ENVIRONMENTAL INVESTIGATION SERVICES

REPORT

TO

LAND AND PROPERTY MANAGEMENT AUTHORITY C/- GOVERNMENT ARCHITECTS OFFICE

ON

PRELIMINARY ENVIRONMENTAL SITE ASSESSMENT

FOR

PROPOSED REDEVELOPMENT - WATERFRONT

AT

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

AUGUST 2010

REF: E24125Krpt

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EXECUTIVE SUMMARY

Land and Property Management Authority commissioned Environmental Investigation Services (EIS), a division of Jeffery & Katauskas Pty Ltd (J&K), to undertake a preliminary environmental site assessment for a proposed waterfront redevelopment at Sydney Fish Markets (SFM), 56-60 Pyrmont Bridge Road, Pyrmont, NSW. The site is identified as part of Lot 1 in DP835794, part of Lot 1 in DP734655 and part of Lot 2 in DP827434, and at the time of this investigation was occupied by a car park, several buildings/processing facilities and public eating areas associated with the SFM.

The primary objectives of the investigation were to:

- Assess the soil and groundwater contamination conditions at the site in relation to the proposed redevelopment of the site for use as waterfront parkland;
- Assess the soil conditions at the site for acid sulfate soil potential;
- Assess the contamination and acid sulfate soil conditions in the sediments of Blackwattle Bay, immediately adjacent to the existing seawall;
- Assess the harbour water contamination conditions in Blackwattle Bay, immediately adjacent to the seawall;
- Prepare preliminary waste classification documentation for off-site disposal of excavated soil associated with the proposed development works; and
- Prepare a report presenting the results of the preliminary assessment.

EIS have previously undertaken an environmental site assessment within the adjacent redevelopment area located to the north and east of the site, as shown on Figure 2 (i.e. for a separate part of the SFM redevelopment application). The EIS report is referenced as *"Report to Sydney Fish Market Pty Ltd on Environmental Site Assessment and Preliminary Acid Sulfate Soil Assessment for Proposed Redevelopment at Sydney Fish Markets, 56-60 Pyrmont Bridge Road, Pyrmont, NSW"* (Ref: E23982K), dated June 2010.

Relevant historical information obtained during preparation of the above referenced EIS report has been incorporated into this report. EIS understand that the soil and groundwater laboratory analysis data obtained from the adjacent areas of the SFM site will be used in conjunction with the information obtained during the preliminary environmental site assessment of the waterfront (i.e. the information contained in this report) to eventually develop a remedial strategy for the whole SFM redevelopment site.

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.

Samples were obtained from 10 sampling locations (BH601 to BH610 inclusive) for this investigation. This density is approximately 60% of the minimum sampling density. The boreholes were generally drilled on a systematic sampling plan with a spacing of approximately 30m-40m between sampling points. Monitoring wells were also installed in three boreholes. The sediment and harbour water screening included sampling from three locations (SSA/SWA to SSC/SWC inclusive) immediately adjacent to the site. Sampling for the acid sulfate soil assessment was undertaken from four selected boreholes, together with the three sediment sampling locations.

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), cyanide and asbestos. Sediment samples were analysed for a similar suite of contaminants to those detailed above, however, additional analysis was also undertaken for tributyltin (TBT). Selected fill, natural soil and sediment samples were also analysed for acid sulfate soil potential (sPOCAS testing).

The groundwater and harbour water samples were analysed for heavy metals, PAHs, TPH, volatile organic compounds (VOCs), oil and grease (groundwater only) and tributyltin (harbour water only).

The search of historical information has indicated the following:

- The historical aerial photographs indicated that the west section of the site (i.e. the Blackwattle Bay waterfront) has undergone significant changes since the 1930s. Shipping and transport associated with industrial activities appeared to be the most obvious land use;
- At least part of 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 either at the site or in the immediate vicinity during this time;
- Several large industrial-type buildings and circular storage towers/silos (possibly associated with petroleum storage and/or refinery processes) were located immediately adjacent to the east site boundary from at least 1930. The towers/silos and buildings remained 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 in 2004 and sub-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.

Based on the site inspection and the historical information reviewed as part of the preliminary assessment, 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 and/or adjacent areas for petroleum storage and refining processes;
- The suspected USTs;
- Unidentified USTs;
- Historical use of the site for unknown commercial/industrial purposes; and
- Historical activities such as use of pesticides.

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

- Elevated concentrations of heavy metals, TBT, PAHs and mid to heavy fraction (C_{10}-C_{36}) TPH in the sediment samples;
- An elevated concentration of lead (640mg/kg) in a fill soil sample obtained from BH601 (0.6m-0.95m);
- Elevated concentrations of total PAHs and/or benzo(a)pyrene in fill soil samples obtained from BH601, BH602, BH606, BH607 and BH610. The maximum total PAHs and benzo(a)pyrene concentrations in the soil samples were 249.9mg/kg and 24mg/kg respectively;

- Elevated concentrations of TPH (C_{10}-C_{36}) in the majority of the fill soil samples. The maximum TPH (C_{10}-C_{36}) concentration in the soil samples was 22,100mg/kg;
- Elevated concentrations of copper and zinc in all three of the harbour water samples;
- Marginally elevated concentrations of arsenic in all three groundwater samples. Also, elevated concentrations of copper, lead and zinc in MW608;
- Elevated concentrations of TPH (C_{10}-C_{36}) in two of the three monitoring wells. The maximum concentration of TPH (C_{10}-C_{36}) in the groundwater samples was 1.15mg/L in MW606;
- Elevated concentrations of the PAH compounds anthracene and phenanthrene in MW605, and pheneanthrene in MW606;

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

Based on the results of the investigation, remediation of the site will be required. A remediation action plan (RAP) should be prepared detailing the remediation options, remediation strategy and other site requirements prior to commencement of the proposed redevelopment works. Further assessment of the potential health risks associated with the contaminants may also be required.

The conclusions presented in this report have been made within the limitations of the scope of works undertaken for the investigation. The conclusions and recommendations should be read in conjunction with the limitations presented in the body of the report.

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1 INTRODUCTION

Land and Property Management Authority commissioned Environmental Investigation Services (EIS), a division of Jeffery & Katauskas Pty Ltd (J&K), to undertake a preliminary environmental site assessment for a proposed waterfront redevelopment at Sydney Fish Markets (SFM), 56-60 Pyrmont Bridge Road, Pyrmont, NSW.

The site is identified as part of Lot 1 in DP835794, part of Lot 1 in DP734655 and part of Lot 2 in DP827434, and at the time of this investigation was occupied by a car park, several buildings/processing facilities and public eating areas associated with the SFM. The site location is shown on Figure 1 and the investigation was confined to the site boundaries as shown on Figures 2 and 5.

The preliminary assessment was undertaken generally in accordance with a revised EIS proposal (Ref: EP4881K) of 8 July 2010 and written acceptance from Land and Property Management Authority of 19 July 2010.

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

A geotechnical report was prepared by J&K based on the EIS preliminary investigation findings together with the findings of investigation work previously undertaken at the site by J&K (ref: 24125Srpt).

1.1 Proposed Development Details

EIS understand that the development applications for the SFM redevelopment project have generally been divided into four separate areas:

1. RTA lease part 3A application;
2. SFM Part 3A application;
3. SFM Part 4 application; and
4. Waterfront works Part 3A application.

This investigation has been restricted to the area applicable to the 'waterfront works part 3A application' (as shown on Figures 2 and 5), and the area of Blackwattle Bay immediately adjacent to the existing seawall. Based on the details provided by Government Architects Office we understand the works may include construction of a promenade, boardwalk, waterfront park and seawall. We have been advised that the works associated with the seawall construction are unlikely to include dredging of the sediments.

The proposed redevelopment at the site is unlikely to include significant excavation works. Some filling may be required in the vicinity of the proposed park in order to achieve the desired site levels.

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]).

A brief summary of the above referenced reports is included in Section 4.

EIS have previously undertaken an environmental site assessment within the adjacent redevelopment area located to the north and east of the site as shown on Figure 2 (for the Part 4 and Part 3A development applications). The EIS report is referenced as follows:

- "*Report to Sydney Fish Market Pty Ltd on Environmental Site Assessment and Preliminary Acid Sulfate Soil Assessment for Proposed Redevelopment at Sydney Fish Markets, 56-60 Pyrmont Bridge Road, Pyrmont, NSW"* Ref: E23982K, dated June 2010.

Relevant historical information obtained during preparation of the above referenced EIS report has been incorporated into this report. EIS understand that the soil and groundwater laboratory analysis data obtained from the adjacent areas of the SFM site will be used in conjunction with the information obtained during the preliminary environmental site assessment of the waterfront (i.e. the information contained in this report) to eventually develop a remedial strategy for the whole SFM redevelopment site.

J&K has previously undertaken several geotechnical investigations at the site and in the adjacent areas of the SFM. Reference should be made to the EIS report E23982Krpt, dated June 2010 for further details.

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[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 soil and groundwater contamination conditions at the site in relation to the proposed redevelopment of the site for use as waterfront parkland;
- Assess the soil conditions at the site for acid sulfate soil potential;
- Assess the contamination and acid sulfate soil conditions in the sediments of Blackwattle Bay, immediately adjacent to the existing seawall;
- Assess the harbour water contamination conditions in Blackwattle Bay, immediately adjacent to the seawall;
- Prepare preliminary waste classification documentation for off-site disposal of excavated soil associated with the proposed development works; and
- Prepare a report presenting the results of the preliminary assessment 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. Review of the relevant historical information presented in EIS report E23982Krpt, dated June 2010;
2. Review of historical aerial photographs;
3. Review of historical land title records;
4. Search of the NSW DECCW notices for the site under Section 58 of the *Contaminated Land Management Act* (1997[5])[6];
5. Search of the NSW DECCW public register (POEO[7]) for licences, applications or notices for the site;
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;

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

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

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

8. Review of regional geology and groundwater conditions, including the location of registered groundwater bores in the vicinity of the site;
9. Review of the environmental assessment reports previously prepared for the site by other consultants;
10. Design and implementation of a limited field sampling program;
11. Installation of three groundwater monitoring wells at selected locations to assess widespread groundwater contamination conditions;
12. Laboratory analysis of selected soil and groundwater samples; and
13. Preparation of a report presenting the results of the assessment together with recommendations on the suitability of the site for the proposed development.

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

- Drilling, soil sampling and installation of the groundwater monitoring wells was undertaken on 20 and 21 July 2010;
- The groundwater monitoring wells were developed on 22 July 2010; and
- Groundwater samples were obtained from the monitoring wells on 27 July 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:	Part of Lot 1 in DP835794, part of Lot 1 in DP734655 and part of Lot 2 in DP827434
Current Land Use:	Commercial/Retail
Proposed Land Use:	Commercial/Open Space
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 7,000m^2
AHD:	Approximately 1-3m
Geographical Location (MGA):	N: 6250535 E: 332720 (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 a long, irregular shape and is located in the west section of the wider SFM site, adjacent to Blackwattle Bay. Access to the site is made via a public walkway off Pyrmont Bridge Road (in the south) or via the main car park which is accessed off Bank Street.

At the time of the investigation the north section of the site was predominantly occupied by the fish markets car park. The car park area was 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 site areas immediately adjacent to Blackwattle Bay in the north of the site were used as a storage area and as a helipad. Various materials including ropes, chains, disused fridges, waste oil storage drums (labelled as containing engine oil) and a shipping container were located in this area. A waste engine oil storage area was located to the south-east of the helipad (as shown on Figure 2). The waste oil storage appeared to be in an above ground tank, however, this could not be confirmed. The seawall in this section of the site was constructed of timber and sandstone block, and was in relatively poor condition.

Two circular metal plates that appeared consistent with the presence of UST dip/fill points were located at the ground surface in the car park, approximately 30m to the north-east of the waste engine oil storage area (as shown on Figure 2). No other fuel infrastructure such as vent pipes or bowsers were evident. The dip/fill points are likely to be associated with two disused USTs located in this section of the site.

