ENVIRONMENTAL INVESTIGATION SERVICES

# REPORT

TO

# SYDNEY FISH MARKET PTY LTD

ON

# ENVIRONMENTAL SITE ASSESSMENT AND ACID SULFATE SOIL ASSESSMENT

FOR

# PROPOSED REDEVELOPMENT

AT

# SYDNEY FISH MARKETS, 56-60 PYRMONT BRIDGE ROAD, PYRMONT, NSW

VOLUME 1 OF 2

JUNE 2010

REF: E23982Krpt



Postal Address: PO Box 976, North Ryde BC NSW 1670
Tel: 02 9888 5000 • Fax: 9888 5004
EIS is a division of Jeffery and Katauskas Pty Ltd • ABN 17 003 550 801

# EXECUTIVE SUMMARY

Conybeare Morrison International Pty Ltd and Reilly Design Group (CM+ & R), acting on behalf of Sydney Fish Market Pty Ltd commissioned Environmental Investigation Services (EIS), a division of Jeffery & Katauskas Pty Ltd (J&K), to undertake an environmental site assessment and acid sulfate soil assessment for the proposed redevelopment at Sydney Fish Markets, 56-60 Pyrmont Bridge Road, Pyrmont, NSW. The investigation area (referred to as 'the site' within this report) is identified as Lot 2 in DP827434, part of Lot 1 in DP734622 and part of Lot 1 in DP836351.

The primary objectives of the investigation were to:

- Assess the potential risk of significant widespread contamination of the site;
- Assess the soil and groundwater contamination conditions at the site in relation to the proposed land use;
- Undertake a waste classification assessment for off-site disposal of excavated soil associated with the proposed development works;
- Assess the soil conditions for acid sulfate soil potential; and
- Prepare a report presenting the results of the assessment/investigation.

The scope undertaken to achieve the objectives generally included a site history assessment including review of: historical aerial photographs; historical land titles records; historical archives held by City of Sydney Council in relation to development applications and building approvals; and review of WorkCover records, search of the on-line DECCW databases regarding notices or licenses, review of regional geology and groundwater conditions, and a limited soil and groundwater investigation in conjunction with the J&K geotechnical assessment.

Samples were obtained from 17 sampling locations (BH501 to BH504 inclusive, BH506 to BH508 inclusive and BH510 to BH519 inclusive) for this investigation. This density is approximately 60% of the minimum sampling density. The boreholes were generally drilled on a systematic grid with a spacing of approximately 40m between sampling points. Monitoring wells were also installed in five boreholes.

A range of fill and natural samples were analysed for heavy metals, total petroleum hydrocarbons (TPH), monocyclic aromatic hydrocarbons (BTEX compounds), polycyclic aromatic hydrocarbons (PAHs), organochlorine and organophosphorus pesticides (OCPs and OPPs), polychlorinated biphenyls (PCBs) and asbestos. Selected fill and natural soil samples from six boreholes were also analysed for acid sulfate soil potential (sPOCAS testing).

The search of historical information has indicated the following:

- The site was leased by the British Imperial Oil Company Ltd and the Shell Company of Australia Ltd from around 1902 to 1930. The Shell Company of Australia continued to lease the site until the early 1960s. Site use during this period has not been confirmed, however it is considered likely that various activities associated with petroleum storage, distribution and possibly oil refining processes were undertaken at the site during this time;
- The 1930 aerial photograph indicated that the site was located within an industrial area. Several large industrial-type buildings and circular storage towers/silos (possibly associated with petroleum storage and/or refinery processes) were located in the south section of the site. The towers/silos and buildings remained at the site until at least 1961;
- The New South Wales Fish Authority progressively leased portions of the site from 1965. These leases were transferred to the Fish Marketing Authority in the early 1970s and leased by various companies associated with the sale and distribution of seafood;
- There are no recorded notices listed on the NSW DECCW CLM or POEO register; and
- WorkCover have no records of UST licenses issued for the site.

Elevated concentrations of contaminants were encountered in the fill soil and groundwater samples obtained during this investigation at concentrations above the adopted site assessment criteria. In summary these included:

- Elevated concentrations of arsenic (1,300mg/kg), Total PAHs (149.7mg/kg) and benzo(a)pyrene (19mg/kg and 5.7mg/kg) in several soil samples obtained from BH504;
- Elevated concentrations of light fraction ($C_6$-$C_9$) TPH (ranging from 82mg/kg to 480mg/kg) in soil samples obtained from BH507, BH511 and BH517;
- Elevated concentrations of mid to heavy fraction ($C_{10}$-$C_{36}$) TPH (ranging from 1,070mg/kg to 15,370mg/kg) in soil samples obtained from BH503, BH507, BH508, BH511 and BH517;
- Elevated concentrations of mid to heavy fraction ($C_{10}$-$C_{36}$) TPH (1.3mg/L), light fraction ($C_6$-$C_9$) TPH (0.19mg/L) and oil and grease (57mg/kg) in the groundwater sample obtained from MW517;
- Elevated concentrations of phenanthrene (0.00452mg/L), fluoranthene (0.001mg/L) and total PAHs (0.0163mg/L) in the groundwater sample obtained from MW517.

Potential acid sulfate soils were also identified at the site and were considered to be associated with the natural alluvial soils. An acid sulfate soil management plan will be required prior to commencement of excavation works at the site.

Based on the results of the assessment, remediation and/or management of the site will be required. A remediation action plan (RAP) should be prepared detailing the remediation/management options for the site prior to the commencement of the proposed redevelopment works.

Prior to preparation of the RAP, an additional soil and groundwater investigation should be undertaken. The investigation should include the following:

- Additional soil sampling in the east and south sections of the site in order to meet the minimum sampling density specified by the EPA (now DECCW);
- Additional delineation of the groundwater contamination in the vicinity of BH/MW517 to better assess the contamination conditions encountered. This should include (as a minimum) the installation of three additional groundwater monitoring wells: one in the far south-west corner of the site; one in between BH510 and BH/MW517; and one in the vicinity of BH507. Consideration should also be given to an off-site well located to the west of BH/MW517. The additional groundwater assessment should address the effects of tidal movements on the migration of the groundwater contaminants;
- Additional soil sampling in the vicinity of BH504 to better assess the TPH and arsenic contamination;
- Further detailed analysis should be included to assess the nature of the TPH contamination. This could include a silica gel cleanup of the samples to remove any false positive results that could arise from the presence of fats and oils associated with food processing; and speciation of the hydrocarbons to gain a greater understanding of the potential health impacts of the TPH contamination;
- Ground penetrating radar (GPR) survey of the areas that surround BH/MW517 and BH503 to attempt to identify potential USTs; and
- Further sampling and analysis around BH504 and BH517 in order to attempt to reduce the waste classification from Restricted Solid Waste to General Solid Waste, or minimise the volume of Restricted Solid Waste.

The results of the additional investigation, together with the results of this investigation, should be used to prepare the RAP. A site survey should also be prepared detailing the site boundaries (applicable to this investigation) and included in the RAP.

Based on the scope of work undertaken for this assessment EIS consider that the site can be made suitable for the proposed redevelopment provided that the recommendations made within the report are adequately addressed.

# TABLE OF CONTENTS

LIST OF TABLES:



LIST OF FIGURES:



LIST OF APPENDICES:

# 1 INTRODUCTION

Conybeare Morrison International Pty Ltd and Reilly Design Group (CM+ & R), acting on behalf of Sydney Fish Market Pty Ltd commissioned Environmental Investigation Services (EIS), a division of Jeffery & Katauskas Pty Ltd (J&K), to undertake an environmental site assessment and acid sulfate soil assessment for the proposed redevelopment at Sydney Fish Markets, 56-60 Pyrmont Bridge Road, Pyrmont, NSW.

The investigation area (referred to as 'the site' within this report) is identified as Lot 2 in DP827434, part of Lot 1 in DP734622 and part of Lot 1 in DP836351. At the time of this investigation the site was predominantly occupied by a paved car park. Several buildings occupied by seafood retailers/wholesalers and processing facilities were located at the site to the north and east of the car park. The site location is shown on Figure 1 and the investigation was confined to the site boundaries as shown on Figure 2.

The assessment was undertaken generally in accordance with an EIS proposal (ref: EP4823K) of 7 April 2010 and written acceptance from CM+ & R acting on behalf of Sydney Fish Market Pty Ltd of 10 May 2010.

This report describes the investigation procedures and presents the results of the environmental site assessment and acid sulfate soil assessment, together with comments, discussion and recommendations.

A geotechnical investigation was undertaken in conjunction with the environmental site assessment by J&K and the results are presented in two separate reports (ref: 23982Srpt-Stage1, dated 5 May 2010 and 23982Srpt-Stages 2-4, dated 16 June 2010).

## 1.1 Proposed Development Details

Based on the limited details provided by CM+ & R, EIS understand that the proposed development consists of four stages (Stages 1 to 4 inclusive). Each stage will be undertaken in sequence to reduce the potential for disruption to the existing fish market operations.

Stage 1 of the development will comprise a single-storey extension to the west end of Building 34 as shown on the attached Figure 2. The extension will have the same finished floor level (FFL) as the ground floor of Building 34, which is slightly above current ground levels within the proposed extension footprint. We understand that the

ground floor slab is to be built as a suspended slab. Excavation will only be required if necessary for new services trenches and footing construction.

Stages 2 and 3 will include demolition of the existing buildings in the east of the site and construction of a four-storey building as shown on the attached Figure 2. The ground floor of this building will be at RL 3.6m and will have a delivery/pick up area over part of the ground floor. The first floor will be made up of both retail and parking areas, with the second and third floors also for parking. We have been advised that there is the possibility that a further two floors may be added to this building.

Stage 4 will include further works to building 34 as well as building 35 in the north-east section of the site. These buildings will be two-storeys, with the ground floor level for the building being at RL 3.6m. There will also be a new arrival forecourt which will be at approximately RL 6m.

Excavation for the proposed new works will be to a maximum depth of about 1.5m to achieve the required ground floor level of RL 3.6m for the stages 2 to 4 buildings. Locally deeper excavation may be required if necessary for new services trenches, lift pits and footing construction.

### 1.2 Previous Investigation Reports and Documents

An environmental investigation was previously undertaken at the site by ICF Pty Ltd in 1994 and AXIS Environmental Consultants Pty Ltd subsequently updated the ICF report later that year. A summary of the following reports is presented in Section 4:

- "*Environmental Assessment, Sydney Fish Markets, Prepared for City West Development Corporation by ICF Pty Ltd"* (dated 28 January 1994[1]); and
- *"Updated Environmental Assessment of the Sydney Fish Markets Site, Prepared for NSW Government and Sydney Fish Market Pty Ltd"* (dated 13 September 1994[2]).

J&K has also previously undertaken several geotechnical investigations at the site. Reference should be made to the J&K 2010 geotechnical reports for further details.

[1] *Environmental Assessment for Sydney Fish Markets,* ICF Pty Ltd, 1994 (ICF 1994)

[2] *Updated Environmental Assessment for NSW Government and Sydney Fish Markets,* AXIS Environmental Consultants Pty Ltd, 1994 (AXIS Environmental 1994)

## 2 OBJECTIVES AND SCOPE OF WORK

### 2.1 Objectives

The primary objectives of the investigation were to:

- Assess the potential risk of significant widespread contamination of the site;
- Assess the soil and groundwater contamination conditions at the site in relation to the proposed land use;
- Undertake a waste classification assessment for off-site disposal of excavated soil associated with the proposed development works;
- Assess the soil conditions for acid sulfate soil potential; and
- Prepare a report presenting the results of the assessment/investigation generally in accordance with the *NSW EPA (now DECCW) Guidelines for Consultants Reporting on Contaminated Sites (1997[3])* and *State Environmental Planning Policy No.55 – Remediation of Land (1998[4])*.

### 2.2 Scope of Work

The scope of work undertaken to achieve the objectives included:

1. Preliminary review of the ICF 1994 and AXIS Environmental 1994 reports previously prepared for the site (as referenced in Section 1.2 of this report);
2. Review of historical aerial photographs;
3. Review of historical land title records;
4. Search of the NSW DECCW public register[5] for notices for the site under Section 58 of the *Contaminated Land Management Act* (1997[6]);
5. Search of the NSW DECCW public register[7] for licences, applications or notices for the site under the Protection of the Environment Operations (POEO) Act (1997[8]);
6. Search of WorkCover databases for licenses to store dangerous goods including underground fuel storage tanks (USTs);
7. Review of Councils historical development applications (DA) and building approvals (BA) records for the site;
8. Review of regional geology and groundwater conditions, including the location of registered groundwater bores in the vicinity of the site;

---

[3] *Guidelines for Consultants Reporting on Contaminated Sites,* NSW EPA (now DECCW), 1997 (Reporting Guidelines 1997)

[4] *State Environmental Planning Policy No. 55 – Remediation of Land,* NSW Government, 1998 (SEPP55)

[5] http://www.environment.nsw.gov.au/prclmapp/searchregister.aspx visited on 11 June 2010

[6] *Contaminated Land Management Act,* NSW Government Legislation, 1997 (CLM Act 1997)

[7] http://www.environment.nsw.gov.au/prpoeoapp/searchregister.aspx visited on 11 June 2010

[8] *Protection of the Environment Operations Act,* NSW Government, 1997 (POEO Act 1997)

9. Design and implementation of a limited field sampling program;
10. Installation of five groundwater monitoring wells at selected locations to assess the groundwater contamination conditions;
11. Laboratory analysis of selected soil and groundwater samples; and
12. Preparation of a report presenting the results of the assessment together with a discussion and any recommendations.

Field work for this investigation was undertaken on the following dates:

- Drilling, soil sampling and installation of the groundwater monitoring wells was undertaking on 11, 13, 14, 17, 19, 20 and 21 May 2010;
- The groundwater monitoring wells were developed on 24 May 2010; and
- Groundwater samples were obtained from the monitoring wells on 28 May 2010.

# 3 SITE INFORMATION

## 3.1 Site Identification

The site identification details are summarised in the following table:

| | |
|---|---|
| **Site Owner:** | State Property Authority |
| **Site Address:** | 56-60 Pyrmont Bridge Road, Pyrmont, NSW |
| **Lot & Deposited Plan:** | Lot 2 in DP827434, part of Lot 1 in DP734622 and part of Lot 1 in DP836351 |
| **Current Land Use:** | Commercial/Retail |
| **Proposed Land Use:** | Commercial/Retail |
| **Local Government Authority:** | City of Sydney Council |
| **Current Zoning:** | Residential-Business (Non-residential Development) – Ultimo-Pyrmont Zoning Map, City of Sydney LEP 2005 |
| **Site Area:** | Approximately 18,000m$^2$ |
| **AHD:** | Approximately 2-3m |
| **Geographical Location (MGA):** | N: 6250570 E: 332765 (approximately) |
| **Site Locality Plan:** | Refer to Figure 1 |
| **Borehole Location Plan:** | Refer to Figure 2 |

## 3.2 Site Description

The Sydney Fish Markets are situated on the eastern foreshore of Blackwattle Bay and are generally bounded by: the Hymix concrete batching plant to the north; Pyrmont Bridge Road to the south; Bank Street to the east; and Blackwattle Bay to the west.

The site is located in the north section of the wider fish markets site, to the north of the main fish market building. Access to the site (and the wider fish markets site) is via an access ramp off Bank Street at the north east end of the site. The ramp is supported by a concrete retaining wall which is approximately 1.3m in height at the west end 3.5m in height towards Bank Street (i.e. the east end). The concrete wall abutted a sandstone outcrop which ran in a north-west to south-east direction, and supported the overflow car park (located beyond the site boundary to the north-east) which is at a similar level to Bank Street.

At the time of the investigation the majority of the site was occupied by the fish markets car park. The car park area was predominantly paved with asphaltic concrete (AC) which was in relatively poor condition. Cracks, slumped areas, reinstated areas and large potholes were evident throughout the car park. A thorough visual

assessment of the surface areas within the car park could not be undertaken due to the presence of parked cars at the site.

The north and east sections of the site were occupied by various retail and wholesale outlets. The retail/wholesale buildings were generally of steel frame, concrete block or brick construction. An additional brick and steel frame building (Claudio's Seafood) was located in the south-west section of the site. No obvious indicators of chemical or petroleum storage were observed within the buildings.

A timber retaining wall (approximately 1m in height) was located beyond the south-west corner of the building in the north section of the site. The wall retained a portion of the site to accommodate the floor level of the building and the surrounding slope. A relatively large tree, estimated to be approximately 6-8m in height, was located at the top of the timber retaining wall and a steel plate (purpose unknown) was located at the base of the tree.

The north-west section of the site was occupied by a pay booth and boom gates associated with the car park entrance/exit.

Two dip/fill points most likely associated with a UST were located just beyond the central section of the west site boundary (as shown on Figure 2).

Adjacent to Blackwattle Bay the foreshore is supported by a dilapidated sea wall constructed of sandstone masonry, concrete and timber. The wall ranged in height between 0.9m to 1.5m and was in poor condition in some sections.

### 3.2.1 On-site Services

No plans were available detailing the on-site electrical, stormwater and sewer services.

Numerous sewer manhole covers were located in the central section of the car park and appeared to lie in a north-south axis. An electrical substation (see Figure 2) was located in the south-east section of the site, to the rear of the existing buildings. It was understood that the main electrical services extended from the vicinity of the substation along the south site boundary.

## 3.3 Surrounding Land Use

The surrounding land use included:

- A concrete batching plant to the north;
- The main Sydney Fish Markets building (predominantly used as a processing facility and by a number of seafood retailers) to the south;
- A paved overflow car park to the east, with Bank Street (and the elevated Western Distributor) located beyond the overflow car park. Areas further to the east were generally occupied by medium to high density residential buildings; and
- Car park areas (continuing directly on from the site) to the west, with a seafood processing facility and/or possibly an ice plant and Blackwattle Bay located further to the West.

## 3.4 Topography

The regional topography is characterised by a hill slope that generally falls towards the south-west before levelling out in the vicinity of the site and Blackwattle Bay.

The site area was generally uneven and gently undulating. Surface slopes within the site generally ranged from 0° to 5° and predominantly fell towards the west, south and south-west.

## 3.5 Regional Geology

The geological map of Sydney (1983[9]) indicates the site to be located in the vicinity of two geological formations. Generally the areas towards Blackwattle Bay and the west portion of the site are mapped as being underlain by manmade fill which typically consists of dredged estuarine sand and mud, demolition rubble, industrial and household waste over Quaternary aged deposits of silty to peaty quartz sand, silt and clay with ferruginous and humic cementation and common shell layers.

The areas towards the north and east sections of the site are mapped as being underlain by Hawkesbury Sandstone, which typically consists of medium to coarse grained quartz sandstone with minor shale and laminite lenses.

## 3.6 Acid Sulfate Soil Risk Map

The acid sulfate soil risk maps indicate areas of high risk, low risk and no known occurrence of acid sulfate soils. The acid sulfate soil risk map for the

[9] *1:100,000 Geological Map of Sydney (Series 9130),* Department of Mineral Resources (1983) [now Department of Primary Industries]

Prospect/Parramatta area prepared by Department of Land and Soil Conservation (1997[10]) indicates that the site is located within an area of 'disturbed terrain' to depths of approximately 2-4m. The 'disturbed terrain' classification is adopted in large scale filled areas which often occur during reclamation of low lying swamps for urban development, in areas which may have been mined or dredged or have undergone heavy ground disturbance through general urban development or the construction of dams and levees.

## 3.7 Hydrogeology

NSW Office of Water (formerly Department of Water and Energy[11]) records were researched for the investigation and indicated that five registered groundwater bores lie within 1km of the site. The groundwater works summaries and a map indicating the location of the bores in relation to the site are attached in Appendix C. The details are summarised in the following table:

| Ref No | Approximate Distance from site (m) | Approximate Direction from site | Gradient from site | Depth (m) | Registered Purpose |
|---|---|---|---|---|---|
| GW110370 | 300 | South-west | Down | 4.0 | Monitoring |
| GW110371 | 300 | South-west | Down | 4.0 | Monitoring |
| GW110372 | 300 | South-west | Down | 4.0 | Monitoring |
| GW110373 | 300 | South-west | Down | 4.0 | Monitoring |
| GW110374 | 300 | South-west | Down | 4.0 | Monitoring |

The stratigraphy of the site is expected to consist of a combination of residual clayey soils overlying relatively shallow bedrock and manmade fill over relatively high permeability alluvial sandy soil. Based on these conditions and the results of the groundwater bore search groundwater is not considered to be a significant resource in the immediate area of the site.

## 3.8 Surface Water

The nearest surface water body is Blackwattle Bay which is located down gradient and approximately 50m to the west of the site. Based on the site levels and surrounding topography, excess surface water flows would be expected to flow directly into Blackwattle Bay.

---

[10] *1:25,000 Acid Sulfate Soil Risk Map (Series 9130N3, Ed 2),* Department of Land and Soil Conservation (1997) [now NSW Land and Property Management Authority]

[11] http://www.waterinfo.nsw.gov.au/gw/ visited on 19 May 2010

# 4 SUMMARY OF PREVIOUS INVESTIGATIONS

## 4.1 Environmental Assessment (ICF 1994)

The report was divided into two sub-sections that included a Stage 1 site assessment and Stage 2 site assessment. A summary of each section is presented below:

- The purpose of the Stage 1 site assessment was to evaluate past and present site uses with respect to potential soil and groundwater contamination;
- The assessment was divided into two separate areas, A and B. Area A incorporated the site area applicable to the EIS 2010 investigation;
- The site history assessment was based on a review of documentation/information provided by a number of sources that included City of Sydney Council, the Maritime Services Board (MSB), the Shell Company of Australia (Shell), Department of Planning, consultants reports, the Heritage and Environment database and interviews with site personnel;
- At the time of the Stage 1 assessment the site was occupied by a car park and various retail/wholesale and seafood processing facilities;
- Based on the site inspection and the available historical information, the potential for contamination at the site was generally considered to be associated with:
    - Former use of the site by Shell which included petroleum distribution and storage;
    - The UST(s) located on the vicinity of Blackwattle Bay (beyond the site boundary of the EIS 2010 investigation); and
    - Polychlorinated Biphenyls (PCBs) associated with the electrical substations (believed to be located in the east section of the site);
    - Fill material beneath the pavement.
- The report generally recommended the following:
    - Completion of a geophysical (electro-magnetic) survey to establish the presence of any USTs;
    - Assess the soil and groundwater in the vicinity of the USTs for total petroleum hydrocarbon (TPH) and monocyclic aromatic hydrocarbon (BTEX) compounds;
    - Assess the soil and groundwater conditions in the vicinity of the substations for PCBs;
    - Assess the fill material and groundwater for heavy metals and total organic carbon; and
    - Assess the buildings for the presence of asbestos containing building materials.

- The purpose of the Stage 2 was to evaluate the nature, degree and extent of contamination associated with past site uses;
- The investigation included an electro-magnetic survey to assess the presence of possible USTs, soil sampling from a total of seven boreholes and groundwater sampling from three monitoring wells. An asbestos survey of the buildings was also undertaken;
- The sampling locations included four boreholes drilled in the vicinity of two potential USTs (as shown on the attached Figure 2), two boreholes drilled in arbitrary locations to assess the fill material and one borehole drilled in the vicinity of the electrical substation (located in the south-east section of the site). Drilling and sampling was undertaken on 20 and 21 December 1993;
- A total of 12 soil samples were analysed for various contaminants including heavy metals, TPH/BTEX and PCBs. Three groundwater samples were also analysed for TPH/BTEX and heavy metals. The results were compared to the concentrations specified in an Australia and New Zealand Environment and Conservation Council (ANZECC) document;
- Elevated concentrations of TPHs, above the ANZECC guidelines, were encountered in one of the boreholes drilled in the vicinity of the suspected UST (located in the vicinity of the west site boundary of the EIS 2010 investigation). Elevated concentrations of some heavy metals including copper, lead and mercury were also encountered, above the ANZECC guidelines, in the borehole drilled adjacent to the substation;
- Elevated concentrations of TPHs, above the ANZECC guidelines, were encountered in one groundwater sample obtained from a monitoring well in the south section of the site. Heavy metals, BTEX compounds and TPH were detected in the remaining samples at concentrations below the ANZECC guidelines;
- The report generally concluded the following:
    - The electro-magnetic survey detected several anomalies that may represent USTs, however non-homogenous backfill may have also contributed to these anomalies (the locations of the suspected USTs are shown on Figure 2);
    - No PCB contamination was encountered in the vicinity of the substation;
    - Ash and bitumen encountered in the fill soils may be a potential source of polycyclic aromatic hydrocarbon (PAH) contamination;
    - Under the existing and proposed development scenario that included the site being sealed by bitumen or concrete pavement, the contamination identified during the investigation was not considered to represent a health risk to site occupants or visitors. However, if another

development scenario was proposed, a health and environmental risk assessment would be required;
    - The environmental risk to inhabitants of the adjoining marine environment was not considered to be significant due to the low flow rate and flux associated with tidal movement into the bay, and the dilution of potential contaminants; and
    - Asbestos containing materials were present in the buildings.
- The Stage 2 assessment report recommended the following:
    - The USTs be removed and the surrounding soils be remediated/validated until the levels of contaminants are "acceptable";
    - The asbestos identified in the buildings be removed and disposed of accordingly. This would require further assessment of inaccessible areas; and
    - In the event that there were any changes to the proposed development that may result in greater exposure of the workers or site users to the contaminants, a qualitative assessment of health and environmental risks be undertaken.

Site conditions may have changed since preparation of the ICF 1994 report and therefore EIS have not relied upon the soil and groundwater contamination data presented in the report. In addition, since 1995 there have been significant changes associated with the assessment of contaminated sites including changes to the site assessment guidelines, soil and groundwater assessment criteria, and the consultant guidelines for reporting. EIS note that the ICF 1994 report would not meet the criteria for a Stage 1 or Stage 2 environmental site assessment in accordance with the current guidelines.

### 4.2 Updated Environmental Assessment (AXIS Environmental 1994)

The purpose of the report was to update the Environmental Assessment report prepared by ICF 1994 and to examine any changes that had occurred since preparation of the report which may have affected the contaminated areas.

The AXIS Environmental 1994 report generally concluded the following:

- The ICF 1994 report did not delineate the full extent of soil and groundwater contamination. A detailed drilling and sampling program would be required to establish the full extent of the contamination;
- The ICF recommendation to remove the USTs was not acted upon;
- The report agreed that the potential health and environmental risks associated with the contamination were not significant given the current and proposed site use;

- As the contamination risks were considered minimal, remediation of the site was not considered necessary (at the time) provided that the current use continued and no site disturbance was undertaken that may change the exposure pathway for the contaminants;
- The current and future site activities of the Sydney Fish Markets were not considered to cause additional contamination or impact the existing contamination provided that the areas remained covered;
- The construction workers would need to be protected from potential exposure to contamination during works;
- During works, additional sampling was recommended to confirm the conditions encountered during the ICF 1994 assessment and to develop a safety plan for the workers;
- No work had been undertaken to remove the asbestos containing building materials; and
- Provided there were no changes in site activities it could be assumed that any contamination associated with heavy metals or petroleum products found at the site now (1994) or in the future, resulted from past activities and hence would not be the responsibility of the operators of the site. Should the site activities change to include fuel storage or disposal of contaminated waste, this assumption would have to be reviewed.

In light of the regulatory changes that occurred with reference to environmental site assessments/investigations and remediation of contaminated land, EIS consider that that some of the above conclusions are no longer applicable. Reference should be made to Section 7 of this report for further details regarding the current regulatory framework.

# 5 SITE HISTORY ASSESSMENT

## 5.1 Aerial Photographs

Aerial photographs of the site taken in 1930, 1951, 1961, 1970, 1978, 1986, 1994 and 2002 were obtained from the Department of Lands and were reviewed as part of the assessment of the site history. EIS has also reviewed the 1943 and 2007 historical aerial photograph available for the site on the NSW Department of Lands SIX Viewer[12]. The information obtained from the photographs is summarised in the following table:

| Year | Details |
|---|---|
| 1930 | The photograph was of relatively poor quality. The south-west section of the site and the areas in the vicinity of the south site boundary appeared to be occupied by large industrial type buildings. Four circular towers/silos (possibly associated with an oil refinery) were located to the north-east of the buildings. A number of smaller buildings and/or shipping containers were located over the remainder of the site.<br><br>The surrounding areas appeared to be developed for industrial type land use. Bank Street was located to the east of the site. Several wharfs and/or pontoons were located to the west of the site within Blackwattle Bay. |
| 1943 | The buildings in the south and south-west sections of the site generally appeared to be similar to the 1930 photograph. Several additional towers/silos were located to the north-east of these buildings. An additional building was located adjacent to the east site boundary that appeared consistent with the existing building occupied by the seafood retailers/wholesalers. A large commercial/industrial type building together with several smaller sheds/containers and a circular tower/silo were located in the north section of the site. A paved driveway area extended from Bank Street and separated the north and south sections of the site.<br><br>The immediate surrounds generally appeared to be similar to the 1930 photograph. |
| 1951 | The site and the immediate surrounds generally appeared to be similar to the 1943 photograph. |
| 1961 | The south section of the site generally appeared to be similar to the 1951 photograph. The larger building formerly located in the north-west section of the site had been demolished and two smaller buildings (of unknown use) |

[12] https://six.maps.nsw.gov.au/wps/portal/SIXViewer

| | |
|---|---|
| | occupied the central north section of the site. The east most building of the two generally appeared similar to the existing (2010) Building 34.<br><br>A large building that appeared similar to the existing (2010) Sydney Fish Markets main building was located to the south of the site. |
| 1970 | The circular towers/silos formerly located in the south section of the site were no longer evident and the areas where the towers were located appeared to be paved. The far north section of the site appeared to be vacant and paved.<br><br>The immediate surrounds generally appeared to be similar to the 1961 photograph. |
| 1978 | The site generally appeared to be similar to the 1970 photograph.<br><br>Several structures were located to the north of the site that appeared consistent with the existing batching plant. Alterations had been made to the waterfront areas and wharfs adjacent to Blackwattle Bay. |
| 1986 | The site and the immediate surrounds generally appeared to be similar to the 1978 photograph. |
| 1994 | The buildings that formerly occupied the south and south-west sections of the site had been demolished. The majority of the site was occupied by a car park and numerous cars. The site layout including the buildings generally appeared consistent with the existing (2010) Sydney Fish Markets site.<br><br>The Western Distributor was located to the east of the site. Additional residential type buildings were located in the areas to the east of the site. |
| 2002 | The site and immediate surrounds generally appeared to be similar to the 1994 photograph. |
| 2007 | The site and immediate surrounds generally appeared to be similar to the 2002 photograph. |

## 5.2 Land Title Search

A limited historical land title search was performed on our behalf by Advanced Legal Search Pty Ltd. Copies of the title records are presented in Appendix C and a summary of the relevant information is provided in the following table:

| Date | Proprietor |
|---|---|
| | **(Lot 2 DP 827434)** |
| 2008 – todate | State Property Authority |
| *(1993 – todate)* | *(various current commercial leases see Folio Identifier 2/827434)* |
| *(1993 – todate)* | *(various commercial leases see Historical Folio 2/827434)* |
| 1993 – 2008 | The Fish Marketing Authority |
| | **(Lot 2 DP 545500)** |
| 1988 – 1993 | The Fish Marketing Authority |
| *(1988 – 1993)* | *(various commercial leases see Historical Folio 2/545500)* |
| | **(Lot 2 DP 545500 – CTVol 12073 Fol 250)** |
| 1973 – 1988 | Fish Marketing Authority |
| *(1973 – 1988)* | *(various commercial leases see CTVol 12073 Fol 250)* |
| | **(Lot 1 DP 233350 – CTVol 10843 Fol 196)** |
| 1972 – 1973 | Fish Marketing Authority |
| 1969 – 1972 | New South Wales Fish Authority |
| | **(30 ½ Perches Grant Parish St Andrews – CTVol 2088 Fol 91)** |
| 1965 – 1969 | The New South Wales Fish Authority |
| 1930 – 1965 | The Shell Company of Australia Limited |
| (1923 – 1930) | (lease to F Buckle & Sons Limited) |
| (1911 – 1930) | (lease to The British Imperial Oil Company Limited) |
| 1910 – 1930 | F Buckle & Sons Limited |
| | **(Part of John Harris's grant Parish St Andrews – Area 2 Acres 0 Roods 7 ½ Perches – CTVol 3552 Fol 17)** |
| 1965 – 1969 | The New South Wales Fish Authority |
| 1930 – 1965 | The Shell Company of Australia Limited |
| (1917 – 1930) | (lease to The British Imperial Oil Company Limited) |
| 1928 – 1930 | F Buckle & Sons Limited |
| | **(Part of John Harris's grant Parish St Andrews – Area 2 Acres 0 Roods 7 ½ Perches – CTVol 1232 Fol 144)** |
| 1903 – 1928 | F Buckle & Sons Limited |
| (1911 – 1917) | (lease to The British Imperial Oil Company Limited) |
| 1900 – 1903 | Francis Buckle, gentleman |
| (1902 – 1911) | (lease to The Shell Transport and Trading Company Limited) |
| 1897 – 1900 | English Scottish & Australian Bank Ltd |
| | **(Part 1 Acre 2 Roods 14 Perches grant – Area 2sq ft – CTVol 3614 Fol 199)** |
| 1965 – 1969 | The New South Wales Fish Authority |
| (1887 – 1965) | (lease to Robert Maye, contractor) |
| 1927 – 1965 | F Buckle & Sons Limited |
| | **(Part of John Harris's grant Parish St Andrews – Area 2 Acres 0 Roods 7 ½ Perches – CTVol 1232 Fol 144)** |
| 1903 – 1928 | F Buckle & Sons Limited |
| (1911 – 1917) | (lease to The British Imperial Oil Company Limited) |

| | |
|---|---|
| 1900 – 1903 | Francis Buckle, gentleman |
| (1902 – 1911) | (lease to The Shell Transport and Trading Company Limited) |
| 1897 – 1900 | English Scottish & Australian Bank Ltd |
| | **(Part of 1 Acre 2 Roods 14 Perches – Parish St Andrews – Area 1 Acre 2 Roods 13 Perches grant – CTVol 6871 Fol 250)** |
| 1965 – 1969 | The New South Wales Fish Authority |
| 1954 – 1965 | The Shell Company of Australia Limited |
| | **(Part of 1 Acre 2 Roods 14 Perches – Parish St Andrews – Area 1 Acre 2 Roods 13 Perches grant – CTVol 1304 Fol 63)** |
| 1930 – 1954 | The Shell Company of Australia Limited |
| 1903 – 1930 | F Buckle & Sons Limited |
| 1899 – 1903 | Francis Buckle, gentleman |
| (1887 – 1965) | (lease to Robert Maye, contractor) |

The land titles have indicated that at least part of the site was leased to the British Imperial Oil Company Ltd in 1902. Leases for other parts of the site were documented for the same company around 1911 and were dated up until 1930. From 1930 until the mid 1960s the site was leased to the Shell Company of Australia Ltd. Site use from 1902 to 1930 has not been confirmed, however it is considered likely that various activities associated with petroleum storage, distribution and possibly oil refining processes were undertaken at the site during this time.

