application (DA) and Building Approval (BA) records/the property file held by Leichhardt Municipal Council was undertaken on behalf of EIS. The results of the search are summarised below:



Year	Application Details
1993	Illuminated Sign
1997	Change of use- mechanic's shop to car audio installation shop
1997	Reposition and change of use of sign
1999	Placement of car display at front of premises
2000	Internal and external alterations and addition the existing club premises
2000	Reposition and change of use of sign
2001	Notice of inadequate fire safety measures
2002	Transfer of automotive fire alarm monitoring from NSW fire brigade
2001	Notice of inadequate fire safety measures
2002	Transfer of automotive fire alarm monitoring from NSW fire brigade
2003	Transfer of automotive fire alarm monitoring from NSW fire brigade
2004	Replacement of existing sign on Victoria Road
2005	Replacement of existing sign on Victoria Road

#### **4.3 WorkCover Database Records**

A records search for underground storage tanks was undertaken on our behalf by WorkCover. The records did not indicate the existence of any licences for underground storage tanks at this site.

#### **4.4 NSW EPA Records**

A search of the NSW EPA on line database did not indicate the existence of any EPA notices for the site under section 58 of the Contaminated Land Management Act (1997).

#### **4.5 Summary of Historical Site Use**

The search of historical information has indicated the following:

- The site has been used for commercial/industrial purposes since at least 1951.
- There are no recorded notices listed on the NSW EPA register and WorkCover have no records of underground storage tank licenses issued for the site.

#### **4.6 Potential Contamination Sources**

##### **4.6.1 General Contamination Processes**

Contamination of surface and subsurface soils generally arises from previous land use that can include petroleum hydrocarbon and warehouse storage, manufacturing processes and pesticide and fertiliser usage. Imported fill soils may contain contaminants derived from unknown sources. Migration of contaminants can occur in permeable subsurface soil or fill materials and via man-made and natural drainage



systems. The extent of contamination migration is dependent on the hydrogeological environment and the chemical and physical characteristics of the contaminants. Contamination migration in clayey soils can be expected to be limited, whilst sandy soils are conducive to greater spatial migration.

Backfill to service trenches can form contamination migration pathways via poorly compacted or permeable backfill. Backfill may also be contaminated.

The general history of contamination of sites in the Sydney region indicates that analysis for heavy metals including lead, copper and zinc should be incorporated in the schedule of laboratory testing. In addition screening tests should be performed on selected samples for polycyclic aromatic hydrocarbons (PAHs), organochlorine pesticides (OCs), polychlorinated biphenyls (PCBs), petroleum hydrocarbons (TPH) and monocyclic aromatic hydrocarbons (BTEX).

#### **4.6.2 Potential Site Specific Contamination**

Potential contamination due to industrial practices such as mechanics may have occurred on parts of the site. Potentially contaminated fill material imported from off-site is the other major possible source of potential contamination.

#### **4.7 Potential Receptors**

The main potential contamination receptors are considered to include:

- Parramatta River and Iron Cove located approximately 650m to the north-west of the site.
- Site visitors, workers and adjacent property owners, who may come into contact with contaminated soil and/or be exposed to contaminated dust arising from construction activity.
- Future site occupants.

#### **4.8 Contaminant Laydown and Transport Mechanisms**

At this site, mobile contaminants would be expected to move down to the rock surface and migrate laterally down-slope from the source. The movement of contaminants would be expected to be associated with groundwater flow and seepage at the top of the bedrock.



## **5 ASSESSMENT CRITERIA DEVELOPMENT**

### **5.1 Regulatory Background**

In 1997 the NSW Government introduced the *Contaminated Land Management Act, 1997* (CLM Act). This act, associated regulations, State Environmental Planning Policy (SEPP) No.55 – Remediation of Land (1998) and associated NSW EPA guidelines, were designed to provide uniform state-wide control of the management, investigation and remediation of contaminated land.

Prior to granting consent for any proposed rezoning or development, SEPP55 requires the consent authority to:

- consider whether the land is contaminated;
- consider whether the site is suitable, or if contaminated, can be made suitable by remediation, for the proposed land use;
- be satisfied that remediation works will be undertaken prior to use of the site for the proposed use.

Should the assessment indicate that the site poses a risk to human health or the environment, remediation of the site is required prior to commencement of the proposed development works. SEPP55 requires that the relevant local council be notified of all remediation works, whether or not development consent is required. Where development consent is not required, 30 days written notice of the proposed works must be provided to council. Details of validation of remediation work must also be submitted to Council within one month of completion of remediation works.

The consent authority may request that a site audit be undertaken during, or following the completion of the site assessment process. Under the terms of the CLM Act the NSW EPA Site Auditor Scheme was developed to provide a system of independent review for assessment reports. An accredited Contaminated Site Auditor is engaged to review reports prepared by suitably qualified consultants to ensure that the investigation has been undertaken in accordance with the guidelines and confirm that the sites are suitable for their intended use.

Section 59(2) of the CLM Act states that specific notation relating to contaminated land issues must be included on S.149 planning certificates prepared by Council where the land to which the certificate relates is:

- within an investigation or remediation area.
- subject to an investigation or remediation order by the EPA.
- the subject of a voluntary investigation or remediation proposal.
- the subject of a site audit statement.



Submission of contaminated site investigation and validation reports to council as part of rezoning or development application submissions may also result in notation of actual or potential site contamination on future S.149 certificates prepared for the site.

Section 60 of the CLM Act sets out a positive duty on an owner, or person whose activities cause contamination, to notify the EPA if they are aware that the contamination presents a significant risk of harm.

Off-site disposal of fill, contaminated material and excess soil/rock excavated as part of the proposed development works is regulated by the provisions of the Protection of the Environment Operations Act (POEO Act 1997) and associated regulations and guidelines including the *NSW EPA Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-liquid Wastes* (1999). All materials should be classified in accordance with these guidelines prior to disposal.

Section 143 of the *Protection of the Environment Operations Act 1997* states that if waste is transported to a place that cannot lawfully be used as a waste facility for that waste, then the transporter and owner of the waste are each guilty of an offence. The transporter and owner of the waste have a duty to ensure that the waste is disposed of in an appropriate manner.

## **5.2 Soil Contaminant Threshold Concentrations**

The soil investigation levels adopted for this investigation are derived from the NSW EPA document *Guidelines for the NSW Site Auditor Scheme (1998)* and the National Environmental Protection Council document *National Environmental Protection (Assessment of Site Contamination) Measure 1999*. The contaminant thresholds listed below are levels at which further investigation and evaluation is required to assess whether the site is considered suitable for the proposed urban land use.

To accommodate the range of human and ecological exposure settings, a number of generic settings are used on which the Health based Investigation Levels (HILs) can be based. Four categories of HILs are adopted for urban site assessments. Contaminant levels for a standard residential site with gardens and accessible soil (Column A in Table A-1) are based on protection of a young child resident at the site. The remaining categories (Columns D to F) present alternative exposure settings where there is reduced access to soil or reduced exposure time. These categories include residential land use with limited soil access, recreational and public open space and commercial/industrial use. Where the proposed land use will include more than one



land use category (eg. mixed residential/commercial development) the exposure setting of the most "sensitive" land use is adopted for the site.

Threshold concentrations for petroleum hydrocarbon contaminants including total petroleum hydrocarbons (TPH) and monocyclic aromatic hydrocarbon (BTEX) compounds have previously been established in the *NSW EPA Contaminated Sites: Guidelines for Assessing Service Station Sites* (1994) publication and this document is referenced in the 1998 Site Auditor Guidelines. Heavy fraction petroleum hydrocarbon aliphatic/aromatic component threshold concentrations have also been introduced in the *National Environmental Protection (Assessment of Site Contamination) Measure 1999* (NEPC Guidelines).

#### **5.2.1 Site Assessment Criteria for Soil Contaminants**

The commercial/industrial exposure setting has been adopted for this assessment and the appropriate soil criteria are listed in the following table:



Site Soil Assessment Criteria (mg/kg)		
Contaminant	HIL Column F Exposure Setting	Guidelines for Assessing Service Station Sites (1994)
<b>Inorganics</b>		
Arsenic (total)	500	
Cadmium	100	
Chromium (III)	60%	
Copper	5000	
Lead	1500	
Mercury (inorganic)	75	
Nickel	3000	
Zinc	35000	
<b>Organic Contaminants</b>		
TPH (C <sub>6</sub> -C <sub>9</sub> )		65
TPH (C <sub>10</sub> -C <sub>36</sub> )		1000
Benzene		1
Toluene		1.4
Ethylbenzene		3.1
Total Xylenes		14
Total PAHs	100	
Benzo(a)pyrene	5	
Aldrin + Dieldrin	50	
Chlordane	250	
DDT + DDD + DDE	1000	
Heptachlor	50	
PCBs (Total)	50	

For the purpose of off-site disposal, the classification of soil into 'inert', 'solid', 'industrial' and 'hazardous' waste categories is defined by chemical contaminant criteria outlined in the *NSW EPA Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes - 1999*. These chemical contaminant criteria are summarised in Table A-2.

### 5.3 Evaluation of Soil Analysis Data and Contaminant Threshold Concentrations

Assessment of the soil analytical data using the soil contaminant threshold concentrations has been undertaken in accordance with the methodology outlined in the *National Environmental Protection (Assessment of Site Contamination) Measure (1999) Schedule 7(a) Soil Investigation Levels* and the statistical analysis methods outlined in the *NSW EPA Contaminated Sites Sampling Design Guidelines (1995)*.



The following criteria have been adopted for assessment of the analytical data:

- For a site to be considered suitable for the proposed land use the 95% Upper Confidence Limit (UCL) value of the arithmetic mean concentration of each contaminant should be less than the applicable contaminant threshold concentration.
- The relevance of localised elevated values must also be considered and should not be obscured by consideration only of the arithmetic mean of the results. The results must also meet the following criteria:
  - the standard deviation of the results must be less than 50% of the soil assessment criteria; and
  - no single value exceeds 250% of the relevant soil assessment criteria.

Where contamination results exceed the site criteria developed above a method of remediating the site is to physically and selectively remove the contamination hotspots from the site. This process should be continued until statistical analysis of the data meets the above criteria. Validation of the remediated site is generally required to demonstrate that the site is suitable for the proposed land use.

#### **5.4 Groundwater Contaminant Trigger Values**

Groundwater resources in NSW are managed and regulated by environmental and planning legislation, including the Protection of the Environment Operations (POEO) Act 1997, the Environmental Planning and Assessment Act (1979) and the Water Management Act (2000).

The 1999 NEPC Guidelines refer to trigger values presented in the ANZECC Australian Water Quality Guidelines (1992) and the NHMRC/ARMCANZ Australian Drinking Water Guidelines (1996). These guideline values define water quality parameters at the point of use including aquatic ecosystems (fresh and marine waters), drinking water, industrial and agricultural/irrigation uses.

In 2000, ANZECC released the Australian and New Zealand Guidelines for Fresh and Marine Water Quality which supersede the previous guideline documents. The ANZECC 2000 guidelines include a complete framework for the development of appropriate guidelines for aquifer assessment.

The appropriate settings for current and potential uses of groundwater should be identified in establishing applicable groundwater trigger values:

- raw drinking water source;
- agricultural use – stock watering;



- agricultural and domestic use – irrigation;
- protection of aquatic ecosystems – freshwater; and
- protection of aquatic ecosystems – marine.

## **6 ASSESSMENT PLAN AND METHODOLOGY**

The *NSW EPA Sampling Design Guidelines (1995)* for contaminated site investigations state a minimum of 14 evenly spaced sampling points should be undertaken for a site of this size (approximately 5400m<sup>2</sup>). Due to limited site access one sampling location has been undertaken for this Phase 1 preliminary investigation. (One of the two geotechnical boreholes was sampled for the environmental assessment). This density is approximately 7% of the minimum density. The sample was from a central location at the site.

Sampling was not undertaken beneath the existing buildings at the site as access was not possible during the field investigation.

## **7 INVESTIGATION PROCEDURE**

### **7.1 Subsurface Investigation and Soil Sampling Methods**

Subsurface investigations were undertaken using a truck mounted hydraulically operated drill rig equipped with spiral flight augers. Soil samples were obtained from a Standard Penetration Test (SPT) sampler or directly from the auger when conditions did not allow use of the SPT sampler.

The SPT sampler was washed with phosphate free detergent and rinsed following each sampling event. The spiral flight augers were decontaminated using a scrubbing brush and potable water and Decon 90 solution (phosphate free detergent) followed by rinsing with potable water. Sampling personnel used disposable Nylex gloves during sampling activities.

Soil and rock samples were obtained at various depths, based on observations made during the field investigation. All samples were placed in glass jars with plastic caps and teflon seals with minimal headspace. During the investigation, samples were preserved by immediate storage in an insulated sample container with ice. Each sample was labelled with a unique job number, the sampling location, sampling depth and date. All samples were recorded on the borehole logs presented in Appendix A and on the chain of custody (COC) record presented in Appendix B.



On completion of the fieldwork, the samples were delivered in the insulated sample container to a NATA registered laboratory for analysis under standard chain of custody procedures. Detailed EIS field sampling protocols are included in Appendix D.

### **7.1.1 Photoionisation Detector (PID) Screening**

A portable PID was used in this investigation to assist with selection of samples for laboratory hydrocarbon (TPH/BTEX) analysis. The PID is sensitive to volatile organic compounds. The sensitivity of the PID is dependent on the organic compound and varies for different mixtures of hydrocarbons. Some compounds give relatively high readings and some can be undetectable even though present in identical concentrations. The portable PID is best used semi-quantitatively to compare samples contaminated by the same hydrocarbon source.

The PID is calibrated before use by measurement of an isobutylene standard gas. All the PID measurements are quoted as parts per million (ppm) isobutylene equivalents.

Photoionisation detector (PID) screening of detectable volatile organic compounds (VOC) was undertaken on soil samples using the soil sample headspace method. VOC data was obtained from partly filled glass jar samples following equilibration of the headspace gases. The PID headspace data is included on the COC documents.

## **7.2 Laboratory Analysis**

### **7.2.1 Soil Samples**

Analysis of soil samples was undertaken by NATA registered laboratories using analytical methods detailed in the Schedule B(3) NEPC (1999) Guideline on Laboratory Analysis of Potentially Contaminated Soils. Laboratory analysis was undertaken by SGS Environmental Services Pty Ltd (NATA Accreditation No. 2562).

For this investigation selected soil samples were analysed for contaminants using the following laboratory techniques:

- Heavy metals – Nitric acid digestion. Analysis by ICP.
- Low level mercury – cold vapour AAS.
- OC pesticides and PCBs – Extracted with acetone/hexane. Analysis by GC/ECD.
- PAHs – Soil extracted with dichloromethane/acetone. Analysis by GC/MS.
- TPH (volatile) – Soil extracted with methanol. Analysis by P&T GC/PID.
- TPH – Soil extracted with dichloromethane/acetone. Analysis by GC/FID.
- BTEX – Soil extracted with methanol. Analysis by P&T PID. Confirmed with column flame ionisation detection.