The central section of the site was occupied by a seafood wholesaler/retailer and processing facility, together with several refrigeration rooms. No obvious indicators of chemical or petroleum storage were observed within the buildings.

The south section of the site was occupied by part of a concrete driveway that extended along the west side of the SFM main Building. The areas to the west of the driveway were occupied by an astroturf surfaced picnic area. An elevated boardwalk with numerous chairs and tables was located further to the west, adjacent to Blackwattle Bay.

The only vegetation observed at the site included several palm trees located in the vicinity of the picnic area. A small area was also grassed in the south section of the site.

During rain events, stormwater would be expected to flow into the on-site stormwater drains and into Blackwattle Bay. Some infiltration would be expected in the low lying or slumped area of the car park areas where the pavement is severely cracked or potholed.

3.2.1 On-site Services and Surrounding Land use

No plans were available detailing the on-site electrical, stormwater and sewer services. No obvious major services were observed at the site. Some on-site stormwater infrastructure was observed in the car park areas and overhead power/ telecommunications were observed in the vicinity of the buildings.

The surrounding land use included:

- A concrete batching plant to the north;
- The SFM main car park (the site forms part of this car park) beyond the east site boundary in the north section of the site;
- The main SFM building to the east (in the south section of the site). The SFM main building adjacent to the site boundary was occupied by a number of retailers including seafood shops, fruit shops and a bakery. The remainder of the SFM main building located further to the east is predominantly used as a processing facility and for seafood auctions; and
- Pyrmont Bridge Road to the south, with Wentworth park located further to the south.

3.3 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 3° and predominantly fell towards the west, south and south-west.

3.4 Regional Geology

The geological map of Sydney (1983[8]) indicates that the site is located in an area 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 to the north-east 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.

[8] *1:100,000 Geological Map of Sydney (Series 9130),* Department of Mineral Resources (1983) [now Department of Primary Industries]

3.5 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 Prospect/Parramatta area prepared by Department of Land and Soil Conservation (1997[9]) 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.

3.6 Hydrogeology

NSW Office of Water (formerly Department of Water and Energy[10]) 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	200	South-west	Down	4.0	Monitoring
GW110371	200	South-west	Down	4.0	Monitoring
GW110372	200	South-west	Down	4.0	Monitoring
GW110373	200	South-west	Down	4.0	Monitoring
GW110374	200	South-west	Down	4.0	Monitoring

The stratigraphy of the site is expected to consist manmade fill over relatively high permeability alluvial sandy soil. The stratigraphy in the north-east sections of the site may consist of residual clayey soils overlying relatively shallow bedrock. 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.

[9] *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]

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

3.7 Surface Water

The nearest surface water body is Blackwattle Bay which is located down gradient and immediately adjacent to the west site boundary. Based on the site levels and surrounding topography, excess surface water flows would be expected to flow directly into Blackwattle Bay. It is understood that wastewater from the seafood wholesalers/retailers flows through underground pipe work directly into Blackwattle Bay.

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 preliminary environmental assessment of the SFM waterfront;
- 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 (as shown in Figure 2); and
    - PCBs associated with the electrical substations (believed to be located in the far east section of the SFM site, beyond the waterfront site boundary applicable to the EIS 2010 investigation);
    - 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 TPH and BTEX compounds;
    - Assess the soil and groundwater conditions in the vicinity of the substation 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 assessment 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 (USTs are 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. 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 EIS BH606). 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;
    - 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 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 SFM 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[11]. The information obtained from the photographs is summarised in the following table:

Year	Details
1930	The photograph was of relatively poor quality. The site appeared to form part of a larger industrial area adjacent to Blackwattle Bay. The Blackwattle Bay foreshore was not clearly defined and appeared to be occupied by numerous boats, barges and/or shipping containers. The surrounding areas appeared to be developed for industrial type land use. Four circular towers/silos (possibly associated with an oil refinery) and several relatively large buildings were located immediately to the east of the site. Smaller buildings and/or shipping containers were also located in the areas to the east of the site. Several wharfs, landings and/or pontoons were located to the west of the site within Blackwattle Bay. Bank Street was located in the vicinity of the site to the east.
1943	The south sections of the site appeared to be at least partly occupied by Blackwattle Bay. Several barges/boats were located in this area. Smaller buildings/shipping containers and a paved roadway occupied the central section of the site. Part of a large warehouse type building was located in the north section of the site. The building extended beyond the site boundaries to the north and east. Several additional towers/silos were located to the east of site. Small sheds/containers and a circular tower/silo were located in the vicinity of the large warehouse building to the north-east of the site.
1951	The site and the immediate surrounds generally appeared to be similar to the 1943 photograph.
1961	The south section of the site appeared to be occupied by a narrow paved walkway/drive way. The larger building formerly located in the north section of the site had been demolished and a smaller building (of unknown use)

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

	occupied the central north section of the site. A large building that appeared similar to the existing (2010) Sydney Fish Markets main building was located to the east of the site (towards the southern end).
1970	The site generally appeared to be similar to the 1961 photograph. Fewer barges, shipping containers and/or boats occupied the areas of Blackwattle Bay to the west of the site. The circular towers/silos formerly located to the east of the site were no longer evident and the areas where the towers were located appeared to be paved.
1978	The site generally appeared to be similar to the 1970 photograph. Alterations had been made to the wharfs adjacent to Blackwattle Bay. Several structures were located to the north of the site that appeared consistent with the existing batching plant.
1986	The site and the immediate surrounds generally appeared to be similar to the 1978 photograph. There appeared to be an increase in residential type buildings in the areas to the east of the site.
1994	The building that formerly occupied the central north section of the site had been demolished. The north and central sections of the site were predominantly occupied by a car park and numerous cars. Several smaller buildings were located in the central section of the site, adjacent to Blackwattle Bay. The wider site layout, including the buildings, generally appeared consistent with the existing (2010) configuration of the SFM site. The Western Distributor was located further to the east of the site. Additional residential type buildings were also 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)

Date	**Proprietor**
	(Lot 1 DP 835794)
2004 – todate	Waterways Authority of New South Wales
(1994 – todate)	*(lease to Fish Marketing Authority)*
1994 – 2004	The Maritime Services Board of New South Wales
	(Sydney Harbour - CTVol 5018 Fol 1)
1939 – 1994	The Maritime Services Board of New South Wales
(1939 – 1994)	*(various leases over parts of Sydney Harbour)*
	(Sydney Harbour – CTVol 2050 Fol 103)
1936 – 1939	The Maritime Services Board of New South Wales
1910 – 1936	The Sydney Harbour Trust Commissioners
(1910 – 1939)	*(various leases over parts of Sydney Harbour)*

The land titles records applicable to the majority of the central and north sections of the site 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.

The land titles records applicable to the south section of the site and a small portion of the north section of the site have indicated that the site has been owned by the Sydney Harbour Trust and Maritime Services Board since the early 1900s. Ownership was subsequently transferred to the NSW Waterways Authority in 2004. From the early 1900s the records indicated that various leases have existed, however, apart from the current lease to the Fish Marketing Authority, details regarding the previous leases were not available.

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 SFM. 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 historical aerial photographs indicated that the west section of the site (i.e. the Blackwattle Bay waterfront) has undergone significant changes since the 1930s. Shipping and transport associated with industrial activities appeared to be the most obvious land use;
- At least part of 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 either at the site or in the immediate vicinity during this time;
- Several large industrial-type buildings and circular storage towers/silos (possibly associated with petroleum storage and/or refinery processes) were located immediately adjacent to the east site boundary from at least 1930. The towers/silos and buildings remained 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 in 2004 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

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 and/or adjacent areas for petroleum storage and refining processes;
- The suspected USTs;
- Unidentified USTs;
- Historical use of the site for unknown commercial/industrial purposes; and
- Historical activities such as use of pesticides.

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;
- OCPs including Aldrin, dieldrin, chlordane, DDT, DDD, DDE and heptachlor;
- OPPs;
- PCBs;
- Cyanide (low probability); 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;
- VOCs;
- PAHs;
- Oil and grease; and
- Cyanide (low probability).

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. The transport of contaminants may also be associated with tidal movement in the areas immediately adjacent to Blackwattle Bay.

6.4 Sediment and Harbour Water

The screening of the sediment and harbour water immediately adjacent to the site was undertaken to provide baseline data prior to commencement of the proposed development works.

The sediment samples were analysed for a range of contaminants including:

- Heavy metals: arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc;
- TPH;
- BTEX;
- PAHs including benzo(a)pyrene;
- OCPs;
- OPPs;
- PCBs;
- Total Cyanide; and
- Tributyltin.

The harbour water samples were analysed for a range of contaminants including:

- Heavy metals: arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc;
- TPH;
- VOCs;

- PAHs including benzo(a)pyrene;
- Total Cyanide; and
- Tributyltin.

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[12]).

The CLM Act 1997, associated regulations, SEPP55 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:

[12] *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[13]) and associated regulations and guidelines including the *NSW DECC (now DECCW) Waste Classification Guidelines - Part 1: Classifying Waste* (2009[14]). 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[15]) and the National Environmental Protection Council document *National Environmental Protection (Assessment of Site Contamination) Measure* (1999[16]). The contaminant thresholds listed below are levels at which further investigation and

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

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

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

[16] *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[17]) 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.

Soil samples for this investigation have been analysed for total recoverable hydrocarbons (TRH) rather than TPH. TRH analysis is undertaken without a preliminary silica gel clean-up of the sample. Consequently the TRH result may include other compounds such as phthalates, humic acids, fatty acids and sterols (if present). For comparative purposes in relation to the threshold concentrations, we have referred to TRH as TPH within this report.

7.2.1 Sediments

The sediment threshold concentrations adopted for this investigation are presented in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (2000[18]) document. The values are referred to as Interim Sediment Quality Guidelines (ISQG). The ISQGs have an upper and lower value, referred to as ISQG-low and ISQG-high. The ISQG-low values are the levels below which adverse effects on organisms are very unlikely. The ISQG-high values are the levels above which are known to

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

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

adversely affect some organisms. For those contaminants with no ISQGs, the relevant HILs have been adopted. For the purpose of this investigation, the ISQGs have been referred to as site assessment criteria (SAC).

7.2.2 Asbestos in Soil

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"

"*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.

7.2.3 Site Assessment Criteria (SAC) for Soil Contaminants

The 'parks and recreational open space' (Column E) exposure setting has been adopted for this assessment and the appropriate soil criteria are listed in the following table:

[19] *Working with Asbestos Guide,* NSW WorkCover, 2008 (WorkCover Working with Asbestos Guide 2008)
[20] *Occupational Health and Safety Regulation,* NSW Government, 2001 (NSW OH&S Regulation 2001)

Contaminant	SAC - HILs Column E (mg/kg)
Heavy Metals	
Arsenic (total)	200
Cadmium	40
Chromium (III)	24%
Copper	2000
Lead	600
Mercury (inorganic)	30
Nickel	600
Zinc	14000
Petroleum Hydrocarbons	
TPH (C_6-C_9)	65 [a]
TPH (C_{10}-C_{36})	1000 [a]
Benzene	1 [a]
Toluene	1.4 [a]
Ethylbenzene	3.1 [a]
Total Xylenes	14 [a]
PAHs	
Total PAHs	40
Benzo(a)pyrene	2
Pesticides (OCPs & OPPs)	
Aldrin + Dieldrin	20
Chlordane	100
DDT + DDD + DDE	400
Heptachlor	20
Total OPPs	0.1[b]
Others	
Cyanides (complexed)	1000
PCBs (Total)	20
Asbestos	NDLR [c]

Note:

[a] Service Station Guidelines 1994

[b] Due to the absence of locally endorsed guideline criteria, the laboratory practical quantitation limit (PQL) has been adopted.

[c] Not Detected at Limit of Reporting (NDLR)

Reference should be made to the attached Table D for details regarding the sediment SAC.

7.2.4 Waste Classification Assessment Criteria

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 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[21]). 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.

7.3.1 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)[22]. 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

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

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

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 I for further details.