The New South Wales Fish Authority progressively leased portions of the site from 1965. These leases were transferred to the Fish Marketing Authority in the early 1970s and leased by various companies associated with the sale and distribution of seafood. The records indicated that the site was transferred and listed as being state property in 2008.

### 5.3 Council Records

A search of Development Application (DA) and Building Approval (BA) records held by City of Sydney Council was undertaken by EIS. Records were identified dating back to the late 1990s and were generally associated with the existing land use by the Sydney Fish Markets. Various applications/approvals included the following:

- Processing facilities and cool rooms;
- New kiosk;
- Construction of a mezzanine floor level to one of the existing shops; and
- Shop fit-out for an existing restaurant.

The council records search has not indicated any particular site use or development that may be considered to have resulted in significant contamination of the soil and groundwater at the site.

## 5.4 WorkCover Database Records

A records search for licenses to store dangerous goods was undertaken on our behalf by WorkCover. The records did not indicate the existence of any licences, including USTs, at this site.

## 5.5 NSW DECCW Records

A search of the NSW DECCW (EPA) on-line database did not indicate the existence of any EPA notices for the site under section 58 of the CLM Act 1997. A search of the NSW DECCW public register (POEO) did not indicate the existence of any EPA notices, applications and licenses for the site.

## 5.6 Assessment of Historical Information Integrity

The site history assessment has generally been obtained from: government records including the NSW land titles office, local government historical archives, historical aerial photographs and NSW WorkCover records. The veracity of the information from these sources is considered to be high, however, given the age of the development, the gap of up to 13 years between aerial photographs and the lack of detailed information available on activities prior to and during the early 1900s, a certain degree of information loss is to be expected.

Non verifiable anecdotal information has not been relied upon during assessment of historical site use. Therefore, there is considered to be a high level of integrity associated with information obtained with respect to historical use of the site.

## 5.7 Summary of Historical Site Use

The search of historical information has indicated the following:

- The site was leased by the British Imperial Oil Company Ltd and the Shell Company of Australia Ltd from around 1902 to 1930. The Shell Company of Australia continued to lease the site until the early 1960s. Site use during this period has not been confirmed, however it is considered likely that various activities associated with petroleum storage, distribution and possibly oil refining processes were undertaken at the site during this time;

- The 1930 aerial photograph indicated that the site was located within an industrial area. Several large industrial-type buildings and circular storage towers/silos (possibly associated with petroleum storage and/or refinery processes) were located in the south section of the site. The towers/silos and buildings remained at the site until at least 1961;
- The New South Wales Fish Authority progressively leased portions of the site from 1965. These leases were transferred to the Fish Marketing Authority in the early 1970s and leased by various companies associated with the sale and distribution of seafood;
- There are no recorded notices listed on the NSW DECCW CLM or POEO register; and
- WorkCover have no records of UST licenses issued for the site.

# 6 POTENTIAL CONTAMINATION SOURCES

## 6.1 Potential Site Specific Contamination

Potential contamination at the site would be anticipated to be associated with:

- Potentially contaminated, imported fill material;
- Potential asbestos contamination associated with demolition of the former site buildings/sheds;
- Potential use of the site (particularly the south and south-west sections) for petroleum storage and refining processes;
- Unidentified USTs;
- Historical use of the site for unknown commercial/industrial purposes;
- Historical activities such as use of pesticides; and
- The suspected UST located off-site but adjacent to the west boundary.

### 6.1.1 Site Specific Soil Contaminants of Concern

The compounds identified as soil contaminants of concern at the site include:

- Heavy metals: arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc;
- TPH;
- BTEX;
- PAHs including benzo(a)pyrene;
- Organochlorine pesticides (OCPs) including Aldrin, dieldrin, chlordane, DDT, DDD, DDE and heptachlor;
- Organophosphorus pesticides (OPPs);
- PCBs; and
- Asbestos.

### 6.1.2 Site Specific Groundwater Contaminants of Concern

The compounds identified as groundwater contaminants of concern at the site include:

- Heavy metals: arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc;
- TPH;
- Volatile organic compounds (VOCs) and
- PAHs.

## 6.2 Potential Receptors

The main potential contamination receptors are considered to include:

- Blackwattle Bay located approximately 40m to the west (south-west) of the site;
- Site visitors, site occupants, workers and adjacent property owners, who may come into contact with contaminated soil and/or be exposed to contaminated dust arising from construction activity; and
- Future site occupants.

## 6.3 Contaminant Laydown and Transport Mechanisms

At this site, mobile contaminants would be expected to move down to the rock surface or groundwater table and migrate laterally down-slope from the source. The movement of contaminants would generally be expected to be associated with groundwater flow and seepage at the top of the bedrock. In the vicinity of the west site boundary, the transport of contaminants may also be associated with tidal movement.

# 7 ASSESSMENT CRITERIA

## 7.1 Regulatory Background

In 1997 the NSW Government introduced the CLM Act. This Act has recently been amended by the *Contaminated Land Management Amendment Act* (2008[13]).

The CLM Act 1997, associated regulations and NSW DECCW (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; and
- 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 may be required prior to occupation of the proposed development. 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 1997 the NSW DECCW (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 1997 states that specific notation relating to contaminated land issues must be included on Section149 (s149) planning certificates prepared by Council where the land to which the certificate relates is:

[13] *Contaminated Land Management Amendment Act,* NSW Government Legislation, 2008 (CLM Amendment Act 2008)

- Within an investigation or remediation area;
- Subject to an investigation or remediation order by the DECCW (EPA);
- The subject of a voluntary investigation or remediation proposal; and/or
- 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 s149 certificates prepared for the site.

Section 60 of the CLM Amendment Act 2008 sets out a positive duty on a land owner, or person whose activities have caused contamination, to notify the DECCW if they are or become aware that contamination exists on a site that generally poses "*an unacceptable risk to human health or the environment, given the site's current or approved use*". This duty to report is based on trigger values, above which notification is required.

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* (1997[14]) and associated regulations and guidelines including the *NSW DECC (now DECCW) Waste Classification Guidelines - Part 1: Classifying Waste* (2009[15]). All materials should be classified in accordance with these guidelines prior to disposal.

Section 143 of the POEO 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.

## 7.2 Soil Contaminant Threshold Concentrations

The soil investigation levels adopted for this investigation are derived from the NSW DEC (now DECCW) document *Guidelines for the NSW Site Auditor Scheme, 2nd Edition* (2006[16]) and the National Environmental Protection Council document *National Environmental Protection (Assessment of Site Contamination) Measure* (1999[17]). The contaminant thresholds listed below are levels at which further investigation and

[14] *Protection of Environment Operations Act,* NSW Government, 1997 (POEO Act 1997)

[15] *Waste Classification Guidelines, Part 1: Classifying Waste,* NSW DECC, 2009 (Waste Classification Guidelines 2009)

[16] *Guidelines for the NSW Site Auditor Scheme, 2nd ed.,* NSW DEC, 2006 (Site Auditor Guidelines 2006)

[17] *National Environmental Protection (Assessment of Site Contamination) Measure,* National Environment Protection Council (NEPC), 1999 (NEPM 1999)

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 TPH and BTEX compounds have previously been established in the *NSW EPA (now DECCW) Contaminated Sites: Guidelines for Assessing Service Station Sites* (1994[18]) publication and this document is referenced in the Site Auditor Guidelines 2006. Heavy fraction petroleum hydrocarbon aliphatic/aromatic component threshold concentrations have also been introduced in NEPM 1999.

### 7.2.1 Asbestos

NEPM 1999 does not provide numeric guidelines for the assessment of asbestos in soil. NSW DECCW (EPA) advice (2006) has indicated that consultants should use their 'professional judgement' regarding determination of appropriate investigation and remediation levels for asbestos in soils; however the NSW DECCW (EPA) have not published numerical guidelines for the assessment of asbestos in subsurface soils.

The WorkCover publication *Working with Asbestos Guide* (2008[19]) states that, where buried asbestos is encountered, "A competent occupational hygienist should assess the site to determine:

- If asbestos material is bonded or friable
- The extent of asbestos contamination
- Safe work procedures for the remediation of the site"

[18] *Guidelines for Assessing Service Station Sites,* NSW EPA, 1994 (Service Station Guidelines 1994)

[19] *Working with Asbestos Guide,* NSW WorkCover, 2008 (WorkCover Working with Asbestos Guide 2008)

"*Any asbestos cement products that have been subjected to weathering, or damaged by hail, fire or water blasting are considered to be friable asbestos and an asbestos removal contractor with a WorkCover license for friable asbestos removal is required for its removal*". Under the *NSW Occupational Health and Safety (OHS) Regulations 2001*[20] and WorkCover requirements all necessary disturbance works associated with asbestos containing materials must be conducted by a licensed AS-1 Asbestos Removal Contractor.

### 7.2.2 Assessment Criteria for Soil Contaminants

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

| Soil Assessment Criteria (mg/kg) | | |
|---|---|---|
| **Contaminant** | **Health Investigation Levels (HILs) Column F** | **Guidelines for Assessing Service Station Sites (1994)** |
| **Inorganics** | | |
| Arsenic (total) | 500 | - |
| Cadmium | 100 | - |
| Chromium (III) | 60% | - |
| Copper | 5000 | - |
| Lead | 1500 | - |
| Mercury (inorganic) | 75 | - |
| Nickel | 3000 | - |
| Zinc | 35000 | - |
| **Organic Contaminants** | | |
| TPH ($C_6$-$C_9$) | - | 65 |
| TPH ($C_{10}$-$C_{36}$) | - | 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 | - |
| Total OPPs | 0.1* | - |
| NOTE: * In the absence of local guidelines, the laboratory Practical Quantitation Limit (PQL) has been adopted. | | |

[20] *Occupational Health and Safety Regulation,* NSW Government, 2001 (NSW OH&S Regulation 2001)

### 7.2.3 Assessment Criteria for Waste Classification

For the purpose of off-site disposal, the classification of soil into 'General Solid Waste (non-putrescible)', 'Restricted Solid Waste (non-putrescible)' and 'Hazardous Waste (non-putrescible)' categories is defined by chemical contaminant criteria outlined in the Waste Classification Guidelines 2009. The contaminant criteria are summarised in Table A-2.

## 7.3 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 NEPM 1999 Schedule 7(a) and the statistical analysis methods outlined in the *NSW EPA (now DECCW) Contaminated Sites Sampling Design Guidelines* (1995[21]).

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 the concentration of each contaminant is less than the applicable contaminant threshold concentration (site assessment criteria) in all samples, UCL calculations may not be required and the suitability of the site for the proposed use may be assessed based solely on individual analytical results.

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.

[21] *Contaminated Sites Sampling Design Guidelines,* NSW EPA, 1995 (EPA Sampling Design Guidelines 1995)

## 7.4 Acid Sulfate Soils

Assessment of acid sulfate soil conditions and the impacts of the proposed development are based on information presented in the *Acid Sulfate Soil Manual* (1998[22]). The guidelines include information on assessment of the likelihood that the site lies within an acid sulfate soil area, the need for an acid sulfate soil management plan, and the development of mitigation methods for the proposed development.

### 7.4.1 Acid Sulfate Soil Assessment Criteria

The ASS Manual 1998 presents "action criteria" for the assessment of laboratory analysis results. These "action criteria" define the need to prepare a management plan and are based on the percentage of oxidisable sulfur (or equivalent Total Potential Acidity) for broad categories of soil types. It should be noted however that where disturbance of greater than 1,000 tonnes of acid sulfate soil is proposed, the action criteria for 'coarse' textured soils apply to all soil types. The action criteria for the three soil types are detailed below:

| Soil Type | pH | TAA/TSA/TPA (pH 5.5) | $S_{pos}$% |
|---|---|---|---|
| Coarse textured (sands to loamy sands) | <5 | >18mol $H^+$/tonne | 0.03 |
| Medium textured (loams to light clays) | <5 | >36mol $H^+$/tonne | 0.06 |
| Fine textured (medium to heavy clays) | <5 | >62mol $H^+$/tonne | 0.1 |

Standard methods for the laboratory analysis of samples are presented in the *Australian Standard for Analysis of Acid Sulfate Soil,* AS4969-2008/2009 (part 1 to 14)[23]. The principle analytical method is sPOCAS – suspension Peroxide Oxidation Combined Acidity and Sulfate.

The sPOCAS method specified in AS4969-2008/2009 has superseded the sPOCAS method specified in the ASS Manual 1998. It should note that the endpoint for the pH titration in AS4969-2008/2009 is pH6.5 as opposed to pH5.5 in the ASS Manual 1998. Therefore the values for TAA, TSA and TPA will more conservative when analysed using the sPOCAS method specified AS4969-2008/2009.

The assessment criteria adopted for this investigation varied based on the soil type. Reference should be made to Table H for further details.

[22] *Acid Sulfate Soil Manual,* Acid Sulfate Soils Management Advisory Committee, 1998 (ASS Manual 1998)

[23] *Analysis of Acid Sulfate Soils*, Standards Australia, 2008/2009 (AS4969-2008/2009)

## 7.5 Groundwater Contaminant Trigger Values

Groundwater resources in NSW are managed and regulated by environmental and planning legislation which including the POEO Act 1997, *Environmental and Planning Assessment Act* (1979[24]) and the *Water Management Act* (2000[25]).

In 2000, Australian and New Zealand Environment Conservation Council (ANZECC) released the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (2000[26]) which superseded the previous guideline documents.

The ANZECC 2000 guidelines include a complete framework for the development of appropriate guidelines for aquifer assessment. The above guidelines provide water quality parameters at the point of use including aquatic ecosystems (fresh and marine waters), drinking water, industrial and agricultural/irrigation uses.

The National Health and Medical Research Council (NHMRC) released the *Australian Drinking Water Guidelines* (2004[27]). These guidelines are predominantly used to assess drinking water quality and have been referenced in some cases.

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.

The presence of elevated contaminant concentrations in groundwater triggers further investigation of aquifer conditions to assess the source(s) of contamination and the lateral and vertical extent of the contamination.

### 7.5.1 Petroleum Hydrocarbons and VOCs in Groundwater

In the absence of locally endorsed guidelines for total petroleum hydrocarbon compounds in water, the 'intervention value' concentration for mineral oil specified in

[24] *Environmental and Planning Assessment Act,* NSW Government, 1979 (E&PAA 1979)

[25] *Water Management Act*, NSW Government, 2000 (Water Act 2000)

[26] *Australian and New Zealand Guidelines for Fresh and Marine Water Quality,* ANZECC, 2000 (ANZECC 2000)

[27] *Australian Drinking Water Guidelines*, National Health and Medical Research Council, 2004 (NHMRC 2004)

the *Circular on Target Values and Intervention Values for Soil Remediation* (2000[28]) has been adopted. It is noted that these guidelines have not been endorsed by NSW DECCW (EPA) and are used only as a preliminary screening tool.

Similarly, in the absence of locally endorsed guidelines for a number of VOC's in water, the US EPA Region 9 Preliminary Remediation Goals (2004[29]) have been adopted and have been used only as screening tool.

### 7.5.2 Assessment Criteria for Groundwater Contaminants

The marine groundwater trigger values have been adopted along with other guideline values for this investigation as outlined in the table below. Reference should also be made to the attached Table D for further details regarding the individual trigger values.

[28] *Circular on Target Values and Intervention Values for Soil Remediation,* Ministry of Housing, Spatial Planning and Environment, 2000 (Dutch Guidelines 2000)

[29] *Region 9 Preliminary Remediation Goals,* US EPA, 2004 (US EPA 2004)

| Groundwater Contaminant Assessment Criteria (mg/L) | |
|---|---|
| **Contaminant** | **95% Trigger Value for Marine Water** |
| **Inorganics** | |
| Arsenic | 0.0023[t] |
| Cadmium | 0.0055 |
| Chromium | 0.059[H] |
| Copper | 0.008[H] |
| Lead | 0.068[H] |
| Mercury | 0.0004 |
| Nickel | 0.439[H] |
| Zinc | 0.094[H] |
| **Organics** | |
| Benzene | 0.7 |
| Toluene | 0.18[t] |
| Ethyl benzene | 0.005[t] |
| o-Xylene | 0.35[t] |
| m + p Xylene | 0.275[t] |
| Total Xylenes | 0.38[#] |
| Isopropylbenzene | 0.66[US] |
| n-Propylbenzene | 0.24[US] |
| *tert*-Butylbenzene | 0.24[US] |
| *sec*-Butylbenzene | 0.24[US] |
| n-Butylbenzene | 0.24[US] |
| Naphthalene | 0.16 |
| Phenanthrene | 0.0006[L] |
| Anthracene | 0.0004[t] |
| Fluoranthene | 0.001[L] |
| Benzo(a)pyrene | 0.0001[L] |
| Total PAHs | 0.003[#] |
| TPH $C_{10}$-$C_{36}$ | 0.6 |
| **Miscellaneous Inorganics** | |
| Oil and grease | 10[#] |

**Note:**

[t] Moderate or low reliability trigger value adopted due to absence of high reliability value

[#] NSW EPA (now DECCW) Service Station Guidelines 1994

[H] Hardness modified trigger value adopted in accordance with ANZECC 2000

[US] USEPA Region 9 PGRs adopted in absence of locally endorsed guidelines

[L] 99% trigger values adopted due to potential for bioaccumulation

# 8 ASSESSMENT PLAN

## 8.1 Soil Sampling Density

The EPA Sampling Design Guidelines 1995 for contaminated site investigations state that samples should be obtained from a minimum of 28 evenly spaced sampling points for a site of this size (approximately 18,000m$^2$).

Samples were obtained from 17 sampling locations (BH501 to BH504 inclusive, BH506 to BH508 inclusive and BH510 to BH519 inclusive) for this investigation. This density is approximately 60% of the minimum sampling density. It should be noted that BH505 and BH509 were drilled outside the site boundary and were utilised only for the J&K geotechnical investigation.

The boreholes were generally drilled on a systematic grid with a spacing of approximately 40m between sampling points. A systematic sampling plan was considered most appropriate for this investigation as the investigation was designed to assess significant, widespread contamination.

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

### 8.1.1 Acid Sulfate Soil Assessment

The ASS Manual 1998 includes recommendations for the density of sampling locations within the site. A minimum of four sampling locations should be undertaken for a site with an area up to 1 Ha in size to assess development constraints with a reduced density for sites greater than 4Ha of two locations per hectare. The sampling locations should include all areas where significant disturbance of soils will occur and/or areas with a high environmental sensitivity. In some instances a varied sampling plan may be more suitable, particularly for sites less than 1000m$^2$ in area.

Samples were obtained from six locations for the purpose of the acid sulfate soil assessment (BH501, BH502, BH506, BH508, BH510 and BH518).

## 8.2 Groundwater Sampling

The assessment included the installation of five groundwater monitoring wells (MW508, MW512, MW513, MW516 and MW517) in boreholes BH508, BH512, BH513, BH516 and BH517. The location of the groundwater monitoring wells is shown on Figure 2.

## 8.3 Data Quality Objectives (DQOs)

The DQOs for the assessment are outlined in the following table:

| DQOs | |
|---|---|
| **State the problem** | The historical information indicated that the site has a history of industrial land use, possibly including petroleum storage/distribution and refinery processes. The site also lies within an area of reclaimed land that has been filled in order to create the existing site levels.<br><br>The principal soil contaminants of concern at the site are heavy metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc), TPH/BTEX, PAHs, OCP/OPPs, PCBs and asbestos. The principal groundwater contaminants of concern are heavy metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc), TPH, VOCs (including BTEX compounds) and PAHs. |
| **Identify the decision** | The primary objectives of the investigation were to:<br>• Assess the potential risk of significant widespread contamination of the site;<br>• Assess the soil and groundwater contamination conditions at the site in relation to the proposed land use;<br>• Undertake a waste classification assessment for off-site disposal of excavated soil associated with the proposed development works;<br>• Assess the soil conditions for acid sulfate soil potential; and<br>• Prepare a report presenting the results of the assessment. |
| **Identify inputs into the decision** | The following data will be reviewed to resolve the decision statement:<br>• Site history information; and<br>• Physical site data that includes topography and other relevant information.<br><br>The soil contamination assessment included:<br>• Soil sampling from 17 boreholes drilled at the site;<br>• Laboratory analysis of selected fill samples and natural samples for the following contaminants: heavy metals, PAHs, TPH, BTEX, OCP, OPP, PCBs and asbestos. Reference should be made to the attached Table B for details regarding the analysis schedule; and<br>• Laboratory analysis of selected samples for acid sulfate soil characteristics (sPOCAS analysis).<br><br>The groundwater contamination assessment included:<br>• Installation of five groundwater monitoring wells in selected boreholes;<br>• Laboratory analysis of four groundwater samples for the following contaminants and parameters: heavy metals, PAHs, TPH, VOC's, pH, hardness, electrical conductivity and oil & grease. One groundwater sample was analysed for heavy metals, light fraction ($C_6$-$C_9$) TPH and VOC's only. |

| | |
|---|---|
| | Details of the field QA/QC adopted for the assessment is outlined in Section 8.4 below. |
| **Study Boundaries** | The study was confined to the boundaries of the site as shown in Figure 2. |
| **Develop a Decision Rule** | The results of the laboratory analyses were compared with the site assessment criteria adopted for the investigation. The QA/QC program implemented for the project was assessed by comparison with the criteria outlined in Section 8.4. |
| **Specify Limits on Decision Errors** | Decision errors are false positive or false negative i.e. stating the site is clean when it is contaminated; or stating that the site is contaminated when it is not. The most significant of these is a false positive i.e. stating that the site is suitable for proposed use when, if fact, it is contaminated. This error could potentially impact on the health of the site users. This study has assumed that elevated concentrations of the contaminants of concern are present in the soils at the site unless demonstrated otherwise. |
| **Optimise the Design for Obtaining data** | The overall data set was optimised by reviewing the data as the project proceeded. When necessary, adjustments were made to the sampling or analytical program. |

## 8.4 Data Quality Indicators (DQIs) and Quality Assurance

The validation, as part of the DQOs, involves the technical review of the data using defined Quality Assurance (QA) Assessment Criteria. The success of the DQIs is based on assessment of the data set as a whole and not on individual acceptance or exceedance within the data set. The following table provides the DQIs and the methods adopted to achieve these.

| DQIs | Method of Achievement |
|---|---|
| Documentation Completeness | • Review of previous investigation reports<br>• Preparation of sampling location plan<br>• Preparation of chain of custody (COC) records<br>• Laboratory sample receipt information<br>• NATA registered laboratory results |
| Data Completeness | • Appropriately distributed sampling<br>• Sampling program based on the EPA Sampling Design Guidelines 1995<br>• On-site visual and PID assessment of samples<br>• Analysis for all potential contaminants of concern |
| Data Comparability | • The use of appropriate sampling techniques<br>• The use of appropriate preservation, storage and transport methods<br>• The use of NATA registered laboratories for all analyses |
| Data Representativeness | • Adequate coverage of sample locations across the site<br>• Representative coverage of analysis for contaminants of concern |
| Data Precision and Accuracy | • Use of trained and qualified field staff<br>• Appropriate industry standard sampling equipment and decontamination procedures<br>• Field QA/QC including collection and analysis of the following for the contaminants of concern:<br>➢ approximately 5% of field soil samples as inter-laboratory duplicates;<br>➢ approximately 10% of field soil samples as intra-laboratory duplicates;<br>➢ trip blank samples and rinsate samples of field equipment, and<br>➢ soil and water trip spike samples.<br>• Acceptable RPDs for duplicate comparison. The RPD is calculated as the absolute value of the difference between the initial and repeat result divided by the average value, expressed as a percentage. The following acceptance criteria will be used to assess the RPD results:<br>➢ For results that were greater than 10 times the Practical Quantitation Limit (PQL) RPDs less than 50% were considered acceptable;<br>➢ For results that were between 5 and 10 times PQL RPDs less than 75% were considered acceptable; and<br>➢ For results that were less than 5 times the PQL RPDs less than 100% were considered acceptable.<br>• Review of laboratory QA/QC data (including surrogate recovery, repeat analysis, duplicates, matrix spikes and method blanks)<br>• Acceptable concentrations in blank, rinsate and trip spike samples<br>• Check of laboratory quality control methods and results |

# 9 INVESTIGATION PROCEDURE

## 9.1 Subsurface Investigation and Soil Sampling Methods

Subsurface investigation was undertaken using truck and track mounted hydraulically operated drill rigs 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. Details of the decontamination procedure adopted during sampling are presented in Appendix D.

Soil and rock samples were obtained at various depths, based on observations made during the field investigation. During sampling, soil at selected depths was split into initial and duplicate samples for QA/QC assessment.

All samples were placed in: glass jars with plastic caps and teflon seals with minimal headspace (analysis for soil contaminants); zip-lock plastic bags (asbestos analysis); or plastic bags with minimal headspace (for sPOCAS analysis). Sampling personnel used disposable nitrile gloves during sampling activities.

During the investigation, soil samples were preserved by immediate storage in an insulated sample container with ice in accordance with AS 4482.1-2005[30] and AS 4482.2-1999[31] as summarised in the following table:

| Analyte | Preservation | Storage |
|---|---|---|
| Heavy metals | Unpreserved glass jar with Teflon lined lid | Store at <4°, analysis within 28 days (mercury and Cr[VI]) and 180 days (other metals). |
| VOCs (TPH/BTEX) | | Store at <4°, nil headspace, extract within 14 days, analysis within forty days |
| PAHs, OCP, OPP & PCBs | | |
| Asbestos | Sealed plastic bag | None |

[30] *Guide to the Investigation and Sampling of sites with Potentially Contaminated Soil,* Standards Australia, 2005 (AS 2005)

[31] *Guide to the Sampling and Investigation of Potentially Contaminated Soil Part2: Volatile Substances,* Standards Australia, 1999 (AS 1999)

Samples for acid sulfate soil analysis were stored on ice during fieldwork and frozen at the end of each day. Selected samples were then analysed as soon as possible.

The samples were labelled with the job number, sampling location, sampling depth and date. All samples were recorded on the borehole logs presented in Appendix A and on the laboratory 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 COC procedures. Detailed EIS field sampling protocols are included in Appendix D.

## 9.2 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 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.

PID screening of detectable VOCs was undertaken on soil samples using the soil sample headspace method. VOC data was obtained from partly filled zip-lock plastic bags following equilibration of the headspace gases. The PID headspace data is presented on the COC documents presented in Appendix B. PID calibration certificates are presented in Appendix E.

## 9.3 Groundwater Monitoring Well Installation

Five groundwater monitoring wells (MW508, MW512, MW513, MW516 and MW518) were installed in boreholes BH508, BH512, BH513, BH516 and BH518 as shown on Figure 2. The monitoring well construction details are documented on appropriate borehole logs presented in Appendix A.

Applications to license the monitoring wells were submitted to The Department of Water and Energy (DWE) by EIS. Copies of the licenses will be forwarded when received.

The well construction details are summarised in the following table:

| Groundwater Monitoring Well Construction Details | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Well / BH No.** | **Depth (m)** | **SWL On 28 June 2010 (m)** | **Approx Surface R.L. (m)** | **Un-slotted PVC* Casing (m)** | **Machine Slotted PVC* Screen (m)** | **Sand Filter Pack (m)** | **Bentonite Seal (m)** | **Well Finishing Details#** |
| MW508 | 6.0 | 2.86 | 3.8 | 0.0-3.0 | 3.0-6.0 | To 2.0 | To 0.5 | Gatic cover |
| MW512 | 6.0 | 3.3 | 4.3 | 0.0-3.0 | 3.0-6.0 | To 2.0 | To 0.5 | Gatic cover |
| MW513 | 4.2 | 1.34 | 2.3 | 0.0-1.2 | 1.2-4.2 | To 1.0 | To 0.3 | Gatic cover |
| MW516 | 3.0 | 2.46 | 3.0 | 0.0-1.0 | 1.0-3.0 | To 0.8 | To 0.3 | Gatic cover |
| MW517 | 5.5 | 2.53 | 3.3 | 0.0-2.5 | 2.5-5.5 | To 1.5 | To 0.3 | Gatic cover |

***Annotations and Abbreviations:***
*50mm diameter Class 18 PVC has been used for the wells
# concrete/cement grout was used to seal the monitoring well
SWL: Standing Water Level
RL: Reduced Level (AHD)

## 9.4 Monitoring Well Development

Groundwater was purged from the monitoring wells using a submersible electric pump. The pH, temperature, conductivity (EC), dissolved oxygen (DO) and redox potential (Eh) were monitored during development using calibrated field instruments to assess the development of steady state conditions.