## **8 RESULTS OF INVESTIGATION**

### **8.1 Subsurface Conditions**

Site details and borehole locations are shown on Figure 2. For details of the subsurface soil profile reference should be made to the borehole logs in Appendix A. A summary of the subsurface conditions encountered by the boreholes drilled for the geotechnical investigation is presented below:

#### ***Pavement***

Asphaltic pavement was encountered to a depth of approximately 50mm to 80mm.

#### ***Fill***

Fill materials were encountered below the asphaltic concrete to depths of 0.6m (BH1) and 1.7m (BH2). The fill in BH1 consisted of a gravely clay of low plasticity and a clayey sand with a trace of rounded medium grained ironstone gravel. The fill in BH2 consisted of fine to medium grained, orange-brown to dark brown gravely sand and clayey sand with traces of slag, brick fragments and sandstone gravel.

#### ***Natural Soils***

The underlying residual soils consisted of silty and sandy clay of medium plasticity. This horizon was 1.5m thick in BH1 and included some ironstone bands. In BH2, the horizon was 1.3m thick and also included ironstone bands.

#### ***Bedrock***

The underlying sandstone bedrock was encountered at 2.1m depth in BH1 and 3.1m depth in BH2.

#### ***Groundwater***

Groundwater levels were measured in both BH1 and BH2 at depths of 3.58m and 3.6m respectively on completion of the augering.

### **8.2 Laboratory Results - Soil**

The laboratory analysis results for soil samples are summarised in Table B to Table D inclusive and analysis reports are presented in Appendix A. The site soil assessment criteria for this investigation are specified in the "Site Assessment Criteria for Soil



Contaminants" section earlier in this report. The results of the analyses are summarised below.

#### **Heavy Metals**

One individual soil sample was analysed for heavy metals. The results of the analyses were below the site assessment criteria.

#### **Petroleum Hydrocarbons (TPH) and Monocyclic Aromatic Hydrocarbons (BTEX)**

PID headspace readings on all samples screened for this investigation were zero. One selected sample was analysed for petroleum hydrocarbons and BTEX compounds. The results of the analyses showed elevated levels of heavy fraction hydrocarbons C<sub>10</sub>-C<sub>36</sub> of 4092mg/kg.

#### **Polycyclic Aromatic Hydrocarbons (PAHs)**

One selected sample was analysed for a range of PAHs including Benzo(a)pyrene. The results of the analyses showed elevated levels of PAHs of 937mg/kg and elevated Benzo(a)pyrene of 54mg/kg.

#### **Organochlorine (OC) Pesticides and Polychlorinated Biphenyls (PCBs)**

One selected samples were analysed for a range of OC pesticides and PCBs. The results of the analyses were below the site assessment criteria.

#### **PID Screening - Volatile Organic Compounds (VOCs)**

PID soil sample headspace readings were all zero ppm equivalent isobutylene. These results indicate a lack of PID detectable volatile organic contaminants.

### **8.3 Assessment of Analytical QA/QC**

The objective of the assessment of the laboratory QA/QC is to ensure that the sample data is reliable. All laboratory reports for project E19319FK have been checked and issued as final by SGS Laboratories Pty Ltd, NATA Accreditation No. 2562, Report numbers: 36143.

Chain of custody documentation were signed and dated by SGS laboratories stating that all samples were received cool, in good order and in suitable containers. Compliance of holding times was met for all analyses undertaken by the above laboratory. EIS and laboratory QA/QC procedures for the site screening are summarised in the following table:



Contaminant	QA/QC Procedure			
	Total no. of Samples	Matrix Spike	Lab Blank	Surrogate Spike
Heavy metals	1	✓	✓	✓
TPH	1	✓	✓	✓
BTEX	1	✓	✓	✓
PAH	1	✓	✓	✓
PCB	1	✓	✓	✓

The following comments are an overall summary of the quality of the analytical component of the project:

1. Sample integrity and container requirements were documented as satisfactory.
2. All sample and extraction and analyses were performed within the required holding times.
3. Matrix spike duplicate and surrogate recovery values indicated that the laboratory accuracy was very good, and that no outliers were reported.
4. All method, rinsate and field blanks were found to be free of analyte concentrations above the PQLs.

The QA/QC data reported by SGS laboratory for the documented soil samples were assessed to be of sufficient quality to be considered acceptable for the environmental assessment of EIS project E19319FK.

The QA/QC data including the RPD results are considered to meet the Data Quality Objectives developed for this project.

## 9 COMMENTS AND RECOMMENDATIONS

The environmental site screening undertaken for the proposed commercial development at 138-152 Victoria Road, Rozelle was designed to assess the suitability of the site for the proposed land use. The proposed development consists of alterations and extensions to the existing Balmain Leagues Club.

The site screening included performance of a site inspection, review of historical site use, including examination of regional aerial photographs and review of geology and groundwater conditions. Historical information and inspection of the site and surrounding areas did not indicate any obvious on-site or nearby off-site activity that could be expected to generate significant soil or groundwater contamination apart from



previous industrial site use including a mechanics workshop. The single sampling location was located centrally at the site.

Elevated levels of contaminants were encountered in a fill soil sample from BH2 during this investigation. A summary of the elevated results is presented below:

- C<sub>10</sub>-C<sub>36</sub> - 4092mg/kg
- Total PAHs - 937
- Benzo(a)pyrene - 54mg/kg

Further sampling and analyses is recommended to assess the extent and severity of the contaminants encountered at the site.

Further analysis of samples for waste classification will be required if off-site disposal of excess soil is undertaken as part of the proposed development. Fill and contaminated soil disposal costs are significant and may affect project viability. These costs should be assessed at an early stage of the project development to avoid significant future unexpected additional costs.

Groundwater was encountered in the borehole drilled for this project at a depth of approximately 3.6m. Groundwater is not considered to be a significant resource in the area and on this basis has not been considered in any further detail for this screening.

Should the proposed basement penetrate the groundwater table, minor dewatering may be required. Water quality measurements prior to construction should be undertaken. Offsite discharge of groundwater should be approved by the consent authority and other authorities if appropriate.

The investigation undertaken by EIS did not reveal the presence of asbestos sheeting fragments within samples of the subsurface soils at this site, discernible to the naked eye. No microscopic or other systematic screening for small or rare fragments was undertaken. The investigation has not assessed the presence of free asbestos fibres within the soils and EIS adopts no responsibility whatsoever for any problems associated with undetected free or bound asbestos fibres at this site.

The boreholes drilled for the investigation have enabled an assessment to be made of the existence of significant, large quantities of contaminated soils. The conclusions based on this investigation are that, while major contamination of the site is not apparent, problems may be encountered with smaller scale features between boreholes. EIS adopts no responsibility whatsoever for any problems such as underground storage tanks, buried items or contaminated material that may be encountered between sampling locations at the site. The proposed construction



activities at the site should be planned on this basis, and any unexpected problem areas that are encountered between boreholes should be immediately inspected by experienced environmental personnel. This should ensure that such problems are dealt with in an appropriate manner, with minimal disruption to the project timetable and budget.

During demolition works, the site should be inspected by experienced environmental personnel to assess any unexpected conditions or subsurface facilities that may be discovered between investigation locations. This should facilitate appropriate adjustment of the works programme and schedule in relation to the changed site conditions.

Based on the scope of work undertaken, further environmental assessment and remediation of the site is required, followed by validation to demonstrate that the site is suitable for the proposed land use in accordance with NSW EPA requirements. Normal good engineering site management practice including control of run-off and dust suppression is recommended during earthworks and construction. An appropriate occupational health and safety plan should be prepared for the contaminants encountered at this site.

## **10. LIMITATIONS**

The conclusions developed in this report are based on site conditions which existed at the time of the site assessment. They are based on investigation of conditions at specific locations, chosen to be as representative as possible under the given circumstances, and visual observations of the site and vicinity, together with the interpretation of available historical information and documents reviewed as described in this report.

Subsurface soil and rock conditions encountered between investigation locations may be found to be different from those expected. Groundwater conditions may also vary, especially after climatic changes.

Previous industrial use of this site may have involved excavation for the foundations of buildings, services, and similar facilities. In addition, unrecorded excavation and burial of material may have occurred on the site. Backfilling of excavations could have been undertaken with potentially contaminated material that may be discovered in discrete, isolated locations across the site during construction work.



During construction at the site, soil, fill and any unsuspected materials that are encountered should be monitored by qualified environmental and geotechnical engineers to confirm assumptions made on the basis of the limited investigation data, and possible changes in site level and other conditions since the investigation. Soil materials considered to be suitable from a geotechnical point of view may be unsatisfactory from a soil contamination viewpoint, and vice versa.

This report has been prepared for the particular project described and no responsibility is accepted for the use of any part of this report in any other context or for any other purpose. Copyright in this report is the property of EIS. EIS has used a degree of care, skill and diligence normally exercised by consulting engineers in similar circumstances and locality. No other warranty expressed or implied is made or intended. Subject to payment of all fees due for the investigation, the client alone shall have a licence to use this report.

Should you require any further information regarding the above, please do not hesitate to contact us.

Yours faithfully  
For and on behalf of  
ENVIRONMENTAL INVESTIGATION SERVICES

A handwritten signature in black ink, appearing to read 'T. Hore'.

Todd Hore  
Junior Environmental Engineer

A handwritten signature in black ink, appearing to read 'E H Fletcher'.

E H Fletcher  
Principal Engineer



## **ABBREVIATIONS**

AAS	Atomic Absorption Spectrometry
AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment Conservation Council
B(a)P	Benzo(a)Pyrene
BH	Borehole
BTEX	Benzene, Toluene, Ethyl benzene, Xylene
COC	Chain of Custody documentation
DP	Deposited Plan
DQO	Data Quality Objective
EIL	Ecological Investigation Level
EPA NSW	Environment Protection Authority, New South Wales
GC-ECD	Gas Chromatograph-Electron Capture Detector
GC-FID	Gas Chromatograph-Flame Ionisation Detector
GC-MS	Gas Chromatograph-Mass Spectrometer
HIL	Health Based Investigation Level
HM	Heavy Metals
ICP-AES	Inductively Couple Plasma – Atomic Emission Spectra
NATA	National Association of Testing Authorities, Australia
NEPC	National Environmental Protection Council
NHMRC	National Health and Medical Research Council
OCPs	Organochlorine Pesticides
PAH	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PID	Photoionisation Detector
PQL	Practical Quantitation Limit
P&T	Purge & Trap
RPD	Relative Percentage Difference
SWL	Standing Water Level
TP	Test Pit
TPH	Total Petroleum Hydrocarbons
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
VOC	Volatile Organic Compounds
UCL	Upper Confidence Limit



### REFERENCE DOCUMENTS

- ANZECC/ARMCANZ (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality.
- DUAP/NSW EPA (1998) Managing Land Contamination: Planning Guidelines SEPP 55 - Remediation of Land.
- NEPM (1999) National Environmental Protection (Assessment of Site Contamination) Measure (NEPC Guidelines).
- NSW EPA (1994) Contaminated Sites: Guidelines for Assessing Service Station Sites.
- NSW EPA (1995) Contaminated Sites: Sampling Design Guidelines.
- NSW EPA (1997) Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites.
- NSW EPA (1998) Contaminated Sites: Guidelines for the NSW Site Auditor Scheme.
- NSW EPA (1999) Contaminated Sites: Guidelines on Significant Risk of Harm and the Duty to Report.
- NSW EPA (1999) Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-liquid Wastes.
- NSW Legislation (1997) Contaminated Land Management Act.
- NSW Legislation (1997) Protection of the Environment Operations Act No156 which includes Schedule 2 of the Clean Waters Regulations 1972 made under the Clean Waters Act (1970).



**ENVIRONMENTAL INVESTIGATION SERVICES**  
**IMPORTANT INFORMATION ABOUT YOUR**  
**ENVIRONMENTAL SITE ASSESSMENT**

These notes have been prepared by Environmental Investigation Services (EIS) to assist with the assessment and interpretation of this assessment report.

**An Environmental Assessment Report Is Based on a Unique Set of Project Specific Factors**

This assessment report has been prepared in response to specific project requirements as stated in the EIS proposal document which may have been limited by instructions from the client. This report should be reviewed, and if necessary, revised if any of the following occur:

- the proposed land use is altered;
- the defined subject site is increased or subdivided;
- the proposed development details including size, configuration, location, orientation of the structures are modified;
- the proposed development levels are altered, eg addition of basement levels; or
- ownership of the site changes.

EIS/J&K will not accept any responsibility whatsoever for situations where one or more of the above factors have changed since completion of the assessment. If the subject site is sold, ownership of the assessment report should be transferred by EIS to the new site owners who will be informed of the conditions and limitations under which the assessment was undertaken. No person should apply an assessment for any purpose other than that originally intended without first conferring with the consultant.

**Changes in Subsurface Conditions**

Subsurface conditions are influenced by natural geological and hydrogeological process and human activities. Groundwater conditions are likely to vary over time with changes in climatic conditions and human activities within the catchment (eg. water extraction for irrigation or industrial uses, subsurface waste water disposal, construction related dewatering). Soil and groundwater contaminant concentrations may also vary over time through contaminant migration, natural attenuation of organic contaminants, ongoing contaminating activities and placement or removal of fill material. The conclusions of an assessment report may have been affected by the above factors if a significant period of time has elapsed prior to commencement of the proposed development.

**This Assessment Is Based on Professional Interpretations of Factual Data**

Site assessments identify actual subsurface conditions at the actual sampling locations at the time of the investigation. Data obtained from the sampling and subsequent laboratory analyses, available site history information and published regional information is interpreted by geologists, engineers or environmental scientists and opinions are drawn about the overall subsurface conditions, the nature and extent of contamination, the likely impact on the proposed development and appropriate remediation measures. Actual conditions may differ from those inferred, because no professional, no matter how qualified, and no subsurface exploration program, no matter how comprehensive, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than an assessment indicates. Actual conditions in areas not

sampled may differ from predictions. Nothing can be done to prevent the unanticipated, but steps can be taken to help minimise the impact. For this reason, site owners should retain the services of their consultants throughout the development stage of the project, to identify variances, conduct additional tests which may be needed, and to recommend solutions to problems encountered on site.

#### **Environmental Site Assessment Limitations**

Although information provided by an environmental site assessment can reduce exposure to the risk of the presence of contamination, no environmental site assessment can eliminate the risk. Even a rigorous professional assessment may not detect all contamination on a site. Contaminants may be present in areas that were not surveyed or sampled, or may migrate to areas which showed no signs of contamination when sampled. Contaminant analysis cannot possibly cover every type of contaminant which may occur; only the most likely contaminants are screened.

#### **Misinterpretation of Environmental Site Assessments by Design Professionals**

Costly problems can occur when other design professionals develop plans based on misinterpretation of an environmental assessment report. To minimise problems associated with misinterpretations, the environmental consultant should be retained to work with appropriate professionals to explain relevant findings and to review the adequacy of plans and specifications relevant to contamination issues.