7.4 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[23]).

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 SAC, 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 SAC. Validation of the remediated site is generally required to demonstrate that the site is suitable for the proposed land use.

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

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 water quality guidelines document (ANZECC 2000) 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[26]). 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.

Guidance on the remediation and management of contaminated groundwater is presented in the document *NSW DECCW (EPA) Guidelines for the Assessment and Management of Groundwater Contamination (2007[27])*.

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

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

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

[27] *Guidelines for the Assessment and Management of Groundwater Contamination,* NSW DECCW, 2007 (Groundwater Contamination Guidelines 2007)

7.5.1 Petroleum Hydrocarbons in Groundwater

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

7.5.2 Hardness Modified Trigger Values (HMTVs)

Water hardness can affect the bioavailability of metals/metalloids in fresh water. Consequently, Section 3.4.3.2 of the ANZECC 2000 guidelines includes algorithms to derive hardness modified trigger values (HMTVs) for metals/metalloid concentrations in fresh water. The calculations for the HMTVs are included in Appendix F and have been included in the SAC table below. Only the groundwater results for MW605 and MW606 have been compared with the HMTVs. The groundwater in MW608 was considered too saline for the HMTVs to be applicable.

7.5.3 Site Assessment Criteria (SAC) for Groundwater Contaminants

The marine groundwater trigger values have been adopted along with other guideline values for this investigation as outlined in the following table:

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

Groundwater Contaminant Assessment Criteria (mg/L)	
Contaminant	**95% Trigger Value for Marine Water**
Inorganics	
Arsenic	0.0023[t]
Cadmium	0.0055
Chromium	0.01[t]
Copper	0.0013
Lead	0.0044
Mercury	0.0004
Nickel	0.07
Zinc	0.015
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[#]
VOCs	See Table E
Naphthalene	0.16
Phenanthrene	0.0006[L]
Anthracene	0.0004[t]
Fluoranthene	0.001[L]
Benzo(a)pyrene	0.0001[L]
TPH C_{10}-C_{36}	0.6[c]
Other	
Total Cyanide	0.004
Oil and grease	10[#]

Note:

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

[c] Due to the absence of locally endorsed criteria, the Dutch Guidelines 2000 have been adopted

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

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

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

Note: Reference should also be made to the hardness modified trigger values presented in Table E

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 17 evenly spaced sampling points for a site of this size (approximately 7,000m^2).

Samples were obtained from 10 sampling locations (BH601 to BH610 inclusive) for this investigation. This density is approximately 60% of the minimum sampling density. The boreholes were drilled on a relatively systematic sampling plan with a spacing of approximately 30-40m between sampling points. This sampling density and sampling plan was considered most appropriate for this investigation as:

- The sample locations and sample spacing were considered to address the conditions in the vicinity of the contaminant point sources (i.e. the USTs);
- The distribution of contamination was also expected to be associated with imported potentially contaminated fill material and is therefore likely to be random;
- A significant amount of soil and groundwater contamination data has already been obtained for the area immediately adjacent to (and up-gradient of) the site
- The sensitivity of the current/proposed land use is conducive to a reduced sampling density due to the reduced risks and likelihood of exposure to potential site contamination.

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

The sediment and harbour water screening included sampling from three locations (SSA/SWA to SSC/SWC inclusive) immediately adjacent to the site. Sampling for the acid sulfate soil assessment was undertaken from four selected boreholes, together with the three sediment sampling locations.

8.2 Groundwater Sampling

The assessment included the installation of three groundwater monitoring wells in selected boreholes. The location of the groundwater monitoring wells is shown on Figures 2 and 3.

8.3 Data Quality Objectives (DQOs)

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

DQOs	
State the problem	The historical information identified that the site was most likely used for industrial purposes in the early to mid 1900s. The principal contaminants of concern at the site include heavy metals, TPH/BTEX, VOCs (in groundwater), PAHs, OCPs, OPPs, PCBs, and asbestos. The site also lies within a risk area for potential acid sulfate soils.
Identify the decision	The primary objectives of the investigation were to: • Assess the soil and groundwater contamination conditions at the site in relation to the proposed redevelopment of the site for use as waterfront parkland; • Assess the soil conditions at the site for acid sulfate soil potential; • Assess the contamination and acid sulfate soil conditions in the sediments of Blackwattle Bay, immediately adjacent to the existing seawall; • Assess the seawater contamination conditions in Blackwattle Bay, immediately adjacent to the seawall; • Prepare preliminary waste classification documentation for off-site disposal of excavated soil associated with the proposed development works; and • Prepare a report presenting the results of the preliminary assessment.
Identify inputs into the decision	The following data will be reviewed to resolve the decision statement: • Site history information; • Previous site investigation results including soil and groundwater laboratory analysis data; and • Physical site data that includes topography and other relevant information. The soil contamination assessment included: • Soil sampling from 10 boreholes drilled at the site; • Laboratory analysis of: - Twenty three fill and three natural samples for heavy metals; - Twenty four fill and three natural samples for PAHs; - Twelve fill samples for OCPs, OPPs and PCBs; - Five fill samples for total cyanide; - Twenty three fill and three natural samples for TPH/BTEX; - Twenty three fill samples for asbestos; - The sediment and harbour water screening included sampling from three locations immediately adjacent to the site. The groundwater contamination assessment included: • Installation of three groundwater monitoring wells in selected boreholes; • Laboratory analysis of three groundwater samples for the following contaminants and parameters: heavy metals, PAHs, TPH, VOCs, Oil and grease, total cyanide, pH, EC and hardness.

	The sediment and harbour water screening included: • Sampling from three locations within Blackwattle Bay, immediately to the west of the site; • Laboratory analysis of selected samples for a range of contaminants including heavy metals, TPH/BTEX, PAHs, OC/OP/PCBs, sPOCAS. • Laboratory analysis of three groundwater samples for the following contaminants and parameters: heavy metals, PAHs, TPH, VOCs, Oil and grease, total cyanide, pH, EC and hardness. Details of the field QA/QC adopted for the assessment is outlined in Section 8.4 below.
Study Boundaries	The soil and groundwater contamination assessment was confined to the boundaries of the site as shown in Figures 2 and 5. The sediment and harbour water screening was confined to three locations as shown on Figure 2.
Develop a Decision Rule	The results of the laboratory analyses were compared with the SAC 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 (QA)

The validation, as part of the DQOs, involves the technical review of the data using defined 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 • Preparation of sampling location plan • Preparation of chain of custody (COC) records • Laboratory sample receipt information • NATA registered laboratory results
Data Completeness	• Appropriately distributed sampling • Sampling program with reference to the Sampling Design Guidelines 1995 • On-site visual and PID assessment of samples • Analysis for all potential contaminants of concern
Data Comparability	• The use of appropriate sampling techniques • The use of appropriate preservation, storage and transport methods • The use of NATA registered laboratories for all analyses
Data Representativeness	• Adequate coverage of sample locations across the site • Representative coverage of analysis for contaminants of concern
Data Precision and Accuracy	• Use of trained and qualified field staff • Appropriate industry standard sampling equipment and decontamination procedures • Field QA/QC including collection and analysis of the following for the contaminants of concern: ➢ approximately 5-7% of field soil samples as inter-laboratory duplicates; ➢ approximately 10-15% of field soil samples as intra-laboratory duplicates; ➢ field blank samples, rinsate samples of field equipment, and ➢ soil/water trip spike samples. • 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: ➢ For results that were greater than 10 times the Practical Quantitation Limit (PQL) RPDs less than 50% were considered acceptable; ➢ For results that were between 5 and 10 times PQL RPDs less than 75% were considered acceptable; and ➢ For results that were less than 5 times the PQL RPDs less than 100% were considered acceptable. • Review of laboratory QA/QC data (including surrogate recovery, repeat analysis, duplicates, matrix spikes and method blanks) • Acceptable concentrations in blank samples • Check of laboratory quality control methods and results

9 INVESTIGATION PROCEDURE

9.1 Soil Sampling Methods

Subsurface investigation for the boreholes (BH601 to BH610 inclusive) was undertaken using a truck mounted hydraulically operated drill rig equipped with spiral flight augers. Soil samples were obtained from a Standard Penetration Test (SPT) sampler or directly from the auger when conditions did not allow use of the SPT sampler.

The SPT sampler was washed with phosphate free detergent and rinsed following each sampling event. The spiral flight augers were decontaminated using a scrubbing brush and potable water and Decon 90 solution (phosphate free detergent) followed by rinsing with potable water. Details of the decontamination procedure adopted during sampling are presented in Appendix D.

Subsurface investigation at the sediment sampling locations was undertaken using a hand auger. The hand auger was rinsed prior to each sampling event.

Soil and sediment 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 for contamination testing were placed in glass jars with plastic caps and teflon seals with minimal headspace. Samples for asbestos analysis were placed in zip-lock plastic bags. 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[29] and AS 4482.2-1999[30] as summarised in the following table:

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

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

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

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 volatile organic compounds (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. PID calibration records are presented in Appendix E.

9.3 Groundwater Monitoring Well Installation

Three monitoring wells, MW605, MW606 and MW608, were installed in boreholes BH605, BH606 and BH608 respectively as shown on Figures 2 and 3. 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 to the client when received.

The well construction details are summarised in the following table:

Borehole No.	Final Depth (m)	Un-slotted PVC[1] Casing (m)	Machine Slotted PVC[1] Screen (m)	Sand Filter Pack (m)	Bentonite Seal (m)	Well Finishing Details[2]
BH605	6.0	0-3.0	3.0-6.0	To 1.0	1.0-0.5	Gatic cover
BH606	4.0	0-1.0	1.0-4.0	4.0-0.7	0.7-0.5	Gatic cover
BH608	6.0	0-3.0	3.0-6.0	6.0-2.0	2.0-1.6	Gatic cover

Notes:
[1] 50mm diameter Class 18 PVC has been used for the wells
[2] Concrete grout was used to seal the monitoring well

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 8L to 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.

Due to the relatively slow infiltration of groundwater into MW606 and MW608, groundwater was removed from these wells until they were effectively 'dry'.

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

The monitoring wells were allowed to recharge prior to sampling. The pump and hose were flushed between sampling point with potable water. Details of the decontamination procedure adopted during sampling 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. When the drum is filled a sample is analysed to classify the water for disposal.

9.5 Groundwater Sampling

Groundwater samples were obtained from the monitoring wells 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.

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[31] as summarised in the following table:

[31] *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	45μm 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

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).

9.6.1 Soil Samples

For this investigation selected soil and sediment 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;
- Cyanide – Determined colourmetrically after distillation;
- TBT – Extraction with acidified ethanol then derivitisation with sodium tetraethylborate. Ethylated derivatives extracted in hexane and analysed by GC-AED; 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.

9.6.2 Groundwater Samples

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;
- Cyanide – Determined colourmetrically after distillation;
- TBT – Solid phase extraction of alkyltins. Cartidge elution with acidified ethanol then derivitisation with sodium tetraethylborate. Ethylated derivatives extracted in hexane and analysed by GC-AED;
- 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

Concrete pavement was encountered at the surface in BH601 to BH604 (inclusive). The pavement ranged in thickness from approximately 0.17m to 0.23m. Asphaltic concrete (AC) pavement was encountered at the surface in all remaining boreholes and ranged in thickness from approximately 0.04m to 0.15m. A secondary pavement (concrete) was encountered under the AC in BH606.

Fill

Fill material was encountered beneath the pavement in all 10 boreholes and extended to depths ranging from approximately 1.1m in BH609 to 5.5m in BH601. The fill material typically consisted of brown and grey brown silty clayey sand, silty sand and silty sandy clay with inclusions of igneous and sandstone gravel, sandstone cobbles, bricks/brick fragments, ash and slag. BH602 and BH603 refused in the fill material at depths of approximately 3.5m and 2.5m respectively.