Steady state conditions were considered to have been achieved when the difference in the pH measurements was less than 0.2 units and the difference in conductivity was less than 10%. Typically a minimum of 17-40L were purged to remove stagnant water and sediment from the monitoring well prior to sampling to obtain samples representative of the general aquifer conditions.

For wells that either encountered no infiltration of groundwater, or relatively slow infiltration of groundwater during development (i.e. MW508, MW512 and MW516), groundwater was removed from these wells until they were effectively 'dry'.

The monitoring well development sheets and the equipment calibration documents are presented in Appendix E.

The pump and hose were flushed between sampling point with potable water. Details of the decontamination procedure adopted during development are presented in Appendix D.

Groundwater removed from the wells during purging was transported to EIS, where the water is stored in a holding drum prior to collection by licensed waste water contractors.

## 9.5 Groundwater Sampling

Groundwater samples were obtained (approximately four days after development) from all monitoring wells, except MW516, using micro-purge sampling equipment to reduce the disturbance of the water column and loss of volatiles. The pH, temperature, EC, DO and Eh were monitored during sampling using calibrated field instruments to assess the development of steady state conditions.

Due to the lack of recharge in MW516, EIS assumed that steady state conditions would not be achieved during sampling. As an alternative, a 'grab' sample was obtained from this location using a disposable polyethylene bailer.

The sampling data sheets and the calibration documentation for the instruments are presented in Appendix E.

Once steady state conditions were considered to have been achieved, groundwater samples were obtained directly from the pump tubing and placed in appropriate glass bottles, BTEX vials or plastic bottles.

Duplicate samples were obtained by alternate filling of sample containers. This technique was adopted to minimise disturbance of the samples and loss of volatile contaminants associated with mixing of liquids in secondary containers, etc.

The samples were preserved in accordance with water sampling requirements detailed in NEPM 1999 and placed in an insulated container with ice. During the investigation, groundwater samples were preserved by immediate storage in an insulated sample container with ice in accordance with AS/NZS 5667.1:1998[32] as summarised in the following table:

[32] *Water Quality – Part 1: Sampling, Guidance on the Design of Sampling Programs, Sampling Techniques and the Preservation and Handling of Samples,* Standards Australia, 1998 (AS/NZS 5667.1:1998)

| Analyte | Preservation | Storage Period |
|---|---|---|
| Heavy metals | 45$\mu$m Filter, acidify with nitric acid to pH 1-2. | Store at <4°, analysis within 30 days |
| VOCs (TPH) | Zero headspace, teflon seal | Store at <4°, analysis within 7 days |
| VOCs (BTEX + Light TPH) | Zero headspace, Teflon seal, acidify with HCl to pH 1-2. | Store at <4°, analysis within 7 days |
| sVOCs (PAHs) | nil | Store at <4°, analysis within 7 days |
| Oil & grease | Some headspace, Teflon seal, acidify with $H_2SO_4$ or HCl to pH 1-2 | Store at <4°, analysis within 30 days |

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.

### 9.6 Laboratory Analysis - Soil Samples

Analysis of soil samples was undertaken by NATA registered laboratories using analytical methods detailed in the Schedule B(3) NEPM (1999) Guideline on Laboratory Analysis of Potentially Contaminated Soils.

Laboratory analysis was undertaken by Envirolab Services Pty Ltd (NATA Accreditation No. 2901) with additional Quality Control Analysis 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/AES;
- Low level mercury – cold vapour AAS;
- OC and OP pesticides and PCBs – Extracted with dichloromethane/acetone. 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/MS;
- TPH – Soil extracted with dichloromethane/acetone. Analysis by GC/FID;
- BTEX – Soil extracted with methanol. Analysis by P&T GC/MS;
- Asbestos – Polarizing light microscopy; and
- sPOCAS – Determined using titrimetric and ICP-AES techniques.

Toxicity characteristic leaching procedure (TCLP) leachates were prepared by rotating soil samples in a mild acid solution for 18 hours (NSW EPA WD-3 Method). Leachates were analysed using the analytical procedures outlined above.

## 9.7 Laboratory Analysis - Groundwater Samples

Analysis of water samples for this assessment was undertaken by NATA registered laboratories using analytical techniques endorsed by the NSW EPA (Schedule B(3) of NEPM 1999 does not apply to water samples).

Laboratory analysis was undertaken by Envirolab Services Pty Ltd (NATA Accreditation No. 2901) with additional Quality Control Analysis undertaken by SGS Environmental Services Pty Ltd (NATA Accreditation No. 2562).

For this investigation selected groundwater samples were analysed for contaminants and parameters using the following laboratory techniques:

- Heavy metals – Direct injection. Analysis by ICP-AES;
- Low level mercury – Direct injection. Analysis by flow injection AAS;
- PAHs – Triple solvent (dichloromethane) extraction. Analysis by GC/MS;
- TPH (volatile) – P&T. Analysis by GC/MS;
- TPH – Solvent (dichloromethane) extraction. Analysis GC/FID;
- VOCs – Direct purge and trap. Analysis by GC/MS;
- Oil & Grease – Gravimetric. Hexane Extractable;
- pH – measured using pH meter and electrode in accordance with APHA4500;
- EC – measured using conductivity cell and meter in accordance with APHA 2510; and
- Hardness – by calculation following analysis of calcium and magnesium using direct injection and ICP-AES analysis.

## 10 RESULTS OF INVESTIGATION

### 10.1 Subsurface Conditions

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 in the boreholes is presented below:

***Pavement***

Asphaltic concrete (AC) was encountered at the surface in most boreholes and ranged in thickness from approximately 0.05m to 0.1m. Concrete pavement was encountered at the surface in BH512 and BH514 and extended to depths of approximately 0.32m and 0.23m respectively. Secondary AC or concrete pavements were encountered in most boreholes.

***Fill***

Fill material was encountered beneath the pavement in all 17 boreholes and extended to depths ranging from approximately 0.4m in BH503 to 4.2m in BH511. The fill material typically consisted of brown and dark brown sandy gravel, sand and silty sand with inclusions of igneous, sandstone and concrete gravel, ash, slag and clay nodules. Hydrocarbon odours were noted during drilling at most locations. BH518 was terminated within the fill material due to an obstruction at a depth of 1.6m.

***Natural Soils***

Alluvial silty sand soil was generally encountered beneath the fill material in most boreholes. Silty clayey sand, sandy clay and silty clayey sand soils were also encountered at some locations. The alluvial soils were typically grey or dark grey and extended to depths ranging from approximately 2.2m in BH513 to 8.5m in BH511. Organic material and shell fragments were noted in several boreholes.

***Bedrock***

Sandstone bedrock was generally encountered beneath the fill material in BH502 and BH503, and beneath the natural soils in the remaining boreholes. The sandstone was typically fine to medium grained, yellow brown, light grey or orange brown and extended to the termination depth of each borehole.

***Groundwater***

Groundwater seepage was encountered during drilling in most boreholes generally at depths ranging from approximately 2.0m to 3.0m. Due to the introduction of

water into the boreholes during the coring process, the standing water levels (SWLs) recorded on the borehole logs should be used as a guide only.

The standing water levels (SWLs) measured in the monitoring wells (from existing ground level) during the investigation is presented in the table below. The approximate groundwater level in metres AHD has also been calculated based on the approximate surface level of the borehole as detailed on the J&K/EIS borehole logs.

| Monitoring Well | SWL (m) on 28 June 2010 | Approximate Groundwater R.L (mAHD) |
|---|---|---|
| MW508 | 2.86 | 0.94 |
| MW512 | 3.3 | 1.00 |
| MW513 | 1.34 | 0.96 |
| MW516 | 2.46 | 0.54 |
| MW517 | 2.53 | 0.77 |

## 10.2 Direction of Groundwater Flow

Based on the surrounding topography and the estimated groundwater RLs, the groundwater would be expected to flow across the site in a south-westerly direction towards Blackwattle Bay.

## 10.3 Laboratory Results – Soil Samples

The laboratory results for the contamination assessment are presented in Tables B and C, and analysis reports are presented in Appendix B. The assessment criteria adopted for this investigation are specified in Section 7.2.2. Statistical calculations have been undertaken using ProUCL version 3.0 (USEPA) and the reports are presented in Appendix F. The results of the analyses are summarised below:

***Heavy Metals***

Thirty four fill samples and one natural soil sample were analysed for heavy metals. An elevated concentration of arsenic (1,300mg/kg) was encountered in a fill soil sample obtained from BH504 (1.6m-1.95m) which was above the site assessment criterion of 500mg/kg. The results of the remaining analyses were below the site assessment criteria.

The upper level 99% confidence limit on the mean value (99% UCL) was calculated using the arsenic results obtained from the fill soil samples (ProUCL indicated that the 99% UCL should be adopted rather than the 95% UCL). The 99% UCL for arsenic was calculated to be 422mg/kg, with a mean of 43mg/kg and a standard deviation of 222mg/kg. These results met the site and data assessment criteria.

With the exception of the elevated arsenic concentration in BH504, all results were less than the SCC1 criteria outlined in the Waste Classification Guidelines 2009. Concentrations of arsenic, lead, mercury and nickel above the CT1 criterion were encountered in several samples.

TCLP leachates were prepared from the samples that encountered concentrations of heavy metals above the respective CT1 criteria and the leachates were analysed for the relevant heavy metals. All results were less than the respective TCLP1 criteria outlined in the Waste Classification Guidelines 2009.

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

PID soil sample headspace readings ranged from 0ppm to 324ppm equivalent isobutylene. The higher PID readings were generally encountered in samples obtained from BH507, BH511 and BH517.

Thirty five fill samples and five natural soil samples were analysed for TPH and BTEX compounds. Elevated concentrations of light fraction ($C_6$-$C_9$) TPH and mid to heavy fraction ($C_{10}$-$C_{36}$) TPH were encountered in several fill samples as detailed in the following table:

| Summary of Elevated TPH Contamination Data in Fill Soil (mg/kg) | | |
|---|---|---|
| **Borehole and Sample Depth (m)** | **Site Assessment Criteria (mg/kg)** | **Concentration (mg/kg)** |
| ***TPH $C_6$-$C_9$*** | | |
| BH507 (1.6-2.05) | 65 | 310 |
| BH511 (1.5-1.95) | | 82 |
| BH511 (3.0-3.45) | | 480 |
| BH517 (3.0-3.45) | | 450 |
| ***TPH $C_{10}$-$C_{36}$*** | | |
| BH503 (0.1-0.4) | 1000 | 1500 |
| BH507 (1.6-2.05) | | 1740 |
| BH508 (0.3-0.5) | | 1070 |
| BH511 (1.5-1.95) | | 8400 |
| BH511 (3.0-3.45) | | 3810 |
| BH517 (3.0-3.45) | | 15370 |

The results of the remaining analyses were below the site assessment criteria.

The upper level 99% confidence limit on the mean value (99% UCL) was calculated using the TPH ($C_6$-$C_9$) and TPH ($C_{10}$-$C_{36}$) results obtained from the fill soil samples (ProUCL indicated that the 99% UCL should be adopted rather than the 95% UCL). The 99% UCL for TPH ($C_6$-$C_9$) was calculated to be 244mg/kg, with a mean of 49mg/kg and a standard deviation of 116mg/kg. These results generally exceeded the site and data assessment criteria. It was also noted that the TPH ($C_6$-$C_9$) concentration in several samples was greater than 250% of the site assessment criterion.

The 99% UCL for TPH ($C_{10}$-$C_{36}$) was calculated to be 6,041mg/kg, with a mean of 1,175mg/kg and a standard deviation of 2,893mg/kg. These results generally exceeded the site and data assessment criteria. It was also noted that the TPH ($C_{10}$-$C_{36}$) concentration in several samples was greater than 250% of the site assessment criterion.

With the exception of the TPH ($C_{10}$-$C_{36}$) concentration in BH517, the results of all analyses were less than the relevant CT1 and SCC1 criteria outlined in the Waste Classification Guidelines 2009.

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

Thirty four fill samples and one natural soil sample were analysed for a range of PAHs including benzo(a)pyrene. An elevated concentration (149.7mg/kg) of total PAHs was encountered in a fill soil sample obtained from BH504 (0.5m-0.95m) which was above the site assessment criterion of 100mg/kg. Elevated concentrations of benzo(a)pyrene (19mg/kg and 5.7mg/kg) were also encountered in fill samples BH504 (0.5m-0.95m) and BH504 (1.3m-1.6m) respectively, which were above the site assessment criterion of 5mg/kg. The results of the remaining analyses were below the site assessment criteria.

The upper level 99% confidence limit on the mean value (99% UCL) was calculated using the total PAH and benzo(a)pyrene results obtained from the fill soil samples (ProUCL indicated that the 99% UCL should be adopted rather than the 95% UCL). The 99% UCL for total PAHs was calculated to be 57mg/kg, with a mean of 11.5mg/kg and a standard deviation of 26.7mg/kg. These results generally meet the site and data assessment criteria.

The 99% UCL for benzo(a)pyrene was calculated to be 6.9mg/kg, with a mean of 1.2/kg and a standard deviation of 3.3mg/kg. These results generally exceeded the site and data assessment criteria. It was also noted that the benzo(a)pyrene concentration in BH504 (0.5m-0.95m) was greater than 250% of the site assessment criterion.

With the exception of the benzo(a)pyrene concentration in BH504 (0.5m-0.95m), the results of all analyses were less than the relevant SCC1 criteria outlined in the Waste Classification Guidelines 2009. Concentrations of benzo(a)pyrene were encountered in several samples above the CT1 criterion.

TCLP leachates were prepared from the samples that encountered concentrations of benzo(a)pyrene above the CT1 criterion and the leachates were analysed for PAHs. The benzo(a)pyrene results were less than the TCLP1 criterion outlined in the Waste Classification Guidelines 2009.

***Organochlorine Pesticides (OCP), Organophosphorus Pesticides (OPP) and Polychlorinated Biphenyls (PCBs)***

Twenty seven fill soil samples were analysed for a range of OCPs, OPPs and PCBs. The results of the analyses were below the site assessment criteria. Traces of DDT, DDD and DDE compounds were detected in two samples obtained from BH501 (0.5m-0.95m) and BH519 (0.5m-0.8m), however the concentrations were significantly less than the site assessment criterion of 1,000mg/kg.

The results of all analyses were less than the relevant SCC1 criteria outlined in the Waste Classification Guidelines 2009.

***Asbestos***

Thirty four fill soil samples were screened for the presence of asbestos fibres. Neither asbestos nor respirable fibres were detected at concentrations above the reporting limit in any of the samples analysed.

### 10.3.1 Acid Sulfate Soil Analysis

The laboratory results for the acid sulfate soil assessment are presented in Table H and analysis reports are presented in Appendix B. The assessment criteria adopted for this investigation are specified in Section 7.4.1.

sPOCAS analyses was scheduled on a total of nine fill samples and 10 natural soil samples. The results of the analyses are summarised below:

- Soil pH (1:5 soil:water) results generally ranged from 7.1 to 11.4 and were indicative of neutral to very alkaline soils;
- The $pH_{KCl}$ results for the soil ranged from 4.5 to 11. These results were indicative of slightly acidic to very alkaline soils; and
- Following oxidation the $pH_{ox}$ results for the soil samples ranged from 2.4 to 8.3. The majority of the results were below pH 5. The largest differences in pH were generally recorded in the natural soil samples which generally dropped by 2 or more pH units.

***Acid Trail***

- Titratable actual acidity (TAA) results indicated that the soils were generally non-acidic prior to oxidation;
- Total potential acidity (TPA) results for four natural soil samples were above the site assessment criteria. The remaining TPA results were less than the site assessment criteria; and
- Titratable sulfidic acidity (TSA) results for four natural soil samples were above the site assessment criteria. The remaining TSA results were less than the site assessment criteria.

***Sulfur Trail***

- The $S_{pos}$% results for the majority of the fill and natural soil samples were above the site assessment criteria. The most significant $S_{pos}$% were recorded for the natural alluvial soil samples. EIS consider that the elevated $S_{pos}$% in the majority of the fill soil samples could be attributed to sulfur compounds contained within slag material rather than potential acid sulfate soils. This is supported by the general lack of significant TPA concentrations within the fill material samples.

## 10.4 Laboratory Results - Groundwater

The laboratory results are presented in Table D and analysis reports are presented in Appendix B. The assessment criteria adopted for this investigation are specified in Section 7.5.2. The results of the analysis are summarised below:

***Heavy Metals***

Five groundwater samples (MW508, MW512, MW513, MW516 and MW517) were analysed for heavy metals. An elevated concentration of lead (0.071mg/L) was encountered in MW516 which was above the hardness modified trigger value of 0.068mg/L. The results of the remaining analyses were below the site assessment criteria.

***Petroleum Hydrocarbons (TPH) and Volatile Organic Compounds (VOCs)***

The five groundwater samples were analysed for TPH and VOCs (note that sample MW516 was not analysed for TPH $C_{10}$-$C_{36}$). An elevated concentration of mid to heavy fraction ($C_{10}$-$C_{36}$) TPH (1.3mg/L) was encountered in MW517 which was above the site assessment criterion of 0.6mg/L. The results of the remaining analyses were below the site assessment criteria.

An elevated concentration of light fraction ($C_6$-$C_9$) TPH (0.19mg/L) was also encountered in MW517. There is no NSW DECCW endorsed guideline level for TPH ($C_6$-$C_9$) in groundwater.

Concentrations of some VOCs including isopropylbenzene, n-propylbenzene, *tert*-butylbenezene, *sec*-butylbenzene and n-butylbenzene were also encountered in MW517, however the concentrations did not exceed the adopted site assessment criteria.

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

Four groundwater samples (MW508, MW512, MW513 and MW517) were analysed for a range of PAHs including benzo(a)pyrene. Elevated concentrations of phenanthrene (0.00452mg/L), fluoranthene (0.001mg/L) and total PAHs (0.0163mg/L) were encountered in MW517. These concentrations exceeded the respective site assessment criteria of 0.0006mg/L for phenanthrene, 0.001mg/L for fluoranthene and 0.003mg/L for total PAHs. The results of the remaining analyses were less than the laboratory practical quantitation limit and below the site assessment criteria.

***Oil and Grease***

Four groundwater samples were analysed for oil and grease. The oil and grease concentrations in the primary samples were all less than the laboratory practical quantitation limit. However, an oil and grease concentration of 57mg/L was encountered in the inter-laboratory duplicate sample (GW Dup 2) obtained from MW517.

***Groundwater Parameters***

The four groundwater samples obtained from MW508, MW512, MW513 and MW517 were analysed for pH, EC and hardness. The results were as follows:

- pH values ranged from 6.3 to 6.8 and were all outside the acceptable range of pH7 to pH8.5 for south-east Australian estuaries;
- EC values ranged from 0.69mS/cm to 1.1mS/cm and were generally considered to be consistent with marginal river waters; and
- Hardness values ranged from 186mg$CaCO_3$/L to 315mg$CaCO_3$/L.

***Field Measurements***

Field measurements recorded during sampling indicated that:

- pH values ranged from 6.63 to 7.09;
- EC values ranged from 0. 8mS/cm to 1.3mS/cm;
- Eh values ranged from 45mV to 134mV; and
- DO values ranged from 0.2% to 0.3%.

## 11 ASSESSMENT OF ANALYTICAL QA/QC

The objective of the assessment of the laboratory QA/QC is to assess whether the sample data is reliable. All laboratory reports for project E23982K have been checked and issued as final by the following NATA Registered Laboratories unless stated otherwise:

- Laboratory — Envirolab Services Pty Ltd
  NATA Accreditation No. 2901
  Report numbers: 40916, 40916-A, 41031, 41031-A, 41184, 41184-A, 41301, 41301-B, 41426, 41426-A and 41592.
- Laboratory — SGS Laboratories Pty Ltd
  NATA Accreditation No. 2562
  Report numbers: SE78266, SE78396, SE78564 and SE78671.

Chain of custody documentation and sample receipt advice notices were signed and dated by Envirolab Services and 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 laboratories.

A summary of the field QA/QC samples are specified in the following table:

| Field QA/QC | Sample Details |
|---|---|
| Inter-laboratory duplicates | *Soil Samples:*<br>Dup 5 is a soil duplicate of sample BH517 (0.2m-0.5m);<br>Dup 8 is a soil duplicate of sample BH502 (0.3m-0.8m); and<br>Dup 15 is a soil duplicate of sample BH512 (0.32m-0.4m).<br><br>*Groundwater Sample:*<br>GW Dup 2 is a water duplicate of sample MW517. |
| Intra-laboratory duplicates | *Soil Samples:*<br>Dup 1 is a soil duplicate of sample BH513 (1.1m-1.5m);<br>Dup 2 is a soil duplicate of sample BH516 (1.1m-1.4m);<br>Dup 10 is a soil duplicate of sample BH504 (0.2m-0.5m);<br>Dup 11 is a soil duplicate of sample BH506 (0.5m-1.0m); and<br>Dup 13 is a soil duplicate of sample BH508 (0.3m-0.5m).<br><br>*Groundwater Sample:*<br>GW Dup 1 is a water duplicate of sample MW513. |

| | |
|---|---|
| Trip blanks | *Soil Samples:*<br>TB1 (soil) is a sand blank taken on 11 May 2010;<br>TB2 (soil) is a sand blank taken on 13 May 2010;<br>TB3 (soil) is a sand blank taken on 14 May 2010;<br>TB4 (soil) is a sand blank taken on 17 May 2010;<br>TB5 (soil) is a sand blank taken on 19 May 2010;<br>TB6 (soil) is a sand blank taken on 20 May 2010; and<br>Trip Blank 7 (soil) is a sand blank taken on 21 May 2010.<br><br>*Groundwater Sample:*<br>GW Trip Blank (water) is a water blank taken on 28 May 2010. |
| Trip spikes | *Soil Samples:*<br>Trip Spike 1 (soil) is a BTEX spike taken on 11 May 2010;<br>T Spike 2 (soil) is a BTEX spike taken on 14 May 2010;<br>T Spike 3 (soil) is a BTEX spike taken on 17 May 2010;<br>T Spike 4 (soil) is a BTEX spike taken on 20 May 2010; and<br>T Spike 5 (soil) is a BTEX spike taken on 21 May 2010.<br><br>*Groundwater Sample:*<br>GW Trip Spike (water) is a BTEX spike taken on 28 May 2010. |
| Rinsates | Rinsate 1 is a field rinsate from the SPT decontamination process taken on 11 May 2010;<br>Rinsate 2 is a field rinsate from the SPT decontamination process taken on 13 May 2010;<br>Rinsate 3 is a field rinsate from the SPT decontamination process taken on 14 May 2010;<br>Rinsate 4 is a field rinsate from the SPT decontamination process taken on 17 May 2010;<br>Rinsate 5 is a field rinsate from the SPT decontamination process taken on 19 May 2010;<br>Rinsate 6 is a field rinsate from the SPT decontamination process taken on 20 May 2010; and<br>Rinsate 7 is a field rinsate from the SPT decontamination process taken on 21 May 2010. |

The laboratory analysis results for the inter-laboratory and intra-laboratory duplicate samples listed above are presented in Tables E and F. The analysis results for the field blank, rinsate and trip spike samples are presented in Table G.

An assessment of the DQIs adopted for this investigation is summarised in the following table. A brief explanation of the individual DQI is presented in Appendix D.

| Data Quality Indicator (DQI) | Comments |
|---|---|
| Precision | Field and Laboratory Consideration:<br>• EIS sampling protocols outlined in Appendix D was complied with during the investigation;<br>• Intra-laboratory and inter-laboratory duplicates were obtained during the investigation and analysed; and<br>• Laboratory duplicates were analysed.<br><br>Laboratory Duplicate RPD Results:<br>Laboratory duplicate RPD results for the soil samples were generally within the acceptance criteria adopted by Envirolab and SGS laboratories. Slightly elevated RPD results ranging from 57% to 131% were reported for individual OCPs in the Envirolab Report 41184. These results are considered to indicate sample heterogeneity rather than laboratory inaccuracy.<br><br>Laboratory duplicate RPD results for the groundwater samples were within the acceptance criteria adopted by Envirolab Services. A duplicate sample was not analysed by SGS.<br><br>Matrix Duplicate RPD Results:<br>Matrix duplicate RPD results were within the acceptance criteria adopted by Envirolab and SGS laboratories.<br><br>Intra-laboratory RPD Results:<br>The intra-laboratory RPD values for the soil samples indicated that field precision was acceptable. The RPD values for several individual PAHs and heavy metals were outside the acceptance criteria (refer to Table E). The results ranged from 75% to 105%. The duplicate results with variances outside of acceptable limits have been attributed to sample heterogeneity and the difficulties associated with obtaining homogenous duplicate samples of heterogenous matrices. Where applicable, the higher duplicate value has been adopted for the project data assessment as a conservative measure.<br><br>The intra-laboratory RPD values of the groundwater sample indicated that the field precision was acceptable (refer to Table F).<br><br>Inter-laboratory RPD Results:<br>The inter-laboratory RPD values for the soil samples indicated that laboratory and field precision was acceptable. The RPD values for several heavy metals and a range of individual PAHs were outside the acceptance criteria (refer to Table E). The results ranged from 63% to 183%. These results were attributed to variability in the fill material rather than inaccurate laboratory extraction/analysis methods. Where applicable, the higher duplicate value has been adopted for the project data assessment as a conservative measure.<br><br>The inter-laboratory RPD values for the groundwater sample indicated that field precision was acceptable. Marginally elevated RPDs were |

| | |
|---|---|
| | encountered for several PAH compounds, Oil & grease, and light fraction ($C_6$-$C_9$) TPH (refer to Table F). The elevated RPDs can generally be attributed to results that are close the PQL. The significantly higher oil and grease concentration in the duplicate sample is considered to be an artefact. The higher duplicate value has been adopted for the project data assessment as a conservative measure. |
| Accuracy | Field and Laboratory Consideration:<br>• EIS sampling protocols outlined in Appendix D was complied with during the investigation; and<br>• Analysis of trip blanks, laboratory blanks, matrix spikes, surrogate spikes, laboratory control sample (LCS) and trip spikes.<br><br>Matrix and surrogate spikes and LCS Results:<br>Matrix & surrogate spikes and LCS recovery concentrations were within the acceptable limits of 60-140% for organics and 70-130% for inorganics. It is noted that surrogate concentrations for TPH analyses were not reported in some soil samples, with the lack of results explained as interference from analytes other than those being tested.<br><br>Laboratory and Trip Blank Results:<br>All laboratory blanks were found to be free of analyte concentrations above the PQLs.<br><br>The soil and groundwater trip blank analysis results were all less than the PQLs (refer to Table G).<br><br>Trip Spike Results:<br>The BTEX results for the trip spikes ranged from 87% to 107%, (refer to Table G) and indicated that field preservation methods were appropriate. |
| Representativeness | Field and Laboratory Consideration:<br>• All critical samples were analysed;<br>• Samples were collected to reflect the characteristics of fill and natural soils;<br>• Sample collection, handling, storage and preservation were considered appropriate; and<br>• No in-house laboratory artefacts were detected. All lab blanks were found to be free of analyte concentrations above the PQLs.<br><br>Field Rinsate Results:<br>Relatively low concentrations of light fraction ($C_6$-$C_9$) TPH (refer to Table G) were detected in most rinsate samples. These concentrations can be attributed to trihalomethanes which are commonly encountered in tap water in the Sydney region.<br><br>Mid fraction ($C_{10}$-$C_{28}$) TPHs were detected in Rinsate 1 and Rinsate 2 taken on 11 and 13 May 2010 respectively. These concentrations may be attributed to the following:<br>• The presence of a small amount of the phosphate free detergent transferred into the second decontamination rinse bucket (resulting in an artificial TPH result); and/or |

| | |
|---|---|
| | • A small amount of TPH contamination transferred from the SPT into the wash buckets.<br><br>EIS are of the opinion that the presence of mid fraction ($C_{10}$-$C_{28}$) TPH in Rinsate 1 and 2 does not indicate that significant cross contamination between samples has occurred as concentrations of TPH ($C_{10}$-$C_{28}$) were only encountered in isolated samples analysed (refer to Envirolabs reports 40916 and 41031). The data is therefore considered reliable and suitable for this assessment.<br><br>As a result of TPH ($C_{10}$-$C_{28}$) detections in Rinsates 1 and 2, the decontamination procedure was revised for the project to include a third rinse bucket. Following this revision concentrations of TPH ($C_{10}$-$C_{28}$) were not encountered in the rinsates at concentrations above the PQLs. |
| Completeness | <u>Field and Laboratory Consideration:</u><br>• EIS sampling protocols outlined in Appendix D were complied with during the investigation;<br>• Samples were obtained by experienced staff with appropriate qualifications;<br>• Documentation (including site notes, borehole logs and COC etc) was correctly maintained;<br>• All of the laboratory data was used for the assessment;<br>• Samples from each borehole location were analysed for the site specific contaminants of concern where applicable. Additional samples were also analysed for TPH and BTEX compounds based on the PID screening;<br>• Appropriate analytical methods used by the laboratory; and<br>• Sampling holding times were complied with. |
| Comparability | <u>Field and Laboratory Consideration:</u><br>• Same sampling procedures and handling techniques were used;<br>• Samples were obtained by experienced staff with appropriate qualifications;<br>• Samples were collected in appropriate containers;<br>• No significant influence on sampling from climatic or sampling conditions were reported; and<br>• Samples were analysed by Envirolab with additional QA/QC analyses undertaken by SGS. |

## 12 CONCLUSION AND RECOMMENDATIONS

The environmental site assessment and acid sulfate soil assessment undertaken for the proposed redevelopment at Sydney Fish Markets, 56-60 Pyrmont Bridge Road, Pyrmont, NSW was designed to:

- Assess the potential risk of significant widespread contamination of the site;
- Assess the soil and groundwater contamination conditions at the site in relation to the proposed land use;
- Undertake a waste classification assessment for off-site disposal of excavated soil associated with the proposed development works; and
- Assess the soil conditions for acid sulfate soil potential.

Based on the results of the assessment, EIS consider that the potential for significant, widespread soil and groundwater contamination at the site is relatively high. Potential contamination at the site would be anticipated to be associated with:

- Potentially contaminated, imported fill material;
- Potential asbestos contamination associated with demolition of the former site buildings/sheds;
- Potential use of the site (particularly the south and south-west sections) for petroleum storage and refining processes;
- Unidentified;
- Historical use of the site for unknown commercial/industrial purposes;
- Historical activities such as use of pesticides; and
- The suspected UST located off-site but adjacent to the west boundary.

### 12.1 Summary of Soil Laboratory Results

Soil samples obtained for the investigation were analysed for the contaminants of concern identified in Section 6.1.1. Elevated concentrations of contaminants were encountered in fill soil samples analysed for the investigation. The depth of fill material across the site ranged from approximately 0.4m in BH503 to 4.2m in BH511. The deeper fill material was typically encountered in the south and west sections of the site as shown on Figure 2.

The soil contamination data is shown on Figure 3. A summary of the elevated results encountered in the fill soils are presented in the table below:

| Summary of Contamination Data in Fill Soil (mg/kg) | | | | | | |
|---|---|---|---|---|---|---|
| **Contaminant** | **Site Assessment Criteria** | **No. of Fill Samples Analysed** | **No. of Results Above the Assessment Criteria** | **Maximum Value** | **Mean Value** | **95% UCL** |
| Arsenic | 500$^{+}$ | 34 | 1 | 1,300 | 43 | 422 |
| Total PAHs | 100$^{+}$ | 34 | 1 | 149.7 | 11.5 | 57 |
| B(a)pyrene | 5$^{+}$ | 34 | 2 | 19 | 1.2 | 6.9 |
| TPH ($C_6$-$C_9$) | 65$^{\wedge}$ | 35 | 4 | 480 | 49 | 244 |
| TPH ($C_{10}$-$C_{36}$) | 1,000$^{\wedge}$ | 35 | 6 | 15,370 | 1,175 | 6,041 |

***Guideline Levels:***
+ HILs: Health Investigation Levels for 'Commercial/Industrial' sites (Column F); and
^ Service Station Guidelines 1994.
***Explanation:***
TPH - Total Petroleum Hydrocarbons
PAH - Polycyclic Aromatic Hydrocarbons

### 12.1.1 Source of Contamination

The source of the PAH (including benzo[a]pyrene) contamination encountered in BH504 is likely to be ash and slag deposits in the fill material. The historical site information indicated that the site was developed prior to 1930 and it is understood that the areas adjacent to Blackwattle Bay and around Wentworth Park (located further to the south of the site) were reclaimed in the late 1800s. Significant filling was undertaken in order to raise the site to the current levels.