#### **Logs Should Not Be Separated From The Environmental Assessment Report**

Borehole and test pit logs are prepared by environmental scientists, engineers or geologists based upon interpretation of field conditions and laboratory evaluation of field samples. Logs are normally provided in our reports and these should not be re-drawn for inclusion in site remediation or other design drawings, as subtle but significant drafting errors or omissions may occur in the transfer process. Photographic reproduction can eliminate this problem, however contractors can still misinterpret the logs during bid preparation if separated from the text of the assessment. If this occurs, delays, disputes and unanticipated costs may result. In all cases it is necessary to refer to the text of the report to obtain a proper understanding of the assessment.

To reduce the likelihood of borehole and test pit log misinterpretation, the complete assessment should be available to persons or organisations involved in the project, such as contractors, for their use. Denial of such access and disclaiming responsibility for the accuracy of subsurface information does not insulate an owner from the attendant liability. It is critical that the site owner provides all available site information to persons and organisations such as contractors.

#### **Read Responsibility Clauses Closely**

Because an environmental site assessment is based extensively on judgement and opinion, it is necessarily less exact than other disciplines. This situation has resulted in wholly unwarranted claims being lodged against consultants. To help prevent this problem, model clauses have been developed for use in written transmittals. These are definitive clauses designed to indicate consultant responsibility. Their use helps all parties involved recognise individual responsibilities and formulate appropriate action. Some of these definitive clauses are likely to appear in the environmental site assessment, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to any questions.

**TABLE A-1  
ENVIRONMENTAL AND HEALTH-BASED SOIL INVESTIGATION LEVELS (mg/kg)**

Substances	Health Investigation Levels (HILs) <sup>1</sup>				Interim Urban Ecological Investigation Levels (EILs) <sup>1</sup>	NSW EPA Guidelines for Assessing Service Station Sites <sup>2</sup>	Background Ranges <sup>1</sup>
	A	D	E	F			
	'Standard' residential with garden/ accessible soil (home-grown produce contributing less than 10% of vegetable and fruit intake; no poultry); includes children's day-care centres, kindergartens, preschools and primary schools	Residential with minimal opportunities for soil access; includes dwellings with fully and permanently paved yard space such as high-rise apartments and flats	Parks, recreational open space and playing fields; includes secondary schools	Commercial/Industrial: includes premises such as shops and offices as well as factories and industrial sites			
<b>METALS/METALLOIDS</b>							
Arsenic (total)	100	400	200	500	20		1-50
Barium					300		100-3000
Beryllium	20	80	40	100			
Cadmium	20	80	40	100	3		1
Chromium(III)	12%	48%	24%	60%	400		
Chromium(VI)	100	400	200	500	1		
Chromium (total)							5-1000
Cobalt	100	400	200	500			1-40
Copper	1000	4000	2000	5000	100		2-100
Lead	300	1200	600	1500	600		2-200
Manganese	1500	6000	3000	7500	500		850
Methyl mercury	10	40	20	50			
Mercury (inorganic)	15	60	30	75	1		0.03
Nickel	600	2400	600	3000	60		5-500
Vanadium					50		20-500
Zinc	7000	28000	14000	35000	200		10-300
<b>ORGANICS</b>							
Aldrin + Dieldrin	10	40	20	50			
Chlordane	50	200	100	250			
DDT + DDD + DDE	200	800	400	1000			
Heptachlor	10	40	20	50			
Polycyclic aromatic hydrocarbons (PAHs)	20	80	40	100			
Benzo(a)pyrene	1	4	2	5			
Phenol	8500	34000	17000	42500			
PCBs (total)	10	40	20	50			
Petroleum Hydrocarbon Components (constituents):							
>C16 - C35 Aromatics	90	360	180	450			
>C16 - C35 Aliphatics	5600	22400	11200	28000			
>C35 Aliphatics	56000	224000	112000	280000			
C6-C9						65	
C10-C40						1000	
Benzene						1	
Toluene						1.4	
Ethyl Benzene						3.1	
Total Xylenes						14	
<b>OTHER</b>							
Boron	3000	12000	6000	15000			
Cyanides (complexed)	500	2000	1000	2500			
Cyanides (free)	250	1000	500	1250			
Phosphorus					2000		
Sulfur					600		
Sulfate					2000		

Reference should be made to the following guidelines for further details (as referenced in the above table):

1 National Environment Protection (Assessment of Site Contamination) Measure - 1999, National Environment Protection Council. Human exposure settings based on land use have been established for HILs and details are outlined in Taylor and Langley 1998.

2 NSW EPA Guidelines for Assessing Service station Sites - 1994.

**TABLE A - 2  
CHEMICAL CONTAMINANT CRITERIA FOR WASTE CLASSIFICATION**

ENVIRONMENTAL GUIDELINES: ASSESSMENT, CLASSIFICATION AND MANAGEMENT OF LIQUID AND NON-LIQUID WASTES - NSW EPA 1999

INERT WASTE	SOLID WASTE	INDUSTRIAL WASTE	HAZARDOUS WASTE
IF SCC ≤ CT1, TCLP NOT NEEDED	IF SCC ≤ CT2, TCLP NOT NEEDED	IF SCC ≤ CT3, TCLP NOT NEEDED	IF TCLP > TCLP3 STORE OR TREAT AS APPROPRIATE
IF TCLP ≤ TCLP1 AND SCC ≤ SCC1 TREAT AS INERT WASTE	IF TCLP1 < TCLP ≤ TCLP2 AND SCC ≤ SCC2 TREAT AS SOLID WASTE	IF TCLP2 < TCLP ≤ TCLP3 AND SCC ≤ SCC3 OR IF TCLP ≤ TCLP3 AND SCC2 < SCC ≤ SCC3 TREAT AS INDUSTRIAL WASTE	
IF TCLP ≤ TCLP1 AND SCC > SCC1, IMMOBILISE (EPA APPROVED METHOD) OR RECLASSIFY WASTE	IF TCLP1 < TCLP ≤ TCLP2 AND SCC > SCC2, IMMOBILISE (EPA APPROVED METHOD) OR RECLASSIFY WASTE	IF TCLP2 < TCLP ≤ TCLP3 AND SCC > SCC3, IMMOBILISE (EPA APPROVED METHOD) OR RECLASSIFY WASTE	IF TCLP ≤ TCLP3 AND SCC > SCC3 AND IMMOBILISATION NOT EPA APPROVED, STORE OR TREAT WASTE AS APPROPRIATE

CONTAMINANT	INERT WASTE			SOLID WASTE			INDUSTRIAL WASTE		
	CT1 (mg/kg)	TCLP1 (mg/L)	SCC1 (mg/kg)	CT2 (mg/kg)	TCLP2 (mg/L)	SCC2 (mg/kg)	CT3 (mg/kg)	TCLP3 (mg/L)	SCC3 (mg/kg)
Arsenic	10	0.5	500	100	5 <sup>3</sup>	500	400	20	2,000
Beryllium	2	0.1	100	20	1.0 <sup>10</sup>	100	80	4	400
Cadmium	2	0.1	100	20	1.0 <sup>3</sup>	100	80	4	400
Chromium (total) <sup>5</sup>	10	0.5	1,900	100	5 <sup>3</sup>	1,900	400	20	7,600
Cyanide (total) <sup>6</sup>	32 <sup>2</sup>	1.6	5,900	320	16 <sup>3</sup>	5,900	1280	64	23,600
Cyanide (Amenable) <sup>6,a</sup>	7 <sup>2</sup>	0.35	300	70	3.5	300	280	14	1,200
Fluoride	300	15	10,000	3,000	150 <sup>4</sup>	10,000	12,000	600	40,000
Lead	10	0.5	1,500	100	5 <sup>3</sup>	1,500	400	20	6,000
Mercury	0.4	0.02	50	4	0.2 <sup>3</sup>	50	16	0.8	200
Molybdenum	10	0.5	1,000	100	5 <sup>4</sup>	1,000	400	20	4,000
Nickel	4	0.2	1,050	40	2 <sup>4</sup>	1,050	160	8	4,200
Selenium	2	0.1	50	20	1 <sup>3</sup>	50	80	4	200
Silver	10	0.5	180	100	5.0 <sup>3</sup>	180	400	20	720
Benzene	1.0	0.05	18	10	0.5 <sup>3</sup>	18	40	2	72
Toluene	28.8	1.44	518	288	14.4 <sup>3</sup>	518	1,152	57.6	2,073
Ethylbenzene	60	3	1,080	600	30 <sup>6</sup>	1,080	2,400	120	4,320
Total xylenes	100	5	1,800	1,000	50 <sup>14</sup>	1,800	4,000	200	7,200
Total petroleum hydrocarbons (C6-C9) <sup>11,13</sup>	-	-	650	-	-	650	-	-	2,600
Total petroleum hydrocarbons (C10-C36) <sup>11,13</sup> (C10-C14, C15-C28, C29-C36)	-	-	5,000	-	-	10,000	-	-	40,000
Benzo(a)pyrene <sup>4</sup>	0.08	0.004	1	0.8	0.04 <sup>5</sup>	10	3.2	0.16	23
Polycyclic aromatic hydrocarbons (Total) <sup>4,11,12</sup>	-	-	200	-	-	200	-	-	800
Polychlorinated biphenyls <sup>6</sup>	-	-	2	-	-	<50	-	-	<50
Phenol (nonhalogenated)	28.8	1.44	518	288	14.4 <sup>13</sup>	518	1,152	57.6	2,073
Scheduled chemicals <sup>7,8</sup>	-	-	1	-	-	<50	-	-	<50



TABLE B  
 SUMMARY OF LABORATORY TEST DATA  
 HEAVY METALS - FILL SOILS  
 All data in mg/kg unless stated otherwise

ANALYTE	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc
PQL - SGS	3	0.5	0.5	0.5	2	0.05	0.2	0.5
Guideline concentration-HIL *	500	100	60%	5000	1500	75	3000	35000
SAMPLE (Depth in metres)								
BH2 (0.2-0.4)	4	1	18	82	570	0.28	12	660
<b>Total no. of samples</b>	1	1	1	1	1	1	1	1

**EXPLANATION:**

\*: National Environment Protection (Assessment of Site Contamination) Measure 1999 (NEPC Guidelines)  
 HIL - Column F, Commercial/Industrial

Concentration above HIL 100  
 Concentration above EIL **100**

PQL: Practical Quantitation Limit  
 NA: Not Analysed

**NOTE:** Statistical analysis only shown  
 where appropriate.



TABLE C  
 SUMMARY OF LABORATORY TEST DATA  
 ORGANICS - FILL SOILS  
 All data in mg/kg unless stated otherwise

ORGANICS	Total PAHs	B(a)P	Aldin and Dieldrin	Chlordane	DDT & DDD & DDE	Heptachlor	PCBs
PQL - SGS	-	0.05	0.1	0.1	0.1	0.1	1
Guideline concentration *	100	5	50	250	1000	50	50
SAMPLE							
BH2 (0.2-0.4)	937	54	LPQL	LPQL	LPQL	LPQL	LPQL
<b>Total no. of samples</b>	1	1	1	1	1	1	1

**EXPLANATION:**

\*: National Environment Protection (Assessment of Site Contamination) Measure 1999 (NEPC Guidelines)  
 Column F, Commercial/Industrial

Concentration above guideline level

**ABBREVIATIONS:**

PCBs: Polychlorinated Biphenyls  
 PAH: Polycyclic aromatic hydrocarbons  
 B(a)P: Benzo(a)pyrene  
 PQL: Practical Quantitation Limit  
 LPQL: Less than PQL



TABLE D  
SUMMARY OF LABORATORY TEST DATA  
PETROLEUM HYDROCARBONS  
All data in mg/kg unless stated otherwise

	PETROLEUM HYDROCARBONS								PID Reading
	Total Petroleum Hydrocarbons				Benzene	Toluene	Ethyl Benzene	Total Xylenes	
	C <sub>5</sub> -C <sub>9</sub>	C <sub>10</sub> -C <sub>14</sub>	C <sub>15</sub> -C <sub>28</sub>	C <sub>29</sub> -C <sub>36</sub>					
PQL - SGS	20	20	50	50	0.5	0.5	0.5	1.5	
Guideline concentration *	65		1000		1	1.4 <sup>^</sup>	3.1	14	
SAMPLE (Depth in metres)									
BH2 (0.2-0.4)	LPQL	92	3700	1300	LPQL	LPQL	LPQL	LPQL	0
Total no. of samples	1	1	1	1	1	1	1	1	

**EXPLANATION:**

\* EPA Guidelines for Assessing Service Station Sites - 1994

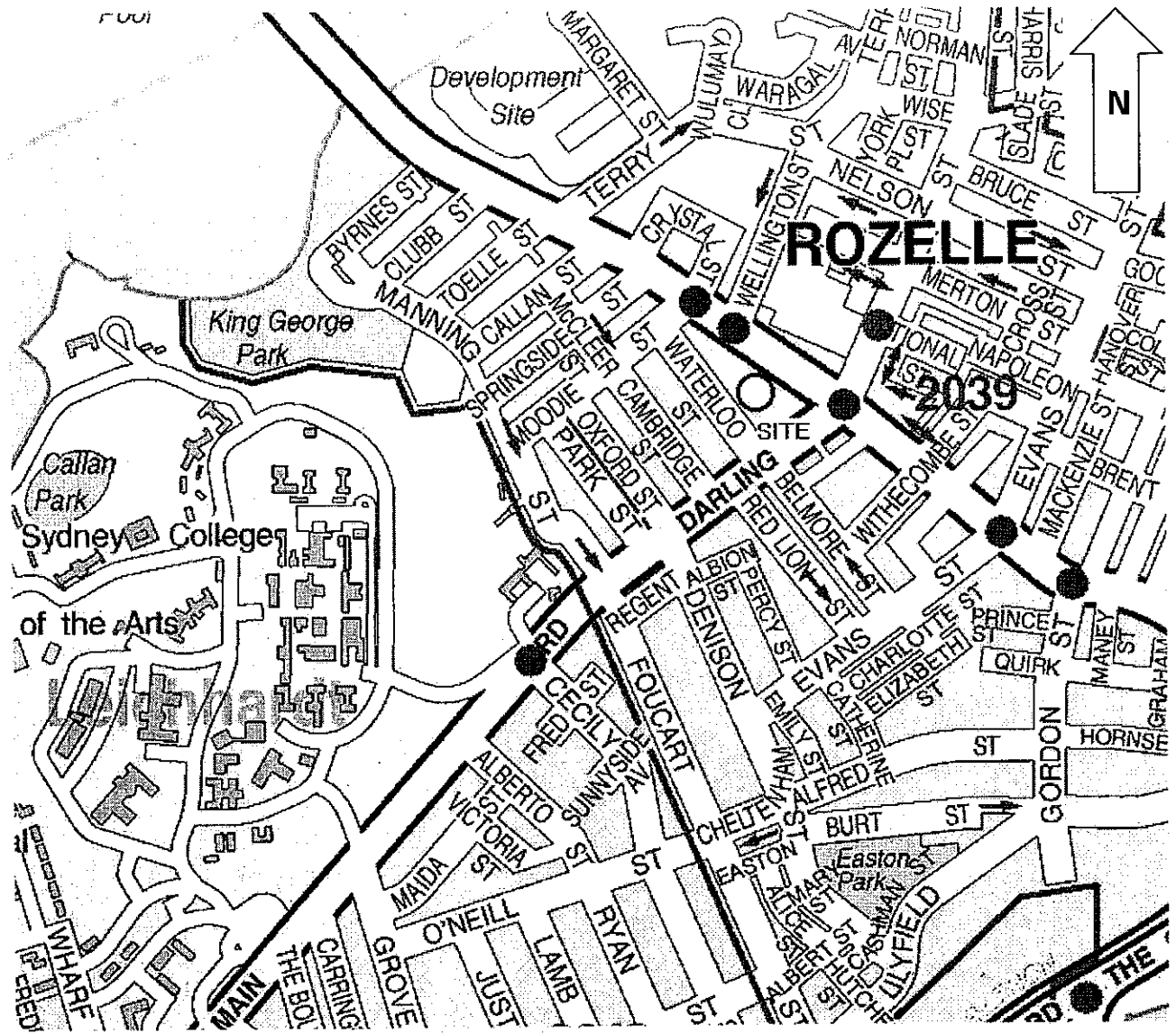
Concentration above Guideline Level

<sup>^</sup>Toluene guideline of 15.5mg/kg can be adopted as corrected value based on original data (ve de Plasse et al 1993)