Natural Soils

Natural silty clay/clayey silt, silty sand and/or silty clayey sand was encountered beneath the fill in BH601, BH604, BH605, BH607 and BH610. The natural soils varied in colour from dark grey, to grey and brown. Shell fragments were encountered in the natural soils in most boreholes. BH601, BH604, BH605, BH607 and BH610 were terminated in the natural soil at depths ranging from approximately 6.45 to 6.0m.

Bedrock

Sandstone bedrock was encountered beneath the fill material in BH606, BH608 and BH609. The sandstone was typically light grey, brown or orange brown. BH606, BH608 and BH609 were terminated in the sandstone at depths of 4.0m, 6.0m and 1.5m respectively.

Groundwater

Groundwater seepage was encountered during drilling in several boreholes. Seepage depths ranged from approximately 2.0m to 4.0m. Groundwater monitoring wells were installed in boreholes BH605, BH606 and BH608. Standing Water Level (SWL) measured in the monitoring wells (from existing ground level) during the investigation is presented in the following table:

Monitoring Well	SWL (m) on 22.7.10	SWL (m) on 27.7.10
MW605	2.1	2.04
MW606	2.19	2.18
MW608	1.71	1.56

10.2 Laboratory Results

The laboratory reports are presented in Appendix B. The results have been assessed against the SAC adopted for this investigation.

10.2.1 Soil Samples

The soil laboratory results are presented in Tables B and C. 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

Twenty three fill and three natural soil samples were analysed for heavy metals. A marginally elevated concentration of lead, above the SCA of 600mg/kg, was encountered in BH601 (0.6m-0.95m). The elevated lead concentration was 640mg/kg. The results of the remaining analyses were below the SAC.

The upper 95% confidence limit (95% UCL) value was calculated using the lead data from the fill soil samples. The 95% UCL for lead was 153mg/kg which was below the SAC of 600mg/kg. The data followed a gamma distribution with a mean and standard deviation of 92mg/kg and 160mg/kg respectively.

Waste Classification:

The lead concentrations in four fill samples, chromium concentration in one fill sample and nickel concentrations in two fill samples exceeded CT1 criteria outlined in the Waste Classification Guidelines 2009. The remaining heavy metal concentrations were below the SCC1 criteria. All results were below the SCC1 criteria.

TCLP leachates were prepared from the relevant fill samples and analysed for lead, chromium and/or nickel. The results were less than the 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 50.6ppm equivalent isobutylene. These results indicate that PID detectable volatile organic contaminants may be present in some samples. The highest PID readings were typically encountered in samples obtained from BH606, adjacent to the suspected UST.

Twenty three fill and three natural soil samples were analysed for TPH and BTEX compounds. Elevated concentrations of mid to heavy fraction (C_{10}-C_{36}) TPH, above the SAC of 1,000mg/kg, were encountered in fill soil samples obtained from BH604 to BH608 (inclusive). The elevated TPH (C_{10}-C_{36}) concentrations ranged from 1,230mg/kg in BH606 (1.7 m-1.95m) to 22,100mg/kg in BH606 (2.2m-2.5m).

The remaining TPH and BTEX results were below the SAC. However, it was noted that the PQLs for light fraction (C_6-C_9) TPH and the BTEX compounds in BH606 (2.2m-2.5m) were raised above the SAC. This may have resulted in LPQLs being recorded when in fact the contaminant concentrations may have been above the SAC.

The 95% UCL value was calculated using the TPH (C_{10}-C_{36}) data from the fill soil samples. The 95% UCL for TPH (C_{10}-C_{36}) was 5,630mg/kg which was above the SAC of 1,000mg/kg. The data followed a non-parametric distribution with a mean and standard deviation of 1,647mg/kg and 4,476mg/kg respectively.

Waste Classification:

The TPH (C_{10}-C_{36}) concentration in BH606 (2.2m-2.5m) exceeded the SCC1 criterion outlined in the Waste Classification Guidelines 2009. However, as noted above the 95% UCL was 5,630mg/kg and was less than the SCC1 criterion. The results of the remaining analyses were less than the relevant CT1and SCC1 criteria outlined in the Waste Classification Guidelines 2009.

Polycyclic Aromatic Hydrocarbons (PAHs)

Twenty three fill and three natural soil samples were analysed for a range of PAHs including benzo(a)pyrene. Elevated concentrations of total PAHs, above the SAC

of 40mg/kg, were encountered in four fill soil sample obtained from BH601 (0.3m-0.5m), BH606 (2.2m-2.5m), BH607 (0.5m-0.7m) and BH610 (0.7m-0.95m). The concentrations of total PAHs in these samples were 46.3mg/kg, 249.9mg/kg, 47.9mg/kg and 40.9mg/kg respectively.

Elevated concentrations of benzo(a)pyrene, above the SAC of 2mg/kg, were encountered in seven fill soil samples. The elevated benzo(a)pyrene concentrations ranged from 3mg/kg in BH602 (1.7m-1.92m) to 24mg/kg in BH606 (2.2m-2.5m). The results of the remaining analyses were below the SAC.

The 95% UCL values were calculated using the total PAH and benzo(a)pyrene data from the fill soil samples. The 95% UCL for total PAHs was 66mg/kg which was above the SAC of 40mg/kg. The data followed a non-parametric distribution with a mean and standard deviation of 21mg/kg and 51mg/kg respectively.

The 95% UCL for benzo(a)pyrene was 6.7mg/kg which was above the SAC of 2mg/kg. The benzo(a)pyrene data followed a non-parametric distribution with a mean and standard deviation of 2.2mg/kg and 5mg/kg respectively.

Waste Classification:

The benzo(a)pyrene concentrations in seven fill samples exceeded the CT1 criterion outlined in the Waste Classification Guidelines 2009. The total PAH concentration in BH606 (2.2m-2.5m) exceeded the SCC1 criterion. The benzo(a)pyrene concentration in BH606 (2.2m-2.5m) exceeded the SCC2 criterion.

TCLP leachates were prepared from the relevant fill samples and analysed for PAHs. The results were less than the TCLP1 criterion for benzo(a)pyrene.

Organochlorine (OCPs) and Organophosphorus (OPPs) Pesticides

Twelve fill soil samples were analysed for a range of OCPs and OPPs. The results of the analyses were below the laboratory PQL and less than the SAC.

Waste Classification:

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

Polychlorinated Biphenyls (PCBs)

Twelve fill soil samples were analysed for a range of PCBs. The results of the analyses were below the laboratory PQL and less than the SAC.

Waste Classification:

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

Total Cyanide

Five fill soil samples were screened for the presence of cyanide. The results of the analysis were below the laboratory PQL and less than the SAC.

Waste Classification:

The results of all analyses were less than the CT1 criterion outlined in the Waste Classification Guidelines 2009.

Asbestos

Twenty three fill soil samples were screened for the presence of asbestos fibres. The results of the analyses indicated that asbestos fibres were not encountered within the samples and no respirable fibres were detected.

10.2.2 Sediment Samples

The sediment laboratory results and SAC are presented in Table D. The results of the analyses are summarised below.

Heavy Metals

Three sediment samples (SSA, SSB and SSC) were analysed for heavy metals. Elevated concentrations of copper, lead, mercury and zinc, above the relevant ISQG-low SAC, were encountered in all three samples. An elevated concentration of nickel, above the ISQG-low SAC was also encountered in SSB. The lead concentration in one sample (SSA), mercury concentration in one sample (SSB) and zinc concentrations in two samples (SSA and SSB) also exceeded the respective ISQG-high SAC.

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

The three sediment samples were analysed for TPH and BTEX compounds. Elevated concentrations of TPH (C_{10}-C_{36}), above the adopted SAC of 1,000mg/kg, were encountered in SSA and SSB. The TPH (C_{10}-C_{36}) concentrations were 1,160mg/kg and 1,260mg/kg respectively. The remaining TPH and BTEX concentrations were below the adopted SAC.

Polycyclic Aromatic Hydrocarbons (PAHs)

The three sediment samples were analysed for PAHs. Elevated concentrations of total PAHs, together with numerous PAH compounds exceeded the ISQG-low

SAC in all three samples. The concentrations of benzo(a)pyrene in SSA and SSB also exceeded the ISQG-high SAC.

Organochlorine (OCPs) and Organophosphorous (OPPs) Pesticides

The three sediment samples were analysed for OCPs and OPPs. The results of the analyses were below the laboratory PQL and less than the adopted SAC.

Polychlorinated Biphenyls (PCBs)

The three sediment samples were analysed for PCBs. The results of the analyses were below the laboratory PQL and less than the adopted SAC.

Total Cyanide

Five fill soil samples were screened for the presence of cyanide. The results of the analysis were below the laboratory PQL and less than the SAC.

Tributyltin (TBT)

The three sediment samples were analysed for TBT. The TBT concentrations in SSA, SSB and SSC were 0.23mg/kg, 0.045mg/kg and 0.023mg/kg respectively. These concentrations all exceeded the ISQG-low SAC of 0.005mg/kg. The SSA TBT concentration also exceeded the ISQG-high SAC of 0.07mg/kg.

10.2.3 Acid Sulfate Soil Analysis

The laboratory results for the acid sulfate soil assessment are presented in Table I and analysis reports are presented in Appendix B. The assessment criteria adopted for this investigation are specified in Section 7.3.1.

sPOCAS analyses was scheduled on a total of eight fill samples, two natural soil samples and three sediment samples. The results of the analyses are summarised below:

Soil

- Soil pH_{KCl} results ranged from 5.6 to 9.6. These results indicated that the soil suspended in potassium chloride solution was generally slightly acidic to alkaline prior to oxidation;
- Following oxidation the pH_{ox} results for the soil samples ranged from 2.5 to 7.8. Half of the results were below pH 5. The largest differences in pH were generally recorded in the natural soil samples which generally dropped by 4 or more pH units.

Sediment

- The pH_{KCl} results for the soil ranged from 8.7 to 8.9. These results indicated that the soil suspended in potassium chloride solution was alkaline prior to oxidation; and
- Following oxidation the pH_{ox} results for the soil samples ranged from 2.9 to 7.2. The SSB and SSC samples recorded the most significant drop in pH, with both samples dropping by at least 4 pH units.

Acid Trail

Soil

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

Sediment

- Titratable actual acidity (TAA) results indicated that the soils were non-acidic prior to oxidation;
- Total potential acidity (TPA) results for two samples (SSB and SSC) were above the SAC. The remaining TPA results were less than the SAC; and
- Titratable sulfidic acidity (TSA) results for two samples (SSB and SSC) were above the SAC. The remaining TPA results were less than the SAC.

Sulfur Trail

Soil

The S_{pos}% results for the two natural soil samples and one of the fill samples were above the SAC. The most significant S_{pos}% was recorded for the natural soil sample obtained from BH601 (5.8m-6.0m).

Sediment

The S_{pos}% results for all three sediment samples were above the SAC.

10.2.4 Groundwater Samples

The groundwater laboratory results are presented in Table E. The results of the analysis are summarised below:

Heavy Metals

Three groundwater samples (MW605, MW606 and MW608) were analysed for heavy metals. Elevated concentrations of arsenic, above the SAC of 0.0023mg/L, were encountered in all three samples. The arsenic concentrations ranged from 0.003mg/L to 0.004mg/L. Elevated concentrations of copper, lead and zinc, above the respective SAC of 0.0013mg/L, 0.0044mgL and 0.015mg/L, were also encountered in MW608. The concentrations of copper, lead and zinc in the MW608 sample were 0.057mg/L, 0.008mg/L and 0.17mg/L respectively.

Petroleum Hydrocarbons (TPH)

The three groundwater samples were analysed for TPH and BTEX compounds. Elevated concentrations of TPH (C_{10}-C_{36}), above the SAC of 0.6mg/L, were encountered in MW606 and MW608. The TPH (C_{10}-C_{36}) concentrations in the MW606 and MW608 samples were 1.15mg/L and 0.638mg/L respectively. The results of the remaining TPH analyses were below the SAC.