Slag and ash was frequently used as fill material during this period in Sydney. The slag and ash may have originated from various metal processing industries and from coal burning, respectively. EIS has undertaken a number of investigations in the area that have identified similar fill material types and associated contamination conditions.

The exact source of the arsenic contamination in BH504 has not been established. High concentrations of arsenic are sometimes associated with slag material, however historical uses of arsenic also included use in pesticides, insecticides and timber preservation.

The light ($C_6$-$C_9$) and heavy fraction ($C_{10}$-$C_{36}$) TPHs encountered in BH507, BH508, BH511 and BH517 (all of which are generally located in the south and south-west sections of the site) are considered likely to be associated with unidentified USTs and/or potential historical use of these sections of the site for petroleum storage and

refinery processes. This was supported by the historical aerial photographs that indicated the presence of several circular towers/silos in the south and south-west sections of the site from at least 1930 until at least 1961. The site was leased by the British Imperial Oil Company Ltd and the Shell Company of Australia Ltd from around 1902 to 1930. The Shell Company of Australia continued to lease part of the site until the early 1960s. Although the site use during this period has not been confirmed, it is considered likely that various activities associated with petroleum storage, distribution and possibly oil refining processes were undertaken which may have resulted in the TPH contamination identified during this investigation.

The source of the TPH ($C_{10}$-$C_{36}$) contamination identified in BH503 has not been established. The concentrations encountered are considered to be relatively minor and may be associated with contaminated fill material, minor spills or an unidentified UST.

## 12.2 Asbestos Screening

Asbestos was not detected, above the reporting limit, in any of the samples analysed for the investigation. The scope of work undertaken was designed to assess the widespread asbestos contamination in soil. EIS adopts no responsibility for small scale or buried asbestos features at the site which may be encountered during earthworks or construction works at the site.

Prior to demolition of the existing site buildings (or parts of the existing buildings), a suitably qualified consultant should undertake a hazardous building materials inspection. The demolition works should be undertaken in accordance with the recommendations made within the hazardous building materials report.

In the event that asbestos is encountered during the proposed excavation/piling works, EIS should be contacted for advice. Reference should also be made to the WorkCover publication WorkCover Working with Asbestos Guide 2008.

## 12.3 Waste Classification

### 12.3.1 Fill Soils

Based on the results of the assessment, the fill material in the vicinity of BH504 and BH517 is classified as **'Restricted Solid Waste (non-putrescible)'** according to the criteria outlined in Waste Classification Guidelines 2009. Any material excavated in the vicinity of BH504 and BH517 and (as shown on the attached Figure 3) should be disposed of to a suitably licensed NSW DECCW (EPA) landfill. Further analysis of material excavated from these areas may result in reducing this waste classification to

'General Solid Waste (non-putrescible)' or reducing the volume of Restricted Solid Waste.

Based on the results of the assessment, the fill soils across the remainder of the site are classified as 'General Solid Waste (non-putrescible)' according to the criteria outlined in Waste Classification Guidelines 2009. All fill material excavated from the site should be disposed of to a suitably licensed NSW DECCW (EPA) landfill.

## 12.4 Summary of Groundwater Conditions and Laboratory Results

Five groundwater monitoring wells were installed during the investigation as shown on the attached Figure 4. A summary of the groundwater levels in each of the monitoring wells is presented in the table below:

| Monitoring Well | SWL (m) on 28 June 2010 | Approximate Groundwater R.L (mAHD) |
|---|---|---|
| MW508 | 2.86 | 0.94 |
| MW512 | 3.3 | 1.00 |
| MW513 | 1.34 | 0.96 |
| MW516 | 2.46 | 0.54 |
| MW517 | 2.53 | 0.77 |

Based on the surrounding topography and the estimated groundwater RLs, the groundwater would be expected to flow across the site in a south-westerly direction towards Blackwattle Bay.

The groundwater samples obtained from the monitoring wells were analysed for the contaminants of concern identified in Section 6.1.2. Elevated concentrations of oil and grease, light ($C_6$-$C_9$) and heavy fraction ($C_{10}$-$C_{36}$) TPHs, the PAH compounds phenanthrene and fluoranthene, and total PAHs were encountered in the MW517 sample. An elevated concentration of lead was also encountered in the MW516 sample. The results of the remaining analyses were below the site assessment criteria. The groundwater contamination data is shown on Figure 4.

### 12.4.1 Source of Groundwater Contamination

EIS consider that the lead concentration in MW516 may be a result of:

- Regional groundwater issues; and/or
- An artefact resulting from installation of the monitoring well at this location.

The oil and grease, TPH and PAH contamination encountered in MW517 is considered likely to be associated with an unidentified UST(s) and/or historical use of the south section of the site as detailed in Section 12.1.1 above.

As a result of uncontrolled filling at the beginning of the twentieth century the groundwater beneath the Pyrmont area is considered to be a "highly disturbed system". Imposition of a regulatory framework that attempts to impose the same level of protection as for a pristine ecosystem to the Pyrmont groundwater is considered to be impractical. The general philosophy outlined in the ANZECC 2000 promotes this approach. However, care should be taken to minimise further degradation of the groundwater quality.

### 12.4.2 Dewatering During Development

Groundwater was encountered at the site at RLs of approximately 0.5m to 1.0m. As no basement levels or significant excavation works are proposed, dewatering is unlikely to be required during the redevelopment works. Groundwater may however be intercepted during piling works.

In unexpected event that dewatering is necessary during the proposed works, the water must not be disposed of to stormwater, sewer or harbour without prior treatment and approval from the relevant authorities.

## 12.5 Extent of Soil and Groundwater Contamination

The soil TPH contamination is generally associated with the areas in the south and east sections of the site. The highest concentrations of TPHs were encountered in fill samples obtained from BH511 and BH517 in the south section of the site. The fill material in BH511 and BH517 extended to depths of 4.2m and 3.6m respectively. Analysis of underlying natural soil samples from these two locations did not encounter significant concentrations of TPHs above the site assessment criteria.

The vertical extent of the soil arsenic contamination encountered in BH504 has not been established. Elevated arsenic concentrations were not, however, encountered in any of the boreholes that surrounded BH504. TCLP analysis of the BH504 (1.6m-1.95m) sample indicated that the potential for significant concentrations of arsenic to leach (and therefore migrate) from this location is relatively low.

The groundwater contamination issues (TPHs and PAHs) encountered in MW517 appeared to be confined to south-west section of the site. Significantly elevated concentrations of TPHs or PAHs were not encountered in MW508, MW512 and

MW516 which would generally be considered to be located up-gradient and cross-gradient of MW517. Groundwater flows in the vicinity of MW517 may be influenced by tidal movements within Blackwattle Bay.

Although the exact source of the soil and groundwater contamination in the south-west section of the site has not been established, it is considered likely that the contamination may extend off-site and towards Blackwattle Bay.

## 12.6 Health Risks associated with the Contaminants

The principal contamination exposure route for the soil and groundwater contaminants encountered is ingestion (either directly or through inhalation). Based on the existing site configuration that includes a pavement across the entire site area, the potential health risks associated with the contaminants are considered to be relatively low.

However, the proposed redevelopment works may include demolition of parts of the paved areas which will increase the potential for exposure to the contaminants. These risks should be assessed prior to commencement of the proposed redevelopment works and an appropriate occupational health and safety plan should be developed.

## 12.7 Acid Sulfate Soils

Based upon the site inspection and analysis results, the risk of the generation of acid sulfate conditions following disturbance of the natural alluvial soils at the site is considered to be high. An acid sulfate soil management plan (ASSMP) is considered necessary for the proposed works at the site.

Once the proposed development details are finalised (this includes confirmation of the proposed foundations and any excavation works) the ASSMP can then be prepared. The ASSMP should be prepared prior to commencement of any excavation or piling works.

## 12.8 Additional Investigation Requirements

Based on the results of the assessment, remediation and/or management of the site will be required. A remediation action plan (RAP) should be prepared detailing the remediation/management options for the site prior to the commencement of the proposed redevelopment works.

Prior to preparation of the RAP, an additional soil and groundwater investigation should be undertaken. The investigation should include the following:

- Additional soil sampling in the east and south sections of the site in order to meet the minimum sampling density specified by the EPA (now DECCW);
- Additional delineation of the groundwater contamination in the vicinity of BH/MW517 to better assess the contamination conditions encountered. This should include (as a minimum) the installation of three additional groundwater monitoring wells: one in the far south-west corner of the site; one in between BH510 and BH/MW517; and one in the vicinity of BH507. Consideration should also be given to an off-site well located to the west of BH/MW517. The additional groundwater assessment should address the effects of tidal movements on the migration of the groundwater contaminants;
- Additional soil sampling in the vicinity of BH504 to better assess the TPH and arsenic contamination;
- Further detailed analysis should be included to assess the nature of the TPH contamination. This could include a silica gel cleanup of the samples to remove any false positive results that could arise from the presence of fats and oils associated with food processing; and speciation of the hydrocarbons to gain a greater understanding of the potential health impacts of the TPH contamination;
- Ground penetrating radar (GPR) survey of the areas that surround BH/MW517 and BH503 to attempte to identify potential USTs; and
- Further sampling and analysis around BH504 and BH517 in order to attempt to reduce the waste classification from Restricted Solid Waste to General Solid Waste, or minimise the volume of Restricted Solid Waste.

The results of the additional investigation, together with the results of this investigation, should be used to prepare the RAP.

A site survey should also be prepared detailing the site boundaries (applicable to this investigation) and included in the RAP.

## 12.9 Suitability of Site for Proposed Development

Based on the scope of work undertaken for this assessment EIS consider that the site can be made suitable for the proposed redevelopment provided that:

- An additional investigation is undertaken as detailed in Section 12.8 above;
- A RAP is prepared for the site and is successfully implemented. Any validation works and management/monitoring specified in the RAP should also be undertaken;
- An appropriate occupational health and safety plan is prepared for the contaminants encountered at this site;

- A hazardous building materials inspection is undertaken for any parts of the existing buildings that will be demolished;
- The buildings are demolished appropriately and in accordance with the recommendations made within the hazardous building materials report(s);
- An ASSMP is prepared to address the management requirements associated with disturbance of potential acid sulfate soils at the site; and
- The site is inspected by experienced environmental personnel during demolition and excavation works, 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.

## 12.10 Regulatory Requirement

The requirement to report to the DECCW (EPA) under Section 60 and *Guidelines on the Duty to Report Contamination*[33] under the CLM Amendment Act 2008 should be assessed once the results of the additional investigation works have been reviewed and a remedial strategy has been selected.

[33] *Guidelines on the Duty to Report Contamination*, NSW Government Legislation, 2008 (Duty to Report Contamination 2008)

## 13 LIMITATIONS

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 some contamination of the site is apparent, problems may also 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.

The conclusions developed in this report are based on site conditions which existed at the time of the site assessment and the scope of work outlined previously in this report. 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.

The investigation and preparation of this report have been undertaken in accordance with accepted practice for environmental consultants, with reference to applicable environmental regulatory authority and industry standards, guidelines and the assessment criteria outlined previously in this report.

Where information has been provided by third parties, EIS has not undertaken any verification process, except where specifically stated.

EIS has not undertaken any assessment of off-site areas that may be potential contamination sources or may have been impacted by site contamination.

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 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.

EIS accept no responsibility for potentially asbestos containing materials that may exist at the site. These materials may be associated with demolition of pre-1990 constructed buildings or fill material at the site.

EIS have not and will not make any determination regarding finances associated with the site.

Changes in the proposed or current site use may result in remediation or further investigation being required at the site.

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 of the 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

Brendan Page
Environmental Scientist

Adrian Kingswell
Senior Associate

## ABBREVIATIONS

| | |
|---|---|
| AAS | Atomic Absorption Spectrometry |
| AGST | Above Ground Storage Tank |
| AHD | Australian Height Datum |
| ANZECC | Australian and New Zealand Environment Conservation Council |
| ASS | Acid Sulfate Soil |
| B(a)P | Benzo(a)pyrene |
| BH | Borehole |
| BTEX | Benzene, Toluene, Ethyl benzene, Xylene |
| COC | Chain of Custody documentation |
| CLM | Contaminated Land Management |
| DECCW | Department of Environment, Climate Change and Water (formerly EPA) |
| DNR | NSW Department of Natural Resources (now split between DWE and DECCW) |
| DWE | NSW Department of Water and Energy |
| DP | Deposited Plan |
| DQO | Data Quality Objective |
| EC | Electrical Conductivity |
| EPA NSW | Environment Protection Authority, New South Wales (now part of DECCW) |
| 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 |
| OPPs | Organophosphorous Pesticides |
| OHS (OH&S) | Occupational Health and Safety |
| PAH | Polycyclic Aromatic Hydrocarbons |
| PCBs | Polychlorinated Biphenyls |
| PID | Photo-ionisation Detector |
| PPIL | Provisional Phyto-toxicity Investigation Levels |
| PQL | Practical Quantitation Limit |
| P&T | Purge & Trap |
| RAP | Remedial Action Plan |
| QA/QC | Quality Assurance and Quality Control |
| RPD | Relative Percentage Difference |
| SEPP | State Environmental Planning Policy |
| sPOCAS | suspension Peroxide Oxidation Combined Acidity and Sulfate |
| SPT | Standard Penetration Test |
| SWL | Standing Water Level |
| TCLP | Toxicity Characteristic Leaching Procedure |
| TP | Test Pit |
| TPH | Total Petroleum Hydrocarbons |
| USEPA | United States Environmental Protection Agency |
| UCL | Upper Confidence Limit |
| UST | Underground Storage Tank |
| VOC | Volatile Organic Compounds |

## IMPORTANT INFORMATION ABOUT THE SITE ASSESSMENT REPORT

These notes have been prepared by EIS to assist with the assessment and interpretation of this report.

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

This 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 sub-divided;
- 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 problems, 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 test of the report to obtain a proper understanding of the assessment. Please note that logs with the 'Environmental Log' header are not suitable for geotechnical purposes as they have not been peer reviewed by a Senior Geotechnical Engineer.

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)[1] | | | | Provisional Phyto-toxicity Investigation Levels (PPILs)[1] | NSW EPA Guidelines for Assessing Service Station Sites[2] | Back-ground Ranges[1] |
|---|---|---|---|---|---|---|---|
| | 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 | | | |
| **METALS/METALLOIDS** | | | | | | | |
| 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 |
| **ORGANICS** | | | | | | | |
| 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 | |
| **OTHER** | | | | | | | |
| Boron | 3000 | 12000 | 6000 | 15000 | | | |
| Cyanides (complexed) | 500 | 2000 | 1000 | 2500 | | | |
| Cyanides (free) | 250 | 1000 | 500 | 1250 | | | |
| Phosphorus | | | | | 2000 | | |
| Sulfur | | | | | 600 | | |
| Sulfate | | | | | 2000 | | |

**NOTE:** 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 DECCW (formerly EPA) Guidelines for Assessing Service Station Sites - 1994.

# TABLE A - 2
## CHEMICAL CONTAMINANT CRITERIA FOR WASTE CLASSIFICATION
**Waste Classification Guidelines. Part 1: Classifying Waste DECC (now DECCW) NSW July 2009**

| GENERAL SOLID WASTE | RESTRICTED SOLID WASTE | HAZARDOUS WASTE |
|---|---|---|
| IF SCC ≤ CT1, TCLP NOT NEEDED TO CLASSIFY AS GENERAL SOLID WASTE | IF SCC ≤ CT2, TCLP NOT NEEDED TO CLASSIFY AS RESTRICTED SOLID WASTE | IF SCC > CT2, TCLP NOT NEEDED TO CLASSIFY AS HAZARDOUS WASTE |
| IF TCLP ≤ TCLP1 AND SCC ≤ SCC1 TREAT AS GENERAL SOLID WASTE | IF TCLP ≤ TCLP2 AND SCC ≤ SCC2 TREAT AS RESTRICTED SOLID WASTE | IF TCLP > TCLP2 AND/OR SCC > SCC2 TREAT AS HAZARDOUS WASTE |

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

**NOTE:**
SCC – Specific Contaminant Concentration
CT – Contaminant Threshold
TCLP – Toxicity Characteristics Leaching Procedure

# TABLE A - 3
# SUMMARY ORGANIC AND INORGANIC GROUNDWATER CONTAMINANT GUIDELINE LEVELS

| ANALYTE | | Drinking Water[1] (mg/L) | ANZECC 2000 95% Values[2] | | Dutch Intervention Values[3] (mg/L) |
|---|---|---|---|---|---|
| | | | Fresh Water (mg/L) | Marine Water (mg/L) | |
| Arsenic (As) (As III) | | 0.007 | 0.024 | $0.0023^{t}$ | – |
| Cadmium (Cd) | | 0.002 | 0.0002 | 0.0055 | – |
| Chromium III | | – | $0.0033^{t}$ | $0.01^{t}$ | – |
| Chromium (Cr) (Hexavalent) | | 0.05 | 0.001 | 0.0044 | – |
| Copper (Cu) | | 2.0 | 0.0014 | 0.0013 | – |
| Iron (Fe) (Filtrable) | | $0.3^{\#}$ | $0.3^{t}$ | – | – |
| Lead (Pb) | | 0.01 | 0.0034 | 0.0044 | – |
| Mercury (Hg) - inorganic | | 0.001 | 0.0006 | 0.0004 | – |
| Nickel (Ni) | | 0.02 | 0.011 | 0.07 | – |
| Zinc (Zn) | | $3^{\#}$ | 0.008 | 0.015 | – |
| $C_{10}$-$C_{36}$ Petroleum Hydrocarbons | | – | – | – | 0.6 |
| BTEX | Benzene | 0.001 | 0.95 | 0.7 | – |
| | Toluene | 0.8 | $0.18^{t}$ | $0.18^{t}$ | – |
| | Ethyl Benzene | 0.3 | $0.08^{t}$ | $0.005^{t}$ | – |
| | *o*-Xylene | – | $0.35^{t}$ | $0.35^{t}$ | – |
| | *p*-Xylene | – | $0.2^{t}$ | $0.2^{t}$ | – |
| | *m*-Xylene | – | $0.075^{t}$ | $0.075^{t}$ | – |
| | Total Xylenes | 0.6 | – | – | – |
| Polycyclic Aromatic Hydrocarbons | Naphthalene | – | 0.016 | 0.07 | – |
| | Anthracene | – | $0.0004^{t}$ | $0.0004^{t}$ | – |
| | Phenanthrene | – | $0.002^{t}$ | $0.002^{t}$ | |
| | Fluoranthrene | – | $0.0014^{t}$ | $0.0014^{t}$ | – |
| | Benzo(a)pyrene | $1*10^{-5}$ | $0.0002^{t}$ | $0.0002^{t}$ | – |
| Total Phenol | | – | $0.32^{t}$ | $0.4^{t}$ | – |
| PCB – Aroclor 1242 | | – | 0.0006 | – | – |
| PCB – Aroclor 1254 | | – | $3*10^{-5}$ | – | |
| Organochlorine Pesticides | Aldrin | $1*10^{-5}$ | $1*10^{-6\,t}$ | $3*10^{-6t}$ | – |
| | Dieldrin | $1*10^{-5}$ | $1*10^{-5\,t}$ | $1*10^{-5\,t}$ | – |
| | Chlordane | $1*10^{-5}$ | $8*10^{-5\,t}$ | $1*10^{-6\,t}$ | – |
| | DDT | $6*10^{-5}$ | $1*10^{-5\,t}$ | $4*10^{-7\,t}$ | – |
| | Endosulfan | $5*10^{-5}$ | $2*10^{-4\,t}$ | $1*10^{-5\,t}$ | – |
| | Endrin | – | $2*10^{-5\,t}$ | $8*10^{-7\,t}$ | – |
| | Heptachlor | $5*10^{-5}$ | $9*10^{-5\,t}$ | $4*10^{-7\,t}$ | – |
| | Lindane | $5*10^{-5}$ | $2*10^{-4\,t}$ | $7*10^{-6\,t}$ | – |
| | Methoxychlor | $2*10^{-4}$ | $5*10^{-6\,t}$ | $4*10^{-6\,t}$ | |
| pH | | 6.5-8.5 | $6.0\text{-}8.0^{+}$ | $7\text{-}8.5^{@}$ | – |
| Sulphate ($SO_4$) | | 500 | – | – | – |
| Fluoride (F) | | 1.5 | – | – | – |
| Chloride (Cl) | | 250 | - | - | – |
| Nitrate (as N) | | – | $0.7^{t}$ | $0.7^{t}$ | – |

Notes:
1 NHMRC Australian Drinking Water Guidelines (2004).
2 ANZECC Australian Water Quality Guidelines for Fresh and Marine Waters, 2000 – Trigger values for protection of 95% of species.
3 In the absence of locally endorsed guidelines, the Dutch intervention levels specified in '*Circular on target values and intervention values for soil remediation' (Ministry of Housing, Spatial Planning and the Environment 2000)* have been quoted.
# In the absence of a health guideline the aesthetic guideline concentration has been quoted.
t In the absence of a high reliability guideline concentration, the moderate or low reliability guideline concentration has been used.
+ ANZECC Australian Water Quality Guidelines for Fresh and Marine Waters, 2000 – Level for NSW Lowland Rivers.
@ ANZECC Australian Water Quality Guidelines for Fresh and Marine Waters, 2000 – Level for South-East Australian estuaries.

TABLE B
SUMMARY OF LABORATORY TEST DATA
SOIL CHARACTERISATION ASSESSMENT
All data in mg/kg unless stated otherwise

| ANALYTE | | | HEAVY METALS | | | | | | | | PAHs | | ORGANOCHLORINE PESTICIDES | | | | OP | PCBs | PETROLEUM HYDROCARBONS | | | | | | | | PID | ASBESTOS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | Petroleum Hydrocarbons | | | | | Benzene | Toluene | Ethyl | Total | VALUES | FIBRES |
| | | | Arsenic | Cadmium | Chromium | Copper | Lead | Mercury | Nickel | Zinc | Total PAHs | B(a)P | Aldrin and Dieldrin | Chlordane | DDT, DDD & DDE | Heptachlor | PESTICIDES | | $C_6$-$C_9$ | $C_{10}$-$C_{14}$ | $C_{15}$-$C_{28}$ | $C_{29}$-$C_{36}$ | $C_{10}$ - $C_{36}$ | | | Benzene | Xylenes | | |
| PQL - Envirolab Services | | | 4 | 0.5 | 1 | 1 | 1 | 0.1 | 1 | 1 | - | 0.05 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 25 | 50 | 100 | 100 | 100 | 0.5 | 0.5 | 1 | 1 | | |
| Site Assessment Criteria ^ | | | 500 * | 100 * | 60% * | 5000 * | 1500 * | 75 * | 3000 * | 35000 * | 100 * | 5 * | 50 * | 250 * | 1000 * | 50 * | 0.1 ^^ | 50 * | 65 # | NSL | NSL | NSL | 1000 # | 1 # | 1.4 # | 3.1 # | 14 # | | |
| General Solid Waste CT1[+] | | | 100 | 20 | 100 | NSL | 100 | 4 | 40 | NSL | NSL | 0.8 | NSL | | | | | NSL | NSL | NSL | | | NSL | 10 | 288 | 600 | 1000 | | |
| General Solid Waste SCC1[+] | | | 500 | 100 | 1900 | NSL | 1500 | 50 | 1050 | NSL | 200 | 10 | 50 | | | | | 50 | 650 | NSL | | | 10000 | 18 | 518 | 1080 | 1800 | | |
| Restricted Solid Waste CT2[+] | | | 400 | 80 | 400 | NSL | 400 | 16 | 160 | NSL | NSL | 3.2 | NSL | | | | | NSL | NSL | NSL | | | NSL | 40 | 1152 | 2400 | 4000 | | |
| Restricted Solid Waste SCC2[+] | | | 2000 | 400 | 7600 | NSL | 6000 | 200 | 4200 | NSL | 800 | 23 | 50 | | | | | 50 | 2600 | NSL | | | 40000 | 72 | 2073 | 4320 | 7200 | | |
| Location | Depth in metres | DESCRIPTION | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BH501 | 0.5-0.95 | Fill: sand | 7 | LPQL | 24 | 46 | 140 | 0.4 | 19 | 150 | 5.5 | 0.9 | LPQL | LPQL | 1.3 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 0 | No Asbestos Detected |
| BH501 | 1.5-1.95 | Fill: sand | 7 | LPQL | 23 | 9 | 28 | 0.1 | 2 | 26 | 0.05 | 0.05 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 0 | No Asbestos Detected |
| BH502[D] | 0.3-0.8 | Fill: sandy gravel | 11 | LPQL | 9 | 73 | 230 | 0.1 | 7 | 160 | 3.4 | 0.043 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 340 | 480 | 820 | LPQL | LPQL | LPQL | LPQL | 0 | No Asbestos Detected |
| BH503 | 0.1-0.4 | Fill: gravelly sand | LPQL | LPQL | 11 | 120 | 98 | 0.2 | 14 | 160 | 1.5 | 0.2 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 400 | 1100 | **1500** | LPQL | LPQL | LPQL | LPQL | 0 | No Asbestos Detected |
| BH504[D] | 0.2-0.5 | Fill: gravelly sand | 4 | LPQL | 13 | 71 | 58 | LPQL | 11 | 34 | 6.5 | 0.8 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 260 | 650 | 910 | LPQL | LPQL | LPQL | LPQL | 0 | No Asbestos Detected |
| BH504 | 0.5-0.95 | Fill: gravelly sand | 7 | LPQL | 11 | 130 | 170 | 0.5 | 4 | 93 | **149.7** | **19** | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 520 | 380 | 900 | LPQL | LPQL | LPQL | LPQL | 0 | No Asbestos Detected |
| BH504 | 1.3-1.6 | Fill: sandy gravel | 11 | 0.5 | 14 | 600 | 230 | 0.3 | 18 | 270 | 55.5 | **5.7** | NA | NA | NA | NA | NA | NA | LPQL | LPQL | 430 | 250 | 680 | LPQL | LPQL | LPQL | LPQL | 0 | No Asbestos Detected |
| BH504 | 1.6-1.95 | Fill: silty sand | **1300** | 1.7 | 9 | 300 | 260 | 40 | 6 | 280 | 0.06 | 0.06 | NA | NA | NA | NA | NA | NA | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 0 | No Asbestos Detected |
| BH506 | 0.5-1.0 | Fill: gravelly sand | LPQL | LPQL | 31 | 16 | 9 | LPQL | 23 | 22 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 0 | No Asbestos Detected |
| BH506 | 1.85-2.05 | Fill: gravelly sand | 9 | LPQL | 8 | 11 | 52 | LPQL | 3 | 7 | 1.6 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 110 | 280 | LPQL | 390 | LPQL | LPQL | LPQL | LPQL | 0 | No Asbestos Detected |
| BH507 | 0.5-0.8 | Fill: gravelly sand | LPQL | LPQL | 60 | 25 | 17 | LPQL | 45 | 54 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 3 | No Asbestos Detected |
| BH507 | 1.6-2.05 | Fill: gravelly sand | LPQL | LPQL | 13 | 76 | 130 | 0.3 | 8 | 340 | 7.7 | 0.3 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | **310** | 1400 | 340 | LPQL | **1740** | LPQL | LPQL | LPQL | 2.1 | 94.7 | No Asbestos Detected |
| BH507 | 3.0-3.45 | Silty sand | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 21 | NA |
| BH508[D] | 0.3-0.5 | Fill: gravelly sand | 5 | LPQL | 15 | 110 | 130 | 0.2 | 20 | 120 | 5.7 | 1 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 130 | 430 | 510 | **1070** | LPQL | LPQL | LPQL | LPQL | 0 | No Asbestos Detected |
| BH508 | 1.5-1.95 | Fill: silty sand | LPQL | LPQL | 9 | 50 | 39 | LPQL | 4 | 110 | 0.29 | 0.09 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 0 | No Asbestos Detected |
| BH510 | 1.0-1.45 | Fill: gravelly sand | 11 | LPQL | 19 | 47 | 170 | 2 | 6 | 72 | 27.8 | 2.7 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 310 | 250 | 560 | LPQL | LPQL | LPQL | LPQL | 0 | No Asbestos Detected |
| BH510 | 3.0-3.45 | Fill: gravelly sand | 5 | 1.8 | 15 | 120 | 210 | 1.1 | 8 | 160 | 18.1 | 1.6 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 150 | LPQL | 150 | LPQL | LPQL | LPQL | LPQL | 0 | No Asbestos Detected |
| BH511 | 0.3-0.8 | Fill: gravelly sand | 4 | LPQL | 52 | 62 | 87 | 0.3 | 43 | 97 | 1.3 | 0.2 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 180 | 240 | 420 | LPQL | LPQL | LPQL | LPQL | 0 | No Asbestos Detected |
| BH511 | 1.5-1.95 | Fill: gravelly sand | 4 | LPQL | 7 | 58 | 110 | 0.3 | 3 | 68 | 8 | 0.1 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | **82** | 4900 | 2400 | 1100 | **8400** | LPQL | LPQL | LPQL | LPQL | 100 | No Asbestos Detected |
| BH511 | 3.0-3.45 | Fill: gravelly sand | 25 | LPQL | 85 | 74 | 390 | 1.6 | 31 | 140 | 9.5 | 0.8 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | **480** | 2100 | 1300 | 410 | **3810** | LPQL | LPQL | LPQL | LPQL | 324 | No Asbestos Detected |
| BH511 | 4.5-4.95 | Silty sand | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 8.3 | NA |
| BH512 | 0.32-0.4 | Fill: gravelly sand | LPQL | LPQL | 2 | 33 | 71 | 0.2 | 1 | 130 | 6.1 | 0.6 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 0 | No Asbestos Detected |
| BH512 | 0.9-1.0 | Fill: gravelly sand | 6 | LPQL | 8 | 100 | 300 | 1.7 | 4 | 160 | 14.1 | 1.3 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 220 | 150 | 370 | LPQL | LPQL | LPQL | LPQL | 0 | No Asbestos Detected |
| BH512 | 1.4-1.5 | Fill: sand | LPQL | 0.5 | 6 | 25 | 56 | 0.4 | 1 | 330 | 15.3 | 1.5 | NA | NA | NA | NA | NA | NA | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 0 | No Asbestos Detected |
| BH512 | 2.9-3.0 | Fill: sandy clay | 5 | 0.9 | 11 | 65 | 230 | 0.4 | 9 | 1500 | 11.8 | 1 | NA | NA | NA | NA | NA | NA | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 0 | No Asbestos Detected |
| BH513 | 1.1-1.5 | Fill: silty clayey sand | LPQL | LPQL | 5 | 6 | 24 | LPQL | 1 | 5 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 0.8 | No Asbestos Detected |
| BH514 | 0.5-0.9 | Fill: clayey gravelly sand | 5 | LPQL | 14 | 16 | 45 | 0.4 | 4 | 41 | 2.2 | 0.2 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 0 | No Asbestos Detected |
| BH514 | 1.0-1.45 | Fill: silty sand | LPQL | LPQL | 8 | 7 | 21 | LPQL | 6 | 44 | LPQL | LPQL | NA | NA | NA | NA | NA | NA | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 0 | No Asbestos Detected |
| BH515 | 0.5-0.95 | Fill: gravelly sand | LPQL | LPQL | 8 | 13 | 31 | 0.1 | 3 | 31 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 0 | No Asbestos Detected |
| BH516 | 0.5-0.9 | Fill: silty sand | 5 | LPQL | 25 | 31 | 85 | 0.2 | 25 | 280 | 2.57 | 0.07 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 190 | LPQL | 190 | LPQL | LPQL | LPQL | LPQL | 0 | No Asbestos Detected |
| BH516 | 1.1-1.4 | sand | LPQL | LPQL | 10 | 3 | 16 | LPQL | 2 | 40 | 1.98 | 0.08 | NA | NA | NA | NA | NA | NA | LPQL | 180 | 540 | LPQL | 720 | LPQL | LPQL | LPQL | LPQL | 57.1 | NA |
| BH517 | 0.2-0.5 | Fill: gravelly sand | LPQL | LPQL | 22 | 49 | 5 | LPQL | 150 | 49 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 14.9 | No Asbestos Detected |
| BH517 | 0.5-0.95 | Fill: sand | 6 | LPQL | 3 | LPQL | 1 | LPQL | 1 | 2 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 0 | No Asbestos Detected |
| BH517 | 1.5-1.95 | Fill: gravelly sand | LPQL | LPQL | 12 | 150 | 68 | 0.3 | 4 | 240 | LPQL | LPQL | NA | NA | NA | NA | NA | NA | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 0 | No Asbestos Detected |
| BH517 | 3.0-3.45 | Fill: silty sand | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | **450** | 11000 | 4100 | 270 | **15370** | LPQL | LPQL | LPQL | LPQL | 178 | NA |
| BH517 | 4.5-4.95 | Silty sand | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | LPQL | 190 | LPQL | LPQL | 190 | LPQL | LPQL | LPQL | LPQL | 159 | NA |
| BH517 | 5.5-6.0 | Silty sand | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | LPQL | 160 | LPQL | LPQL | 160 | LPQL | LPQL | LPQL | LPQL | 44.6 | NA |
| BH518 | 0.5-0.8 | Fill: sandy gravel | 4 | LPQL | 11 | 10 | 42 | LPQL | 5 | 110 | 1.2 | 0.1 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 550 | LPQL | 550 | LPQL | LPQL | LPQL | LPQL | 0 | No Asbestos Detected |
| BH518 | 1.0-1.6 | Fill: sandy gravel | LPQL | LPQL | 83 | 26 | 11 | LPQL | 20 | 58 | LPQL | LPQL | NA | NA | NA | NA | NA | NA | LPQL | 51 | 150 | LPQL | 201 | LPQL | LPQL | LPQL | LPQL | 5.6 | No Asbestos Detected |
| BH519 | 0.5-0.8 | Fill: sandy gravel | 9 | 0.7 | 40 | 94 | 180 | 0.9 | 36 | 190 | 22.6 | 2.2 | LPQL | LPQL | 44 | LPQL | LPQL | LPQL | LPQL | LPQL | 210 | 300 | 510 | LPQL | LPQL | LPQL | LPQL | 0 | No Asbestos Detected |
| **Total no. of samples** | | | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 27 | 27 | 27 | 27 | 27 | 27 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 34 |
| **Maximum Value** | | | 1300 | 1.8 | 85 | 600 | 390 | 40 | 150 | 1500 | 149.7 | 19 | LPQL | LPQL | 44 | LPQL | LPQL | LPQL | 480 | 11000 | 4100 | 1100 | 15370 | LPQL | LPQL | LPQL | 2.1 | 324 | NC |
| **Mean Value** | | | 43 | NC | NC | NC | NC | NC | NC | NC | 11.5 | 1.2 | NC | NC | NC | NC | NC | NC | 49 | NC | NC | NC | 1175 | NC | NC | NC | NC | NC | NC |
| **Standard Deviation** | | | 222 | NC | NC | NC | NC | NC | NC | NC | 26.7 | 3.3 | NC | NC | NC | NC | NC | NC | 116 | NC | NC | NC | 2893 | NC | NC | NC | NC | NC | NC |
| **Coefficient of Variation** | | | 5.1 | NC | NC | NC | NC | NC | NC | NC | 2.3 | 2.8 | NC | NC | NC | NC | NC | NC | 2.4 | NC | NC | NC | 2.5 | NC | NC | NC | NC | NC | NC |
| **Distribution** * | | | Non-parametric | NC | NC | NC | NC | NC | NC | NC | Non-parametric | Non-parametric | NC | NC | NC | NC | NC | NC | Non-parametric | NC | NC | NC | Non-parametric | NC | NC | NC | NC | NC | NC |
| **Upper Level 99% Confidence Limit on Mean Value (99% UCL)** ++ | | | 422 | NC | NC | NC | NC | NC | NC | NC | 57 | 6.9 | NC | NC | NC | NC | NC | NC | 244 | NC | NC | NC | 6041 | NC | NC | NC | NC | NC | NC |