PQL: Practical Quantitation Limit

LPQL: - Less than Practical Quantitation Limit

NOTE: Statistical analysis only shown where appropriate



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## SITE LOCATION PLAN

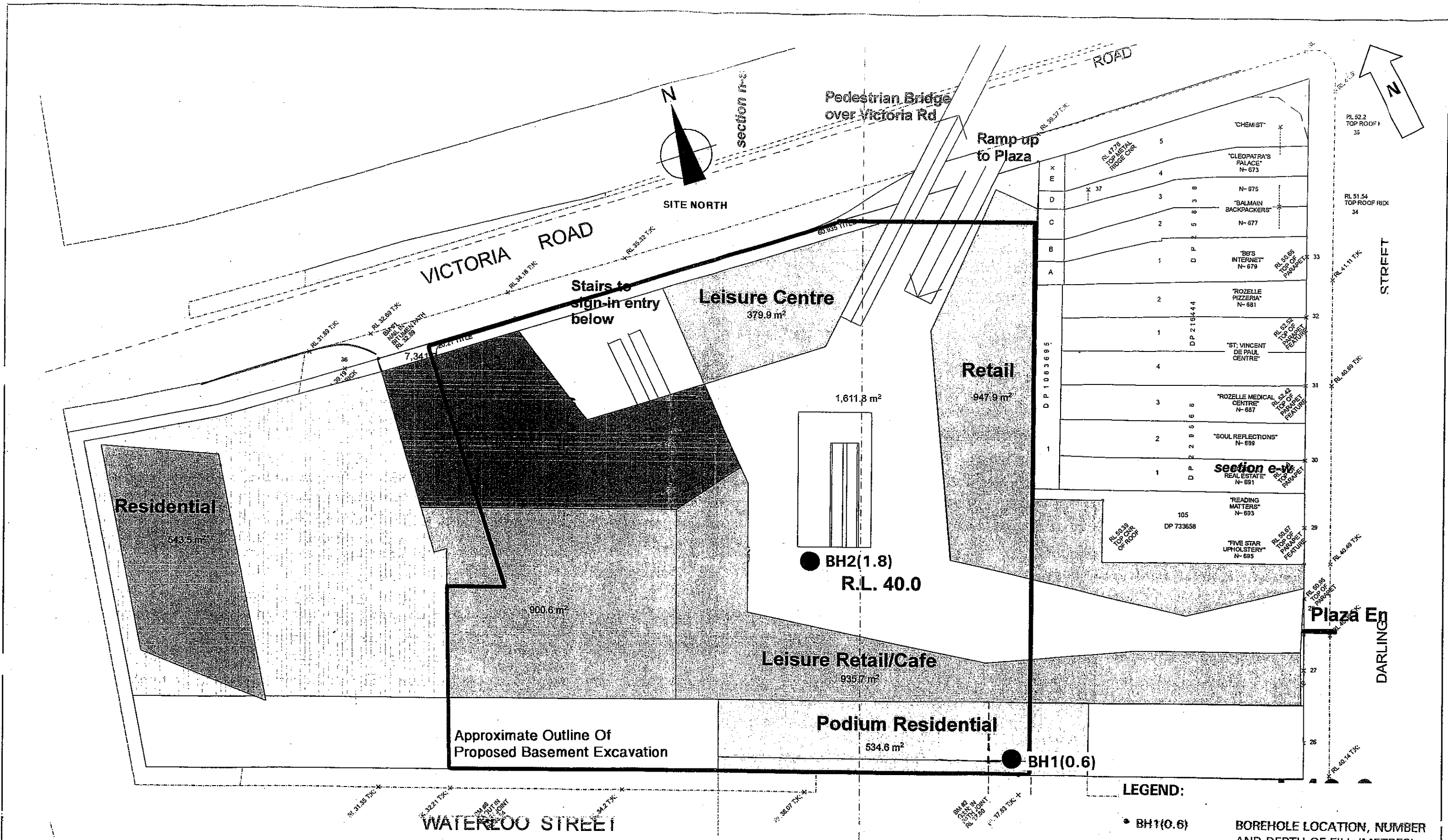
138-152 VICTORIA ROAD, ROZELLE



**ENVIRONMENTAL  
 INVESTIGATION  
 SERVICES**

Report No. E19319FK  
 Figure: 1

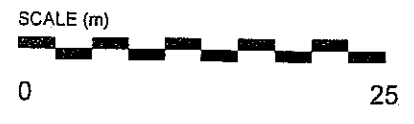
*NOTE: Reference should be made to the text for a full understanding of this plan.*



**LEGEND:**

- BH1(0.6) BOREHOLE LOCATION, NUMBER AND DEPTH OF FILL (METRES)

**BOREHOLE LOCATION PLAN**  
138-152 VICTORIA ROAD, ROZELLE



*NOTE: Reference should be made to the text for a full understanding of this plan.*



Report No. E19319FK  
Figure: 2

# APPENDIX A



Borehole No.

**1**

1/3

# BOREHOLE LOG

**Client:** BALMAIN LEAGUES CLUB  
**Project:** PROPOSED BALMAIN LEAGUES CLUB REDEVELOPMENT  
**Location:** BALMAIN LEAGUES CLUB, VICTORIA ROAD, ROZELLE, NSW

**Job No.** 19319W      **Method:** SPIRAL AUGER JK350      **R.L. Surface:** ≈ 37.9m  
**Date:** 14-3-05      **Datum:** AHD  
**Logged/Checked by:** L.A./ *BRJ*

Groundwater Record	SAMPLES				Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	ES	USO	DB	DS									
						0		-	ASPHALTIC CONCRETE: 50mm.t FILL: Gravelly clay, low plasticity, dark brown.	MC<PL			APPEARS MODERATELY COMPACTED
				N = 7 1,2,5		1		CL	FILL: Clayey sand, fine grained, orange brown, with a trace of rounded medium grained ironstone gravel. SILTY CLAY: medium plasticity, orange, with a trace of fine grained sand and ironstone bands.	D-M MC>PL	F-St	90 110	POSSIBLE FILL
				SPT 5/100mm REFUSAL		2					VSt	290 350	
						3		-	SANDSTONE: fine grained, light grey, with ironstone bands.	XW	EL-VL	-	NO 'TC' BIT RESISTANCE WITH MODERATE BANDS
						4			SANDSTONE: fine to medium grained, light grey, with occasional ironstained bands.	DW	VL-L		LOW RESISTANCE
						5							LOW TO MODERATE RESISTANCE
						6			REFER TO CORED BOREHOLE LOG				
						7							

▼ ON COMPLETION OF AUGERING  
▼ ON COMPLETION OF CORING



Borehole No.

**1**

2/3

# CORED BOREHOLE LOG

<b>Client:</b>	BALMAIN LEAGUES CLUB	
<b>Project:</b>	PROPOSED BALMAIN LEAGUES CLUB REDEVELOPMENT	
<b>Location:</b>	BALMAIN LEAGUES CLUB, VICTORIA ROAD, ROZELLE, NSW	
<b>Job No.</b> 19319W	<b>Core Size:</b> NMLC	<b>R.L. Surface:</b> ≈ 37.9m
<b>Date:</b> 14-3-05	<b>Inclination:</b> VERTICAL	<b>Datum:</b> AHD
<b>Drill Type:</b> JK350	<b>Bearing:</b> -	<b>Logged/Checked by:</b> L.A./SPW

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$	DEFECT DETAILS														
								DEFECT SPACING (mm)					DESCRIPTION									
								500	300	100	50	10	Specific	General								
		5		START CORING AT 5.77m																		
		6		SANDSTONE: fine to medium grained, light grey, bedded at 10°.	DW	L-M	X															
					XW	EL-VL	X															
		7			DW	L-M																
								X														
		8						X														
								X														
		9																				
						XW	EL-VL															
						DW	L-M	X														
		10																				
							X															
		11																				
					XW	EL-VL																

75% RETURN

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- XWS, 110mm.t
- XWS, 20mm.t
- Be, 20°, Un, R, IRON STAINED
- Be, 0°, Un, R
- J, 40°, Un, R
- 9.15-9.30m 3x INTERSECTING J, 40-90°, Un, R
- J, 10°, P, S
- XWS WITH J, 60°, P, R
- J, 50°, P, S
- Be, 20°, P, S
- J, 70-90°, P, S, CLAY COATED
- FRAGMENTED ZONE, 30mm.t
- J, 70-80°, P, S
- Be, 20°, P, S
- Be, 20°, P, S, CLAY COATED
- Be, 20°, P, S, CLAY COATED
- CS, 0-5°, 30mm.t
- J, 60-80°, Un, S
- CS, 0-5°, 5mm.t
- J, 50-90°, Un, S
- Be, 20°, CLAY COATED





Borehole No.

**2**

1/3

# BOREHOLE LOG

**Client:** BALMAIN LEAGUES CLUB  
**Project:** PROPOSED BALMAIN LEAGUES CLUB REDEVELOPMENT  
**Location:** BALMAIN LEAGUES CLUB, VICTORIA ROAD, ROZELLE, NSW

**Job No.** 19319W      **Method:** SPIRAL AUGER JK350      **R.L. Surface:** ≈ 35.0m  
**Date:** 15-3-05      **Datum:** AHD  
**Logged/Checked by:** L.A./BFW

Groundwater Record	SAMPLES				Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	ES	U50	DB	DS									
						0			ASPHALTIC CONCRETE: 80mm.t	D			APPEARS MODERATELY COMPACTED
				N = 8 6,5,3		1			FILL: Gravelly sand, medium grained, dark grey, with some medium grained slag. FILL: Gravelly sand, medium grained, orange brown, with brick fragments.				
						2			FILL: Clayey sand, fine to medium grained, dark brown, with medium to coarse grained angular sandstone gravel.	D-M			APPEARS POORLY COMPACTED
				N = 5 1,2,3		3		CL	SANDY CLAY: medium plasticity, orange brown, with fine to medium grained ironstone gravel. as above, but with ironstone bands.	MC>PL	St	100 140	OCCASIONAL MODERATE RESISTANCE BANDS
						4			SANDSTONE: fine to medium grained, light grey, with occasional ironstone bands and clay seams.	XW	EL-VL		VERY LOW 'TC' BIT RESISTANCE WITH MODERATE BANDS
						5			SANDSTONE: fine to medium grained, light grey, with occasional red brown seams.	DW	VL-L		LOW RESISTANCE
						6			SANDSTONE: medium to coarse grained, red brown, with orange brown bands.		L-M		MODERATE RESISTANCE MODERATE TO HIGH RESISTANCE
						7			REFER TO CORED BOREHOLE LOG				

ON COMPLETION OF CORING

ON COMPLETION OF AUGERING



Borehole No.

**2**

2/3

# CORED BOREHOLE LOG

**Client:** BALMAIN LEAGUES CLUB  
**Project:** PROPOSED BALMAIN LEAGUES CLUB REDEVELOPMENT  
**Location:** BALMAIN LEAGUES CLUB, VICTORIA ROAD, ROZELLE, NSW

**Job No.** 19319W      **Core Size:** NMLC      **R.L. Surface:** ≈ 35.0m  
**Date:** 15-3-05      **Inclination:** VERTICAL      **Datum:** AHD  
**Drill Type:** JK350      **Bearing:** -      **Logged/Checked by:** L.A./BAS

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$		DEFECT DETAILS											
									DEFECT SPACING (mm)		DESCRIPTION Type, inclination, thickness, planarity, roughness, coating.									
							EL	VH	500	300	100	50	30	10	Specific	General				
		5		START CORING AT 5.78m																
		6		SANDSTONE: medium grained, red brown, with occasional light grey seams, bedded at 10-15°.	DW	L	X													- XWS, 20mm.t - XWS, 40mm.t
		7		CORE LOSS 0.68m																
		8		SANDSTONE: medium grained, red brown, with occasional light grey seams, bedded at 10-15°.	DW	L	X													NOTE: MULTIPLE DRILL BREAKS ALONG BEDDING PLANE - Be, 10°, Un, R, IS
		9		as above, but light grey, with orange brown seams and occasional grey laminae and bedded at 15- 20°.			X													- FRAGMENTED ZONE, 20mm.t - FRAGMENTED ZONE, 40mm.t - CS, 20mm.t - 9.45-9.55m 3xBe, 0-15°, P, R, IS
		10				L-M	X													- 79.00° Un, P, 150mm LONG
		11		CORE LOSS 0.23m																- XWS, 20mm.t
				SANDSTONE: medium grained, light grey with orange brown seams and occasional grey laminae and bedded at 10-15°.	DW	L M	X													- XWS, 25mm.t
				as above,																- Be, 10°, Un, R, IS

50% RETURN





## REPORT EXPLANATION NOTES

### INTRODUCTION

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

The ground is a product of continuing natural and man-made processes and therefore exhibits a variety of characteristics and properties which vary from place to place and can change with time. Geotechnical engineering involves gathering and assimilating limited facts about these characteristics and properties in order to understand or predict the behaviour of the ground on a particular site under certain conditions. This report may contain such facts obtained by inspection, excavation, probing, sampling, testing or other means of investigation. If so, they are directly relevant only to the ground at the place where and time when the investigation was carried out.

### DESCRIPTION AND CLASSIFICATION METHODS

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726, the SAA Site Investigation Code. In general, descriptions cover the following properties – soil or rock type, colour, structure, strength or density, and inclusions. Identification and classification of soil and rock involves judgement and the Company infers accuracy only to the extent that is common in current geotechnical practice.