It was noted that the PQLs for light fraction (C_6-C_9) TPH in samples MW606 and MW608 were raised to a level that exceeded the SAC as the samples were 'foamy' and required dilution (as reported by Envirolab Services). This may have resulted in LPQLs being recorded when in fact the contaminant concentrations may have been above the SAC.

Volatile Organic Compounds (VOCs)

The three groundwater samples were analysed for VOCs. The results of the analyses were below the SAC. Detectable concentrations of the VOCs isopropylbenzene (0.003mg/L) and n-propyl benzene (0.0013mg/L) were encountered in the MW605 sample, however these concentrations were significantly less than the SAC.

It was noted that the PQLs for VOCs in samples MW606 and MW608 were raised as the samples were 'foamy' and required dilution (as reported by Envirolab Services). This may have resulted in LPQLs being recorded when in fact the contaminant concentrations for some compounds may have been above the SAC.

Polycyclic Aromatic Hydrocarbons (PAHs)

The three groundwater samples were analysed for a range of PAHs including benzo(a)pyrene. Elevated concentrations of phenanthrene, above the SAC of 0.0006mg/L, were encountered in MW605 and MW606. The phenanthrene concentrations in MW605 and MW606 were 0.0029mg/L and 0.0008mg/L respectively. An elevated concentration of Anthracene, above the SAC of

0.0004mg/L, was also encountered in MW605. The anthracene concentration in MW605 was 0.0006mg/L. The results of the remaining PAH analyses were below the adopted SAC.

Cyanide

The three groundwater samples were analysed for cyanide. The results of the analysis were below the laboratory PQL and less than the SAC.

Other Parameters

Three groundwater samples were analysed for pH, EC and hardness. The results were as follows:

- pH ranged from 5.7 in MW608 to 7 in MW605;
- EC ranged from 1.2mS/cm in MW605 to 8.9mS/cm in MW608; and
- Hardness ranged from 387$CaCO_3$/L in MW605 to 1346mg$CaCO_3$/L in MW608.

Field Measurements

Field measurements recorded during sampling are as follows:

- pH ranged from 5.4 to 6.9;
- EC ranged from 1.4mS/cm to 11.9mS/cm;
- Eh ranged from 35.9mV to 272.9mV; and
- DO ranged from 0.2ppm to 0.7ppm.

10.2.5 Harbour Water Samples

The harbour water laboratory results are presented in Table E1. The results of the analysis are summarised below:

Heavy Metals

Three harbour water samples (SWA, SWB and SWC) were analysed for heavy metals. Elevated concentrations of copper and zinc, above the respective SAC of 0.0013mg/L and 0.015mg/L, were encountered in all three samples. The concentrations of copper in SSA, SSB and SSC were 0.012mg/L, 0.008mg/L and 0.008mg/L respectively. The concentrations of zinc were 0.026mg/L, 0.024mg/L and 0.029mg/L respectively. The remaining heavy metal concentrations were below the SAC.

Petroleum Hydrocarbons (TPH)

The three harbour water samples were analysed for TPH. The results of the analyses were below the laboratory PQL and less than the SAC.

Volatile Organic Compounds (VOCs)

The three harbour water samples were analysed for VOCs. The results of the analyses were below the laboratory PQL and less than the SAC.

Polycyclic Aromatic Hydrocarbons (PAHs)

The three harbour water samples were analysed for a range of PAHs including benzo(a)pyrene. The results of the analyses were below the laboratory PQL and less than the SAC.

Cyanide

The three harbour water samples were analysed for cyanide. The results of the analysis were below the laboratory PQL and less than the SAC.

Tributyltin (TBT)

Two selected harbour water samples obtained from SWB and SWC were analysed for TBT. The results of the analysis were below the laboratory PQL and less than the SAC.

Field Measurements

Field measurements recorded during sampling are as follows:

- pH ranged from 7.32 to 7.86;
- EC ranged from 33.2mS/cm to 33.8mS/cm;
- Eh ranged from 249.1mV to 255.4mV; and
- DO ranged from 6.7ppm to 7.7ppm.

11 ASSESSMENT OF ANALYTICAL QA/QC

The DQOs and DQIs established for the investigation have been assessed in this section of the report. The assessment includes a review of the laboratory QA/QC procedure to assess whether the sample data is reliable.

The laboratory reports for this investigation have been checked and issued as final by:

- Envirolab Services Pty Ltd
  NATA Accreditation No. 2901
  Report numbers: 43806, 43806-A, 43809, 43817, 43818 and 44007.
- SGS Laboratories Pty Ltd
  NATA Accreditation No. 2562
  Report numbers: SE80060 and SE80198.

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

Field QA/QC	Sample Details
Inter-laboratory duplicates	*Soil Samples:* Dup 1 is a soil duplicate of sample BH608 (0.3m-0.5m) Dup 2 is a soil duplicate of sample BH608 (1.3m-1.5m) *Groundwater Samples:* GW Dup 2 is a groundwater duplicate of sample MW605
Intra-laboratory duplicates	*Soil and Sediment Samples:* Dup 3 is a soil duplicate of sample BH609 (0.2m-0.5m) Dup 4 is a soil duplicate of sample BH606 (1.7m-1.95m) Dup 7 is a soil duplicate of sample BH602 (0.3m-0.5m) Dup 8 is a soil duplicate of sample BH604 (0.3m-0.5m) SS Dup is a sediment duplicate of sample SSA *Groundwater and Harbour Water Samples:* GW Dup 1 is a groundwater duplicate of sample MW608 SW Dup is a harbour water duplicate of sample SWA
Trip blanks	Trip Blank A is a sand blank taken on 20/7/10 Trip Blank B is a sand blank taken on 21/7/10 GW Trip Blank is a water blank taken on 27/7/10
Trip spikes	Trip Spike A (soil sampling) taken on 20/7/10 Trip Spike B (soil sampling) taken on 21/7/10 SS Trip Spike (sediment sampling) taken on 22/7/10

	SW Trip Spike (harbour water sampling) 22/7/10 GW Trip Spike (groundwater sampling) 27/7/10
Rinsate	Rinsate A is a field rinsate from the SPT decontamination process (20/7/10) Rinsate B is a field rinsate from the SPT decontamination process (21/7/10)

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

The following field staff completed the activities associated with this project:

- Brendan Page – Environmental Scientist – soil sampling and field testing activities.

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.

DQI	Comments
Precision	Intra-laboratory RPD Results: The intra-laboratory RPD values for the soil and sediment samples indicated that field precision was acceptable. The RPD values for a range of individual PAHs and heavy metals were outside the acceptance criteria (refer to Table F). The results ranged from 67% to 190%. The RDP values 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 as a conservative measure. The intra-laboratory RPD values of the groundwater and harbour water samples indicated that the field precision was acceptable (refer to Table G). The RPD value for copper (82%) was marginally outside the acceptable limits for SWA/SW Dup. The higher duplicate value has been adopted as a conservative measure. Inter-laboratory RPD Results: The inter-laboratory RPD values for the soil samples indicated that field precision was acceptable. The RPD value for TPH (C29-36) was marginally outside the acceptance criteria (refer to Table F). This has 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 as a conservative measure. The inter-laboratory RPD values for the groundwater samples indicated that field precision was acceptable. The RPD values for a range of individual PAHs and heavy metals were outside the acceptance criteria (refer to Table G). The results ranged from 58% to 156%. The RDP values outside the acceptable limits have been attributed to results that are close to the PQL. Where applicable, the higher duplicate value has been adopted as a conservative measure. <u>Laboratory Duplicate RPD Results:</u> Laboratory duplicate RPD results for the soil and groundwater analysis were generally within the acceptance criteria adopted by the laboratories. Slightly elevated RPD results were reported for individual PAHs in the Envirolab Report 43806. Slightly elevated RPDs were also reported for the sPOCAS testing in report 43818. These results are considered to indicate sample heterogeneity rather than laboratory inaccuracy. <u>Trip Spike Results:</u> The BTEX results for the trip spikes ranged from 74% to 122%, (refer to Table H) and indicated that field preservation methods were appropriate. <u>Field Rinsate Results:</u> The field rinsate samples (refer to Table H) did not identify any cross-contamination artefacts associated with sampling equipment. <u>Trip Blank Results:</u> The soil and water trip blank results did not encounter analyte concentrations above the laboratory PQLs.
Accuracy	<u>Matrix Spike Recovery:</u> Matrix spike recovery concentrations were within the acceptable limits of 60-140% for organics and 70-130% for inorganics. <u>Surrogate Spike Recovery:</u> Surrogate spike recovery concentrations were within the acceptable limits of 60-140% for organics and 70-130% for inorganics. It is noted that surrogate concentrations were not reported for TPH in some soil samples, with the lack of results explained as matrix interference. <u>LCS Results:</u> LCS recovery concentrations were within the acceptable limits of 60-140% for organics and 70-130% for inorganics.

Representativeness	• Sample collection, handling, storage and preservation were considered appropriate; • No laboratory artefacts were detected; and • Samples extracted and analysed within holding time. <u>Laboratory Blank Results:</u> All laboratory blanks were found to be free of analyte concentrations above the PQLs.
Comparability	• Same sampling procedures and handling techniques were used; • Samples were obtained by qualifications staff; • Samples were collected in appropriate containers; • No significant influence on sampling from climatic or sampling conditions were reported; and • Standard laboratory analytical methods were used.
Completeness	• Documentation (including site notes, borehole logs and COC etc) was correctly maintained; • Samples obtained were analysed for the contaminants of concern; and • Appropriate analytical methods used by the laboratory.

12 DISCUSSION

The preliminary environmental site assessment undertaken for the proposed redevelopment of the SFM waterfront was designed to:

- Assess the soil and groundwater contamination conditions at the site in relation to the proposed redevelopment of the site for use as waterfront parkland;
- Assess the soil conditions at the site for acid sulfate soil potential;
- Assess the contamination and acid sulfate soil conditions in the sediments of Blackwattle Bay, immediately adjacent to the existing seawall;
- Assess the harbour water contamination conditions in Blackwattle Bay, immediately adjacent to the seawall;
- Prepare preliminary waste classification documentation for off-site disposal of excavated soil associated with the proposed development works; and
- Prepare a report presenting the results of the preliminary assessment.

12.1 Summary of Soil Conditions

Soil samples obtained for the investigation were analysed for the potential contaminants of concern identified at the site. Elevated concentrations of contaminants were encountered in the fill soil samples above the SAC. The soil contamination data is shown on Figure 3. A summary of the elevated results are presented in the following table:

Contaminant (mg/kg)	SAC	No. of Fill Samples Analysed	No. of Results above SAC	95% UCL
TPH C_{10}-C_{36}	1,000	23	6	5,630
Lead	600	23	1	153
Total PAHs	40	24	4	66
B(a)P	2	24	7	6.7

The source of the TPH contamination at the site is likely to be a result of three primary factors:

- The suspected USTs;
- Unidentified USTs; and/or
- Historical activities associated with use of the site and adjacent areas for petroleum storage, distribution and/or refinery processes.

The highest TPH concentrations were encountered in BH606 which was located immediately adjacent to the suspected USTs in the central-north section of the site (see Figure 2). Due to the relatively permeable sandy soils encountered at the site and the shallow groundwater table, the potential for the contamination to migrate away

from BH606 and the UST is considered to be high. However, the potential for migration may be reduced slightly if the USTs near BH606 are founded on the sandstone bedrock. The contaminant migration may have contributed to the elevated TPH concentrations in adjacent boreholes.

The source of the PAHs (including the benzo(a)pyrene) in the fill samples is considered most likely to be associated with the ash and slag material encountered in the fill matrix. The PAHs that are commonly associated with ash and slag are usually the higher molecular weight compounds. The elevated lead concentration in BH601 (0.6m-0.95m) is also likely to be associated with the ash and slag 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 (including the adjacent areas of the SFM) that have identified similar fill material types and associated contamination conditions.

The potential for contaminant migration associated with ash and slag in fill soils is considered to be relatively low. This was supported by the TCLP data obtained during this investigation which demonstrated that significant concentrations of PAH compounds were unlikely to leach from the samples.