***EXPLANATION:***

^ Site Assessment Criteria: Guideline concentrations adopted for the investigation as outlined below:
* National Environment Protection (Assessment of Site Contamination) Measure 1999 (NEPC Guidelines) Health Investigation Levels (HIL) - Column F, Commercial/Industrial
# NSW EPA (DECCW) Guidelines for Assessing Service Station Sites - 1994
^^ In the absence of Australian guidelines, the laboratory PQL has been adopted as the site assessment criteria
* Waste Classification Guidelines – Part 1: Classifying Waste (2009)
D Higher duplicate values adopted where appropriate for UCL calculations

Concentration above the Site Assessment Criteria **VALUE**

***ABBREVIATIONS:***

PAHs: Polycyclic Aromatic Hydrocarbons
B(a)P: Benzo(a)pyrene
PQL: Practical Quantitation Limit
LPQL: Less than PQL
NA: Not Analysed
NC: Not Calculated
OP: Organophosphorus Pesticides
PID: Photoionisation Detector
PCBs: Polychlorinated Biphenyls
NSL: No Set Limit

NOTE: ++ Statistical analysis has been calculate using ProUCL version 3.0 (USEPA). Statistical analyses has only been undertaken for those contaminants that exceeded the health based site assessment criteria. Fill samples only.

TABLE C
SUMMARY OF LABORATORY TEST DATA
TOXICITY CHARACTERISTICS LEACHING PROCEDURE (TCLP)
All data in mg/L unless stated otherwise

| ANALYTE | | Arsenic | Lead | Mercury | Nickel | B(a)P |
|---|---|---|---|---|---|---|
| PQL - Envirolab | | 0.05 | 0.03 | 0.0005 | 0.02 | 0.001 |
| TCLP1 - General Solid Waste * | | 5 | 5 | 0.2 | 2 | 0.04 |
| TCLP2 - Restricted Solid Waste * | | 20 | 20 | 0.8 | 8 | 0.16 |
| TCLP3 - Hazardous Waste * | | >20 | >20 | >0.8 | >8 | >0.16 |
| SAMPLE | Depth in metres | | | | | |
| BH501 | 0.5-0.95 | NA | 0.4 | NA | NA | LPQL |
| BH502 | 0.3-0.8 | NA | 0.8 | NA | NA | NA |
| BH504 | 0.5-0.95 | NA | 0.1 | NA | NA | LPQL |
| BH504 | 1.3-1.6 | NA | 0.6 | NA | NA | LPQL |
| BH504 | 1.6-1.95 | 0.7 | LPQL | LPQL | NA | NA |
| BH507 | 0.5-0.8 | NA | NA | NA | LPQL | NA |
| BH507 | 1.6-2.05 | NA | 0.2 | NA | NA | NA |
| BH508 | 0.3-0.5 | NA | 0.4 | NA | NA | NA |
| BH510 | 1.0-1.45 | NA | 1.2 | NA | NA | LPQL |
| BH510 | 3.0-3.45 | NA | 0.6 | NA | NA | LPQL |
| BH511 | 0.3-0.8 | NA | NA | NA | 0.04 | NA |
| BH511 | 1.5-1.95 | NA | 1 | NA | NA | NA |
| BH511 | 3.0-3.45 | NA | 0.4 | NA | NA | NA |
| BH512 | 0.9-1.0 | NA | 2.8 | NA | NA | LPQL |
| BH512 | 1.4-1.5 | NA | NA | NA | NA | LPQL |
| BH512 | 2.9-3.0 | NA | 2.5 | NA | NA | LPQL |
| BH517 | 0.2-0.5 | NA | NA | NA | 0.1 | NA |
| BH519 | 0.5-0.8 | NA | 0.1 | NA | NA | LPQL |
| Dup 13 | - | NA | 0.5 | NA | NA | NA |
| **Total no. of samples** | | 1 | 15 | 1 | 3 | 9 |
| **Maximum Value** | | 0.7 | 2.8 | LPQL | 0.1 | LPQL |

***EXPLANATION:***
* NSW DECC (EPA) Waste Classification Guidelines - Part 1: Classifying Waste - April 2009

Concentration above the General Solid Waste guideline level **VALUE**

***ABBREVIATIONS:***
PQL: Practical Quantitation Limit
LPQL: Less than PQL
B(a)P: Benzo(a)pyrene

TABLE D
GROUNDWATER MONITORING ANALYSIS
All results in mg/L unless stated otherwise.

| Contaminant | PQL Envirolab | Guideline Concentration ANZECC 2000 Marine Waters [1] | SAMPLES MW508 | MW512 | MW513 | MW516 | MW517[D] |
|---|---|---|---|---|---|---|---|
| **Field Measurements *** | | | | | | | |
| Dissolved oxygen (ppm) | - | NSL | 0.3 | 0.3 | 0.2 | no data | 0.2 |
| Redox potential (mV) | - | NSL | 129.2 | 134.6 | 44.7 | no data | 90.1 |
| pH | - | 7 - 8.5[++] | **6.75** | 7.05 | **6.63** | no data | 7.09 |
| Conductivity (mS/cm) | - | NSL | 1.2 | 0.8 | 0.77 | no data | 1.3 |
| Temperature © | - | NSL | 22.9 | 19.4 | 22.1 | no data | 24 |
| **Miscellaneous Inorganics** | | | | | | | |
| pH | 0.1 | 7 - 8.5[++] | **6.3** | **6.8** | **6.7** | NA | **6.8** |
| Electrical Conductivity (mS/cm) | 0.001 | NSL | 1.1 | 0.8 | 0.69 | NA | 1.1 |
| Hardness (mg/CaC03/L) | 1 | NSL | 304 | 186 | 236 | NA | 315 |
| Oil and Grease | 5 | 10[#^] | LPQL | LPQL | LPQL | LPQL | **57** |
| **Heavy Metals** | | | | | | | |
| Arsenic (As lll) | 0.001 | 0.0023 [t] | 0.005 | 0.005 | LPQL | 0.002 | 0.012 |
| Cadmium | 0.0001 | 0.0055 | LPQL | LPQL | LPQL | LPQL | LPQL |
| Chromium | 0.001 | 0.059[H] | LPQL | LPQL | 0.001 | LPQL | LPQL |
| Copper | 0.001 | 0.008[H] | LPQL | LPQL | LPQL | 0.002 | LPQL |
| Lead | 0.001 | 0.068[H] | LPQL | 0.001 | LPQL | **0.071** | LPQL |
| Mercury | 0.0001 | 0.0004 | LPQL | LPQL | LPQL | LPQL | LPQL |
| Nickel | 0.001 | 0.439[H] | 0.018 | 0.006 | 0.011 | 0.003 | 0.005 |
| Zinc | 0.001 | 0.094[H] | 0.022 | 0.055 | 0.009 | 0.031 | 0.084 |
| **Petroleum Hydrocarbons** | | | | | | | |
| Hydrocarbons C6-C9 | 0.01 | NSL | LPQL | LPQL | LPQL | LPQL | **0.190** |
| Hydrocarbons C10-C14 | 0.05 | 0.6** | LPQL | LPQL | LPQL | NA | **0.830** |
| Hydrocarbons C15-C28 | 0.1 | | 0.190 | LPQL | LPQL | NA | **0.470** |
| Hydrocarbons C29-C36 | 0.1 | | LPQL | LPQL | LPQL | NA | **LPQL** |
| **Volatile Organic Contaminants (VOCs)[2]** | | | | | | | |
| Benzene | 0.001 | 0.7 | LPQL | LPQL | LPQL | LPQL | LPQL |
| Toluene | 0.001 | 0.18 [t] | LPQL | LPQL | LPQL | LPQL | LPQL |
| Ethyl Benzene | 0.001 | 0.005 [t] | LPQL | LPQL | LPQL | LPQL | LPQL |
| Total xylenes | 0.003 | 0.38[#] | LPQL | LPQL | LPQL | LPQL | LPQL |
| o-xylene | 0.001 | 0.35 [t] | LPQL | LPQL | LPQL | LPQL | LPQL |
| m+p-xylene | 0.002 | 0.275 [t] | LPQL | LPQL | LPQL | LPQL | LPQL |
| Isopropylbenzene | 0.001 | 0.66[US] | LPQL | LPQL | LPQL | LPQL | 0.024 |
| n-Propylbenzene | 0.001 | 0.24[US] | LPQL | LPQL | LPQL | LPQL | 0.011 |
| *tert* -Butylbenzene | 0.001 | 0.24[US] | LPQL | LPQL | LPQL | LPQL | 0.0027 |
| *sec* -Butylbenzene | 0.001 | 0.24[US] | LPQL | LPQL | LPQL | LPQL | 0.013 |
| n-Butylbenzene | 0.001 | 0.24[US] | LPQL | LPQL | LPQL | LPQL | 0.0016 |
| Total VOCs | 0.001 | NSL | ALPQL | ALPQL | ALPQL | ALPQL | 0.0523 |
| **Polycyclic Aromatic Hydrocarbons (PAHs)[3]** | | | | | | | |
| Naphthalene | 0.001 | 0.016 | LPQL | LPQL | LPQL | NA | 0.0012 |
| Acenaphthylene | 0.0001 | NSL | LPQL | LPQL | LPQL | NA | 0.0001 |
| Acenaphthene | 0.0001 | NSL | LPQL | LPQL | LPQL | NA | 0.004 |
| Fluorene | 0.0001 | NSL | LPQL | LPQL | LPQL | NA | 0.004 |
| Phenanthrene | 0.0001 | 0.0006[L] | LPQL | LPQL | LPQL | NA | **0.0042** |
| Anthracene | 0.0001 | 0.0004[t] | LPQL | LPQL | LPQL | NA | 0.001 |
| Fluoranthene | 0.0001 | 0.001[L] | LPQL | LPQL | LPQL | NA | **0.001** |
| Pyrene | 0.0001 | NSL | LPQL | LPQL | LPQL | NA | 0.0007 |
| Benzo(a)anthracene | 0.0001 | NSL | LPQL | LPQL | LPQL | NA | 0.0001 |
| Chrysene | 0.0001 | NSL | LPQL | LPQL | LPQL | NA | LPQL |
| Benzo(a)pyrene | 0.0001 | 0.0001 [L] | LPQL | LPQL | LPQL | NA | LPQL |
| 1-Methylnaphthalene | 0.0001 | NSL | LPQL | LPQL | LPQL | NA | LPQL |
| 2-Methylnaphthalene | 0.0001 | NSL | LPQL | LPQL | LPQL | NA | LPQL |
| Total PAHs | - | 0.003[#] | ALPQL | ALPQL | ALPQL | NA | **0.0163** |

***EXPLANATION:***

[1] ANZECC Australian Water Quality Guidelines for Fresh Waters, 2000 - Trigger Values for protection of 95% of species

[2]VOCs listed are BTEX compounds together with all VOCs with detections above the PQL

[3]PAHs listed are those with trigger values presented in ANZECC together with all PAH compounds with detections above the PQLs

* Field Measurements Undertaken on 28 May 2010

[++] ANZECC Australian Water Quality Guidelines for Fresh and Marine Waters, 2000 - Level for South-East Australian Estuaries

^ In the absence of a health guideline the aesthetic guideline concentration has been quoted

** In the absence of locally endorsed guidelines, the Dutch intervention levels specified in *'Circular on target values and intervention values for soil remediation'* (*Ministry of Housing and the Environment 2000* ) have been quoted

[t] In the absence of a high reliability guideline concentration, the moderate or low reliability guideline concentration has been used.

[#] NSW EPA (now DECCW) Guidelines for Assessing Service Station Sites (1994).

^^ In the absence of Australian guidelines, the laboratory practical quantitation limit has been used.

[H] Hardness modified trigger value adopted in accordance with ANZECC 2000

[US] In the absence of locally endorsed guidelines, the USEPA Region 9 PRGs adopted for Tap Water was used for screening level purposes

[L] 99% Protection levels adopted due to potential for bioaccumulation effects

[D] Higher duplicate value adopted where appropriate

Concentration above the Site Assessment Criteria **VALUE**

***ABBREVIATIONS:***

NA : Not Analysed
NSL : No set limit
PQL: Practical Quantitation Limit
LPQL: - Less than Practical Quantitation Limit
ALPQL:- all results less than the Practical Quantitation Limit

TABLE E
LABORATORY DUPLICATE RESULTS - SOIL
QA/QC - RELATIVE PERCENTAGE DIFFERENCES
All data in mg/kg unless stated otherwise

| ANALYTE | | HEAVY METALS | | | | | | | | PAHs | | | | | | | | | | | | | | | | Total OPPs | Total OCPs | Total PCBs | PETROLEUM HYDROCARBONS | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | Petroleum Hydrocarbons | | | | Benzene | Toluene | Ethyl Benzene | Total Xylenes |
| | | As | Cd | Cr | Cu | Pb | Hg | Ni | Zn | Nap | Acenaphty | Acenaphte | Fluo | Phen | Anth | Fluoro | Pyr | B(a)A | Chy | B(b+k)F | B(a)P | I(123-cd) | D(ah)A | B(ghi)P | | | | $C_6$-$C_9$ | $C_{10}$-$C_{14}$ | $C_{15}$-$C_{28}$ | $C_{29}$-$C_{36}$ | | | | |
| PQL - Envirolab Services | | 4 | 0.5 | 1 | 1 | 1 | 0.1 | 1 | 1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.05 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 25 | 50 | 100 | 100 | 0.5 | 0.5 | 1 | 1 |
| PQL - SGS | | 3 | 0.3 | 0.3 | 0.5 | 1 | 0.05 | 0.5 | 0.5 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.20 | 0.05 | 0.10 | 0.10 | 0.10 | 0.2 | 0.1 | 0.1 | 20 | 20 | 50 | 50 | 0.1 | 0.1 | 0.1 | 0.3 |
| **Intra-laboratory Soil Duplicate Results - Envirolab Report Number 40916** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Initial Sample Ref | BH513 (1.1-1.5) | LPQL | LPQL | 5 | 6 | 24 | LPQL | 1 | 5 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQl | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL |
| Duplicate Sample Ref | Dup 1 | LPQL | LPQL | 6 | 17 | 19 | LPQL | 2 | 11 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQl | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL |
| **Mean Value** | | NC | NC | 5.5 | 11.5 | 21.5 | NC | 1.5 | 8 | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC |
| **RPD Value** | | NC | NC | 18 | 96 | 23 | NC | 67 | 75 | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC |
| **Intra-laboratory Soil Duplicate Results - Envirolab Report Number 40916** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Initial Sample Ref | BH516 (1.1-1.4) | LPQL | LPQL | 10 | 3 | 16 | LPQL | 2 | 40 | 1 | LPQL | LPQL | 0.2 | 0.4 | LPQL | 0.1 | 0.1 | LPQL | 0.1 | LPQL | 0.08 | LPQL | LPQL | LPQL | - | - | - | LPQL | 180 | 540 | LPQL | LPQL | LPQL | LPQL | LPQL |
| Duplicate Sample Ref | Dup 2 | LPQL | LPQL | 11 | 6 | 18 | LPQL | 3 | 52 | 0.7 | LPQL | LPQL | 0.3 | 0.5 | LPQL | <0.1 | <0.1 | LPQL | <0.1 | LPQL | <0.05 | LPQL | LPQL | LPQL | - | - | - | LPQL | 230 | 660 | LPQL | LPQL | LPQL | LPQL | LPQL |
| **Mean Value** | | NC | NC | 10.5 | 4.5 | 17 | NC | 2.5 | 46 | 0.85 | NC | NC | 0.25 | 0.45 | NC | 0.075 | 0.075 | NC | 0.075 | NC | 0.0525 | NC | NC | NC | NC | NC | NC | NC | 205 | 600 | NC | NC | NC | NC | NC |
| **RPD Value** | | NC | NC | 10 | 67 | 12 | NC | 40 | 26 | 35 | NC | NC | 40 | 22 | NC | 67 | 67 | NC | 67 | NC | 105 | NC | NC | NC | NC | NC | NC | NC | 24 | 20 | NC | NC | NC | NC | NC |
| **Intra-laboratory Soil Duplicate Results - Envirolab Report Number 41184** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Initial Sample Ref | BH504 (0.2-0.5) | <4 | LPQL | 13 | 71 | 58 | LPQL | 11 | 34 | LPQL | 0.1 | LPQL | LPQL | 0.3 | LPQL | 1 | 1.1 | 0.6 | 0.7 | 1.1 | 0.8 | 0.4 | LPQL | 0.4 | LPQl | LPQL | LPQL | LPQL | LPQL | 260 | 650 | LPQL | LPQL | LPQL | LPQL |
| Duplicate Sample Ref | Dup 10 | 4 | LPQL | 16 | 54 | 67 | 0.5 | 11 | 40 | LPQL | 0.1 | LPQL | LPQL | 0.4 | LPQL | 1 | 1.1 | 0.6 | 0.7 | 1.1 | 0.8 | 0.4 | LPQL | 0.4 | LPQL | LPQL | LPQL | LPQL | LPQL | 220 | 650 | LPQL | LPQL | LPQL | LPQL |
| **Mean Value** | | 3 | NC | 14.5 | 62.5 | 62.5 | NC | 11 | 37 | NC | 0.1 | NC | NC | 0.35 | NC | 1 | 1.1 | 0.6 | 0.7 | 1.1 | 0.8 | 0.4 | NC | 0.4 | NC | NC | NC | NC | NC | 240 | 650 | NC | NC | NC | NC |
| **RPD Value** | | 67 | NC | 21 | 27 | 14 | NC | 0 | 16 | NC | 0 | NC | NC | 29 | NC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | NC | 0 | NC | NC | NC | NC | NC | 17 | 0 | NC | NC | NC | NC |
| **Intra-laboratory Soil Duplicate Results - Envirolab Report Number 41301** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Initial Sample Ref | BH506 (0.5-1.0) | LPQL | LPQL | 31 | 16 | 9 | LPQL | 23 | 22 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL |
| Duplicate Sample Ref | Dup 11 | LPQL | LPQL | 42 | 26 | 20 | LPQL | 36 | 31 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL |
| **Mean Value** | | NC | NC | 36.5 | 21 | 14.5 | NC | 29.5 | 26.5 | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC |
| **RPD Value** | | NC | NC | 30 | 48 | 76 | NC | 44 | 34 | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC |
| **Intra-laboratory Soil Duplicate Results - Envirolab Report Number 41301** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Initial Sample Ref | BH508 (0.3-0.5) | <4 | LPQL | 15 | 110 | 130 | 0.2 | 20 | 120 | <0.1 | LPQL | LPQL | <0.1 | 0.5 | 0.1 | 0.8 | 0.9 | 0.5 | 0.5 | 1 | 0.6 | 0.4 | <0.1 | 0.4 | LPQL | LPQL | LPQL | LPQL | 120 | 380 | 460 | LPQL | LPQL | LPQL | LPQL |
| Duplicate Sample Ref | Dup 13 | 5 | LPQL | 16 | 94 | 200 | 0.4 | 21 | 130 | 0.1 | LPQL | LPQL | 0.1 | 0.8 | 0.3 | 1.3 | 1.4 | 0.8 | 0.8 | 0.4 | 1 | 0.6 | 0.1 | 0.6 | LPQL | LPQL | LPQL | LPQL | 130 | 430 | 510 | LPQL | LPQL | LPQL | LPQL |
| **Mean Value** | | 3.5 | NC | 15.5 | 102 | 165 | 0.3 | 20.5 | 125 | 0.075 | NC | NC | 0.075 | 0.65 | 0.2 | 1.05 | 1.15 | 0.65 | 0.65 | 0.7 | 0.8 | 0.5 | 0.075 | 0.5 | NC | NC | NC | NC | 125 | 405 | 485 | NC | NC | NC | NC |
| **RPD Value** | | 86 | NC | 6 | 16 | 42 | 67 | 5 | 8 | 67 | NC | NC | 67 | 46 | 100 | 48 | 43 | 46 | 46 | 86 | 50 | 40 | 67 | 40 | NC | NC | NC | NC | 8 | 12 | 10 | NC | NC | NC | NC |
| **Inter-laboratory Soil Duplicate Results - Envirolab Report Number , SGS Report Number SE78266** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Initial Sample Ref | BH517 (0.2-0.5) | LPQL | 0.25 | 22 | 49 | 5 | LPQL | 150 | 49 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL |
| Duplicate Sample Ref | Dup 5 | LPQL | 0.4 | 18 | 47 | 5 | LPQL | 130 | 64 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL |
| **Mean Value** | | NC | 0.325 | 20 | 48 | 5 | NC | 140 | 56.5 | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC |
| **RPD Value** | | NC | 46 | 20 | 4 | 0 | NC | 14 | 27 | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC |
| **Inter-laboratory Soil Duplicate Results - Envirolab Report Number 41184, SGS Report Number SE78396** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Initial Sample Ref | BH502 (0.3-0.8) | 8 | 0.25 | 9 | 73 | 230 | 0.1 | 7 | 160 | LPQL | LPQL | LPQL | LPQL | 0.3 | LPQL | 0.5 | 0.5 | 0.3 | 0.4 | 0.5 | 0.4 | 0.2 | LPQL | 0.3 | LPQL | LPQL | LPQL | LPQL | LPQL | 340 | 480 | LPQL | LPQL | LPQL | LPQL |
| Duplicate Sample Ref | Dup 8 | 11 | 0.4 | 9.1 | 92 | 260 | 0.06 | 5.2 | 120 | LPQL | LPQL | LPQL | LPQL | 0.31 | LPQL | 0.64 | 0.65 | 0.4 | 0.38 | 0.69 | 0.43 | 0.29 | LPQL | 0.28 | LPQL | LPQL | LPQL | LPQL | LPQL | 210 | 210 | LPQL | LPQL | LPQL | LPQL |
| **Mean Value** | | 9.5 | 0.325 | 9.05 | 82.5 | 245 | 0.08 | 6.1 | 140 | NC | NC | NC | NC | 0.305 | NC | 0.57 | 0.575 | 0.35 | 0.39 | 0.595 | 0.415 | 0.245 | NC | 0.29 | NC | NC | NC | NC | NC | 275 | 345 | NC | NC | NC | NC |
| **RPD Value** | | 32 | 46 | 1 | 23 | 12 | 50 | 30 | 29 | NC | NC | NC | NC | NC | 3 | NC | 25 | 26 | 29 | 5 | 32 | 7 | 37 | NC | 7 | NC | NC | NC | NC | NC | 47 | 78 | NC | NC | NC | NC |
| **Inter-laboratory Soil Duplicate Results - Envirolab Report Number 41426, SGS Report Number SE78564** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Initial Sample Ref | BH512 (0.32-0.4) | LPQL | LPQL | 2 | 33 | 71 | 0.2 | 1 | 130 | LPQL | LPQL | LPQL | LPQL | 0.8 | LPQL | 1.1 | 1 | 0.6 | 0.5 | 0.9 | 0.6 | 0.3 | LPQL | 0.3 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL |
| Duplicate Sample Ref | Dup 15 | LPQL | LPQL | 1.6 | 23 | 37 | 0.19 | 0.7 | 36 | LPQL | LPQL | LPQL | LPQL | <0.1 | LPQL | <0.1 | <0.1 | <0.1 | <0.1 | <0.2 | <0.1 | <0.1 | LPQL | <0.1 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL |
| **Mean Value** | | NC | NC | 1.8 | 28 | 54 | 0.195 | 0.85 | 83 | NC | NC | NC | NC | 0.425 | NC | 0.575 | 0.525 | 0.325 | 0.275 | 0.5 | 0.325 | 0.175 | NC | 0.175 | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC |
| **RPD Value** | | NC | NC | 22 | 36 | 63 | 5 | 35 | 113 | NC | NC | NC | NC | 176 | NC | 183 | 181 | 169 | 164 | 160 | 169 | 143 | NC | 143 | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC |

***EXPLANATION:***

The RPD value is calculated as the absolute value of the difference between the initial and repeat results divided by the average value expressed as a percentage. The following acceptance criteria will be used to assess the RPD results:

- Results > 10 times PQL = RPD value < 50% are acceptable
- Results between 5 & 10 time PQL = RPD value < 75% are acceptable
- Results < 5 times PQL = RPD value < 100% are acceptable

RPD Results Above the Acceptance Criteria VALUE

***ABBREVIATIONS:***

PQL: Practical Quantitation Limit
LPQL: Less than PQL
( - ) : Not Analysed
nc: Not Calculated
OPP: Organophosphorus Pesticides
OCP: Organochlorine Pesticides
PCBs: Polychlorinated Biphenyls
RPD: Relative Percentage Difference

PAHs: Polycyclic Aromatic Hydrocarbons
Nap: Naphthalene
Acenaphty: Acenapthylene
Acenaphte: Acenaphthene
Fluo: Fluorene
Phen: Phenanthrene
Anth: Anthracene
Fluoro: Fluoranthene

Pyr: Pyrene
B(a)A: Benzo(a)anthracene
Chy: Chrysene
B(a+k)F: Benzo(a+k)fluoranthene
B(a)P: Benzo(a)pyrene
I(123-cd): Indeno(123-cd)pyrene
D(ah)A: Dibenzo(ah)anthracene
B(ghi)P: Benzo(ghi)perylene

As: Arsenic
Cd: Cadmium
Cr: Chromium
Cu: Copper
Pb: Lead
Hg: Mercury
Ni: Nickel
Zn: Zinc