Soil types are described according to the predominating particle size and behaviour as set out in the attached Unified Soil Classification Table qualified by the grading of other particles present (eg sandy clay) as set out below:

Soil Classification	Particle Size
Clay	less than 0.002mm
Silt	0.002 to 0.06mm
Sand	0.06 to 2mm
Gravel	2 to 60mm

Non-cohesive soils are classified on the basis of relative density, generally from the results of Standard Penetration Test (SPT) as below:

Relative Density	SPT 'N' Value (blows/300mm)
Very loose	less than 4
Loose	4 – 10
Medium dense	10 – 30
Dense	30 – 50
Very Dense	greater than 50

Cohesive soils are classified on the basis of strength (consistency) either by use of hand penetrometer, laboratory testing or engineering examination. The strength terms are defined as follows.

Classification	Unconfined Compressive Strength kPa
Very Soft	less than 25
Soft	25 – 50
Firm	50 – 100
Stiff	100 – 200
Very Stiff	200 – 400
Hard	Greater than 400
Friable	Strength not attainable – soil crumbles

Rock types are classified by their geological names, together with descriptive terms regarding weathering, strength, defects, etc. Where relevant, further information regarding rock classification is given in the text of the report. In the Sydney Basin, "Shale" is used to describe thinly bedded to laminated siltstone.

### SAMPLING

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

Disturbed samples taken during drilling provide information on plasticity, grain size, colour, moisture content, minor constituents and, depending upon the degree of disturbance, some information on strength and structure. Bulk samples are similar but of greater volume required for some test procedures.

Undisturbed samples are taken by pushing a thin-walled sample tube, usually 50mm diameter (known as a U50), into the soil and withdrawing it with a sample of the soil contained in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Details of the type and method of sampling used are given on the attached logs.

### INVESTIGATION METHODS

The following is a brief summary of investigation methods currently adopted by the Company and some comments on their use and application. All except test pits, hand auger drilling and portable dynamic cone penetrometers require the use of a mechanical drilling rig which is commonly mounted on a truck chassis.



**Test Pits:** These are normally excavated with a backhoe or a tracked excavator, allowing close examination of the insitu soils if it is safe to descend into the pit. The depth of penetration is limited to about 3m for a backhoe and up to 6m for an excavator. Limitations of test pits are the problems associated with disturbance and difficulty of reinstatement and the consequent effects on close-by structures. Care must be taken if construction is to be carried out near test pit locations to either properly recompact the backfill during construction or to design and construct the structure so as not to be adversely affected by poorly compacted backfill at the test pit location.

**Hand Auger Drilling:** A borehole of 50mm to 100mm diameter is advanced by manually operated equipment. Premature refusal of the hand augers can occur on a variety of materials such as hard clay, gravel or ironstone, and does not necessarily indicate rock level.

**Continuous Spiral Flight Augers:** The borehole is advanced using 75mm to 115mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling and insitu testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface by the flights or may be collected after withdrawal of the auger flights, but they can be very disturbed and layers may become mixed. Information from the auger sampling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively lower reliability due to mixing or softening of samples by groundwater, or uncertainties as to the original depth of the samples. Augering below the groundwater table is of even lesser reliability than augering above the water table. Use can be made of a Tungsten Carbide (TC) bit for auger drilling into rock to indicate rock quality and continuity by variation in drilling resistance and from examination of recovered rock fragments.

**Wash Boring:** The borehole is usually advanced by a rotary bit, with water being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from "feel" and rate of penetration.

**Mud Stabilised Drilling:** Either Wash Boring or Continuous Core Drilling can use drilling mud as a circulating fluid to stabilise the borehole. The term "mud" encompasses a range of products ranging from bentonite to polymers such as Revert or Biogel. The mud tends to mask the cuttings and reliable identification is only possible from intermittent intact sampling (eg from SPT and U50 samples) or from rock coring, etc.

**Continuous Core Drilling:** A continuous core sample is obtained using a diamond tipped core barrel. Provided full core recovery is achieved (which is not always possible in very low strength rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation. In rocks, an NMLC triple tube core barrel, which gives a core of about 50mm diameter, is usually used with water flush. The length of core recovered is compared to the length drilled and any length not recovered is shown as CORE LOSS. The location of losses are determined on site by the supervising engineer; where the location is uncertain, the loss is placed at the top end of the drill run.

**Standard Penetration Tests:** Standard Penetration Tests (SPT) are used mainly in non-cohesive soils, but can also be used in cohesive soils as a means of indicating density or strength and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, "Methods of Testing Soils for Engineering Purposes" – Test F3.1.

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

The test results are reported in the following form:

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

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

Occasionally, the drop hammer is used to drive 50mm diameter thin walled sample tubes (U50) in clays. In such circumstances, the test results are shown on the borehole logs in brackets.

A modification to the SPT test is where the same driving system is used with a solid 60° tipped steel cone of the same diameter as the SPT hollow sampler. The solid cone can be continuously driven for some distance in soft clays or loose sands, or may be used where damage would otherwise occur to the SPT. The results of this Solid Cone Penetration Test (SCPT) are shown as "N<sub>c</sub>" on the borehole logs, together with the number of blows per 150mm penetration.



### **Static Cone Penetrometer Testing and Interpretation:**

Cone penetrometer testing (sometimes referred to as a Dutch Cone) described in this report has been carried out using an Electronic Friction Cone Penetrometer (EFCP). The test is described in Australian Standard 1289, Test F5.1.

In the tests, a 35mm diameter rod with a conical tip is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with an hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the frictional resistance on a separate 134mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are electrically connected by wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck.

As penetration occurs (at a rate of approximately 20mm per second) the information is output as incremental digital records every 10mm. The results given in this report have been plotted from the digital data.

The information provided on the charts comprise:

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

The ratios of the sleeve resistance to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1% to 2% are commonly encountered in sands and occasionally very soft clays, rising to 4% to 10% in stiff clays and peats. Soil descriptions based on cone resistance and friction ratios are only inferred and must not be considered as exact.

Correlations between EFCP and SPT values can be developed for both sands and clays but may be site specific.

Interpretation of EFCP values can be made to empirically derive modulus or compressibility values to allow calculation of foundation settlements.

Stratification can be inferred from the cone and friction traces and from experience and information from nearby boreholes etc. Where shown, this information is presented for general guidance, but must be regarded as interpretive. The test method provides a continuous profile of engineering properties but, where precise information on soil classification is required, direct drilling and sampling may be preferable.

**Portable Dynamic Cone Penetrometers:** Portable Dynamic Cone Penetrometer (DCP) tests are carried out by driving a rod into the ground with a sliding hammer and counting the blows for successive 100mm increments of penetration.

Two relatively similar tests – are used:

- Cone penetrometer (commonly known as the Scala Penetrometer) – a 16mm rod with a 20mm diameter cone end is driven with a 9kg hammer dropping 510mm (AS1289, Test F3.2). The test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various Road Authorities.
- Perth sand penetrometer – a 16mm diameter flat ended rod is driven with a 9kg hammer, dropping 600mm (AS1289, Test F3.3). This test was developed for testing the density of sands (originating in Perth) and is mainly used in granular soils and filling.

### **LOGS**

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

The attached explanatory notes define the terms and symbols used in preparation of the logs.

Interpretation of the information shown on the logs, and its application to design and construction, should therefore take into account the spacing of boreholes or test pits, the method of drilling or excavation, the frequency of sampling and testing and the possibility of other than "straight line" variations between the boreholes or test pits. Subsurface conditions between boreholes or test pits may vary significantly from conditions encountered at the borehole or test pit locations.

### **GROUNDWATER**

Where groundwater levels are measured in boreholes, there are several potential problems:

- Although groundwater may be present, in low permeability soils it may enter the hole slowly or perhaps not at all during the time it is left open.
- A localised perched water table may lead to an erroneous indication of the true water table.
- Water table levels will vary from time to time with seasons or recent weather changes and may not be the same at the time of construction.
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must be washed out of the hole or "reverted" chemically if water observations are to be made.

More reliable measurements can be made by installing standpipes which are read after stabilising at intervals ranging from several days to perhaps weeks



for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from perched water tables or surface water.

#### **FILL**

The presence of fill materials can often be determined only by the inclusion of foreign objects (eg bricks, steel etc) or by distinctly unusual colour, texture or fabric. Identification of the extent of fill materials will also depend on investigation methods and frequency. Where natural soils similar to those at the site are used for fill, it may be difficult with limited testing and sampling to reliably determine the extent of the fill.

The presence of fill materials is usually regarded with caution as the possible variation in density, strength and material type is much greater than with natural soil deposits. Consequently, there is an increased risk of adverse engineering characteristics or behaviour. If the volume and quality of fill is of importance to a project, then frequent test pit excavations are preferable to boreholes.

#### **LABORATORY TESTING**

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

#### **ENGINEERING REPORTS**

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

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

- Unexpected variations in ground conditions – the potential for this will be partially dependent on borehole spacing and sampling frequency as well as investigation technique.
- Changes in policy or interpretation of policy by statutory authorities.
- The actions of persons or contractors responding to commercial pressures.

If these occur, the company will be pleased to assist with investigation or advice to resolve any problems occurring.

#### **SITE ANOMALIES**

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

#### **REPRODUCTION OF INFORMATION FOR CONTRACTUAL PURPOSES**

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

Copyright in all documents (such as drawings, borehole or test pit logs, reports and specifications) provided by the Company shall remain the property of Jeffery and Katauskas Pty Ltd. Subject to the payment of all fees due, the Client alone shall have a licence to use the documents provided for the sole purpose of completing the project to which they relate. License to use the documents may be revoked without notice if the Client is in breach of any objection to make a payment to us.

#### **REVIEW OF DESIGN**

Where major civil or structural developments are proposed or where only a limited investigation has been completed or where the geotechnical conditions/constraints are quite complex, it is prudent to have a joint design review which involves a senior geotechnical engineer.


































#### **SITE INSPECTION**

The company will always be pleased to provide engineering inspection services for geotechnical aspects of work to which this report is related.

Requirements could range from:

- i) a site visit to confirm that conditions exposed are no worse than those interpreted, to
- ii) a visit to assist the contractor or other site personnel in identifying various soil/rock types such as appropriate footing or pier founding depths, or
- iii) full time engineering presence on site.

# GRAPHIC LOG SYMBOLS FOR SOILS AND ROCKS

SOIL	ROCK	DEFECTS AND INCLUSIONS
 FILL	 CONGLOMERATE	 CLAY SEAM
 TOPSOIL	 SANDSTONE	 SHEARED OR CRUSHED SEAM
 CLAY (CL, CH)	 SHALE	 BRECCIATED OR SHATTERED SEAM/ZONE
 SILT (ML, MH)	 SILTSTONE, MUDSTONE, CLAYSTONE	 IRONSTONE GRAVEL
 SAND (SP, SW)	 LIMESTONE	 ORGANIC MATERIAL
 GRAVEL (GP, GW)	 PHYLLITE, SCHIST	<b>OTHER MATERIALS</b>
 SANDY CLAY (CL, CH)	 TUFF	 CONCRETE
 SILTY CLAY (CL, CH)	 GRANITE, GABBRO	 BITUMINOUS CONCRETE, COAL
 CLAYEY SAND (SC)	 DOLERITE, DIORITE	 COLLUVIUM
 SILTY SAND (SM)	 BASALT, ANDESITE	
 GRAVELLY CLAY (CL, CH)	 QUARTZITE	
 CLAYEY GRAVEL (GC)		
 SANDY SILT (ML)		
 PEAT AND ORGANIC SOILS		



# Jeffery and Katauskas Pty Ltd

CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS  
A.B.N. 17 003 550 801 A.C.N. 003 550 801



## LOG SYMBOLS

LOG COLUMN	SYMBOL	DEFINITION	
Groundwater Record		Standing water level. Time delay following completion of drilling may be shown.	
		Extent of borehole collapse shortly after drilling.	
		Groundwater seepage into borehole or excavation noted during drilling or excavation.	
Samples	ES	Soil sample taken over depth indicated, for environmental analysis.	
	U50	Undisturbed 50mm diameter tube sample taken over depth indicated.	
	DB	Bulk disturbed sample taken over depth indicated.	
	DS	Small disturbed bag sample taken over depth indicated.	
Field Tests	N = 17 4, 7, 10	Standard Penetration Test (SPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration. 'R' as noted below.	
	N <sub>c</sub> =	5 7 3R	Solid Cone Penetration Test (SCPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration for 60 degree solid cone driven by SPT hammer. 'R' refers to apparent hammer refusal within the corresponding 150mm depth increment.
	VNS = 25		Vane shear reading in kPa of Undrained Shear Strength.
	PID = 100		Photoionisation detector reading in ppm (Soil sample headspace test).
Moisture Condition (Cohesive Soils)  (Cohesionless Soils)	MC > PL	Moisture content estimated to be greater than plastic limit.	
	MC ≈ PL	Moisture content estimated to be approximately equal to plastic limit.	
	MC < PL	Moisture content estimated to be less than plastic limit.	
	D	DRY - runs freely through fingers.	
	M	MOIST - does not run freely but no free water visible on soil surface.	
	W	WET - free water visible on soil surface.	
Strength (Consistency) Cohesive Soils	VS	VERY SOFT - Unconfined compressive strength less than 25kPa	
	S	SOFT - Unconfined compressive strength 25-50kPa	
	F	FIRM - Unconfined compressive strength 50-100kPa	
	St	STIFF - Unconfined compressive strength 100-200kPa	
	VSt	VERY STIFF - Unconfined compressive strength 200-400kPa	
	H	HARD - Unconfined compressive strength greater than 400kPa	
	( )	Bracketed symbol indicates estimated consistency based on tactile examination or other tests.	
Density Index/ Relative Density (Cohesionless Soils)	VL	Density Index (I <sub>b</sub> ) Range (%)      SPT 'N' Value Range (Blows/300mm) Very Loose      < 15      0-4	
	L	Loose      15-35      4-10	
	MD	Medium Dense      35-65      10-30	
	D	Dense      65-85      30-50	
	VD	Very Dense      > 85      > 50	
	( )	Bracketed symbol indicates estimated density based on ease of drilling or other tests.	
Hand Penetrometer Readings	300	Numbers indicate individual test results in kPa on representative undisturbed material unless noted otherwise.	
	250		
Remarks	'V' bit	Hardened steel 'V' shaped bit.	
	'TC' bit	Tungsten carbide wing bit.	
	T 60	Penetration of auger string in mm under static load of rig applied by drill head hydraulics without rotation of augers.	

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## LOG SYMBOLS

### ROCK MATERIAL WEATHERING CLASSIFICATION

TERM	SYMBOL	DEFINITION
Residual Soil	RS	Soil developed on extremely weathered 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 rock	XW	Rock is weathered to such an extent that it has "soil" properties, ie it either disintegrates or can be remoulded, in water.
Distinctly weathered rock	DW	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by ironstaining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Slightly weathered rock	SW	Rock is slightly discoloured but shows little or no change of strength from fresh rock.
Fresh rock	FR	Rock shows no sign of decomposition or staining.

### ROCK STRENGTH

Rock strength is defined by the Point Load Strength Index ( $I_s$  50) and refers to the strength of the rock substance in the direction normal to the bedding. The test procedure is described by the International Journal of Rock Mechanics, Mining, Science and Geomechanics. Abstract Volume 22, No 2, 1985.