The source of the PAH contamination in BH606 may also be a result of contamination migration from the adjacent UST. The elevated concentrations of TPHs (C_{10}-C_{36}), together with significantly elevated concentrations of naphthalene and the higher molecular weight compounds such as benzo(a)pyrene, may be associated with fuel and/or an oil product(contained within the USTs). Alternatively the lower molecular weight PAHs such as naphthalene may be associated with fuel from the UST, and the higher molecular weight PAHs may be associated with ash and/or slag in the fill.

Based on the results of the investigation, remediation of the site will be required. A remediation action plan (RAP) should be prepared detailing the remediation options, remediation strategy and other site requirements prior to commencement of the proposed redevelopment works. Further assessment of the potential health risks associated with the contaminants may also be required.

EIS understand that the RAP will be prepared for the wider SFM redevelopment site and will include the area subject to the EIS investigation with the job reference E23982K.

12.1.1 Asbestos

Asbestos was not detected above the reporting limit in the soil samples analysed for the investigation.

A hazardous building materials assessment was outside the scope of this investigation. Prior to demolition of the existing site buildings, a suitably qualified environmental consultant should undertake a hazardous building materials survey (if not completed previously). The demolition works should be undertaken in accordance with the recommendations made within the hazardous building materials report.

12.1.2 Sediments

Elevated levels of contaminants including heavy metals, TBT, PAHs and TPHs were encountered in the sediment samples analysed for this investigation. The contamination is possibly associated with former industrial use of the adjacent SFM site together with historical and current use of Blackwattle Bay for commercial shipping. The results are considered to be typical of sediment conditions throughout Sydney Harbour.

The sediment data should be re-assessed once the details of the proposed works are confirmed. The sediment data may be used as baseline data for comparative purposes pending the requirements of the relevant regulatory bodies during the proposed seawall construction. Further detailed assessment of the sediments will be required in the event that the proposed works include significant dredging and/or off-site disposal of the sediments.

12.2 Acid Sulfate Soils

Based on the site inspection and analysis results, the risk of the generation of acid sulfate conditions following disturbance of the natural soils and sediments 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 the ASSMP can then be prepared. The ASSMP should be prepared prior to commencement of any excavation or piling works.

12.3 Summary of Groundwater Conditions

Groundwater monitoring wells were installed in boreholes BH605, BH606 and BH608. Standing Water Level (SWL) measured in the monitoring wells (from existing ground level) during the investigation is presented in the following table:

Monitoring Well	SWL (m) on 22.7.10	SWL (m) on 27.7.10
MW605	2.1	2.04
MW606	2.19	2.18
MW608	1.71	1.56

Three groundwater samples were analysed for the potential contaminants of concern identified at the site.

Summary of Elevated Groundwater Results (mg/L)							
Contaminant	Arsenic	Copper	Lead	Zinc	TPH C_{10}-C_{36}	Anthracene	Phenanthrene
SAC	0.0023	0.0013	0.0044	0.015	0.6	0.0004	0.0006
MW605	0.004	-	-	-	-	0.0006	0.0029
MW606	0.004	-	-	-	1.15	-	0.0008
MW608	0.003	0.057	0.008	0.17	0.638	-	-

(-) indicates that the contaminant was below the SAC

The heavy metal concentrations in the groundwater were considered to be the result of regional groundwater conditions rather than a site specific issue for the following reasons:

- Significant concentrations of arsenic, copper, lead or zinc in the fill material or natural sand which would represent a potential groundwater contamination source, were not identified during the this investigation;
- Elevated concentrations of these heavy metals are commonly encountered in groundwater in urban environments and are associated with factors such as surface water infiltration and leaking water infra-structure.

As a result of uncontrolled filling, 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 ANZECC 2000 promotes this approach. However, care should be taken to minimise further degradation of the groundwater quality.

The TPH and PAH contamination in the groundwater is likely to be associated with the suspected (and/or the unidentified) USTs. The site inspection, together with information reviewed as part of this assessment has indicated that several USTs may exist at the site. The condition of the USTs is likely to be severely degraded due to their age.

Due to the elevated concentrations of TPHs and PAHs in the groundwater, some remediation and/or management of the groundwater will be required. The options for groundwater remediation should be discussed in greater detail within the RAP.

12.3.1 Dewatering During Development

As no basement levels or significant excavation works are proposed, dewatering is unlikely to be required during the redevelopment works. In the unexpected event that dewatering is necessary during the proposed works, the water must not be disposed of to stormwater, sewer or the harbour without prior treatment and approval from the relevant authorities.

12.3.2 Harbour Water

Elevated levels of the heavy metals copper and zinc were encountered in each of the three harbour water samples obtained from Blackwattle Bay. These elevations are consistent with regional levels, particularly areas with high densities of recreational boats. Zinc and copper are both used in marine paints.

The harbour water data may be used as baseline data for comparative purposes pending the requirements of the relevant regulatory bodies during the proposed seawall construction. Further discussion regarding management requirements for the waterfront areas, including the sediments and harbour water, will be detailed in the RAP.

12.4 Waste Classification

12.4.1 Classification of Fill Soils

The investigation has shown that the fill material encountered at the site contains inclusions of ash and slag. A discussion regarding the likely sources of the ash and slag is presented in Section 12.1 of this report.

The *General Approvals of Immobilisation* published in the NSW Government Gazette on 16 July 1999[32] includes an immobilisation approval for metallurgical furnace slag contaminated materials (approval number 1999/07) and ash contaminated materials (approval number 1999/05). GAI 1999 states that metallurgical furnace slag and ash contaminated materials *"...can be classified according to their leachable concentration (TCLP) values alone."*, however, disposal restrictions indicate that the ash contaminated material can only be disposed of to a landfill with a leachate monitoring system. Treatment of this waste stream is not considered to be an economical option.

The fill soils at the site are classified as "General Solid Waste (non-putrescible)", according to the Waste Classification Guidelines 2009 and the GAI 1999. Further details regarding the waste classification will be provided in the RAP.

No excavation works should commence on-site prior to preparation of the ASSMP.

12.5 Conclusion

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:

- A suitable RAP is prepared for the site;
- The RAP is successfully implemented and any further works including site validation, management and/or on-going monitoring is undertaken and appropriately documented;
- An appropriate occupational health and safety plan is prepared for the contaminants encountered at this site prior to the commencement of the proposed redevelopment works; and
- During the redevelopment works, the site is regularly inspected by experienced environmental personnel to assess any unexpected conditions or subsurface facilities that may be discovered between investigation locations. This should facilitate appropriate adjustment of the works programme and schedule in relation to the changed site conditions.

12.6 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 following preparation of the RAP and selection of the remedial strategy.

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[32] *General Approvals of Immobilisation, Approval Numbers 05 and 07*, NSW Government Gazette, 1999 (GAI 1999)

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

Please note that in the event that a suitable RAP is not implemented in the near future, there may be justification to report immediately to the DECCW. EIS can be contacted for further advice regarding notification.

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. 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.

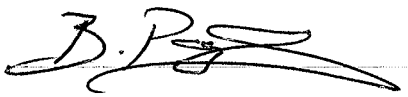
EIS have not and will not make any determination regarding finances associated with the site.

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



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

ANALYTE			HEAVY METALS								PAHs		ORGANOCHLORINE PESTICIDES				OP PESTICIDES	PCBs	Total Cyanide	PETROLEUM HYDROCARBONS								PID VALUES	ASBESTOS FIBRES
			Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Total PAHs	B(a)P	Aldrin and Dieldrin	Chlordane	DDT, DDD & DDE	Heptachlor				Petroleum Hydrocarbons C_6-C_9	C_{10}-C_{14}	C_{15}-C_{28}	C_{29}-C_{36}	C_{10} - C_{36}	Benzene	Toluene	Ethyl Benzene	Total 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	0.5	25	50	100	100	100	0.5	0.5	1	1		
Site Assessment Criteria ^			200 *	40 *	24% *	2000 *	600 *	30 *	600 *	14000 *	40 *	2 *	20 *	100 *	400 *	20 *	0.1 ^^	20 *	1000*	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	320	NSL	NSL			NSL	10	288	600	1000		
General Solid Waste SCC1+			500	100	1900	NSL	1500	50	1050	NSL	200	10	50					50	5900	650	NSL			10000	18	518	1080	1800		
Restricted Solid Waste CT2+			400	80	400	NSL	400	16	160	NSL	NSL	3.2	NSL					NSL	1280	NSL	NSL			NSL	40	1152	2400	4000		
Restricted Solid Waste SCC2+			2000	400	7600	NSL	6000	200	4200	NSL	800	23	50					50	23600	2600	NSL			40000	72	2073	4320	7200		
Location	Depth in metres	DESCRIPTION																											
BH601	0.3-0.5	Fill: Silty sandy clay	5	LPQL	14	90	150	1.5	13	180	46.3	6.1	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	NA	LPQL	LPQL	330	380	710	LPQL	LPQL	LPQL	LPQL	0	No asbestos detected
BH601	0.6-0.95	Fill: Silty clayey sand	8	LPQL	11	56	640	1.2	9	110	26.1	3.4	NA	NA	NA	NA	NA	NA	LPQL	LPQL	LPQL	120	170	290	LPQL	LPQL	LPQL	LPQL	0	No asbestos detected
BH601	3.2-3.45	Fill: Silty sand	LPQL	LPQL	4	LPQL	3	LPQL	LPQL	3	LPQL	LPQL	NA	NA	NA	NA	NA	NA	NA	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0	No asbestos detected
BH602	0.3-0.5	Fill: Silty sandy clay	12	LPQL	25	34	31	0.1	17	70	6.6	0.8	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	NA	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0	No asbestos detected
BH602	1.7-1.92	Fill: Silty sand	7	LPQL	15	33	97	0.1	7	81	20.6	3	NA	NA	NA	NA	NA	NA	NA	LPQL	LPQL	280	320	600	LPQL	LPQL	LPQL	LPQL	0	No asbestos detected
BH602	2.8-3.0	Fill: Silty sand	LPQL	LPQL	8	5	25	LPQL	2	45	0.3	0.1	NA	NA	NA	NA	NA	NA	NA	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0	No asbestos detected
BH603	0.3-0.5	Fill: Sandy gravel	LPQL	LPQL	120	61	6	LPQL	97	54	0.2	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	NA	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0	No asbestos detected
BH603	0.9-1.2	Fill: Silty sand	LPQL	LPQL	7	3	3	LPQL	6	9	LPQL	LPQL	NA	NA	NA	NA	NA	NA	NA	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0	No asbestos detected
BH604	0.3-0.5	Fill: Sandy gravel	6	1.5	41	260	520	2.6	24	840	5.6	0.8	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	NA	LPQL	630	2000	2000	4630	LPQL	LPQL	LPQL	LPQL	23	No asbestos detected
BH604	1.7-1.95	Fill: Silty clayey sand	LPQL	LPQL	25	26	44	0.2	4	37	0.1	LPQL	NA	NA	NA	NA	NA	NA	LPQL	LPQL	140	490	160	790	LPQL	LPQL	LPQL	LPQL	48.3	No asbestos detected
BH604	3.2-3.45	Silty sand	5	LPQL	7	6	21	LPQL	3	28	LPQL	LPQL	NA	NA	NA	NA	NA	NA	NA	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	41.1	NA
BH605	0.7-0.95	Fill: Silty sand	LPQL	LPQL	4	3	16	0.1	LPQL	53	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	NA	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0	No asbestos detected
BH605	1.3-1.5	Fill: Silty gravel	12	LPQL	20	38	120	0.2	18	140	2.29	0.09	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	NA	LPQL	LPQL	120	1500	LPQL	1620	LPQL	LPQL	LPQL	LPQL	9.3	No asbestos detected
BH605	3-3.45	Silty sand	LPQL	LPQL	4	4	8	LPQL	1	4	LPQL	LPQL	NA	NA	NA	NA	NA	NA	NA	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0.6	NA
BH606	0.3-0.5	Fill: Silty clayey sand	LPQL	LPQL	16	30	78	0.2	5	42	0.08	0.08	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	NA	LPQL	LPQL	220	110	330	LPQL	LPQL	LPQL	LPQL	0	No asbestos detected
BH606	0.7-0.95	Fill: Silty clayey sand	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	LPQL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	NA
BH606[D]	1.7-1.95	Fill: Silty clayey sand	LPQL	LPQL	8	3	15	LPQL	4	28	4.9	0.1	NA	NA	NA	NA	NA	NA	NA	LPQL	380	850	LPQL	1230	LPQL	LPQL	LPQL	LPQL	44.8	No asbestos detected
BH606	2.2-2.5	Fill: Silty clayey sand	16	LPQL	14	61	58	0.3	4	220	249.9	24	NA	NA	NA	NA	NA	NA	NA	LPQL	7000	13000	2100	22100	LPQL	LPQL	LPQL	LPQL	50.6	No asbestos detected
BH606	2.8-3.2	Sandstone	LPQL	LPQL	4	1	4	LPQL	LPQL	4	2.4	0.2	NA	NA	NA	NA	NA	NA	NA	LPQL	120	230	LPQL	350	LPQL	LPQL	LPQL	LPQL	44	NA
BH607	0.1-0.2	Fill: Gravelly silty sand	LPQL	LPQL	30	71	46	LPQL	30	41	0.8	0.1	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	630	1800	2430	LPQL	LPQL	LPQL	LPQL	0	No asbestos detected
BH607	0.5-0.7	Fill: Sandy clay	29	LPQL	12	16	40	0.2	2	29	47.9	4.7	NA	NA	NA	NA	NA	NA	NA	LPQL	LPQL	200	130	330	LPQL	LPQL	LPQL	LPQL	0	No asbestos detected
BH607	1.7-1.9	Fill: Sandy clay	16	LPQL	74	1	11	0.1	LPQL	5	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	NA	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	14	No asbestos detected
BH608[DL]	0.3-0.5	Fill: Silty sand	LPQL	LPQL	8	23	27	LPQL	4	58	0.07	0.07	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	NA	LPQL	LPQL	440	1100	1540	LPQL	LPQL	LPQL	LPQL	0	No asbestos detected
BH608	0.7-0.95	Fill: Silty sand	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	LPQL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	NA
BH608	1.3-1.5	Fill: Silty sand	LPQL	LPQL	2	1	5	LPQL	1	620	LPQL	LPQL	NA	NA	NA	NA	NA	NA	NA	LPQL	76	150	LPQL	226	LPQL	LPQL	LPQL	LPQL	6.6	No asbestos detected
BH609	0.2-0.5	Fill: Gravelly sand	30	LPQL	8	35	33	LPQL	3	64	0.26	0.06	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	NA	LPQL	53	LPQL	LPQL	53	LPQL	LPQL	LPQL	LPQL	2.2	No asbestos detected
BH610	0.2-0.4	Fill: Gravelly sand	LPQL	LPQL	11	82	58	0.1	32	63	33.7	3.5	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	NA	LPQL	LPQL	320	620	940	LPQL	LPQL	LPQL	LPQL	0	No asbestos detected
BH610	0.7-0.95	Fill: Silty clayey sand	LPQL	LPQL	5	29	88	0.2	8	250	40.9	5.9	NA	NA	NA	NA	NA	NA	NA	LPQL	LPQL	150	160	310	LPQL	LPQL	LPQL	LPQL	0	No asbestos detected
BH610	1.7-1.95	Fill: Silty clay	NA	NA	NA	NA	NA	NA	NA	NA	LPQL	LPQL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	NA
Total no. of samples			26	26	26	26	26	26	26	26	27	27	12	12	12	12	12	12	5	26	26	26	26	26	26	26	26	29	23
Maximum Value			30	1.5	120	260	640	2.6	97	840	250	24	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	7000	13000	2100	22100	LPQL	LPQL	LPQL	LPQL	50.6	NC
Mean Value			43	NC	NC	NC	92	NC	NC	NC	21	2.2	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	1647	NC	NC	NC	NC	NC	NC
Standard Deviation			NC	NC	NC	NC	160.0	NC	NC	NC	51	5.0	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	4476	NC	NC	NC	NC	NC	NC
Coefficient of Variation			NC	NC	NC	NC	1.7	NC	NC	NC	2.5	2.3	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	2.8	NC	NC	NC	NC	NC	NC
Distribution +			NC	NC	NC	NC	Gamma	NC	NC	NC	Non-parametric	Non-parametric	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	Non-parametric	NC	NC	NC	NC	NC	NC
Upper Level 95% Confidence Limit on Mean Value (95% UCL) ++			NC	NC	NC	NC	153	NC	NC	NC	66	6.7	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	5630	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 E, Parks and recreational open space
# 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
L Laboratory duplicate results adopted for TPH. See page 38 in report 43806.