TABLE F
LABORATORY DUPLICATE RESULTS - GROUNDWATER
QA/QC - RELATIVE PERCENTAGE DIFFERENCES
All data in mg/L unless stated otherwise

| ANALYTE | | HEAVY METALS | | | | | | | | PAHs | | | | | | | | | | | | | | | Oil and Grease | Total VOCs | PETROLEUM HYDROCARBONS | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | | | | | | | | | Petroleum Hydrocarbons | | | | Benzene | Toluene | Ethyl Benzene | Total Xylenes |
| | | As | Cd | Cr | Cu | Pb | Hg | Ni | Zn | Nap | Acenaphty | Acenaphte | Fluo | Phen | Anth | Fluoro | Pyr | B(a)A | Chy | B(b+k)F | B(a)P | I(123-cd) | D(ah)A | B(ghi)P | | | $C_6$-$C_9$ | $C_{10}$-$C_{14}$ | $C_{15}$-$C_{28}$ | $C_{29}$-$C_{36}$ | | | | |
| PQL - Envirolab Services | | 0.001 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.0005 | 0.001 | 0.001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0002 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 5 | 0.001 | 0.01 | 0.05 | 0.1 | 0.1 | 0.001 | 0.001 | 0.001 | 0.001 |
| PQL - SGS | | 0.001 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.0001 | 0.001 | 0.001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0002 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 5 | 0.0005 | 0.04 | 0.1 | 0.2 | 0.2 | 0.0005 | 0.0005 | 0.0005 | 0.001 |
| **Intra-laboratory Groundwater Duplicate Results - Envirolab Report Number 41592** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Initial Sample Ref | MW513 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 0.011 | 0.009 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL |
| Duplicate Sample Ref | GW Dup 1 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 0.01 | 0.008 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL |
| **Mean Value** | | NC | NC | NC | NC | NC | NC | 0.0105 | 0.0085 | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC |
| **RPD Value** | | NC | NC | NC | NC | NC | NC | 10 | 12 | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC |
| **Inter-laboratory Groundwater Duplicate Results - Envirolab Report Number 41592, SGS Report Number SE78671** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Initial Sample Ref | MW517 | 0.012 | LPQL | LPQL | LPQL | LPQL | LPQL | 0.005 | 0.084 | 0.0012 | 0.0001 | 0.004 | 0.0038 | 0.0042 | 0.0007 | 0.0008 | 0.0006 | 0.0001 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | <5 | 0.046 | <0.1 | 0.83 | 0.47 | LPQL | LPQL | LPQL | LPQL | LPQL |
| Duplicate Sample Ref | GW Dup 2 | 0.011 | LPQL | LPQL | LPQL | LPQL | LPQL | 0.004 | 0.076 | 0.0007 | 0.0003 | 0.0038 | 0.004 | 0.0039 | 0.001 | 0.001 | 0.0007 | 0.0001 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 57 | 0.0513 | 0.19 | 0.79 | 0.456 | LPQL | LPQL | LPQL | LPQL | LPQL |
| **Mean Value** | | 0.0115 | NC | NC | NC | NC | NC | 0.0045 | 0.08 | 0.00095 | 0.0002 | 0.0039 | 0.0039 | 0.00405 | 0.00085 | 0.0009 | 0.00065 | 0.0001 | NC | NC | NC | NC | NC | NC | 29.75 | 0.04865 | 0.12 | 0.81 | 0.463 | NC | NC | NC | NC | NC |
| **RPD Value** | | 9 | NC | NC | NC | NC | NC | 22 | 10 | 53 | 100 | 5 | 5 | 7 | 35 | 22 | 15 | 0 | NC | NC | NC | NC | NC | NC | 183 | 11 | 117 | 5 | 3 | NC | NC | NC | NC | NC |

***EXPLANATION:***

The RPD value is calculated as the absolute value of the difference between the initial and repeat results divided by the average value expressed as a percentage. The following acceptance criteria will be used to assess the RPD results:

- Results > 10 times PQL = RPD value < 50% are acceptable
- Results between 5 & 10 time PQL = RPD value < 75% are acceptable
- Results < 5 times PQL = RPD value < 100% are acceptable

RPD Results Above the Acceptance Criteria VALUE

***ABBREVIATIONS:***

PQL: Practical Quantitation Limit
LPQL: Less than PQL
( - ) : Not Analysed
nc: Not Calculated
OPP: Organophosphorus Pesticides
OCP: Organochlorine Pesticides
PCBs: Polychlorinated Biphenyls
RPD: Relative Percentage Difference
VOC: Volatile Organic Compound

PAHs: Polycyclic Aromatic Hydrocarbons
Nap: Naphthalene
Acenaphty: Acenapthylene
Acenaphte: Acenaphthene
Fluo: Fluorene
Phen: Phenanthrene
Anth: Anthracene
Fluoro: Fluoranthene

Pyr: Pyrene
B(a)A: Benzo(a)anthracene
Chy: Chrysene
B(a+k)F: Benzo(a+k)fluoranthene
B(a)P: Benzo(a)pyrene
I(123-cd): Indeno(123-cd)pyrene
D(ah)A: Dibenzo(ah)anthracene
B(ghi)P: Benzo(ghi)perylene

As: Arsenic
Cd: Cadmium
Cr: Chromium
Cu: Copper
Pb: Lead
Hg: Mercury
Ni: Nickel
Zn: Zinc

TABLE G
LABORATORY RESULTS
QA/QC - TRIP SPIKES, TRIP BLANKS AND RINSATES
All data in mg/kg unless stated otherwise

| ANALYTE | | | PAHs | | | | | | | | | | | | | | | PETROLEUM HYDROCARBONS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Nap | Acenaphty | Acenaphte | Fluo | Phen | Anth | Fluoro | Pyr | B(a)A | Chy | B(b+k)F | B(a)P | I(123-cd) | D(ah)A | B(ghi)P | Petroleum Hydrocarbons | | | | Benzene | Toluene | Ethyl Benzene | m+p Xylene | o-Xylenes |
| | | | | | | | | | | | | | | | | | | $C_6$-$C_9$ | $C_{10}$-$C_{14}$ | $C_{15}$-$C_{28}$ | $C_{29}$-$C_{36}$ | | | | | |
| PQL - Soil | | | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.05 | 0.1 | 0.1 | 0.1 | 25 | 50 | 100 | 100 | 0.5 | 0.5 | 1 | 2 | 1 |
| PQL - Water | | | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.002 | 0.001 | 0.001 | 0.001 | 0.001 | 0.01 | 0.05 | 0.1 | 0.1 | 0.001 | 0.001 | 0.001 | 0.002 | 0.001 |
| **Date** | **Report** | **Sample ref** | **Trip Spikes** | | | | | | | | | | | | | | | | | | | | | | | |
| 11/05/2010 | 40916 | Trip Spike 1[S] | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 88% | 98% | 89% | 89% | 89% |
| 14/05/2010 | 41184 | T Spike 2[S] | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 110% | 110% | 108% | 108% | 108% |
| 17/05/2010 | 41184 | T Spike 3[S] | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 104% | 103% | 102% | 102% | 102% |
| 20/05/2010 | 41301 | T Spike 4[S] | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 92% | 90% | 112% | 89% | 89% |
| 21/05/2010 | 41426 | T Spike 5[S] | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 94% | 87% | 87% | 87% | 87% |
| 28/05/2010 | 41592 | GW Trip Spike [W] | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 101% | 107% | 106% | 106% | 106% |
| **Field Rinsates** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11/05/2010 | 40916 | Rinsate 1[W] | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 0.2 | 0.74 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL |
| 13/05/2010 | 41031 | Rinsate 2[W] | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 0.018 | 0.7 | 0.56 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL |
| 14/05/2010 | 41184 | Rinsate 3[W] | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL |
| 17/05/2010 | 41184 | Rinsate 4[W] | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL |
| 19/05/2010 | 41301 | Rinsate 5[W] | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 0.018 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL |
| 20/05/2010 | 41301 | Rinsate 6[W] | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 0.018 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL |
| 21/05/2010 | 41426 | Rinsate 7[W] | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | 0.026 | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL | LPQL |
| **Trip Blanks** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11/05/2010 | 40916 | TB 1[S] | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | LPQL | LPQL | LPQL | LPQL | LPQL |
| 13/05/2010 | 41031 | TB 2[S] | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | LPQL | LPQL | LPQL | LPQL | LPQL |
| 14/05/2010 | 41184 | TB 3[S] | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | LPQL | LPQL | LPQL | LPQL | LPQL |
| 17/05/2010 | 41184 | TB 4[S] | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | LPQL | LPQL | LPQL | LPQL | LPQL |
| 19/05/2010 | 41301 | TB 5[S] | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | LPQL | LPQL | LPQL | LPQL | LPQL |
| 20/05/2010 | 41301 | TB 6[S] | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | LPQL | LPQL | LPQL | LPQL | LPQL |
| 21/05/2010 | 41426 | Trip Blank 7[S] | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | LPQL | LPQL | LPQL | LPQL | LPQL |
| 28/05/2010 | 41592 | GW Trip Blank[W] | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | LPQL | LPQL | LPQL | LPQL | LPQL |

***EXPLANATION:***
[W] Sample type (water) - concentrations in mg/L
[S] Sample type (sand)
BTEX concentrations in trip spikes are presented as % recovery

***ABBREVIATIONS:***

PQL: Practical Quantitation Limit
LPQL: Less than PQL
( - ) : Not Applicable / Not Analysed
OPP: Organophosphorus Pesticides
OCP: Organochlorine Pesticides
PCBs: Polychlorinated Biphenyls

PAHs: Polycyclic Aromatic Hydrocarbons
Nap: Naphthalene
Acenaphty: Acenapthylene
Acenaphte: Acenaphthene
Fluo: Fluorene
Phen: Phenanthrene
Anth: Anthracene
Fluoro: Fluoranthene

Pyr: Pyrene
B(a)A: Benzo(a)anthracene
Chy: Chrysene
B(a+k)F: Benzo(a+k)fluoranthene
B(a)P: Benzo(a)pyrene
I(123-cd): Indeno(123-cd)pyrene
D(ah)A: Dibenzo(ah)anthracene
B(ghi)P: Benzo(ghi)perylene

TABLE H
SUMMARY OF LABORATORY TEST DATA
ACID SULFATE SOILS ANALYSIS (sPOCAS)

| Location | Depth in metres | DESCRIPTION | Soil pH 1:5 soil:water | $pH_{KCL}$ | TAA pH 6.5 | $pH_{ox}$ | TPA pH 6.5 | TSA pH 6.5 | Ca A %w/w | Mg A %w/w | $S_{POS}$ %w/w | Liming Rate kg $CaCO_3$/tonne |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BH501 | 0.5-0.95 | Fill: sand | 7.3 | 9.3 | LPQL | 7.8 | LPQL | LPQL | 0.094 | 0.023 | 0.011 | <0.75 |
| BH501 | 1.5-1.95 | Fill: sand | 7.5 | 7.6 | LPQL | **4.1** | LPQL | LPQL | 0.013 | LPQL | **0.060** | 2.8 |
| BH502 | 0.3-0.8 | Fill: sandy gravel | 7.4 | 9.5 | LPQL | 7.4 | LPQL | LPQL | 0.31 | 0.015 | **0.032** | <0.75 |
| BH506 | 0.5-1.0 | Fill: gravelly sand | 11.4 | 11.0 | LPQL | 8.3 | LPQL | LPQL | 1.5 | 0.039 | 0.022 | <0.75 |
| BH506 | 1.85-2.05 | Fill: gravelly sand | 9.3 | 10.2 | LPQL | 7.6 | LPQL | LPQL | 0.35 | 0.019 | **0.150** | <0.75 |
| BH506 | 3.0-3.45 | Silty sand | 10 | 7.3 | LPQL | **2.4** | **383** | **383** | 0.078 | 0.013 | **0.890** | 33 |
| BH506 | 4.3-4.5 | Silty sand | 9.3 | 7.1 | LPQL | **3.1** | 17 | 17 | LPQL | LPQL | **0.100** | 2.5 |
| BH508 | 0.3-0.5 | Fill: gravelly sand | 9.6 | 9.3 | LPQL | 6.2 | LPQL | LPQL | 0.098 | 0.011 | **0.083** | 3.9 |
| BH508 | 1.5-1.95 | Fill: silty sand | 7.7 | 7.9 | LPQL | 5.6 | LPQL | LPQL | 0.011 | LPQL | **0.048** | 2.2 |
| BH508 | 3.0-3.45 | Silty sand | 8.7 | 7.1 | LPQL | **3** | **72** | **72** | 0.007 | LPQL | **0.230** | 7.2 |
| BH508 | 4.5-4.95 | Silty sand | 7.1 | **4.5** | 12 | **3.5** | 17 | 5 | LPQL | LPQL | **0.076** | 4.5 |
| BH508[M] | 6.1-6.45 | Silty clayey sand | 8.7 | 5.1 | 5 | **4.5** | LPQL | LPQL | 0.006 | 0.011 | 0.006 | <0.75 |
| BH508 | 7.0-7.2 | Silty sand | 8.1 | 5.3 | 5 | **4.3** | LPQL | LPQL | LPQL | LPQL | LPQL | <0.75 |
| BH508 | 7.7-7.8 | Sandstone | 8.4 | 5.1 | 7.5 | **3.9** | LPQL | LPQL | LPQL | LPQL | LPQL | <0.75 |
| BH510 | 3.0-3.45 | Fill: gravelly sand | 9.4 | 9.1 | LPQL | 7.4 | LPQL | LPQL | 0.14 | 0.016 | 0.009 | <0.75 |
| BH510 | 4.5-4.95 | Silty sand | 7.9 | 6.7 | LPQL | **2.4** | **190** | **190** | 0.010 | LPQL | **0.330** | 15 |
| BH510[M] | 6.0-6.5 | Silty clayey sand | 7.8 | 6.1 | LPQL | **3.1** | **40** | **37** | 0.005 | LPQL | **0.140** | 6.7 |
| BH510[M] | 7.5-7.95 | Silty clayey sand | 7.3 | **4.5** | 12 | **4.2** | 5 | LPQL | LPQL | 0.005 | 0.014 | 1.6 |
| BH518 | 0.5-0.8 | Fill: sandy gravel | 9.3 | 9 | LPQL | 7.8 | LPQL | LPQL | 1.7 | 0.057 | 0.050 | <0.75 |

***EXPLANATION:***

Action criteria are defined as follows:

- coarse textured soils (sands to loamy sands):
  - pH < 5
  - TAA/TSA/TPA (pH 5.5) > 18mol $H^+$/tonne
  - $S_{pos}$ > 0.03% sulfure oxidisable

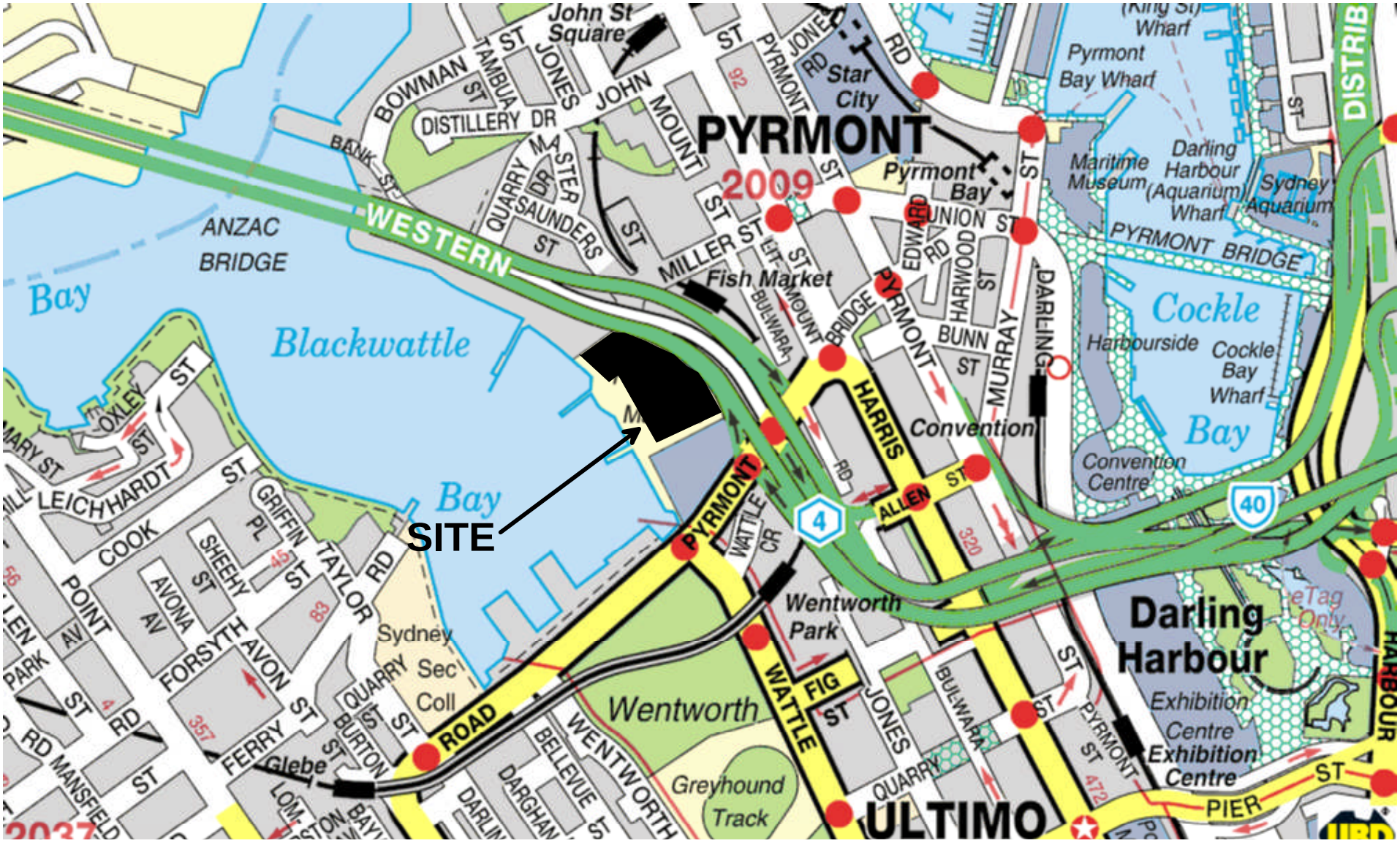
Action criteria for samples marked as 'M' (medium textured soils - sandy loams to light clays):

- pH < 5
- TAA/TSA/TPA (pH 5.5) > 36mol $H^+$/tonne
- $S_{pos}$ > 0.06% sulfure oxidisable

TAA or $S_{POS\ \%}$ Values Exceeding Action Criteria **VALUE**

$pH_{KCL}$ : pH of filtered 1:20, 1M KCL extract, shaken overnight
TAA pH 6.5 : Total Actual Acidity in 1M KCL extract titrated to pH6.5
$pH_{ox}$ : pH filtered 1:20 1M KCl after peroxide digestion
TPA : Total Potential Acidity, 1M KCL peroxide digest titrated to pH6.5
TSA: Total Sulfide Acidity
$S_{POS}$: Peroxide oxidisable Sulfur (SP - SKCL)
$Ca_A$/$Mg_A$: Calcium/Magnesium reacted with acid generated by peroxide digest
Calcium and Magnesium values used to estimate additional Ca/Mg from acid-shell/carbonate/dolomite reaction

Reference: ASSMAC (Acid Sulfate Soils management Advisory Committee - Acid Sulfate Soil Manual 1998).




Recreated from UBD on disc (version 5.0)
Map Ref: 235 N11 (not to scale)

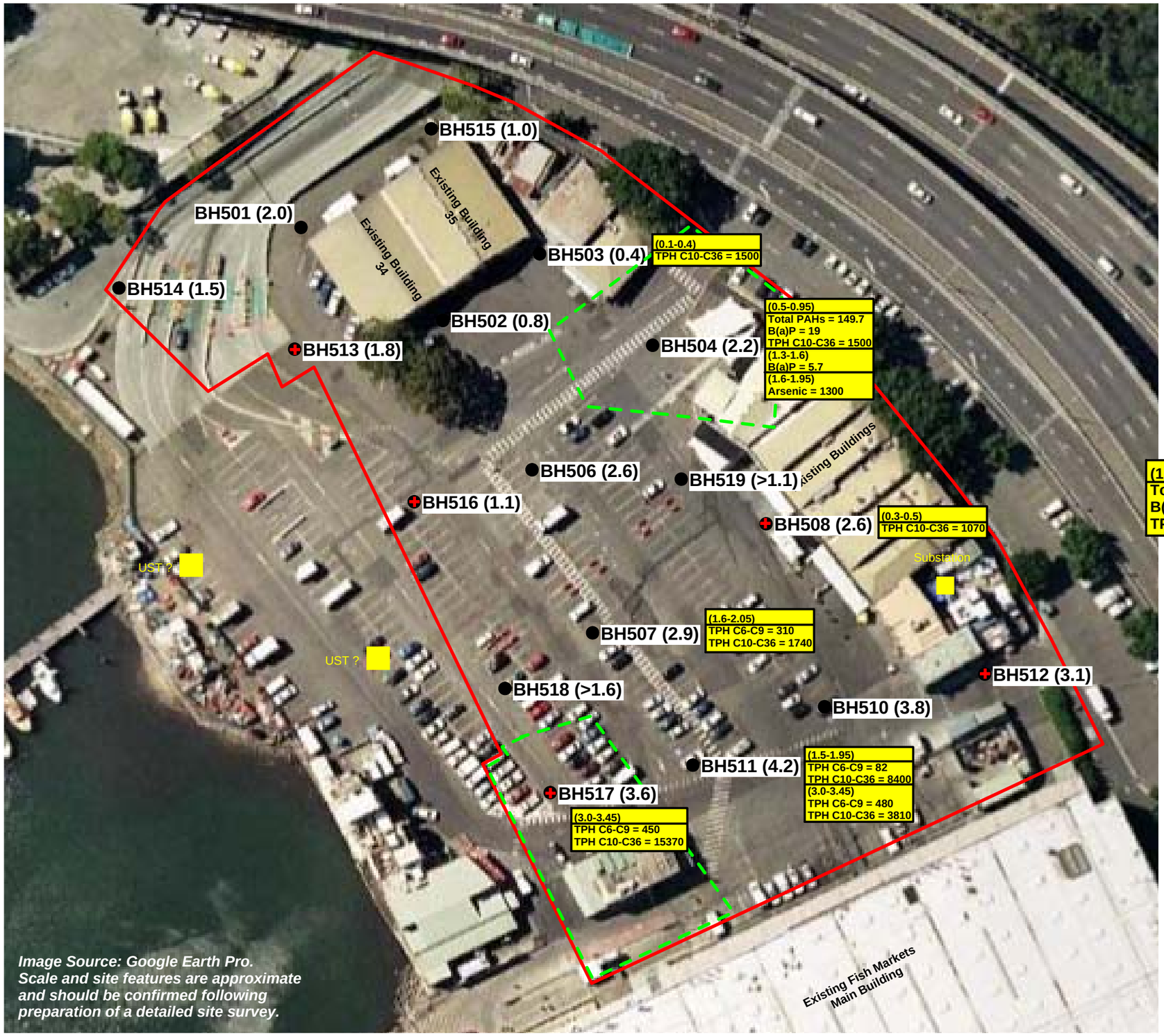
# SITE LOCATION PLAN

Sydney Fish Markets
56-60 Pyrmont Bridge Road, Pyrmont, NSW

EIS
ENVIRONMENTAL INVESTIGATION SERVICES

Job No: E23982Krpt
Figure: 1

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




**LEGEND:**

- BH501 (0.3) BOREHOLE LOCATION, NUMBER AND DEPTH OF FILL (m)
- MONITORING WELL LOCATION
- APPROXIMATE SITE BOUNDARY
- APPROXIMATE EXTENT OF RESTRICTED SOLID WASTE
- (1.5-1.95) / Total PAHs = 100 / B(a)P = 5 / TPH C10-C36 = 1000 — SAMPLE DEPTH (m) CONTAMINANT AND CONCENTRATION (in mg/kg) ABOVE THE SITE ASSESSMENT CRITERIA

Approximate Scale (m)

0 10 20 30 40 50

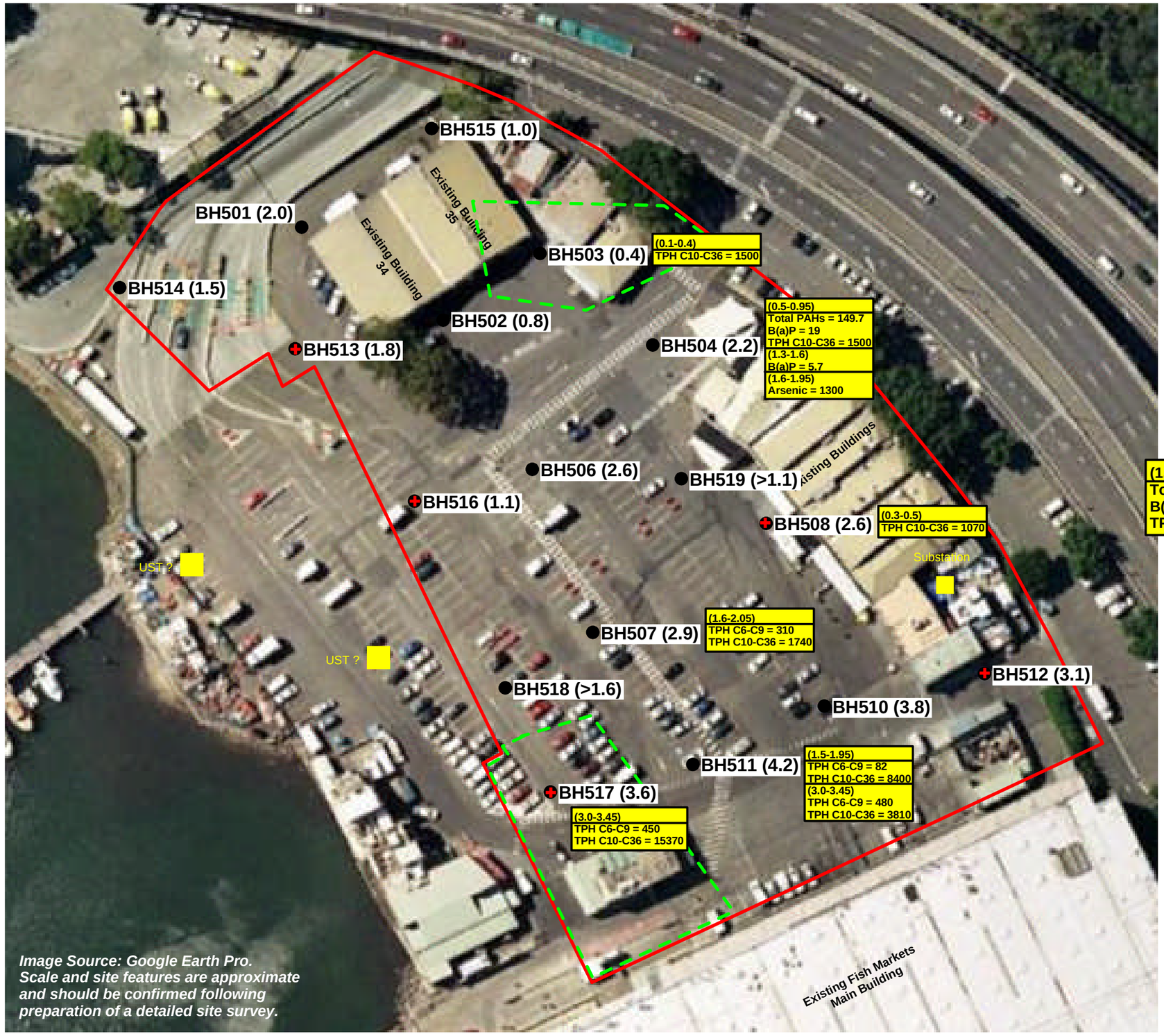
*Note: Not to scale. Reference should be made to the text for a full understanding of this plan*

# BOREHOLE LOCATION PLAN AND SOIL CONTAMINATION DATA

Sydney Fish Markets
56-60 Pyrmont Bridge Rd, Pyrmont, NSW

ENVIRONMENTAL INVESTIGATION SERVICES

Job No: E23982Krpt
Figure: 3




**LEGEND:**

- BH501 (0.3) BOREHOLE LOCATION, NUMBER AND DEPTH OF FILL (m)
- MONITORING WELL LOCATION
- APPROXIMATE SITE BOUNDARY
- APPROXIMATE EXTENT OF RESTRICTED SOLID WASTE
- (1.5-1.95) Total PAHs = 100 B(a)P = 5 TPH C10-C36 = 1000 — SAMPLE DEPTH (m) CONTAMINANT AND CONCENTRATION (in mg/kg) ABOVE THE SITE ASSESSMENT CRITERIA

Approximate Scale (m)

0 10 20 30 40 50

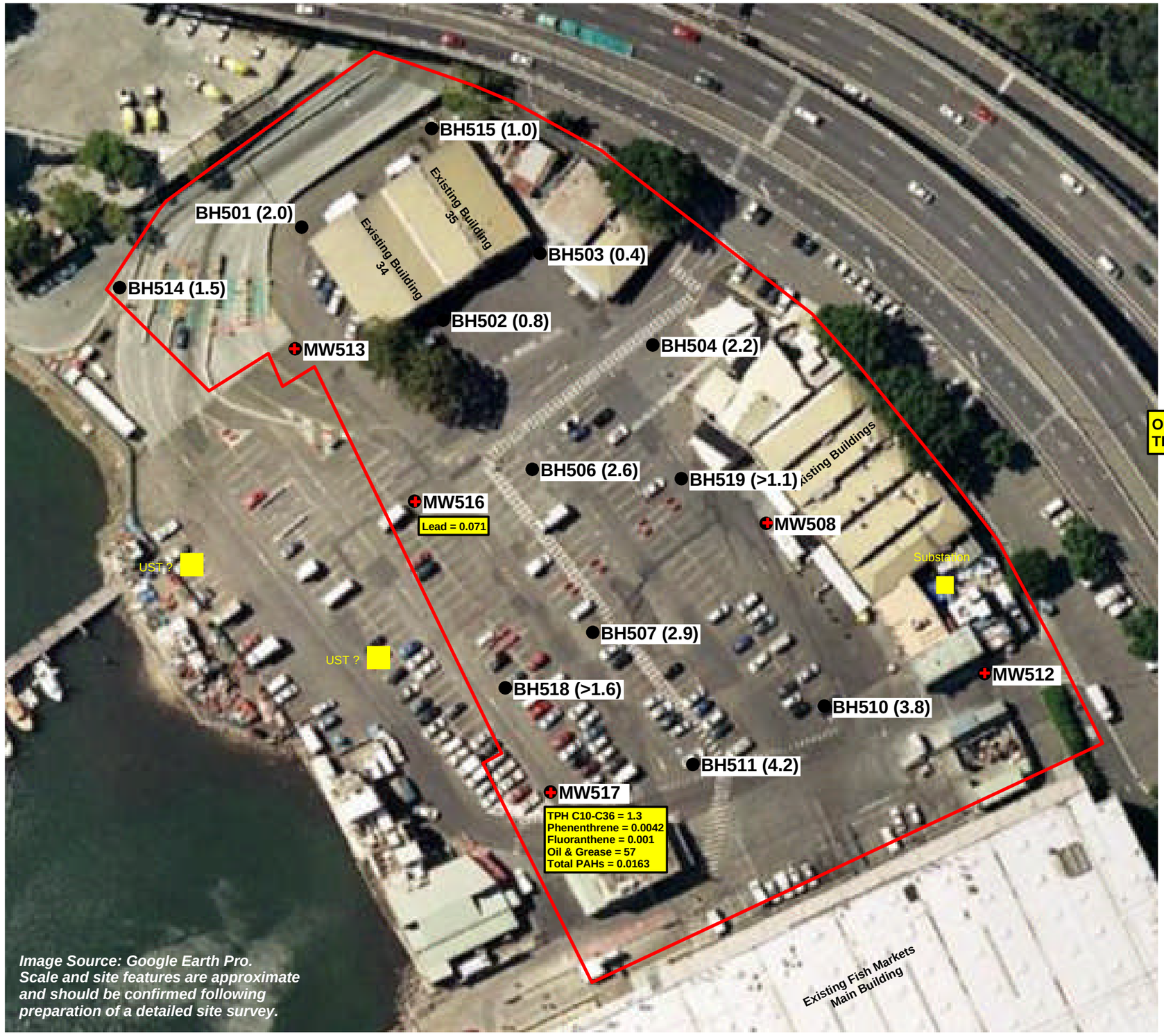
*Note: Not to scale. Reference should be made to the text for a full understanding of this plan*

# BOREHOLE LOCATION PLAN AND SOIL CONTAMINATION DATA

Sydney Fish Markets
56-60 Pyrmont Bridge Rd, Pyrmont, NSW

Job No: E23982Krpt
Figure: 3

ENVIRONMENTAL INVESTIGATION SERVICES




**LEGEND:**

- BH501 (0.3) BOREHOLE LOCATION, NUMBER AND DEPTH OF FILL (m)
- MONITORING WELL LOCATION
- APPROXIMATE SITE BOUNDARY
- Oil and Grease = 10 / TPH C10-C36 = 0.6 — CONTAMINANT AND CONCENTRATION (in mg/L)) ABOVE THE SITE ASSESSMENT CRITERIA

Approximate Scale (m)

0 10 20 30 40 50

*Note: Not to scale. Reference should be made to the text for a full understanding of this plan*