TERM	SYMBOL	$I_s$ (50) MPa	FIELD GUIDE
Extremely Low:	EL	0.03	Easily remoulded by hand to a material with soil properties.
Very Low:	VL	0.1	May be crumbled in the hand. Sandstone is "sugary" and friable.
Low:	L	0.3	A piece of core 150mm long x 50mm dia. may be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling.
Medium Strength:	M	1	A piece of core 150mm long x 50mm dia. can be broken by hand with difficulty. Readily scored with knife.
High:	H	3	A piece of core 150mm long x 50mm dia. core cannot be broken by hand, can be slightly scratched or scored with knife; rock rings under hammer.
Very High:	VH	10	A piece of core 150mm long x 50mm dia. may be broken with hand-held pick after more than one blow. Cannot be scratched with pen knife; rock rings under hammer.
Extremely High:	EH		A piece of core 150mm long x 50mm dia. is very difficult to break with hand-held hammer. Rings when struck with a hammer.

### ABBREVIATIONS USED IN DEFECT DESCRIPTION

ABBREVIATION	DESCRIPTION	NOTES
Be	Bedding Plane Parting	Defect orientations measured relative to the normal to the long core axis (ie relative to horizontal for vertical holes)
CS	Clay Seam	
J	Joint	
P	Planar	
Un	Undulating	
S	Smooth	
R	Rough	
IS	Ironstained	
XWS	Extremely Weathered Seam	
Cr	Crushed Seam	
60t	Thickness of defect in millimetres	

## **APPENDIX B**

SGS Environmental Services  
Botany Industrial Park  
Gate 3, Denison St, Matraville NSW 2036  
Telephone Number : (61 2) 9666 1426  
Fax Number : (61 2) 9666 1364

**SAMPLE RECEIPT CONFIRMATION**

COMPANY : Environmental Investigation Service FAX NO. : 02 9809 7626  
ATTENTION : Adrian Kingswell PAGES : 1  
FROM : Aileen Hie DATE : 24/03/05

This is to confirm that samples for Project **E19319FK, Balmain** were received on **23/03/05** the results are expected to be ready on **4/04/05**. Please quote SGS Reference: **36143** when making enquiries regarding this project. Please refer to below which details information about the integrity of the samples and other useful information.

Samples will be held for 1 month for water samples and 2 months for soil samples from date of receipt of samples, unless otherwise instructed.

Samples received in good order:	YES
Samples received in correct containers:	YES
Samples received without headspace:	YES
Sufficient quantity supplied:	YES
Upon receipt sample temperature:	Cool
Cooling Method:	Ice Pack
Sample containers provided by:	SGS
Samples Clearly Labelled:	YES
Turnaround time requested:	Standard
Completed documentation received:	YES

Comments:

***The signed chain of custody will be returned to you with the original report.***

The contents of this facsimile (including attachments) are privileged and confidential. Any unauthorised use of the contents is expressly prohibited. If you have received the document in error, please advise by telephone (reverse charges) immediately then shred the document. Thank you.

TO:  
 SGS Environmental Services  
 Gate 3 Denison Street,  
 MATRAVILLE  
 Phone: (02) 9666 1426  
 Fax: (02) 9666 1364

### SAMPLE AND CHAIN OF CUSTODY FORM

FROM:  
 Environmental Investigation Services  
 39 Buffalo Road  
 Gladesville NSW 2111  
 Phone: (02) 9809 7322  
 Fax: (02) 9809 7626

Contact: **Kingswell**

Attention: Aileen

Date Results Required: **Std T/a.**

EIS Job Number: E **19319FK**

Sheet **1/1**

Sample Preservation:  
 In esky on ice

Project:

Location: **Balmain**

Sampler: **LA**

Tests Required

Date Sampled	Time Sampled	Location	Sample/Borehole Number	Depth (m)	Sample Container	PID (ppm/Odour)	Sample Description	Package #3	Heavy metals	PAHs	TPH/BTEX	TCLP Prep +							Comments/Detection Limits Required	
<b>15/3/05</b>	<b>36143-1</b>		<b>BH2</b>	<b>0.2-0.4</b>	Glass jar Teflon seal	<b>0.0 ppm Isobutylene</b>		<b>X</b>												
		<b>-2</b>	<b>BH2</b>	<b>0.4-0.5</b>	Glass jar Teflon seal	<b>0.0 ppm Isobutylene</b>														<b>SGS</b>
		<b>-3</b>	<b>BH2</b>	<b>1.0-1.5</b>	Glass jar Teflon seal	<b>0.0 ppm Isobutylene</b>														Received <b>23/3/05 1.05</b>
		<b>-4</b>	<b>BH2</b>	<b>1.8-2.4</b>	Glass jar Teflon seal	<b>0.0 ppm Isobutylene</b>														By <b>KAY</b>
		<b>-5</b>	<b>BH2</b>	<b>2.4-3.0</b>	Glass jar Teflon seal	<b>0.0 ppm Isobutylene</b>														Time <b>5</b>
					Glass jar Teflon seal															Contact <b>36143</b>

Relinquished By: **AK Kingswell**

Date:  
 Time:

Received By: **KAY**  
 23/3/05 5pm

Remarks:

Relinquished By:

Date:  
 Time:

Received By:

Remarks:

4 April 2005

**TEST REPORT**

**Environmental Investigation Service**

39 Buffalo Road  
GLADESVILLE  
NSW 2111

Your Reference: E19319FK, Balmain  
Report Number: 36143

**Attention:** Adrian Kingswell

Dear Adrian

The following samples were received from you on the date indicated.

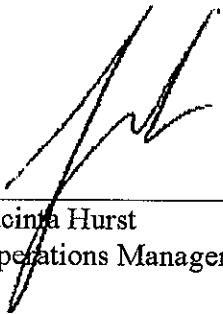
Samples:	Qty.	5 Soils
Date of Receipt of Samples:		23/03/05
Date of Receipt of Instructions:		23/03/05
Date Preliminary Report Faxed:		Not Issued

These samples were analysed in accordance with your written instructions.  
A copy of the instructions is attached with the analytical report.

The results and associated quality control are contained in the following pages of this report.  
Unless otherwise stated, solid samples are expressed on a dry weight basis (moisture has been supplied for your information only), air and liquid samples as received.

Should you have any queries regarding this report please contact the undersigned.

Yours faithfully  
SGS ENVIRONMENTAL SERVICES

  
Jacinta Hurst  
Operations Manager

Page 1 of 13



NATA Endorsed Test Report  
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NATA Accredited Laboratory No. 2562

SGS Australia Pty Ltd  
ABN 44 000 964 278

Environmental Services Botany Industrial Park Gate 3, Denison Street, Matraville 2036 NSW Australia  
t+61 (0)2 9666 1426 f+61 (0)2 9666 1364 url www.sgs.com



NATA Endorsed Test Report

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Our Reference:	Your Reference:	Sample Type	Depth
BTEX in Soil	BH2	soil	0.2-0.4
36143-1	36143-1	-----	
UNITS	UNITS	-----	
Benzene	<0.50	mg/kg	
Toluene	<0.50	mg/kg	
Ethylbenzene	<0.50	mg/kg	
Total Xylenes	<1.5	mg/kg	
Surrogate	85	%	



Total Recoverable Hydrocarbons in Soil		
Our Reference:	Your Reference:	Sample Type
36143-1	BH2	soil
UNITS	-----	-----
Depth	0.2-0.4	
TRH C8 - C9 P&T	mg/kg	<20
TRH C10 - C14	mg/kg	92
TRH C15 - C28	mg/kg	3,700
TRH C29 - C36	mg/kg	1,300

PAHs in Soil Our Reference: Your Reference Sample Type Depth	UNITS ----- -----	36143-1 BH2 soil 0.2-0.4
Naphthalene	mg/kg	4.7
Acenaphthylene	mg/kg	30
Acenaphthene	mg/kg	5.0
Fluorene	mg/kg	25
Phenanthrene	mg/kg	180
Anthracene	mg/kg	44
Fluoranthene	mg/kg	160
Pyrene	mg/kg	130
Benzo[a]anthracene	mg/kg	97
Chrysene	mg/kg	45
Benzo[b,k]fluoranthene	mg/kg	80
Benzo[a]pyrene	mg/kg	54
Indeno[123-cd]pyrene	mg/kg	46
Dibenzo[ah]anthracene	mg/kg	6.9
Benzo[ghi]perylene	mg/kg	29
Total +ve PAH's	mg/kg	937
Surrogate	%	#



OC Pesticides in Soil Our Reference: Your Reference Sample Type Depth	UNITS ----- -----	36143-1 BH2 soil 0.2-0.4
HCB	mg/kg	<0.1
<i>alpha</i> -BHC	mg/kg	<0.1
<i>gamma</i> -BHC(Lindane)	mg/kg	<0.1
Heptachlor	mg/kg	<0.1
Aldrin	mg/kg	<0.1
<i>beta</i> -BHC	mg/kg	<0.1
<i>delta</i> -BHC	mg/kg	<0.1
Heptachlor Epoxide	mg/kg	<0.1
<i>o,p'</i> -DDE	mg/kg	<0.1
<i>alpha</i> -Endosulfan	mg/kg	<0.1
<i>trans</i> -Chlordane	mg/kg	<0.1
<i>cis</i> -Chlordane	mg/kg	<0.1
<i>trans</i> -Nonachlor	mg/kg	<0.1
<i>p,p'</i> -DDE	mg/kg	<0.1
Dieldrin	mg/kg	<0.1
Endrin	mg/kg	<0.1
<i>o,p'</i> -DDD	mg/kg	<0.1
<i>o,p'</i> -DDT	mg/kg	<0.1
<i>beta</i> -Endosulfan	mg/kg	<0.1
<i>p,p'</i> -DDD	mg/kg	<0.1
<i>p,p'</i> -DDT	mg/kg	<0.1
Endosulfan Sulphate	mg/kg	<0.1
Endrin Aldehyde	mg/kg	<0.1
Methoxychlor	mg/kg	<0.1
Endrin Ketone	mg/kg	<0.1
<i>Surrogate</i>	%	114



A handwritten checkmark is located in the bottom right corner of the page.

PCBs in Soil Our Reference: Your Reference Sample Type Depth	UNITS ----- -----	36143-1 BH2 soil 0.2-0.4
Arochlor 1016	mg/kg	<1
Arochlor 1221	mg/kg	<1
Arochlor 1232	mg/kg	<1
Arochlor 1242	mg/kg	<1
Arochlor 1248	mg/kg	<1
Arochlor 1254	mg/kg	<1
Arochlor 1260	mg/kg	<1
Arochlor 1262	mg/kg	<1
Arochlor 1268	mg/kg	<1
Surrogate	%	114



10

Acid Extractable Metals in Soil Our Reference: Your Reference Sample Type Depth	UNITS ----- -----	36143-1 BH2 soil 0.2-0.4
Arsenic	mg/kg	4
Cadmium	mg/kg	1
Chromium	mg/kg	18
Copper	mg/kg	82
Lead	mg/kg	570
Mercury	mg/kg	0.28
Nickel	mg/kg	12
Zinc	mg/kg	660



24

Moisture	UNITS	36143-1
Our Reference:	-----	BH2
Your Reference	-----	soil
Sample Type		0.2-0.4
Depth		
Moisture	%	14



*R*

Method ID	Methodology Summary
SEO-017	BTEX/TRH C6-C9 - Determination by Purge and Trap Gas Chromatography with Flame Ionisation Detection (FID) and Photo Ionisation Detection (PID). The surrogate spike used is aaa-trifluorotoluene.
SEO-020	TRH - Determination of Total Recoverable Hydrocarbons by gas chromatography following extraction with DCM/Acetone for solids and DCM for liquids.
SEO-030	PAHs by GC/MS - Determination of Polynuclear Aromatic Hydrocarbons (PAH's) by Gas Chromatography / Mass Spectrometry following extraction with dichloromethane or dichloromethane/acetone. The surrogate spike used is p-Terphenyl-d14.
SEO-005	OC/OP/PCB - Determination of a suite of Organchlorine Pesticides, Chlorinated Organo-phosphorus Pesticides and Polychlorinated Biphenyls (PCB's) by sonication extraction using dichloromethane for waters or acetone / hexane for soils followed by Gas Chromatographic separation with Electron Capture Detection (GC /ECD). The surrogate spike used is 2,4,5,6-Tetrachloro-m-xylene.
SEM-010	Metals - Determination of various metals by ICP-AES following aqua regia digest.
SEM-005	Mercury - Determination of Mercury by Cold Vapour Generation Atomic Absorption Spectroscopy.
SEP-001	Air Dry - Cover air drying at 40 C, moisture content at 103 C - 105 C, wet slurring, compositing and preparation of a 1:5 soil suspension.



R

QUALITY CONTROL	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Matrix Spike % Recovery Duplicate + %RPD
BTEX in Soil								
Benzene	mg/kg	0.5	SEO-017	<0.50	[NT]	[NT]	Batch	78    79    RPD: 1
Toluene	mg/kg	0.5	SEO-017	<0.50	[NT]	[NT]	Batch	80    79    RPD: 1
Ethylbenzene	mg/kg	0.5	SEO-017	<0.50	[NT]	[NT]	Batch	80    81    RPD: 1
Total Xylenes	mg/kg	1.5	SEO-017	<1.5	[NT]	[NT]	Batch	78    78    RPD: 0
Surrogate	%		SEO-017	[NT]	[NT]	[NT]	Batch	74    73    RPD: 1
QUALITY CONTROL	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Matrix Spike % Recovery Duplicate + %RPD
Total Recoverable Hydrocarbons in Soil								
TRH C6 - C9 P&T	mg/kg	20	SEO-017	<20	[NT]	[NT]	Batch	80    80    RPD: 0
TRH C10 - C14	mg/kg	20	SEO-020	<20	[NT]	[NT]	Batch	65    60    RPD: 8
TRH C15 - C28	mg/kg	50	SEO-020	<50	[NT]	[NT]	Batch	74    71    RPD: 4
TRH C29 - C36	mg/kg	50	SEO-020	<50	[NT]	[NT]	Batch	136    133    RPD: 2
QUALITY CONTROL	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Matrix Spike % Recovery Duplicate + %RPD
PAHs in Soil								
Naphthalene	mg/kg	0.1	SEO-030	<0.1	[NT]	[NT]	Batch	86    107    RPD: 22
Acenaphthylene	mg/kg	0.1	SEO-030	<0.1	[NT]	[NT]	Batch	103    105    RPD: 2
Acenaphthene	mg/kg	0.1	SEO-030	<0.1	[NT]	[NT]	Batch	106    104    RPD: 2
Fluorene	mg/kg	0.1	SEO-030	<0.1	[NT]	[NT]	Batch	[NT]
Phenanthrene	mg/kg	0.1	SEO-030	<0.1	[NT]	[NT]	Batch	91    91    RPD: 0
Anthracene	mg/kg	0.1	SEO-030	<0.1	[NT]	[NT]	Batch	100    100    RPD: 0
Fluoranthene	mg/kg	0.1	SEO-030	<0.1	[NT]	[NT]	Batch	111    109    RPD: 2
Pyrene	mg/kg	0.1	SEO-030	<0.1	[NT]	[NT]	Batch	101    97    RPD: 4
Benzo[a]anthracene	mg/kg	0.1	SEO-030	<0.1	[NT]	[NT]	Batch	[NT]
Chrysene	mg/kg	0.1	SEO-030	<0.1	[NT]	[NT]	Batch	[NT]
Benzo[b,k]fluoranthene	mg/kg	0.2	SEO-030	<0.2	[NT]	[NT]	Batch	[NT]
Benzo[a]pyrene	mg/kg	0.05	SEO-030	<0.05	[NT]	[NT]	Batch	110    115    RPD: 4
Indeno[123-cd]pyrene	mg/kg	0.1	SEO-030	<0.1	[NT]	[NT]	Batch	[NT]
Dibenzo[ah]anthracene	mg/kg	0.1	SEO-030	<0.1	[NT]	[NT]	Batch	[NT]
Benzo[ghi]perylene	mg/kg	0.1	SEO-030	<0.1	[NT]	[NT]	Batch	[NT]
Total +ve PAH's	mg/kg	0	SEO-030	0.00	[NT]	[NT]	Batch	[NT]
Surrogate	%		SEO-030	[NT]	[NT]	[NT]	Batch	92    101    RPD: 9