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		Lead	Chromium	Nickel	B(a)P
PQL - Envirolab		0.03	0.01	0.02	0.001
TCLP1 - General Solid Waste *		5	5	2	0.04
TCLP2 - Restricted Solid Waste *		20	20	8	0.16
TCLP3 - Hazardous Waste *		>20	>20	>8	>0.16
SAMPLE	Depth in metres				
BH601	0.3-0.5	0.4	NA	NA	LPQL
BH601	0.6-0.95	0.3	NA	NA	LPQL
BH602	1.7-1.92	NA	NA	NA	LPQL
BH603	0.3-0.5	NA	LPQL	0.04	NA
BH604	0.3-0.5	1.6	NA	NA	NA
BH605	1.3-1.5	1.3	NA	NA	NA
BH606	2.2-2.5	NA	NA	NA	LPQL
BH607	0.5-0.7	NA	NA	NA	LPQL
BH610	0.2-0.4	NA	NA	NA	LPQL
BH610	0.7-0.95	NA	NA	NA	LPQL
Dup8	-	NA	NA	0.05	NA
Total no. of samples		4	1	2	7
Maximum Value		1.6	LPQL	0.05	LPQL

EXPLANATION:
* NSW DECC (DECCW) 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
SUMMARY OF LABORATORY TEST DATA
SEDIMENT
All data in mg/kg unless stated otherwise

ANALYTE	HEAVY METALS								PAHs												OCPs						TBT	Total OPPs	Total PCBs	Total Cyanide	PETROLEUM HYDROCARBONS								
																															Petroleum Hydrocarbons					Benzene	Toluene	Ethyl Benzene	Total Xylenes
	As	Cd	Cr	Cu	Pb	Hg	Ni	Zn	Nap	Acenaphthy	Acenaphthe	Fluo	Phen	Anth	Fluoro	Pyr	B(a)A	Chy	B(a)P	D(ah)A	Total PAHs	Total DDT	ppDDE	ppDDD	Chlor	Dield	End					C_6-C_9	C_{10}-C_{14}	C_{15}-C_{28}	C_{29}-C_{36}	C_{10}-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	0.05	0.1	-	0.1	0.1	0.1	0.1	0.1	0.1	0.0005	0.1	0.1	0.5	25	50	100	100	100	0.5	0.5	1	1
Guideline*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NSL	NSL	NSL	NA	NSL	NA	NA	NA	NA	NA	NSL	NA	NA	NA	NA	NA	NA	NSL	NSL	0.1	NA	1000	65 #	NSL	NSL	NSL	1000 #	1 #	1.4 #	3.1 #	14 #
Guideline^{S} - ISQG Low	20	1.5	80	65	50	0.15	21	200	0.16	0.044	0.016	0.019	0.24	0.085	0.6	0.665	0.261	0.384	0.43	0.063	4	0.0016	0.0022	0.002	0.0005	0.00002	0.00002	0.005	NA	0.023	NA	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL
Guideline^{S} - ISQG High	70	10	370	270	220	1	52	410	2.1	0.64	0.50	0.54	1.5	1.1	5.1	2.6	1.6	2.8	1.6	0.26	45	0.046	0.027	0.02	0.006	0.008	0.008	0.07	NA	NSL	NA	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL
Sample																																							
SSA	11	0.9	29	260	***260***	1	19	***690***	LPQL	0.1	LPQL	LPQL	0.4	0.2	1.2	1.7	0.8	0.6	***1.8***	0.2	7	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	***0.23***	LPQL	LPQL	LPQL	LPQL	LPQL	560	600	1160	LPQL	LPQL	LPQL	LPQL
SSB	10	0.9	32	150	220	***1.3***	27	***460***	0.1	0.1	LPQL	LPQL	0.6	0.2	1.5	***2.8***	0.9	0.8	***2***	0.2	9.2	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0.045	LPQL	LPQL	LPQL	LPQL	LPQL	560	700	1260	LPQL	LPQL	LPQL	LPQL
SSC	5	LPQL	18	130	150	0.3	11	310	LPQL	0.1	LPQL	LPQL	0.5	0.1	1	1.2	0.6	0.5	1.1	0.1	5.2	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0.023	LPQL	LPQL	LPQL	LPQL	LPQL	210	340	550	LPQL	LPQL	LPQL	LPQL

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 E, Parks and recreational open space
# NSW EPA (DECCW) Guidelines for Assessing Service Station Sites - 1994
^{S} Sediment Quality Guidelines (ANZECC/ARMCANZ, 2000a)

Concentration above ISQG High Guideline	***VALUE***
Concentration above ISQG Low Guideline	VALUE
Concentration above HIL Guideline (if adopted)	VALUE

Note: PQLs for some contaminants are below the ISQGs. Where this occurred, the HILs were adopted as a preliminary screening tool (where possible).

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
ISQG: Interim Sediment Quality Guidelines
NA: Not Applicable
NSL: No Set Limit

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)P: Benzo(a)pyrene
D(ah)A: Dibenzo(ah)anthracene
B(ghi)P: Benzo(ghi)perylene
ppDDE: pp-DDE
ppDDD: pp-DDD
Chlor: Chlordane
Dield: Dieldrin
End: Endrin
TBT: Tributyltin