# BOREHOLE LOCATION PLAN AND GROUNDWATER CONTAMINATION DATA

Sydney Fish Markets
56-60 Pyrmont Bridge Rd, Pyrmont, NSW

Job No: E23982Krpt
Figure: 4

ENVIRONMENTAL INVESTIGATION SERVICES

# APPENDIX A

## (Borehole Logs and Geotechnical Explanatory Notes)

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

**Borehole No. 501** 1/2

# BOREHOLE LOG

**Client:** SYDNEY FISH MARKET PTY LTD

**Project:** SYDNEY FISH MARKET REDEVELOPMENT

**Location:** SYDNEY FISH MARKETS, PYRMONT, NSW

**Job No.** 23982S **Method:** SPIRAL AUGER JK350 **R.L. Surface:** ≈ 2.7m

**Date:** 14-5-10 **Datum:** AHD

**Logged/Checked by:** A.M./

| Groundwater Record | SAMPLES ES | SAMPLES ASB | SAMPLES ASS | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 0 | | - | ASPHALTIC CONCRETE: 70mm.t | M | - | - | |
| | | | | | N = 8 5,4,4 | | | | FILL: Sandy gravel, fine to coarse grained igneous gravel. FILL: Sand, fine to medium grained, brown and grey, with clay bands and sub angular to sub rounded fine to medium grained igneous and slag gravel. | | | | APPEARS MODERATELY COMPACTED |
| | | | | | N = 8 2,3,5 | 1 | | | | | | | SLIGHT HYDROCARBON ODOUR |
| ▼ ON COMPLET- ION | | | | | | 2 | | SM | SILTY SAND: fine to medium grained, yellow brown and grey. | M | - | - | RESIDUAL |
| ▼ DURING DRILL - ING | | | | | | | | - | SANDSTONE: medium to coarse grained, light grey and orange brown. | XW | EL-VL | - | VERY LOW 'TC' BIT RESISTANCE |
| | | | | | | 3 | | | REFER TO CORED BOREHOLE LOG | DW | L-M | | LOW TO MODERATE RESISTANCE |
| | | | | | | 4 | | | | | | | |
| | | | | | | 5 | | | | | | | |
| | | | | | | 6 | | | | | | | |
| | | | | | | 7 | | | | | | | |

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

Borehole No. **501** 2/2

# CORED BOREHOLE LOG

**Client:** SYDNEY FISH MARKET PTY LTD
**Project:** SYDNEY FISH MARKET REDEVELOPMENT
**Location:** SYDNEY FISH MARKETS, PYRMONT, NSW

**Job No.** 23982S | **Core Size:** NMLC | **R.L. Surface:** ≈ 2.7m
**Date:** 14-5-10 | **Inclination:** VERTICAL | **Datum:** AHD
**Drill Type:** JK350 | **Bearing:** - | **Logged/Checked by:** A.M.

| Water Loss/Level | Barrel Lift | Depth (m) | Graphic Log | CORE DESCRIPTION<br>Rock Type, grain characteristics, colour, structure, minor components. | Weathering | Strength | POINT LOAD STRENGTH INDEX $I_S(50)$<br>EL VL L M H VH EH | DEFECT DETAILS<br>DEFECT SPACING (mm)<br>500 300 100 50 30 10 | DESCRIPTION<br>Type, inclination, thickness, planarity, roughness, coating.<br>Specific / General |
|---|---|---|---|---|---|---|---|---|---|
| | | 2 | | START CORING AT 3.0m | | | | | |
| FULL RETURN | | 3 | | SANDSTONE: fine to medium grained, light grey. | SW | M | | | |
| | | 4 | | SANDSTONE: fine to coarse grained, grey, orange and red brown. | DW | | | | - Be, 0°, Un, R<br>- J, 30°, P, R, IS<br>- J, 30°, P, R<br>- J, 30°, HEALED<br>- J, 30°, HEALED |
| | | 5 | | | | | | | - XWS, 250mm.t<br>- CS, 200mm.t<br>- CS, 400mm.t<br>- J, 0°, CLAY INFILL<br>- CS, 300mm.t |
| | | 6 | | | | H | | | |
| | | | | END OF BOREHOLE AT 6.0m | | | | | |
| | | 7 | | | | | | | |
| | | 8 | | | | | | | |
| | | 9 | | | | | | | |

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

# BOREHOLE LOG

**Borehole No.** 502 1/2

**Client:** SYDNEY FISH MARKET PTY LTD
**Project:** SYDNEY FISH MARKET REDEVELOPMENT
**Location:** SYDNEY FISH MARKETS, PYRMONT, NSW

**Job No.** 23982S
**Date:** 14-5-10
**Method:** SPIRAL AUGER JK350
**Logged/Checked by:** A.M./
**R.L. Surface:** ≈ 3.5m
**Datum:** AHD

| Groundwater Record | SAMPLES ES | SAMPLES ASB | SAMPLES ASS | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 0 | | | ASPHALTIC CONCRETE: 100mm.t | | | | |
| | | | | | N = 18 11,18/ 150mm | | | - | FILL: Sandy gravel, fine to coarse grained igneous, brown and grey, fine to coarse grained sand. | M | - | - | APPEARS WELL COMPACTED |
| | | | | | | 1 | | - | SANDSTONE: fine to medium grained, yellow brown. | DW | L-M | - | LOW TO MODERATE 'TC' BIT RESISTANCE |
| | | | | | | | | | REFER TO CORED BOREHOLE LOG | | | | MODERATE RESISTANCE |
| | | | | | | 2 | | | | | | | |
| | | | | | | 3 | | | | | | | |
| | | | | | | 4 | | | | | | | |
| | | | | | | 5 | | | | | | | |
| | | | | | | 6 | | | | | | | |
| | | | | | | 7 | | | | | | | |

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

Borehole No. **502** 2/2

# CORED BOREHOLE LOG

**Client:** SYDNEY FISH MARKET PTY LTD
**Project:** SYDNEY FISH MARKET REDEVELOPMENT
**Location:** SYDNEY FISH MARKETS, PYRMONT, NSW

**Job No.** 23982S | **Core Size:** NMLC | **R.L. Surface:** ≈ 3.5m
**Date:** 14-5-10 | **Inclination:** VERTICAL | **Datum:** AHD
**Drill Type:** JK350 | **Bearing:** - | **Logged/Checked by:** A.M./

| 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 $I_s(50)$ (EL VL L M H VH EH) | DEFECT SPACING (mm) (500 300 100 50 30 10) | DEFECT DETAILS: DESCRIPTION (Type, inclination, thickness, planarity, roughness, coating.) Specific / General |
|---|---|---|---|---|---|---|---|---|---|
| | | 1 | | START CORING AT 1.50m | | | | | |
| | | 2 | | SANDSTONE: medium to coarse grained, orange and red brown. | DW | L-M | × | | |
| | | | | as above, but with quartz inclusions. CORE LOSS 0.82m | | L | × | | |
| FULL RETURN | | 3 | | SANDSTONE: medium to coarse grained, light grey and orange brown, with quartz inclusions. | DW / SW | L | × | | - XWS, 30mm.t |
| ON COMPLETION | | 4 | | SANDSTONE: fine to medium grained, light grey, with dark grey laminae. | | M-H | × × | | - J, 0°, P, CLAY COATED |
| | | | | END OF BOREHOLE AT 4.5m | | | | | |
| | | 5 | | | | | | | |
| | | 6 | | | | | | | |
| | | 7 | | | | | | | |
| | | 8 | | | | | | | |

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

Borehole No. **503** 1/2

# BOREHOLE LOG

**Client:** SYDNEY FISH MARKET PTY LTD

**Project:** SYDNEY FISH MARKET REDEVELOPMENT

**Location:** SYDNEY FISH MARKETS, PYRMONT, NSW

**Job No.** 23982S **Method:** SPIRAL AUGER JK350 **R.L. Surface:** ≈ 3.8m

**Date:** 14-5-10 **Datum:** AHD

**Logged/Checked by:** A.M./

| Groundwater Record | SAMPLES ES | SAMPLES ASB | SAMPLES ASS | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DRY DURING DRILL-ING | | | | | | 0 | | | ASPHALTIC CONCRETE: 80mm.t | | | | |
| | | | | | | | | - | FILL: Gravelly sand, fine to medium grained, brown, fine to coarse grained sub angular igneous, slag and sandstone gravel. | M | - | - | |
| | | | | | N = 29 7,12,17 | | | - | SANDSTONE: fine to coarse grained, yellow brown and light grey. | XW | EL-VL | - | VERY LOW 'TC' BIT RESISTANCE |
| | | | | | | 1 | | | | DW | VL-L | | VERY LOW TO LOW RESISTANCE |
| | | | | | | 2 | | | SANDSTONE: fine to medium grained, light grey. | | L | | MODERATE RESISTANCE |
| | | | | | | | | | | | M | | HIGH RESISTANCE |
| | | | | | | | | | REFER TO CORED BOREHOLE LOG | | | | |
| | | | | | | 3 | | | | | | | |
| | | | | | | 4 | | | | | | | |
| | | | | | | 5 | | | | | | | |
| | | | | | | 6 | | | | | | | |
| | | | | | | 7 | | | | | | | |

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

Borehole No. **503** 2/2

# CORED BOREHOLE LOG

**Client:** SYDNEY FISH MARKET PTY LTD
**Project:** SYDNEY FISH MARKET REDEVELOPMENT
**Location:** SYDNEY FISH MARKETS, PYRMONT, NSW

**Job No.** 23982S **Core Size:** NMLC **R.L. Surface:** ≈ 3.8m
**Date:** 17-5-10 **Inclination:** VERTICAL **Datum:** AHD
**Drill Type:** JK350 **Bearing:** - **Logged/Checked by:** A.M./

| 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 $I_S(50)$ (EL VL L M H VH EH) | DEFECT SPACING (mm) (500 300 100 50 30 10) | DEFECT DETAILS: DESCRIPTION Specific | DEFECT DETAILS: DESCRIPTION General |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 2 | | START CORING AT 2.60m | | | | | | |
| ▼ ON COMPLETION | | 3 | | SANDSTONE: fine to medium grained, light grey, with dark grey laminae. | DW | M | × | | | |
| | | | | SANDSTONE: fine to coarse grained, orange brown and red brown. | SW | | × | | | |
| FULL RETURN | | 4 | | SANDSTONE: fine to medium grained, light grey with dark grey laminae. | | H | × | ■ | - J, 0°, P, S, IS | |
| | | 5 | | SHALE: dark grey. | DW | L | | | - CS, 20mm.t | |
| | | | | SANDSTONE: fine to medium grained, light grey, with dark grey laminae. | SW | H | × | | | |
| | | 6 | | SANDSTONE: fine to coarse grained, orange brown and red brown. | | | | | | |
| | | | | END OF BOREHOLE AT 5.6m | | | | | | |
| | | 7 | | | | | | | | |
| | | 8 | | | | | | | | |
| | | 9 | | | | | | | | |

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

Borehole No. **504** 1/3

# BOREHOLE LOG

**Client:** SYDNEY FISH MARKET PTY LTD

**Project:** SYDNEY FISH MARKET REDEVELOPMENT

**Location:** SYDNEY FISH MARKETS, PYRMONT, NSW

**Job No.** 23982S **Method:** SPIRAL AUGER JK350 **R.L. Surface:** ≈ 4.8m

**Date:** 14-5-10 **Datum:** AHD

**Logged/Checked by:** A.M./

| Groundwater Record | SAMPLES ES | SAMPLES ASB | SAMPLES ASS | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 0 | | | ASPHALTIC CONCRETE: 100mm.t | | | | |
| | | | | | N = 6 6,3,3 | | | - | FILL: Gravelly sand, fine to medium grained, brown, fine to coarse grained sub angular to sub rounded sandstone and slag gravel. | M | - | - | APPEARS MODERATELY TO WELL COMPACTED |
| | | | | | | 1 | | | FILL: Gravelly sand, fine to coarse grained, brown, yellow brown and red brown, fine to coarse grained sub angular sandstone, slag and igneous gravel, with clay lenses. | | | | |
| | | | | | N = 16 7,9,7 | | | | FILL: Sandy gravel, fine to medium grained sub angular ash and slag gravel, dark brown and black, fine to medium grained sand. | | | | |
| | | | | | | 2 | | | FILL: Silty sand, fine to medium grained, brown and yellow brown, with clay bands and sandstone gravel. | | | | |
| | | | | | | | | SM | SILTY SAND: fine to medium grained, brown, dark grey and yellow brown, with organic clayey silt bands | M | L | - | ALLUVIAL |
| ▼ ON COMPLET -ION | | | | | N = 6 5,3,3 | 3 | | | | | | | |
| ▼ DURING DRILL- ING | | | | | | | | | SILTY SAND: fine to coarse grained, dark grey and light grey, with a trace of organic clayey silt bands and decomposed organic material. | W | VL | - | SLIGHT HYDROCARBON ODOUR<br>ALLUVIAL |
| | | | | | N = 3 0,1,2 | 4 | | | | | | | |
| | | | | | | 5 | | | | | | | |
| | | | | | | 6 | | - | SANDSTONE: fine to medium grained, yellow brown and grey. | XW | EL-VL | - | VERY LOW 'TC' BIT RESISTANCE |
| | | | | | | 7 | | | | DW | L | | |

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

Borehole No. **504** 2/3

# BOREHOLE LOG

**Client:** SYDNEY FISH MARKET PTY LTD
**Project:** SYDNEY FISH MARKET REDEVELOPMENT
**Location:** SYDNEY FISH MARKETS, PYRMONT, NSW

**Job No.** 23982S
**Date:** 14-5-10
**Method:** SPIRAL AUGER JK350
**Logged/Checked by:** A.M.
**R.L. Surface:** ≈ 4.8m
**Datum:** AHD

| Groundwater Record | SAMPLES ES | SAMPLES ASB | SAMPLES ASS | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | SANDSTONE: fine to medium grained, yellow brown and grey. | DW | L | | MODERATE RESISTANCE |
| | | | | | | | | | REFER TO CORED BOREHOLE LOG | | | | |
| | | | | | | 8 | | | | | | | |
| | | | | | | 9 | | | | | | | |
| | | | | | | 10 | | | | | | | |
| | | | | | | 11 | | | | | | | |
| | | | | | | 12 | | | | | | | |
| | | | | | | 13 | | | | | | | |
| | | | | | | 14 | | | | | | | |

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

Borehole No. **504** 3/3

# CORED BOREHOLE LOG

**Client:** SYDNEY FISH MARKET PTY LTD
**Project:** SYDNEY FISH MARKET REDEVELOPMENT
**Location:** SYDNEY FISH MARKETS, PYRMONT, NSW

**Job No.** 23982S **Core Size:** NMLC **R.L. Surface:** ≈ 4.8m
**Date:** 17-5-10 **Inclination:** VERTICAL **Datum:** AHD
**Drill Type:** JK350 **Bearing:** - **Logged/Checked by:** A.M./

| 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 $I_S(50)$ (EL VL L M H VH EH) | DEFECT SPACING (mm) (500 300 100 50 30 10) | DEFECT DETAILS: DESCRIPTION (Type, inclination, thickness, planarity, roughness, coating.) Specific / General |
|---|---|---|---|---|---|---|---|---|---|
| | | 7 | | START CORING AT 7.38m | | | | | |
| | | | | CORE LOSS 0.67m | | | | | |
| | | 8 | | SANDSTONE: fine to coarse grained, light grey with red banding. | DW-SW | M | × | | - XWS, 110mm.t |
| 75% RET-URN | | | | SANDSTONE: fine to coarse grained, yellow brown, red brown and light grey, with light grey laminae. | | | | | - 8.48-9.0m J, SUB VERTICAL, Un, R |
| | | 9 | | | | | × | | |
| | | | | | | | | | - Be, 20°, P, S, IS |
| | | | | | | | × | | - Be, 20°, SILTY SAND INFILL |
| | | 10 | | | | | | | - Be, 5°, CLAY INFILL |
| | | | | END OF BOREHOLE AT 10.33m | | | × | | |
| | | 11 | | | | | | | |
| | | 12 | | | | | | | |
| | | 13 | | | | | | | |

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

**Borehole No. 506** 1/2

# BOREHOLE LOG

**Client:** SYDNEY FISH MARKET PTY LTD

**Project:** SYDNEY FISH MARKET REDEVELOPMENT

**Location:** SYDNEY FISH MARKETS, PYRMONT, NSW

**Job No.** 23982S **Method:** SPIRAL AUGER JK500 **R.L. Surface:** ≈ 3.0m

**Date:** 19-5-10 **Datum:** AHD

**Logged/Checked by:** A.M./

| Groundwater Record | SAMPLES ES | SAMPLES ASB | SAMPLES ASS | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 0 | | | ASPHALTIC CONCRETE: 100mm.t | | | | |
| | | | | | SPT 20/20mm REFUSAL | 1 | | - | FILL: Gravelly sand, fine to coarse grained, red brown, fine to medium grained sub angular to sub rounded igneous gravel. | M | - | - | APPEARS WELL COMPACTED |
| | | | | | | | | - | CONCRETE: 500mm.t | - | - | - | |
| | | | | | N = 5 2,2,3 | 2 | | - | FILL: Gravelly sand, fine to medium grained, yellow brown and grey, fine to medium grained sub angular sandstone, igneous and slag gravel. | M | - | - | APPEARS POORLY COMPACTED<br>HYDROCARBON ODOUR |
| ▼ DURING DRILL -ING | | | | | | | | SM | SILTY SAND: fine to medium grained, grey, with a trace of clay fines and decomposing timber fragments. | W | VL | - | SLIGHT HYDROCARBON ODOUR<br>ALLUVIAL |
| | | | | | N = 2 1,1,1 | 3 | | | | | | | |
| | | | | | | 4 | | - | SANDSTONE: fine to medium grained, light grey. | DW | VL | - | VERY LOW TO LOW 'TC' BIT RESISTANCE |
| | | | | | | | | | REFER TO CORED BOREHOLE LOG | | | | |
| | | | | | | 5 | | | | | | | |
| | | | | | | 6 | | | | | | | |
| | | | | | | 7 | | | | | | | |

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

Borehole No. **506** 2/2

# CORED BOREHOLE LOG

**Client:** SYDNEY FISH MARKET PTY LTD
**Project:** SYDNEY FISH MARKET REDEVELOPMENT
**Location:** SYDNEY FISH MARKETS, PYRMONT, NSW

**Job No.** 23982S | **Core Size:** NMLC | **R.L. Surface:** ≈ 3.0m
**Date:** 19-5-10 | **Inclination:** VERTICAL | **Datum:** AHD
**Drill Type:** JK500 | **Bearing:** - | **Logged/Checked by:** A.M.

| 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 $I_s(50)$ EL VL L M H VH EH | DEFECT DETAILS: DEFECT SPACING (mm) 500 300 100 50 30 10 | DEFECT DETAILS: DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific / General |
|---|---|---|---|---|---|---|---|---|---|
| | | 3 | | | | | | | |
| | | 4 | | START CORING AT 4.48m | | | | | |
| | | | | CORE LOSS 0.11m | | | | | |
| ▼ ON COMPLETION | | 5 | | SANDSTONE: fine to medium grained, light grey, with dark grey laminae. | DW | VL-L | × × | | - CS, 45mm.t<br>- CS, 20mm.t |
| | | | | as above, but fine to coarse grained. | | | | | |
| | | 6 | | CORE LOSS 0.34m | | | | | |
| FULL RETURN | | | | SANDSTONE: fine to medium grained, light grey, with dark grey laminae and cross bedding and orange staining. | DW-SW | M | × | | - Be, 0°, Un, R, IS<br>- Be, 0°, Un, R, IS |
| | | 7 | | | | H | × × | | - J, 5°, P, S, IS<br>- J, 45°, P, S, IS |
| | | 8 | | | | M | × | | - Be, 0°, Un, S, IS |
| | | | | END OF BOREHOLE AT 8.20m | | | | | |
| | | 9 | | | | | | | |

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

**Borehole No. 507** 1/2

# BOREHOLE LOG

**Client:** SYDNEY FISH MARKET PTY LTD

**Project:** SYDNEY FISH MARKET REDEVELOPMENT

**Location:** SYDNEY FISH MARKETS, PYRMONT, NSW

**Job No.** 23982S **Method:** SPIRAL AUGER JK500 **R.L. Surface:** ≈ 3.0m

**Date:** 19-5-10 **Datum:** AHD

**Logged/Checked by:** A.M./

| Groundwater Record | SAMPLES ES | SAMPLES ASB | SAMPLES ASS | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 0 | | | ASPHALTIC CONCRETE: 100mm.t | | | | |
| | | | | | SPT 20/10mm REFUSAL | 1 | | - | FILL: Gravelly sand, fine to coarse grained, red brown, fine to medium grained sub angular igneous gravel. | M | - | - | APPEARS WELL COMPACTED |
| | | | | | | | | - | CONCRETE: 300mm.t | - | - | - | |
| | | | | | N = 9 4,5,4 | 2 | | - | FILL: Gravelly sand, fine to medium grained, light grey and dark grey, fine to coarse grained sub angular slag and igneous gravel, with decomposing timber. | M | - | - | HYDROCARBON ODOUR<br>APPEARS MODERATELY COMPACTED |
| ▼ DURING DRILL ING | | | | | N = 3 2,1,2 | 3 | | SM | SILTY SAND: fine to coarse grained, dark grey and light grey, with a trace of decomposing timber. | W | VL | - | SLIGHT HYROCARBON ODOUR<br>ALLUVIAL |
| | | | | | N > 19 1,19/ 10mm REFUSAL | 4 | | - | SANDSTONE: fine to medium grained, grey and yellow brown. | DW | L-M | - | LOW 'TC' BIT RESISTANCE |
| ▼ ON COMPLET- ION | | | | | | 5 | | | REFER TO CORED BOREHOLE LOG | | | | |
| | | | | | | 6 | | | | | | | |
| | | | | | | 7 | | | | | | | |

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

Borehole No. **507** 2/2

# CORED BOREHOLE LOG

**Client:** SYDNEY FISH MARKET PTY LTD
**Project:** SYDNEY FISH MARKET REDEVELOPMENT
**Location:** SYDNEY FISH MARKETS, PYRMONT, NSW

**Job No.** 23982S | **Core Size:** NMLC | **R.L. Surface:** ≈ 3.0m
**Date:** 19-5-10 | **Inclination:** VERTICAL | **Datum:** AHD
**Drill Type:** JK500 | **Bearing:** - | **Logged/Checked by:** A.M.

| 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 $I_S(50)$ (EL VL L M H VH EH) | DEFECT SPACING (mm) (500 300 100 50 30 10) | DEFECT DETAILS: DESCRIPTION (Type, inclination, thickness, planarity, roughness, coating.) Specific / General |
|---|---|---|---|---|---|---|---|---|---|
| | | 4 | | | | | | | |
| | | 5 | | START CORING AT 5.15m | | | | | |
| 75% RET-URN | | 6 | | CORE LOSS 0.08m<br>SANDSTONE: fine to coarse grained, light grey, with dark grey laminae and orange staining. | DW | L-M | × | | - J, 48°, Un, R |
| | | | | as above, but fine to medium grained. | DW-SW | M | × | | |
| | | 7 | | | | | × | | - Be, 0°, P, S, CLAY SMEAR |
| | | | | | | L-M | × | | |
| | | 8 | | | | | × | | - Be, 10°, P, S, CLAY SMEAR<br>- Be, 0°, P, S, CLAY SMEAR |
| | | | | END OF BOREHOLE AT 8.15m | | | | | |
| | | 9 | | | | | | | |
| | | 10 | | | | | | | |

# Jeffery and Katauskas Pty Ltd

CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

**Borehole No. 508** 1/3

# BOREHOLE LOG

**Client:** SYDNEY FISH MARKET PTY LTD

**Project:** SYDNEY FISH MARKET REDEVELOPMENT

**Location:** SYDNEY FISH MARKETS, PYRMONT, NSW

**Job No.** 23982S **Method:** SPIRAL AUGER JK500 **R.L. Surface:** ≈ 3.8m

**Date:** 20-5-10 **Datum:** AHD

**Logged/Checked by:** A.M./

| Groundwater Record | SAMPLES ES | SAMPLES ASB | SAMPLES ASS | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 0 | | | ASPHALTIC CONCRETE: 100mm.t | | | | |
| | | | | | | | | - | FILL: Gravelly sand, fine to medium grained, brown, fine to coarse grained sub angular to sub rounded igneous and slag gravel. | - | - | - | SLIGHT HYDROCARBON ODOUR |
| | | | | | | | | - | CONCRETE: 100mm.t | - | - | - | |
| | | | | | SPT 10/10mm REFUSAL | 1 | | - | FILL: Silty sand, fine to coarse grained, dark grey and brown, with fine to coarse grained sub angular igneous, sandstone and slag gravel and clayey silt bands. | M | - | - | SLIGHT HYDROCARBON ODOUR<br>APPEARS WELL COMPACTED |
| | | | | | N = 17 17,11,6 | 2 | | | | | | | |
| DURING DRILL-ING | | | | | N = 2 1,1,1 | 3 | | SM | SILTY SAND: medium to coarse grained, dark grey, with organic clayey silt bands and decomposing timber. | M | VL | - | SLIGHT HYDROCARBON ODOUR<br>ALLUVIAL |
| | | | | | | 4 | | | SILTY SAND: medium to coarse grained, light grey. | W | VL | - | |
| DURING DRILL-ING | | | | | N = 0 1,0,0 | 5 | | | | | L | | |
| ON COMPLET-ION | | | | | N = 10 5,5,5 | 6 | | SC | SILTY CLAYEY SAND: fine to medium grained, light grey. | W | MD | - | |
| | | | | | | 7 | | SM | SILTY SAND: fine to coarse grained, light grey and yellow brown. | | | | |

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

Borehole No. **508** 2/3

# BOREHOLE LOG

**Client:** SYDNEY FISH MARKET PTY LTD

**Project:** SYDNEY FISH MARKET REDEVELOPMENT

**Location:** SYDNEY FISH MARKETS, PYRMONT, NSW

**Job No.** 23982S **Method:** SPIRAL AUGER JK500 **R.L. Surface:** ≈ 3.8m

**Date:** 20-5-10 **Datum:** AHD

**Logged/Checked by:** A.M./

| Groundwater Record | SAMPLES ES | SAMPLES ASB | SAMPLES ASS | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | SM | SILTY SAND: fine to coarse grained, light grey and yellow brown. | W | MD | | |
| | | | | | N > 11 5,11/ 150mm REFUSAL | | | - | SANDSTONE: fine to coarse grained, light grey yellow brown, with clay bands. | XW | EL-VL | - | VERY LOW 'TC' BIT RESISTANCE |
| | | | | | | 8 | | | | DW | L | | LOW TO MODERATE RESISTANCE |
| | | | | | | | | | REFER TO CORED BOREHOLE LOG | | | | |
| | | | | | | 9 | | | | | | | |
| | | | | | | 10 | | | | | | | |
| | | | | | | 11 | | | | | | | |
| | | | | | | 12 | | | | | | | |
| | | | | | | 13 | | | | | | | |
| | | | | | | 14 | | | | | | | |

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

Borehole No. **508** 3/3

# CORED BOREHOLE LOG

**Client:** SYDNEY FISH MARKET PTY LTD
**Project:** SYDNEY FISH MARKET REDEVELOPMENT
**Location:** SYDNEY FISH MARKETS, PYRMONT, NSW

**Job No.** 23982S **Core Size:** NMLC **R.L. Surface:** ≈ 3.8m
**Date:** 20-5-10 **Inclination:** VERTICAL **Datum:** AHD
**Drill Type:** JK500 **Bearing:** - **Logged/Checked by:** A.M./

| Water Loss/Level | Barrel Lift | Depth (m) | Graphic Log | CORE DESCRIPTION<br>Rock Type, grain characteristics, colour, structure, minor components. | Weathering | Strength | POINT LOAD STRENGTH INDEX $I_S(50)$ EL VL L M H VH EH | DEFECT DETAILS<br>DEFECT SPACING (mm) 500 300 100 50 30 10 | DESCRIPTION<br>Type, inclination, thickness, planarity, roughness, coating.<br>Specific / General |
|---|---|---|---|---|---|---|---|---|---|
| | | 7 | | | | | | | |
| | | 8 | | START CORING AT 8.55m | | | | | |
| FULL RETURN | | 9 | | SANDSTONE: fine to medium grained, light grey, with clay bands. | DW / SW | L | × | | - XWS, 100mm.t |
| | | | | SANDSTONE: medium to coarse grained, light grey, red and yellow brown. | | | × | | - J, 43°, HEALED |
| | | 10 | | | | | × | | |
| | | | | | | M | × | | - 10.6-10.8m 2xJ, 60°, P, S |
| | | 11 | | | | | × | | - CS, 10mm.t<br>- 11.12-11.45m 2xJ, 70°, Un, R |
| | | | | END OF BOREHOLE AT 11.55m | | | | | MONITORING WELL INSTALLED TO 6.0m. CLASS 18 50mm DIA. MACHINE SLOTTED PVC FROM 6.0m TO 3.0m, CASING FROM 3.0m TO SURFACE, 2mm SAND FILTER PACK TO 2.0m, BENTONITE SEAL FROM 2.0m TO 0.5m. BACKFILLED WITH SAND AND CUTTINGS TO SURFACE AND COMPLETED WITH A STEEL GATIC COVER AND LOCKABLE CAP |
| | | 12 | | | | | | | |
| | | 13 | | | | | | | |

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

Borehole No. **510** 1/3

# BOREHOLE LOG

**Client:** SYDNEY FISH MARKET PTY LTD

**Project:** SYDNEY FISH MARKET REDEVELOPMENT

**Location:** SYDNEY FISH MARKETS, PYRMONT, NSW

**Job No.** 23982S **Method:** SPIRAL AUGER JK350 **R.L. Surface:** ≈ 3.3m

**Date:** 21-5-10 **Datum:** AHD

**Logged/Checked by:** A.M./

| Groundwater Record | SAMPLES ES | SAMPLES ASB | SAMPLES ASS | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 0 | | - | ASPHALTIC CONCRETE: 50mm.t | - | - | - | |
| | | | | | | | | - | CONCRETE: 200mm.t | | | | |
| | | | | | | | | - | FILL: Sandy gravel, fine to coarse grained angular igneous gravel. | M | - | - | |
| | | | | | N = 24 10,12,12 | 1 | | | FILL: Gravelly sand, fine to medium grained, brown, yellow brown and grey, with metal wire fragments. | | | | APPEARS WELL COMPACTED<br>SLIGHT HYDROCARBON ODOUR |
| ▼ DURING DRILL-ING | | | | | N = 7 4,3,4 | 3 | | | | W | | | APPEARS POORLY COMPACTED |
| | | | | | N = 2 1,0,1 | 4 | | SM | SILTY SAND: fine to coarse grained, light grey, with organic clayey silt bands. | W | VL | - | ALLUVIAL |
| | | | | | N = 8 2,3,5 | 6 | | SC | SILTY CLAYEY SAND: fine to medium grained, light grey. | M | L | | |
| | | | | | | 7 | | | | | | | |

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

Borehole No. **510** 2/3

# BOREHOLE LOG

**Client:** SYDNEY FISH MARKET PTY LTD
**Project:** SYDNEY FISH MARKET REDEVELOPMENT
**Location:** SYDNEY FISH MARKETS, PYRMONT, NSW