2

QUALITY CONTROL	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Matrix Spike % Recovery Duplicate + %RPD
OC Pesticides in Soil								
HCB	mg/kg	0.1	SEO-005	<0.1	[NT]	[NT]	Batch	[NT]
<i>alpha</i> -BHC	mg/kg	0.1	SEO-005	<0.1	[NT]	[NT]	Batch	[NT]
<i>gamma</i> -BHC(Lindane)	mg/kg	0.1	SEO-005	<0.1	[NT]	[NT]	Batch	[NT]
Heptachlor	mg/kg	0.1	SEO-005	<0.1	[NT]	[NT]	Batch	86    99    RPD: 14
Aldrin	mg/kg	0.1	SEO-005	<0.1	[NT]	[NT]	Batch	85    97    RPD: 13
<i>beta</i> -BHC	mg/kg	0.1	SEO-005	<0.1	[NT]	[NT]	Batch	[NT]
<i>delta</i> -BHC	mg/kg	0.1	SEO-005	<0.1	[NT]	[NT]	Batch	83    96    RPD: 15
Heptachlor Epoxide	mg/kg	0.1	SEO-005	<0.1	[NT]	[NT]	Batch	[NT]
<i>o,p'</i> -DDE	mg/kg	0.1	SEO-005	<0.1	[NT]	[NT]	Batch	[NT]
<i>alpha</i> -Endosulfan	mg/kg	0.1	SEO-005	<0.1	[NT]	[NT]	Batch	[NT]
<i>trans</i> -Chlordane	mg/kg	0.1	SEO-005	<0.1	[NT]	[NT]	Batch	[NT]
<i>cis</i> -Chlordane	mg/kg	0.1	SEO-005	<0.1	[NT]	[NT]	Batch	[NT]
<i>trans</i> -Nonachlor	mg/kg	0.1	SEO-005	<0.1	[NT]	[NT]	Batch	[NT]
<i>p,p'</i> -DDE	mg/kg	0.1	SEO-005	<0.1	[NT]	[NT]	Batch	[NT]
Dieldrin	mg/kg	0.1	SEO-005	<0.1	[NT]	[NT]	Batch	84    96    RPD: 13
Endrin	mg/kg	0.1	SEO-005	<0.1	[NT]	[NT]	Batch	[NT]
<i>o,p'</i> -DDD	mg/kg	0.1	SEO-005	<0.1	[NT]	[NT]	Batch	[NT]
<i>o,p'</i> -DDT	mg/kg	0.1	SEO-005	<0.1	[NT]	[NT]	Batch	[NT]
<i>beta</i> -Endosulfan	mg/kg	0.1	SEO-005	<0.1	[NT]	[NT]	Batch	[NT]
<i>p,p'</i> -DDD	mg/kg	0.1	SEO-005	<0.1	[NT]	[NT]	Batch	[NT]
<i>p,p'</i> -DDT	mg/kg	0.1	SEO-005	<0.1	[NT]	[NT]	Batch	87    104    RPD: 18
Endosulfan Sulphate	mg/kg	0.1	SEO-005	<0.1	[NT]	[NT]	Batch	87    101    RPD: 15
Endrin Aldehyde	mg/kg	0.1	SEO-005	<0.1	[NT]	[NT]	Batch	[NT]
Methoxychlor	mg/kg	0.1	SEO-005	<0.1	[NT]	[NT]	Batch	[NT]
Endrin Ketone	mg/kg	0.1	SEO-005	<0.1	[NT]	[NT]	Batch	[NT]
Surrogate	%		SEO-005	[NT]	[NT]	[NT]	Batch	96    108    RPD: 12



2

QUALITY CONTROL	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Matrix Spike % Recovery Duplicate + %RPD
PCBs in Soil								
Arochlor 1016	mg/kg	0.1	SEO-005	<0.1	[NT]	[NT]	Batch	[NT]
Arochlor 1221	mg/kg	0.1	SEO-005	<0.1	[NT]	[NT]	Batch	[NT]
Arochlor 1232	mg/kg	0.1	SEO-005	<0.1	[NT]	[NT]	Batch	[NT]
Arochlor 1242	mg/kg	0.1	SEO-005	<0.1	[NT]	[NT]	Batch	[NT]
Arochlor 1248	mg/kg	0.1	SEO-005	<0.1	[NT]	[NT]	Batch	[NT]
Arochlor 1254	mg/kg	0.1	SEO-005	<0.1	[NT]	[NT]	Batch	116    99    RPD: 16
Arochlor 1260	mg/kg	0.1	SEO-005	<0.1	[NT]	[NT]	Batch	[NT]
Arochlor 1262	mg/kg	0.1	SEO-005	<0.1	[NT]	[NT]	Batch	[NT]
Arochlor 1268	mg/kg	0.1	SEO-005	<0.1	[NT]	[NT]	Batch	[NT]
Total Positive PCB	mg/kg	0.9	SEO-005	0.90	[NT]	[NT]	Batch	[NT]
Surrogate	%		SEO-005	[NT]	[NT]	[NT]	Batch	102    92    RPD: 10
QUALITY CONTROL	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Matrix Spike % Recovery Duplicate + %RPD
Acid Extractable Metals in Soil								
Arsenic	mg/kg	3	SEM-010	<3	[NT]	[NT]	Sand	99    97    RPD: 2
Cadmium	mg/kg	0.5	SEM-010	<0.5	[NT]	[NT]	Sand	104    102    RPD: 2
Chromium	mg/kg	0.5	SEM-010	<0.5	[NT]	[NT]	Sand	106    104    RPD: 2
Copper	mg/kg	0.5	SEM-010	<0.5	[NT]	[NT]	Sand	107    105    RPD: 2
Lead	mg/kg	2	SEM-010	<2	[NT]	[NT]	Sand	104    102    RPD: 2
Mercury	mg/kg	0.05	SEM-005	<0.05	[NT]	[NT]	Sand	96    96    RPD: 0
Nickel	mg/kg	0.2	SEM-010	<0.2	[NT]	[NT]	Sand	104    102    RPD: 2
Zinc	mg/kg	0.5	SEM-010	<0.5	[NT]	[NT]	Sand	101    98    RPD: 3
QUALITY CONTROL	UNITS	PQL	METHOD	Blank				
Moisture								
Moisture	%		SEP-001	[NT]				



12

**Result Codes**

[INS] : Insufficient Sample for this test  
[NR] : Not Requested  
[NT] : Not tested  
[HBG] : Results not Reported due to High Background Interference  
\* : Not part of NATA Accreditation  
[N/A] : Not Applicable

**Result Comments**

PAH's in Soil: # Surrogate not reported due to matrix interference.

PCB's in Soil: Level of detection raised due to matrix interference.

Date Organics extraction commenced: 31/03/05

NATA Corporate Accreditation No. 2562, Site No 4354

Note: Test results are not corrected for recovery (excluding Dioxins/Furans and PAH in XAD and PUF).

**Quality Control Protocol**

**Reagent Blank:** Sample free reagents carried through the preparation/extraction/digestion procedure and analysed at the beginning of every sample batch analysis. For larger projects, a reagent blank is prepared and analysed with every 20 samples.

**Duplicate:** A separate portion of a sample being analysed which is treated the same as the other samples in the batch. A duplicate is prepared at least every 20 samples.

**Matrix Spike Duplicates:** Sample replicates spiked with identical concentrations of target analyte(s). The spiking occurs during the sample preparation and prior to the extraction/digestion procedure. They are used to document the precision and bias of a method in a given sample matrix. Where there is not enough sample available to prepare a spiked sample, another known soil/sand or water (or Milli-Q water) may be used. A duplicate spiked sample is prepared at least every 20 samples.

**Surrogate Spike:** Added to all samples requiring analysis for organics (where relevant) prior to extraction. Used to determine the extraction efficiency. They are organic compounds which are similar to the target analyte(s) in chemical composition and behaviour in the analytical process, but which are not normally found in environmental samples.

**Internal Standard:** Added to all samples requiring analysis for organics (where relevant) after the extraction process; the compounds serve to give a standard of retention time and response, which is invariant from run-to-run with the instruments.

**Control Standards:** Prepared from a source independent of the calibration standards. At least one control standard is included in each run to confirm calibration validity.

**Additional QC Samples:** A calibration standard and blank are run after every 20 samples of an instrumental analysis run to assess analytical drift.



**TO:**  
 SGS Environmental Services  
 Gate 3 Denison Street,  
 MATRAVILLE  
 Phone: (02) 9666 1426  
 Fax: (02) 9666 1364

**SAMPLE AND CHAIN OF CUSTODY FORM**

**FROM:**  
 Environmental Investigation Services  
 39 Buffalo Road  
 Gladesville NSW 2111  
 Phone: (02) 9809 7322  
 Fax: (02) 9809 7626

Attention: Aileen

Contact: **Kingswell**

Date Results Required: **Std T/a.**

EIS Job Number: E **19319FK**

Sheet **1/1**

Sample Preservation:

In esky on ice

Project:

Location: **Balmain**

Sampler: **LA**

**Tests Required**

Date Sampled	Time Sampled	Location	Sample/Borehole Number	Depth (m)	Sample Container	PID (ppm/Odour)	Sample Description	Package #3	Heavy metals	PAHs	TPH/BTEX	TCLP Prep +	Comments/Detection Limits Required
<b>15/3/05</b>	<b>36143</b>	<b>-1</b>	<b>BH2</b>	<b>0.2-0.4</b>	Glass jar Teflon seal	<b>0.0 ppm</b> <b>Isobutylene</b>		<b>X</b>					
		<b>-2</b>	<b>BH2</b>	<b>0.4-0.5</b>	Glass jar Teflon seal	<b>0.0 ppm</b> <b>Isobutylene</b>							
		<b>-3</b>	<b>BH2</b>	<b>1.0-1.5</b>	Glass jar Teflon seal	<b>0.0 ppm</b> <b>Isobutylene</b>							
		<b>-4</b>	<b>BH2</b>	<b>1.8-2.4</b>	Glass jar Teflon seal	<b>0.0 ppm</b> <b>Isobutylene</b>							
		<b>-5</b>	<b>BH2</b>	<b>2.4-3.0</b>	Glass jar Teflon seal	<b>0.0 ppm</b> <b>Isobutylene</b>							
					Glass jar Teflon seal								

**SGS**

Received: **23/10/05 1.05**

By: **KAY**

Time: **5 am/pm**

Samples intact:  yes/no

Tag color Pack:  yes/no

Comments: **36143**

Relinquished By:

**ASKingswell**

Date:

Time:

Received By:

**KAY**  
**23/10/05 5pm**

Remarks:

Relinquished By:

Date:

Time:

Received By:

## **APPENDIX C**

**Adrian Kingswell**

---

**From:** SSC Bore Data SSC Bore Data [SSCboredata@dipnr.nsw.gov.au]  
**Sent:** Tuesday, 15 March 2005 2:41 PM  
**To:** akingswell@jkgroup.net.au  
**Subject:** bore search - Rozelle

Hi A.Kingswell, I have completed your 1km bore search at junction of Waterloo and Darling Streets - Rozelle. There were no bores within this radius.

Minimum charge applies

Thanks

Sofie Tanner

-----  
This message is intended for the addressee named and may contain confidential/privileged information. If you are not the intended recipient, please delete it and notify the sender.  
Views expressed in this message are those of the individual sender, and are not necessarily the views of the Department.

You should scan any attached files for viruses.  
-----

**Joanne**

**From:** "Ronzel, Tracey" <TraceyR@lmc.nsw.gov.au>  
**To:** <eis@jkggroup.net.au>  
**Sent:** Wednesday, 30 March 2005 12:42 PM  
**Subject:** FW: Balmain leagues

Dear Todd

Try the following unfortunately this information is not available on our website.

Kind Regards  
 Customer Service

Applications Enquiry	
<b>Applications Details</b>	
<b>138-152 Victoria Road, ROZELLE NSW 2039</b>	
Property Applications: BA/1990/917,	...
Property Applications: BA/1996/59,	...
Property Applications: BA/1997/1060,	...
Property Applications: D/1998/527, Change of use-was mechanic's shop into car audio installatic	...
Property Applications: DA/461/1993, ILLUMINATED SIGN	...
Property Applications: DA/640/1997, Alterations and additions to club premises	...
Property Applications: DA/662/1997, Reposition and change of use of existing sign (12.66m x 3.3	...
Property Applications: A/1999/21, The placement of a car display at the front of premises for a p	...
Property Applications: M/1999/218, Modification of development consent to increase the dimensio	...
Property Applications: D/2000/230, Internal and external alterations and additions to existing Balr	...
Property Applications: CC/2000/217, Internal and external alterations and additions to existing Bal	...
Property Applications: CC/2000/220, Reposition and change of use of existing sign (12.66m x 3.3	...
Property Applications: OC/2000/53, Internal and external alterations and additions to existing Balr	...
Property Applications: EPA/2001/491, Inadequate fire safety measures	...
Property Applications: CDC/2002/30, Transfer of automotive fire alarm monitoring from nsw fire b	...
Property Applications: OC/2003/23, Transfer of automotive fire alarm monitoring from nsw fire br	...
Property Applications: D/2004/742, Replacement of existing sign on Victoria Road boundary with	...
Status: <b>Default</b>	Include Sub-Properties <input type="checkbox"/>
<b>Close</b>	

Applications Enquiry	
<b>Applications Details</b>	
Property Applications: BA/1997/1060,	...
Property Applications: D/1998/527, Change of use-was mechanic's shop into car audio installatic	...
Property Applications: DA/461/1993, ILLUMINATED SIGN	...
Property Applications: DA/640/1997, Alterations and additions to club premises	...
Property Applications: DA/662/1997, Reposition and change of use of existing sign (12.66m x 3.3	...
Property Applications: A/1999/21, The placement of a car display at the front of premises for a p	...
Property Applications: M/1999/218, Modification of development consent to increase the dimensid	...
Property Applications: D/2000/230, Internal and external alterations and additions to existing Balr	...
Property Applications: CC/2000/217, Internal and external alterations and additions to existing Bal	...
Property Applications: CC/2000/220, Reposition and change of use of existing sign (12.66m x 3.3	...
Property Applications: OC/2000/53, Internal and external alterations and additions to existing Balr	...
Property Applications: EPA/2001/491, Inadequate fire safety measures	...
Property Applications: CDC/2002/30, Transfer of automotive fire alarm monitoring from nsw fire b	...
Property Applications: OC/2003/23, Transfer of automotive fire alarm monitoring from nsw fire br	...
Property Applications: D/2004/742, Replacement of existing sign on Victoria Road boundary with	...
Property Applications: CC/2005/86, Replacement of existing sign on Victoria Road boundary with	...
<b>DT</b>	
<b>Lot 1 DP 528045</b>	
Status: <b>Default</b>	Include Sub-Properties: <input type="checkbox"/>
<b>Close</b>	

The information contained in this e-mail message may be confidential. If you are not the intended recipient, any use, distribution, disclosure or copying of this information is prohibited. If you receive this e-mail in error, please tell us by return e-mail and delete it and any attachments from your system.