**Job No.** 23982S
**Date:** 21-5-10
**Method:** SPIRAL AUGER JK350
**Logged/Checked by:** A.M.
**R.L. Surface:** ≈ 3.3m
**Datum:** AHD

| Groundwater Record | SAMPLES ES | SAMPLES ASB | SAMPLES ASS | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ▼ ON COMPLETION | | | | | | | | SC | SILTY CLAYEY SAND: fine to medium grained, light grey. | M | L | | |
| | | | | | N = 10 4,4,6 | 8 | | | | | | | |
| | | | | | | | | - | SANDSTONE: fine to coarse grained, light grey, with a trace of yellow. | XW | EL-VL | - | VERY LOW 'TC' BIT RESISTANCE |
| | | | | | | 9 | | | | | | | |
| | | | | | | 10 | | | | | L | | LOW TO MODERATE RESISTANCE |
| | | | | | | | | | REFER TO CORED BOREHOLE LOG | | | | |
| | | | | | | 11 | | | | | | | |
| | | | | | | 12 | | | | | | | |
| | | | | | | 13 | | | | | | | |
| | | | | | | 14 | | | | | | | |

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

Borehole No. **510** 3/3

# CORED BOREHOLE LOG

**Client:** SYDNEY FISH MARKET PTY LTD
**Project:** SYDNEY FISH MARKET REDEVELOPMENT
**Location:** SYDNEY FISH MARKETS, PYRMONT, NSW

**Job No.** 23982S **Core Size:** NMLC **R.L. Surface:** ≈ 3.3m
**Date:** 21-5-10 **Inclination:** VERTICAL **Datum:** AHD
**Drill Type:** JK350 **Bearing:** - **Logged/Checked by:** A.M.

| Water Loss/Level | Barrel Lift | Depth (m) | Graphic Log | CORE DESCRIPTION<br>Rock Type, grain characteristics, colour, structure, minor components. | Weathering | Strength | POINT LOAD STRENGTH INDEX $I_S(50)$<br>EL VL L M H VH EH | DEFECT DETAILS<br>DEFECT SPACING (mm)<br>500 300 100 50 30 10 | DESCRIPTION<br>Type, inclination, thickness, planarity, roughness, coating.<br>Specific / General |
|---|---|---|---|---|---|---|---|---|---|
| | | 9 | | | | | | | |
| | | 10 | | START CORING AT 10.32m | | | | | |
| | | | | CORE LOSS 0.46m | | | | | |
| FULL RET-URN | | 11 | | SANDSTONE: medium to coarse grained, orange brown and grey. | DW | L | | | - Be, 0°, Un, R, IS |
| | | 12 | | | | | | | - J, 70°, Un, R<br>- J, 70°, Un, R |
| | | 13 | | | | | | | - XWS, 80mm.t<br>- XWS, 60mm.t |
| | | | | END OF BOREHOLE AT 13.31m | | | | | |
| | | 14 | | | | | | | |
| | | 15 | | | | | | | |

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

Borehole No. **511** 1/3

# BOREHOLE LOG

**Client:** SYDNEY FISH MARKET PTY LTD

**Project:** SYDNEY FISH MARKET REDEVELOPMENT

**Location:** SYDNEY FISH MARKETS, PYRMONT, NSW

**Job No.** 23982S **Method:** SPIRAL AUGER JK350 **R.L. Surface:** ≈ 3.3m

**Date:** 21-5-10 **Datum:** AHD

**Logged/Checked by:** A.M.

| Groundwater Record | SAMPLES ES | SAMPLES ASB | SAMPLES ASS | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 0 | | - | ASPHALTIC CONCRETE: 50mm.t | - | - | - | |
| | | | | | | | | - | CONCRETE: 180mm.t<br>FILL: Gravelly sand, fine to coarse grained, dark brown, fine to coarse grained sub angular igneous, concrete, slag and sandstone gravel. | M | - | - | SLIGHT HYDROCARBON ODOUR<br>APPEARS MODERATELY COMPACTED |
| ▼ DURING DRILL -ING | | | | | N = 10<br>8,6,4 | 1 | | | | | | | |
| | | | | | | 2 | | | | | | | |
| | | | | | N = 6<br>1,2,4 | 3 | | | FILL: Gravelly sand, fine to coarse grained, dark brown and dark grey, fine to coarse grained angular to sub angular slag and sandstone gravel. | W | L | | APPEARS POORLY COMPACTED |
| | | | | | | 4 | | SM | SILTY SAND: fine to coarse grained, light grey and dark grey, with clayey silt bands and decomposing wood.<br>as above, but without wood. | W | VL | - | STRONG HYDROCARBON ODOUR<br>ALLUVIAL |
| ▼ ON COMPLET- ION | | | | | N = 1<br>1,0,1 | 5 | | | | | | | |
| | | | | | N = 7<br>3,3,4 | 6 | | | | | L | | |
| | | | | | | 7 | | | | | | | |

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

Borehole No. **511** 2/3

# BOREHOLE LOG

**Client:** SYDNEY FISH MARKET PTY LTD

**Project:** SYDNEY FISH MARKET REDEVELOPMENT

**Location:** SYDNEY FISH MARKETS, PYRMONT, NSW

**Job No.** 23982S **Method:** SPIRAL AUGER JK350 **R.L. Surface:** ≈ 3.3m

**Date:** 21-5-10 **Datum:** AHD

**Logged/Checked by:** A.M./

| Groundwater Record | SAMPLES ES | SAMPLES ASB | SAMPLES ASS | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | N = 6<br>2,3,3 | 8 | | SM | SILTY SAND: fine to coarse grained, light grey and dark grey, with clayey silt bands. | W | L | | ALLUVIAL |
| | | | | | | 9 | | - | SANDSTONE: medium to coarse grained, grey and yellow brown. | XW | EL-VL | - | VERY LOW 'TC' BIT RESISTANCE |
| | | | | | | | | | | DW | L | | LOW RESISTANCE |
| | | | | | | | | | REFER TO CORED BOREHOLE LOG | | | | |
| | | | | | | 10 | | | | | | | |
| | | | | | | 11 | | | | | | | |
| | | | | | | 12 | | | | | | | |
| | | | | | | 13 | | | | | | | |
| | | | | | | 14 | | | | | | | |

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

Borehole No. **511** 3/3

# CORED BOREHOLE LOG

**Client:** SYDNEY FISH MARKET PTY LTD
**Project:** SYDNEY FISH MARKET REDEVELOPMENT
**Location:** SYDNEY FISH MARKETS, PYRMONT, NSW

**Job No.** 23982S | **Core Size:** NMLC | **R.L. Surface:** ≈ 3.3m
**Date:** 21-5-10 | **Inclination:** VERTICAL | **Datum:** AHD
**Drill Type:** JK350 | **Bearing:** - | **Logged/Checked by:** A.M./

| Water Loss/Level | Barrel Lift | Depth (m) | Graphic Log | CORE DESCRIPTION<br>Rock Type, grain characteristics, colour, structure, minor components. | Weathering | Strength | POINT LOAD STRENGTH INDEX $I_s(50)$ EL VL L M H VH EH | DEFECT DETAILS<br>DEFECT SPACING (mm) 500 300 100 50 30 10 | DESCRIPTION<br>Type, inclination, thickness, planarity, roughness, coating.<br>Specific / General |
|---|---|---|---|---|---|---|---|---|---|
| | | 8 | | | | | | | |
| | | 9 | | START CORING AT 9.24m | | | | | |
| | | | | CORE LOSS 1.21m | | | | | |
| | | 10 | | | | | | | |
| FULL RET-URN | | | | SANDSTONE: fine to coarse grained, light grey. | DW | L | × | | |
| | | 11 | | SANDSTONE: fine to coarse grained, orange brown and light grey. | | | × × | | - 11.38-12.24m SUBVERTICAL JOINTS TO 80°, HEALED |
| | | 12 | | | | | | | - CS, 110mm.t |
| | | | | END OF BOREHOLE AT 12.24m | | | | | |
| | | 13 | | | | | | | |
| | | 14 | | | | | | | |

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

# BOREHOLE LOG

**Borehole No.** 512 1/2

**Client:** SYDNEY FISH MARKET PTY LTD
**Project:** SYDNEY FISH MARKET REDEVELOPMENT
**Location:** SYDNEY FISH MARKETS, PYRMONT, NSW

**Job No.** 23982S **Method:** SPIRAL AUGER JK300 **R.L. Surface:** ≈ 4.3m
**Date:** 21-5-10 **Datum:** AHD
**Logged/Checked by:** M.L.T./

| Groundwater Record | SAMPLES ES | SAMPLES ASB | SAMPLES ASS | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 0 | | - | CONCRETE: 320mm.t | | | | 4mm DIAMETER REINFORCEMENT, 110mm & 240mm TOP COVER |
| | | | | | | | | - | FILL: Gravelly sand, fine to coarse grained, light grey, fine to medium grained sub angular igneous and concrete gravel. | W / M | VL | - | |
| | | | | | N = 1 1,0,1 | 1 | | | FILL: Gravelly sand, fine to coarse grained, dark brown and brown, fine to coarse grained sandstone and igneous gravel and up to cobble size and metal fragments. | | | | APPEARS POORLY COMPACTED |
| | | | | | N = 6 2,4,2 | 2 | | | FILL: Sand, fine to coarse grained, light grey and orange brown, with fine to coarse grained sandstone and ironstone gravel. | | | | |
| ▼ DURING DRILL -ING | | | | | | | | | FILL: Sandy clay, low plasticity, red brown and orange brown, with fine to medium grained, igneous, sandstone and ironstone gravel and plastic pieces. | | | | |
| | | | | | N = 1 1,0,1 | 3 | | SP | SAND: fine to coarse grained, grey. | M | VL | | ALLUVIAL |
| | | | | | | | | CL | SANDY CLAY: low plasticity, dark grey. | MC > PL | S | | |
| | | | | | | 4 | | SP | SAND: fine to coarse grained, grey and brown, with clay bands. | W | (VL) | | |
| | | | | | SPT 0,0,0 | 5 | | CL/SC | SANDY CLAY/CLAYEY SAND: low plasticity, fine to coarse grained, light grey mottled orange brown, | MC > PL/ W | (St-L) | | |
| | | | | | | | | SC | with fine to coarse grained sandstone gravel. CLAYEY SAND: fine to coarse grained, light grey. | M | (MD) | | |
| | | | | | N > 10 9,10/ 50mm REFUSAL | 6 | | | | | | | |
| | | | | | | 7 | | | REFER TO CORED BOREHOLE LOG | | | | |

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

Borehole No. **512** 2/2

# CORED BOREHOLE LOG

**Client:** SYDNEY FISH MARKET PTY LTD
**Project:** SYDNEY FISH MARKET REDEVELOPMENT
**Location:** SYDNEY FISH MARKETS, PYRMONT, NSW

**Job No.** 23982S **Core Size:** NMLC **R.L. Surface:** ≈ 4.3m
**Date:** 21-5-10 **Inclination:** VERTICAL **Datum:** AHD
**Drill Type:** JK350 **Bearing:** - **Logged/Checked by:** A.M./

| Water Loss/Level | Barrel Lift | Depth (m) | Graphic Log | CORE DESCRIPTION<br>Rock Type, grain characteristics, colour, structure, minor components. | Weathering | Strength | POINT LOAD STRENGTH INDEX $I_S(50)$ EL VL L M H VH EH | DEFECT SPACING (mm) 500 300 100 50 30 10 | DEFECT DETAILS<br>DESCRIPTION<br>Type, inclination, thickness, planarity, roughness, coating.<br>Specific / General |
|---|---|---|---|---|---|---|---|---|---|
| | | 6 | | START CORING AT 6.35m | | | | | |
| FULL RETURN | | 7 | | CORE LOSS 0.07m<br>SANDSTONE: fine to medium grained, light grey, orange brown and red brown massive. | DW | M | | | - Be, 15°, P, S<br>- Be, 15°, P, S<br>- Be, 0°, P, S |
| | | 8 | | as above, but light grey mottled orange brown. | | | | | - Be, 15°, P, R |
| NO RETURN | | 9 | | as above, but orange brown and red brown. | DW | L-M | | | - J, 85°, P, R, IS<br>- Be, 0°, P, R, IS |
| | | 10 | | END OF BOREHOLE AT 9.35m | | | | | MONITORING WELL INSTALLED TO 6.0m. CLASS 18 50mm DIA. MACHINE SLOTTED PVC FROM 6.0m TO 3.0m, CASING FROM 3.0m TO SURFACE, 2mm SAND FILTER PACK TO 2.0m, BENTONITE SEAL FROM 2.0m TO 0.5m. BACKFILLED WITH SAND AND CUTTINGS TO SURFACE AND COMPLETED WITH A STEEL GATIC COVER AND LOCKABLE CAP |
| | | 11 | | | | | | | |
| | | 12 | | | | | | | |

# Jeffery and Katauskas Pty Ltd

CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

**Borehole No. 513** 1/1

# BOREHOLE LOG

**Client:** SYDNEY FISH MARKET PTY LTD

**Project:** SYDNEY FISH MARKET REDEVELOPMENT

**Location:** SYDNEY FISH MARKETS, PYRMONT, NSW

**Job No.** 23982S **Method:** SPIRAL AUGER JK350 **R.L. Surface:** ≈ 2.3m

**Date:** 11-5-10 **Datum:** AHD

**Logged/Checked by:** A.M.

| Groundwater Record | SAMPLES ES | SAMPLES U50 | SAMPLES DB | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 0 | | - | ASPHALTIC CONCRETE: 50mm.t<br>CONCRETE: 180mm.t<br>CONCRETE/CONCRETE RUBBLE | - | - | - | |
| | | | | | | 1 | | - | FILL: Silty clayey sand, fine to medium grained, dark grey. | M | - | - | APPEARS POORLY COMPACTED |
| ON COMPLETION ▼ | | | | | N = 5<br>2,3,2 | | | SP | SAND: fine to coarse grained, grey and dark grey, with quartz. | W | L | - | SLIGHT HYDROCARBON ODOUR<br>ALLUVIAL |
| DURING DRILL -ING ▼ | | | | | | 2 | | - | SANDSTONE: fine to coarse grained, light grey. | DW | VL | - | VERY LOW 'TC' BIT RESISTANCE |
| | | | | | | 3 | | | SANDSTONE: fine to coarse grained, light grey and yellow brown. | DW | VL-L | | VERY LOW TO LOW RESISTANCE |
| | | | | | | 4 | | | | | L-M | | LOW TO MODERATE RESISTANCE |
| | | | | | | 5 | | | | | | | MONITORING WELL INSTALLED TO 4.2m. CLASS 18 50mm DIA. MACHINE SLOTTED PVC FROM 4.2m-1.2m CASING FROM 1.2m TO SURFACE, 2mm SAND FILTER PACK 4.2m-1.0m, BENTONITE SEAL 1.2m-0.3m BACKFILLED WITH SAND & CUTTINGS TO SURFACE, COMPLETED WITH A STEEL GATIC COVER AND LOCKABLE CAP |
| | | | | | | 6 | | | END OF BOREHOLE AT 6.0m | | | | |
| | | | | | | 7 | | | | | | | |

# Jeffery and Katauskas Pty Ltd

CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

**Borehole No. 514** 1/1

# BOREHOLE LOG

**Client:** SYDNEY FISH MARKET PTY LTD

**Project:** SYDNEY FISH MARKET REDEVELOPMENT

**Location:** SYDNEY FISH MARKETS, PYRMONT, NSW

**Job No.** 23982S **Method:** SPIRAL AUGER JK250 **R.L. Surface:** ≈ 2.1m

**Date:** 11-5-10 **Datum:** AHD

**Logged/Checked by:** A.M./

| Groundwater Record | SAMPLES ES | SAMPLES ASB | SAMPLES ASS | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 0 | | | CONCRETE: 230mm.t | | | | |
| | | | | | | | | - | ASPHALTIC CONCRETE: 150mm.t | - | - | - | |
| | | | | | | | | - | FILL: Clayey gravelly sand, fine to medium grained, orange brown and grey, fine to coarse grained sub angular to sub rounded igneous and sandstone gravel. | M | - | - | SLIGHT HYDROCARBON ODOUR |
| | | | | | N = 10 5,7,3 | 1 | | | FILL: Silty sand, fine to medium grained, light grey ad and yellow brown, with fine to coarse grained sub rounded sandstone gravel. | | | | APPEARS MODERATELY COMPACTED |
| | | | | | N = 7 3,3,4 | | | SM | SILTY SAND: fine to medium grained, grey and yellow brown. | M | L | - | |
| ▼ DURING DRILL -ING & ON COMPLET -ION | | | | | | 2 | | | as above, but grey, with shell fragments. | W | L | | ALLUVIAL |
| | | | | | N = 2 0,1,1 | 3 | | | | | VL | | |
| | | | | | | 4 | | - | SANDSTONE: fine to medium grained, yellow brown, with clay bands. | DW | VL-L | - | LOW 'TC' BIT RESISTANCE |
| | | | | | | 5 | | | SANDSTONE: fine to medium grained, light brown. | | L-M | | LOW TO MODERATE RESISTANCE |
| | | | | | | 6 | | | END OF BOREHOLE AT 6.0m | | | | |
| | | | | | | 7 | | | | | | | |

# Jeffery and Katauskas Pty Ltd

CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No. 515 1/1

# BOREHOLE LOG

**Client:** SYDNEY FISH MARKET PTY LTD

**Project:** SYDNEY FISH MARKET REDEVELOPMENT

**Location:** SYDNEY FISH MARKETS, PYRMONT, NSW

**Job No.** 23982S **Method:** SPIRAL AUGER JK350 **R.L. Surface:** ≈ 3.9m

**Date:** 11-5-10 **Datum:** AHD

**Logged/Checked by:** A.M./

| Groundwater Record | SAMPLES ES | SAMPLES ASB | SAMPLES ASS | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DRY ON COMPLETION | | | | | | 0 | | | ASPHALTIC CONCRETE: 100mm.t | | | | |
| | | | | | | | | - | CONCRTE: 140mm.t | - | - | - | |
| | | | | | N = 6 2,2,4 | | | - | FILL: Gravelly sand, fine to medium grained, orange brown and red brown, fine grained sub angular to sub rounded sandstone gravel. | M | - | - | APPEARS MODERATELY COMPACTED |
| | | | | | | 1 | | - | SANDSTONE: fine to medium grained, yellow brown. | XW | EL-L | - | VERY LOW 'TC' BIT RESISTANCE |
| | | | | | | | | | | DW | L-M | | LOW RESISTANCE |
| | | | | | | 2 | | | | | | | MODERATE RESISTANCE |
| | | | | | | | | | as above, but light grey. | | M | | HIGH RESISTANCE |
| | | | | | | | | | END OF BOREHOLE AT 2.8m | | | | 'TC' BIT REFUSAL |
| | | | | | | 3 | | | | | | | |
| | | | | | | 4 | | | | | | | |
| | | | | | | 5 | | | | | | | |
| | | | | | | 6 | | | | | | | |
| | | | | | | 7 | | | | | | | |

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

# BOREHOLE LOG

**Borehole No.** 516 1/1

**Client:** SYDNEY FISH MARKET PTY LTD

**Project:** SYDNEY FISH MARKET REDEVELOPMENT

**Location:** SYDNEY FISH MARKETS, PYRMONT, NSW

**Job No.** 23982S **Method:** SPIRAL AUGER JK350 **R.L. Surface:** ≈ 3.0m

**Date:** 11-5-10 **Datum:** AHD

**Logged/Checked by:** A.M./

| Groundwater Record | SAMPLES ES | SAMPLES U50 | SAMPLES DB | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DRY ON COMPLET-ION | | | | | | 0 | | | ASPHALTIC CONCRETE: 50mm.t | | | | |
| | | | | | | | | - | CONCRTE: 220mm.t | - | - | - | |
| | | | | | N = 25 7,6,17 | | | - | FILL: Silty sand, fine to coarse grained, dark grey and yellow brown, fine to coarse grained sub angular igneous and sandstone gravel. | M | - | - | APPEARS WELL COMPACTED |
| | | | | | | 1 | | SP | SAND: fine to coarse grained, light grey and yellow brown. | M | - | - | HYDROCARBON ODOUR |
| | | | | | N = 43 19,21,22 | | | - | SANDSTONE: fine to medium grained, yellow brown and light grey, with clay bands. | XW | EL-VL | - | RESIDUAL VERY LOW 'TC' BIT RESISTANCE |
| | | | | | | 2 | | | SANDSTONE: fine to medium grained, light grey. | DW | L | | LOW TO MODERATE RESISTANCE |
| | | | | | | | | | | | M | | MODERATE TO HIGH RESISTANCE |
| | | | | | | 3 | | | END OF BOREHOLE AT 3.0m | | | | 'TC' BIT REFUSAL<br><br>MONITORING WELL INSTALLED TO 3.0m. CLASS 18 50mm DIA. MACHINE SLOTTED PVC FROM 3.0m TO 1.0m, CASING FROM 1.0m TO SURFACE, 2mm SAND FILTER PACK TO 3.0m TO 0.8m, BENTONITE SEAL FROM 0.8m TO 0.3m. BACKFILLED WITH SAND AND CUTTINGS TO SURFACE AND COMPLETED WITH A STEEL GATIC COVER AND LOCKABLE CAP |
| | | | | | | 4 | | | | | | | |
| | | | | | | 5 | | | | | | | |
| | | | | | | 6 | | | | | | | |
| | | | | | | 7 | | | | | | | |

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

**Borehole No. 517** 1/1

# BOREHOLE LOG

**Client:** SYDNEY FISH MARKET PTY LTD

**Project:** SYDNEY FISH MARKET REDEVELOPMENT

**Location:** SYDNEY FISH MARKETS, PYRMONT, NSW

**Job No.** 23982S **Method:** SPIRAL AUGER JK350 **R.L. Surface:** ≈ 3.3m

**Date:** 13-5-10 **Datum:** AHD

**Logged/Checked by:** A.M.

| Groundwater Record | SAMPLES ES | SAMPLES U50 | SAMPLES DB | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 0 | | | ASPHALTIC CONCRETE: 100mm.t | | | | |
| | | | | | | | | - | FILL: Gravelly sand, fine to medium grained, grey brown, with fine to coarse grained sub angular to sub rouned igneous and sandstone gravel and ash. | M | - | - | |
| | | | | | N = 11 4,6,5 | 1 | | | FILL: Sand, fine to medium grained, yellow brown, with fine to coarse grained sandstone and sla gravel. | | | | APPEARS MODERATELY COMPACTED |
| | | | | | N = 14 10,7,7 | | | | FILL: Gravelly sand, fine to medium grained, qyellow brown and dark grey, fine to coarse igneous and sandstone gravel. | | | | |
| ON COMPLETION ▼ | | | | | | 2 | | | | | | | |
| DURING DRILLING ▼ | | | | | | | | | | | | | |
| | | | | | N = 2 1,1,1 | 3 | | | FILL: Silty sand, fine to medium grained, grey and dark brown, with clay and fine to coarse grained slag gravel. | W | VL | | STRONG HYDROCARBON ODOUR<br>APPEARS POORLY COMPACTED |
| | | | | | | | | SM | SILTY SAND: fine to medium grained, grey. | W | VL | - | STRONG HYDROCARBON ODOUR<br>ALLUVIAL<br>MONITORING WELL INSTALLED TO 5.5m. CLASS 18 50mm DIA. MACHINE SLOTTED PVC FROM 5.5m-2.5m, CASING 2.5m TO SURFACE, 2mm SAND FILTER PACK TO 1.5m, BENTONITE SEAL FROM 1.5m-0.3m, BACKFILLED WITH SAND & CUTTINGS TO SURFACE & COMPLETED WITH A STEEL GATIC COVER AND LOCKABLE CAP |
| | | | | | N = 4 1,2,2 | 4 | | | | | | | |
| | | | | | | 5 | | | SILTY SAND: fine to medium grained, grey and light grey, with shell fragments. | | (L) | | |
| | | | | | | 6 | | | END OF BOREHOLE AT 6.0m | | | | |
| | | | | | | 7 | | | | | | | |

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

# BOREHOLE LOG

**Borehole No.** 518 1/1

**Client:** SYDNEY FISH MARKET PTY LTD
**Project:** SYDNEY FISH MARKET REDEVELOPMENT
**Location:** SYDNEY FISH MARKETS, PYRMONT, NSW

**Job No.** 23982S
**Date:** 13-5-10
**Method:** SPIRAL AUGER JK350
**Logged/Checked by:** A.M./
**R.L. Surface:** ≈ 3.0m
**Datum:** AHD

| Groundwater Record | SAMPLES ES | SAMPLES ASB | SAMPLES ASS | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DRY ON COMPLETION | | | | | SPT 18/150m REFUSAL | 0 | | - | ASPHALTIC CONCRETE: 100mm.t<br>FILL: Sandy gravel, fine to coarse grained sub angular to sub rounded concrete brick and sandstone gravel, red brown and brown, fine to medium grained sand, with ash and slag. | M | - | - | APPEARS WELL COMPACTED |
| | | | | | | 1 | | | as above,<br>but yellow brown, with concrete gravel and cobbles. | M-D | | | |
| | | | | | | | | | END OF BOREHOLE AT 1.6m | | | | 'TC' BIT REFUSAL IN FILL |
| | | | | | | 2 | | | | | | | |
| | | | | | | 3 | | | | | | | |
| | | | | | | 4 | | | | | | | |
| | | | | | | 5 | | | | | | | |
| | | | | | | 6 | | | | | | | |
| | | | | | | 7 | | | | | | | |

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

Borehole No. **519** 1/1

# BOREHOLE LOG

**Client:** SYDNEY FISH MARKET PTY LTD

**Project:** SYDNEY FISH MARKET REDEVELOPMENT

**Location:** SYDNEY FISH MARKETS, PYRMONT, NSW

**Job No.** 23982S **Method:** SPIRAL AUGER JK350 **R.L. Surface:** ≈ 4.1m

**Date:** 13-5-10 **Datum:** AHD

**Logged/Checked by:** A.M./

| Groundwater Record | SAMPLES ES | SAMPLES ASB | SAMPLES ASS | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DRY ON COMPLETION | | | | | N = 43 10,22,21 | 0 | | - | ASPHALTIC CONCRETE: 100mm.t<br>FILL: Sandy gravel, sandstone and igneous gravel, dark brown and grey, fine to coarse grained sand, with sandstone cobbles and boulders. | M | - | - | APPEARS WELL COMPACTED |
| | | | | | | 1 | | | FILL: Sandstone and concrete rubble. | D | | | |
| | | | | | | | | | END OF BOREHOLE AT 1.1m | | | | 'TC' BIT REFUSAL IN FILL |
| | | | | | | 2 | | | | | | | |
| | | | | | | 3 | | | | | | | |
| | | | | | | 4 | | | | | | | |
| | | | | | | 5 | | | | | | | |
| | | | | | | 6 | | | | | | | |
| | | | | | | 7 | | | | | | | |

**Jeffery and Katauskas Pty Ltd**
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS
ABN 17 003 550 801

# 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, 30/40mm

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 "$N_c$" 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 subsurface 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.



## 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.

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

# GRAPHIC LOG SYMBOLS FOR SOILS AND ROCKS

## SOIL


FILL


TOPSOIL


CLAY (CL, CH)


SILT (ML, MH)


SAND (SP, SW)


GRAVEL (GP, GW)


SANDY CLAY (CL, CH)

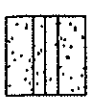

SILTY CLAY (CL, CH)


CLAYEY SAND (SC)


SILTY SAND (SM)


GRAVELLY CLAY (CL, CH)


CLAYEY GRAVEL (GC)


SANDY SILT (ML)


PEAT AND ORGANIC SOILS

## ROCK


CONGLOMERATE


SANDSTONE


SHALE


SILTSTONE, MUDSTONE, CLAYSTONE


LIMESTONE


PHYLLITE, SCHIST


TUFF


GRANITE, GABBRO


DOLERITE, DIORITE


BASALT, ANDESITE


QUARTZITE

## DEFECTS AND INCLUSIONS


CLAY SEAM


SHEARED OR CRUSHED SEAM


BRECCIATED OR SHATTERED SEAM/ZONE


IRONSTONE GRAVEL


ORGANIC MATERIAL

## OTHER MATERIALS


CONCRETE

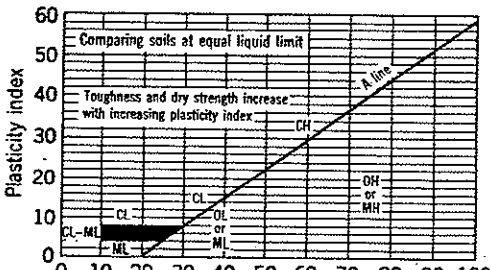

BITUMINOUS CONCRETE, COAL


COLLUVIUM

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

# UNIFIED SOIL CLASSIFICATION TABLE

| Field Identification Procedures (Excluding particles larger than 75 μm and basing fractions on estimated weights) | | | | | Group Symbols[a] | 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[b] (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<br>For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics<br>Example:<br>*Silty sand*, gravelly; 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*) | Use grain size curve in identifying the fractions as given under field identification<br>Determine percentages of gravel and sand from grain size curve<br>Depending on percentage of fines (fraction smaller than 75 μm sieve size) coarse grained soils are classified as follows:<br>Less than 5% *GW, GP, SW, SP*<br>More than 12% *GM, GC, SM, SC*<br>5% to 12% *Borderline* cases requiring use of dual symbols<br>$C_U = \frac{D_{60}}{D_{10}}$ Greater than 4<br>$C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 |
| | | | Predominantly one size or a range of sizes with some intermediate sizes missing | | *GP* | Poorly graded gravels, gravel-sand mixtures, little or no fines | | Not meeting all gradation requirements for *GW* |
| | | 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 |
| | Sands: More than half of coarse fraction is smaller than 4 mm sieve size | Clean sands (little or no fines) | Wide range in grain sizes and substantial amounts of all intermediate particle sizes | | *SW* | Well graded sands, gravelly sands, little or no fines | | $C_U = \frac{D_{60}}{D_{10}}$ Greater than 6<br>$C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 |
| | | | Predominantly one size or a range of sizes with some intermediate sizes missing | | *SP* | Poorly graded sands, gravelly sands, little or no fines | | Not meeting all gradation requirements for *SW* |
| | | Sands with fines (appreciable amount of fines) | Nonplastic fines (for identification procedures, see *ML* below) | | *SM* | Silty sands, poorly graded sand-silt mixtures | | 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 |
| | | | Plastic fines (for identification procedures, see *CL* below) | | *SC* | Clayey sands, poorly graded sand-clay mixtures | | Atterberg limits below "A" line with *PI* greater than 7 |
| 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 | | | | | | | |
| | Silts and clays: liquid limit less than 50 | Dry Strength (crushing characteristics) | Dilatancy (reaction to shaking) | Toughness (consistency near plastic limit) | | | | |
| | | None to slight | Quick to slow | None | *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<br>For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture and drainage conditions<br>Example:<br>*Clayey silt*, brown; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; (*ML*) | |
| | | Medium to high | None to very slow | Medium | *CL* | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays | | |
| | | Slight to medium | Slow | Slight | *OL* | Organic silts and organic silt-clays of low plasticity | | |
| | Silts and clays: liquid limit greater than 50 | Slight to medium | Slow to none | Slight to medium | *MH* | Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts | | |
| | | High to very high | None | High | *CH* | Inorganic clays of high plasticity, fat clays | | |
| | | Medium to high | None to very slow | Slight to medium | *OH* | Organic clays of medium to high plasticity | | |
| Highly Organic Soils | Readily identified by colour, odour, spongy feel and frequently by fibrous texture | | | | *Pt* | Peat and other highly organic soils | | |




Plasticity chart
for laboratory classification of fine grained soils

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.

# 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. |
| | C | 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<br>4, 7, 10 | Standard Penetration Test (SPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration. 'R' as noted below. |
| | $N_c$ = 5<br>7<br>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) | 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. |
| (Cohesionless Soils) | 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) | | **Density Index (Id) Range (%)** / **SPT 'N' Value Range (Blows/300mm)** |
| | VL | 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<br>250 | Numbers indicate individual test results in kPa on representative undisturbed material unless noted otherwise. |
| 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. |

Ref: Standard Sheets Log Symbols
August 2001

# 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

## 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 | |