Any views expressed in this communication are those of the individual sender, except where the sender specifically states them to be the views of **Leichhardt Council**.

[- 1 APR 2005

Our Ref: D05/016010  
Your Ref: E19319FK

31 March 2005

Attention:- Mr Todd Hore  
EIS  
39 Buffalo Road  
GLADESVILLE NSW 2111

Dear Sir


**RE SITE:** 138-152 Victoria Road ROZELLE NSW 2039

I refer to your search request of 24 March 2005 requesting information on licenses to Keep Dangerous Goods for the above site.

A search of the Stored Chemical Information Database (SCID) and the microfiche records held by WorkCover has not located any records pertaining to the abovementioned premises.

An invoice for this search will be forwarded to you in due course.

If you have any further queries, please contact Dangerous Goods Licensing staff on (02) 4321 5500.

  
per. Brent Jones  
**Team Leader  
Dangerous Goods**

WorkCover. **Watching out for you.**



Our Ref: D05/016010  
Your Ref: E19319FK

31 MAR 2005

30 March 2005

Attention:- Mr Todd Hore  
EIS  
39 Buffalo Road  
GLADESVILLE NSW 2111

Dear Sir

**RE SITE:** 138-152 Victoria Road ROZELLE NSW 2039

I refer to your search request and acknowledge receipt on 24 March 2005 requesting information on licenses to Keep Dangerous Goods for the above site.

A search of the Stored Chemical Information Database (SCID) and the microfiche records held by WorkCover will be conducted and any records pertaining to the abovementioned premises will be forwarded to you. Please note there may be a delay if the file needs to be requested from our storage warehouse, which is located offsite.

If you have any further queries, please contact Dangerous Goods Licensing Unit on (02) 4321 5500.

  
Brent Jones  
Team Leader  
Dangerous Goods

WorkCover. **Watching out for you.**

WorkCover NSW ABN 77 682 742 966 92-100 Donnison Street Gosford NSW 2250 Locked Bag 2906 Lisarow NSW 2252  
Telephone 02 4321 5000 Facsimile 02 4325 4145 WorkCover Assistance Service 13 10 50  
DX 13067 Website [www.workcover.nsw.gov.au](http://www.workcover.nsw.gov.au)

WC1216LH

## APPENDIX D



## SOIL AND GROUNDWATER SAMPLING PROTOCOLS

These protocols specify the basic procedures to be used when sampling soils or groundwater for environmental site assessments undertaken by Environmental Investigation Services. The purpose of these protocols is to provide standard methods for: sampling, decontamination procedures for sampling equipment, sample preservation, sample storage and sample handling. Deviations from these procedures must be recorded.

### SOIL SAMPLING

- (i) prepare a test pit/borehole log.
- (ii) Layout sampling equipment on clean plastic sheeting to prevent direct contact with ground surface. The work area should be at a distance from the drill/rig excavator such that the drill rig/excavator can operate in a safe manner.
- (iii) Ensure all sampling equipment has been decontaminated prior to use.
- (iv) Remove any surface debris from the immediate area of the sampling location.
- (v) Collect samples and place in a glass jar with a Teflon sea. This should be undertaken as quickly as possible to prevent the loss of volatiles. If possible, fill the glass jars completely.
- (vi) Label the jar with the EIS job number, sample location (eg. TP1), sampling interval and date. If more than one sample container is used, this should also be indicated (eg. 2 = Sample jar 1 of 2 jars).
- (vii) Photoionisation detector (PID) screening of volatile organic compounds (VOCs) should be undertaken on samples using the soil sample headspace method. Headspace measurements are taken following equilibration of the headspace gases in partly filled glass jars. PID headspace data is recorded on the borehole/test pit log and the chain of custody forms.
- (viii) Record the lithology of the sample and sample depth on the borehole/test pit log in accordance with AS1726-1993.
- (ix) Store the sample in a sample container cooled with ice or chill packs. On completion of the sampling the sample container should be delivered to the lab immediately or stored in the refrigerator prior to delivery to the lab.
- (x) Check for the presence of groundwater after completion of each borehole using an electronic dip metre or water whistle. Boreholes should be left open until the end of fieldwork. All groundwater levels in the boreholes should be rechecked on the completion of the fieldwork.
- (xi) Backfill the boreholes/test pits with the excavation cuttings or clean sand prior to leaving the site.

### DECONTAMINATION PROCEDURES FOR SOIL SAMPLING EQUIPMENT

- (i) All of the equipment associated with the soil sampling procedure should be decontaminated between every sampling location.
- (ii) The following equipment and materials are required for the decontamination procedure:
  - Phosphate free detergent (Extran 100)
  - Tap water
  - Two buckets
  - Stiff brushes
  - Plastic sheets
- (iii) Ensure the decontamination materials are clean prior to proceeding with the decontamination.
- (iv) Fill both buckets with clean tap water and add phosphate free detergent to one bucket.
- (v) In the bucket containing the detergent scrub the sampling equipment until all the material attached to the equipment has been removed.



- (vi) Rinse sampling equipment in the bucket containing tap water.
- (vii) Place cleaned equipment on clean plastic sheets.

If all materials are not removed by this procedure, high-pressure water cleaning is recommended. If any equipment is not completely decontaminated by both these processes that equipment should not be used until it has been thoroughly cleaned.

### GROUNDWATER SAMPLING

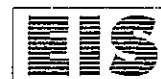
Groundwater samples are more sensitive to contamination than soil samples and therefore adherence to this protocol is particularly important to obtain reliable, reproducible results. The recommendations details in AS2306.1 are considered to form a minimum standard.

The basis of this protocol is to maintain the security of the borehole and obtain accurate and representative groundwater samples. The following procedure should be used for collection of groundwater samples from previously installed piezometers.

- (i) After piezometer installation, at least four bore volumes should be pumped from the piezometers to remove any water introduced during the drilling process. Piezometers should then be left to recharge for at least five days before purging and sampling. Prior to purging or sampling the condition of each well should be observed and any anomalies recorded on the field data sheets. The following information should be noted: the condition of the well, noting any signs of damage, tampering or complete destruction; the condition and operation of the well lock; the condition of the protective casing and the cement footing (raised or cracked); and, the presence of water between protective casing and well.
- (ii) Take the groundwater level from the collar of the piezometer using an electronic dipmeter. The collar level should be taken during the site visit using a dumpy level and staff.
- (iii) Purging and sampling of piezometers should generally be done on the same site visit. Layout and organize all equipment

associated with groundwater sampling in a location where they will not interfere with the sampling procedure and will not pose a risk of contaminating samples. Equipment generally required includes:

- New disposable polyethylene bailer and sufficient cord OR submersible pump.
  - Micropore filtration system (for heavy metals samples).
  - Filter paper (glass fibre and 0.45µm).
  - Buckets with volume increments.
  - Sample containers – at least 1 x Teflon bottle with 1ml nitric acid, 1 x 75mL glass vial and 2 x 1L amber glass bottles for each piezometer.
  - pH/Cond/Eh/T meters.
  - Glass jars for purged samples.
  - Esky and ice.
  - Latex gloves.
  - Distilled water (for cleaning).
  - Electronic dipmeter.
  - Groundwater sampling forms and notebook.
  - Aluminium foil and labels.
- (iv) Clean the Micropore filtration system thoroughly with distilled water prior to use and between each sample. Filter paper should be changed between samples. 0.45µm filter paper should be placed below the glass fibre filter paper in the filtration system.
  - (v) Ensure all non-disposable sampling equipment is decontaminated or that new disposable equipment is available prior to any work commencing at a new location. The procedure for decontamination of groundwater equipment is outlined at the end of this section.
  - (vi) Disposable gloves should be used whenever samples are taken to protect the sampler and to assist in avoidance of contamination.



- (vii) Purge at least four bore volumes from the well. Take pH, conductivity, redox potential, and temperature measurements of the purged groundwater at regular intervals during purging. (Say, every 5-10 litres if abundant groundwater and every 1 litre if only limited groundwater is encountered). Groundwater condition measurements should be taken from a sample in a clean glass jar which has been taken directly from the sampling equipment (either pump or bailer). Electrodes should be placed in the sample after the electrodes have been rinsed with distilled water. Purged volumes and groundwater measurements should be recorded on the field sampling sheet. An assessment of the turbidity of the sample should also be made based on three categories: silty, opaque and clear.
- (viii) Prepare all sample bottles. Label bottles with EIS job number, borehole number and date of collection.
- (ix) Fill amber sample bottles and BTEX vial directly from pump or bailer. Ensure sampling equipment does not touch sample containers. Sample bottles and vials must be filled to the brim, so that a reverse meniscus is formed, seal with aluminium foil and then cap. Check that no air has entered the sample invert and check for bubbles.
- (x) Fill vacuum filtration system and turn on filter pump.
- (xi) Undertake pH/Cond/Eh/T of a sample taken in a clean glass jar used only for groundwater condition measurements. Turn the meters on and insert the electrodes into the sample. Record the measurements when the instruments have stabilized, then discard the sample. Clean the electrodes with distilled water between measurements.
- (xii) When the sample filtering is complete (note: at least 50mL of filtered sample is required for heavy metal analysis), decant the filtered sample into a Teflon bottle containing nitric acid. Check label of sample bottle to ensure container has been treated with nitric acid and not sulfuric acid. Clean the filtration system with distilled water and replace the filters ready for the next sample.
- (xiii) Photoionisation detector (PID) screening of volatile organic compounds (VOC) should be undertaken on groundwater samples using the sample headspace method during fieldwork. VOC data is obtained from partly filled glass jar samples following equilibration of the headspace gases. The PID headspace data should be included on the chain of custody forms and borehole logs.
- (xiv) Store the sample in a sample container cooled with ice or chill packs. On completion of the sampling the sample container should be delivered to the lab immediately or stored in the refrigerator prior to delivery to the lab.
- (xv) Record the sample on the appropriate log in accordance with AS1726-1993. At the end of each water sampling complete a chain of custody form.

#### **DECONTAMINATION PROCEDURE FOR GROUNDWATER SAMPLING EQUIPMENT**

- (i) All of the equipment associated with the groundwater sampling procedure should be decontaminated between every sampling location.
- (ii) The following equipment and materials are required for the decontamination procedure:
- Phosphate free detergent (Extran 100).
  - Tap water.
  - Distilled water.
  - Two buckets.
  - Plastic sheets.



- (iii) Fill one bucket with clean tap water and phosphate free detergent, and one bucket with distilled water.
  - (iv) Flush tap water and detergent through pump. Wash sampling equipment and pump head using brushes in the bucket containing detergent until all materials attached to the equipment are removed.
  - (v) Flush pump with distilled water.
  - (vi) Change water and detergent solution after each sampling location.
  - (vii) Rinse sampling equipment in the bucket containing distilled water.
  - (viii) Place cleaned equipment on clean plastic sheets.
- If all materials are not removed by this procedure that equipment should not be used until it has been thoroughly cleaned.
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## QA/QC DEFINITIONS

The QA/QC terms used in this report are defined below. The definitions are in accordance with current US EPA SW-846 (1994) methods and those described in Environmental Sampling and Analysis, A Practical Guide, (H. Keith 1991).

### **Practical Quantitation Limit (PQL), Limit of Reporting (LOR) and Estimated Quantitation Limit (EQL)**

These terms all refer to the concentration above which results can be expressed with a minimum 95% confidence level. The laboratory reporting limits are generally set at ten times the standard deviation for the Method Detection limit (MDL) for each specific analyte. For the purposes of this report the LOR, PQL, and EQL are considered to be equivalent.

When assessing laboratory data it should be borne in mind that values at or near the PQL have two important limitations.

*"The uncertainty of the measurement value can approach, and even equal, the reported value. Secondly, confirmation of the analytes reported is virtually impossible unless identification uses highly selective methods. These issues diminish when reliably measurable amounts of analytes are present. Accordingly, legal and regulatory actions should be limited to data at or above the reliable detection limit", Keith (1991).*

### **Accuracy**

The proximity of an averaged result to the true value, where all random errors have been statistically removed. Accuracy is measured by percent recovery. Acceptable limits for accuracy generally lie between 70% to 130% recoveries. Certain laboratory methods may allow for values that lie outside these limits.

### **Precision**

The degree to which data generated from repeated measurements differ from one another due to random errors. Precision is measured using the standard deviation or Relative Percent Difference (RPD). Acceptable targets for precision in this report will be less than 50% RPD for concentrations greater than ten times the PQL, less than 75% RPD for concentrations between five and ten times the PQL and less than 100% RPD for concentrations that are less than five times the PQL.

### **Blanks**

The purpose of laboratory and field blanks is to check for artifacts and interferences that may arise during sampling and analysis.

### **Matrix Spikes**

Samples are spiked with laboratory grade standards to detect interactive effects between the sample matrix and the analytes being measured. Matrix Spikes are reported as a percent recovery and are prepared for 1 in every 20 samples. Sample batches that contain less than 20 samples



may be reported with a Matrix Spike from another batch. The percent recovery is calculated using the formula;

$$\frac{(\text{spiked sample result} - \text{sample result})}{\text{concentration of spike added}} \times 100$$

Acceptable recovery limits are 70% to 130%.

#### **Surrogate Spikes**

Samples are spiked with a known concentration of compounds that are chemically related to the analyte being investigated but unlikely to be detected in the environment. The purpose of the Surrogate Spikes is to check the accuracy of the analytical technique. Surrogate Spikes are reported as percent recovery.

#### **Duplicates**

Laboratory duplicates measure precision, expressed as Relative Percent Difference. Duplicates are prepared from a single field sample and analysed as two separate extraction procedures in the laboratory. The RPD is calculated using the formula:

$$\frac{|D1 - D2|}{|(D1 + D2)/2|} \times 100$$

where D1 is the sample concentration and D2 is the duplicate sample concentration.