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

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

Contaminant	PQL Envirolab	Guideline Concentration ANZECC 2000 Marine Waters [1]	Guideline Concentration Hardness Modified Triggers Marine Waters[H]	SAMPLES MW605[D]	MW606	MW608
Field Measurements *						
Dissolved oxygen (ppm)	-	NSL	-	0.2	0.3	0.7
Redox potential (mV)	-	NSL	-	35.9	121.2	272.9
pH	-	7 - 8.5[++]	-	6.9	6.78	5.41
Conductivity (mS/cm)	-	NSL	-	1.4	2	11.9
Temperature ©	-	NSL	-	20.9	20.3	20.8
Miscellaneous						
pH	0.1	7 - 8.5[++]	-	7	6.9	5.7
Electrical Conductivity (mS/cm)	0.001	NSL	-	1.2	1.8	8.9
Hardness (mg/CaC03/L)	1	NSL	-	387	503	1346
Total Cyanide	0.005	0.004	-	LPQL	LPQL	LPQL
Oil and Grease	5	10[#^]	-	LPQL	LPQL	LPQL
Heavy Metals						
Arsenic (As III)	0.001	0.0023 [t]	-	0.004	0.004	0.003
Cadmium	0.0001	0.0055	0.0022[H]	LPQL	LPQL	0.0004
Chromium	0.001	0.01[t]	0.0091[H]	LPQL	LPQL	0.002
Copper	0.001	0.0013	0.0139[H]	LPQL	LPQL	0.057
Lead	0.001	0.0044	0.1045[H]	LPQL	LPQL	0.008
Mercury	0.0001	0.0004	-	LPQL	LPQL	LPQL
Nickel	0.001	0.07	0.1089[H]	0.002	0.006	0.022
Zinc	0.001	0.015	0.0792[H]	0.005	0.03	0.17
Petroleum Hydrocarbons						
Hydrocarbons C6-C9	0.01	NSL	-	LPQL	LPQL	LPQL
Hydrocarbons C10-C14	0.05	0.6**	-	0.060	0.410	0.058
Hydrocarbons C15-C28	0.1			0.350	0.740	0.450
Hydrocarbons C29-C36	0.1			LPQL	LPQL	0.130
Volatile Organic Contaminants (VOCs)[2]						
Benzene	0.001	0.7	-	LPQL	LPQL	LPQL
Toluene	0.001	0.18 [t]	-	LPQL	LPQL	LPQL
Ethyl Benzene	0.001	0.005 [t]	-	LPQL	LPQL	LPQL
Total xylenes	0.003	0.38[#]	-	LPQL	LPQL	LPQL
o-xylene	0.001	0.35 [t]	-	LPQL	LPQL	LPQL
m+p-xylene	0.002	0.275 [t]	-	LPQL	LPQL	LPQL
Isopropylbenzene	0.001	0.66[US]	-	0.0033	LPQL	LPQL
n-Propylbenzene	0.001	0.24[US]	-	0.0013	LPQL	LPQL
tert-Butylbenzene	0.001	0.24[US]	-	LPQL	LPQL	LPQL
sec-Butylbenzene	0.001	0.24[US]	-	LPQL	LPQL	LPQL
n-Butylbenzene	0.001	0.24[US]	-	LPQL	LPQL	LPQL
Total VOCs	0.001	NSL	-	0.0046	ALPQL	ALPQL
Polycyclic Aromatic Hydrocarbons (PAHs)[3]						
Naphthalene	0.001	0.016	-	0.0003	0.0008	LPQL
Acenaphthylene	0.0001	NSL	-	0.0001	0.0003	LPQL
Acenaphthene	0.0001	NSL	-	0.0036	0.0023	LPQL
Fluorene	0.0001	NSL	-	0.0027	0.0027	LPQL
Phenanthrene	0.0001	0.0006[L]	-	0.0029	0.0008	LPQL
Anthracene	0.0001	0.0004[t]	-	0.0006	0.0003	LPQL
Fluoranthene	0.0001	0.001[L]	-	0.0002	0.0004	LPQL
Pyrene	0.0001	NSL	-	0.0001	0.0003	LPQL
Benzo(a)pyrene	0.0001	0.0001 [L]	-	LPQL	LPQL	LPQL
1-Methylnaphthalene	0.0001	NSL	-	LPQL	NA	NA
2-Methylnaphthalene	0.0001	NSL	-	0.0019	NA	NA

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 22 July 2010 for the surface water and 27 July 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. Only adopted for MW605 and MW606 based on EC values

[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 E1
HARBOUR WATER MONITORING ANALYSIS
All results in mg/L unless stated otherwise.

Contaminant	PQL Envirolab	Guideline Concentration ANZECC 2000 Marine Waters [1]	SAMPLES SWA[D]	SWB	SWC
Field Measurements *					
Dissolved oxygen (ppm)	-	NSL	6.7	6.9	7.7
Redox potential (mV)	-	NSL	255.4	260.8	249.1
pH	-	7 - 8.5[++]	7.32	7.85	7.86
Conductivity (mS/cm)	-	NSL	33.8	33.9	33.2
Temperature ©	-	NSL	12	12.3	12.9
Miscellaneous					
pH	0.1	7 - 8.5[++]	NA	NA	NA
Electrical Conductivity (mS/cm)	0.001	NSL	NA	NA	NA
Hardness (mg/CaC03/L)	1	NSL	NA	NA	NA
Total Cyanide	0.005	0.004	LPQL	LPQL	LPQL
Oil and Grease	5	10[#^]	NA	NA	NA
Organotin Compounds					
Monobutyltin (mg/L Sn)	0.000002	NSL	NA	LPQL	0.0000049
Dibutyltin (mg/L Sn)	0.000002	NSL	NA	LPQL	LPQL
Tributyltin (mg/L Sn)	0.000002	0.000006	NA	LPQL	LPQL
Heavy Metals					
Arsenic (As lll)	0.001	0.0023 [t]	0.002	0.002	0.002
Cadmium	0.0001	0.0055	0.0002	0.0001	0.0002
Chromium	0.001	0.01[t]	LPQL	LPQL	LPQL
Copper	0.001	0.0013	0.012	0.008	0.008
Lead	0.001	0.0044	LPQL	LPQL	LPQL
Mercury	0.0001	0.0004	LPQL	LPQL	LPQL
Nickel	0.001	0.07	LPQL	LPQL	0.001
Zinc	0.001	0.015	0.026	0.024	0.029
Petroleum Hydrocarbons					
Hydrocarbons C6-C9	0.01	NSL	LPQL	LPQL	LPQL
Hydrocarbons C10-C14	0.05	0.6**	LPQL	LPQL	LPQL
Hydrocarbons C15-C28	0.1		LPQL	LPQL	LPQL
Hydrocarbons C29-C36	0.1		LPQL	LPQL	LPQL
Volatile Organic Contaminants (VOCs)[2]					
Benzene	0.001	0.7	LPQL	LPQL	LPQL
Toluene	0.001	0.18 [t]	LPQL	LPQL	LPQL
Ethyl Benzene	0.001	0.005 [t]	LPQL	LPQL	LPQL
Total xylenes	0.003	0.38[#]	LPQL	LPQL	LPQL
o-xylene	0.001	0.35 [t]	LPQL	LPQL	LPQL
m+p-xylene	0.002	0.275 [t]	LPQL	LPQL	LPQL
Total VOCs	0.001	NSL	ALPQL	ALPQL	ALPQL
Polycyclic Aromatic Hydrocarbons (PAHs)[3]					
Naphthalene	0.001	0.016	LPQL	LPQL	LPQL
Phenanthrene	0.0001	0.0006[L]	LPQL	LPQL	LPQL
Anthracene	0.0001	0.0004[t]	LPQL	LPQL	LPQL
Fluoranthene	0.0001	0.001[L]	LPQL	LPQL	LPQL
Benzo(a)pyrene	0.0001	0.0001 [L]	LPQL	LPQL	LPQL

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

* Field Measurements Undertaken on 22 July 2010 for harbour water

[++] 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.

[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 F
LABORATORY DUPLICATE RESULTS - SOIL AND SEDIMENT
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	Acenaphthy	Acenaphthe	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 43806																																			
Initial Sample Ref	BH609 0.2-0.5	30	<0.5	8	35	33	LPQL	3	64	LPQL	LPQL	LPQL	LPQL	<0.1	LPQL	0.1	0.1	LPQL	<0.1	LPQL	0.06	LPQL	LPQL	LPQL	-	-	-	LPQL	53	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Duplicate Sample Ref	Dup 3	39	0.6	9	50	53	LPQL	4	83	LPQL	LPQL	LPQL	LPQL	0.1	LPQL	0.2	0.2	LPQL	0.1	LPQL	0.1	LPQL	LPQL	LPQL	-	-	-	LPQL	52	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Mean Value		34.5	0.425	8.5	42.5	43	NC	3.5	73.5	NC	NC	NC	NC	0.075	NC	0.15	0.15	NC	0.075	NC	0.08	NC	NC	NC	-	-	-	NC	52.5	NC	NC	NC	NC	NC	NC
RPD Value		26	82	12	35	47	NC	29	26	NC	NC	NC	NC	67	NC	67	67	NC	67	NC	50	NC	NC	NC	-	-	-	NC	2	NC	NC	NC	NC	NC	NC
Intra-laboratory Soil Duplicate Results - Envirolab Report Number 43806																																			
Initial Sample Ref	BH606 1.7-1.95	LPQL	LPQL	8	3	15	LPQL	4	28	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	LPQL	<0.05	LPQL	LPQL	LPQL	-	-	-	LPQL	<50	<100	LPQL	LPQL	LPQL	LPQL	LPQL
Duplicate Sample Ref	Dup 4	LPQL	LPQL	6	5	14	LPQL	2	28	0.3	0.1	0.2	1.2	1.9	0.2	0.3	0.4	0.1	0.1	LPQL	0.1	LPQL	LPQL	LPQL	-	-	-	LPQL	380	850	LPQL	LPQL	LPQL	LPQL	LPQL
Mean Value		NC	NC	7	4	14.5	NC	3	28	0.157	0.075	0.125	0.625	0.975	0.125	0.157	0.225	0.075	0.075	NC	0.0625	NC	NC	NC	-	-	-	NC	202	450	NC	NC	NC	NC	NC
RPD Value		NC	NC	29	50	7	NC	67	0	143	67	120	184	190	120	143	156	67	67	NC	120	NC	NC	NC	-	-	-	NC	175	178	NC	NC	NC	NC	NC
Intra-laboratory Soil Duplicate Results - Envirolab Report Number 43806																																			
Initial Sample Ref	BH602 0.3-0.5	12	LPQL	25	34	31	0.1	17	70	LPQL	LPQL	LPQL	LPQL	0.5	LPQL	1.1	1.2	0.6	0.5	1.1	0.8	0.4	LPQL	0.4	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Duplicate Sample Ref	Dup 7	6	LPQL	24	24	41	0.1	18	48	LPQL	LPQL	LPQL	LPQL	0.2	LPQL	0.6	0.7	0.4	0.4	0.8	0.6	0.4	LPQL	0.4	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Mean Value		9	NC	24.5	29	36	0.1	17.5	59	NC	NC	NC	NC	0.35	NC	0.85	0.95	0.5	0.45	0.95	0.7	0.4	NC	0.4	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
RPD Value		67	NC	4	34	28	0	6	37	NC	NC	NC	NC	86	NC	59	53	40	22	32	29	0	NC	0	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Intra-laboratory Soil Duplicate Results - Envirolab Report Number 43806																																			
Initial Sample Ref	BH604 0.3-0.5	6	1.5	41	260	520	2.6	24	840	0.1	0.1	LPQL	LPQL	0.2	LPQL	0.6	1.2	0.4	0.3	1	0.8	0.4	LPQL	0.5	LPQL	LPQL	LPQL	LPQL	630	2000	2000	LPQL	LPQL	LPQL	LPQL
Duplicate Sample Ref	Dup 8	<4	0.9	64	170	400	2.1	48	560	0.1	0.1	LPQL	LPQL	0.1	LPQL	0.4	1	0.3	0.2	0.9	0.7	0.5	LPQL	0.6	LPQL	LPQL	LPQL	LPQL	490	1800	1700	LPQL	LPQL	LPQL	LPQL
Mean Value		4	1.2	52.5	215	460	2.35	36	700	0.1	0.1	NC	NC	0.15	NC	0.5	1.1	0.35	0.25	0.95	0.75	0.45	NC	0.55	NC	NC	NC	NC	560	1900	1850	NC	NC	NC	NC
RPD Value		100	50	44	42	26	21	67	40	0	0	NC	NC	67	NC	40	18	29	40	11	13	22	NC	18	NC	NC	NC	NC	25	11	16	NC	NC	NC	NC
Intra-laboratory Soil Duplicate Results - Envirolab Report Number 43818																																			
Initial Sample Ref	SSA	11	0.9	29	260	260	1	19	690	LPQL	0.1	LPQL	LPQL	0.4	0.2	1.2	1.7	0.8	0.6	2.5	1.8	1.2	0.2	1.1	LPQL	LPQL	LPQL	LPQL	LPQL	560	600	LPQL	LPQL	LPQL	LPQL
Duplicate Sample Ref	SS Dup	10	0.5	35	190	210	0.8	23	590	LPQL	0.1	LPQL	LPQL	0.5	0.1	1.4	2	0.9	0.8	2.6	2	1.2	0.2	1.1	LPQL	LPQL	LPQL	LPQL	LPQL	360	420	LPQL	LPQL	LPQL	LPQL
Mean Value		10.5	0.7	32	225	235	0.9	21	640	NC	0.1	NC	NC	0.45	0.15	1.3	1.85	0.85	0.7	2.55	1.9	1.2	0.2	1.1	NC	NC	NC	NC	NC	460	510	NC	NC	NC	NC
RPD Value		10	57	19	31	21	22	19	16	NC	0	NC	NC	22	67	15	16	12	29	4	11	0	0	0	NC	NC	NC	NC	NC	43	35	NC	NC	NC	NC
Inter-laboratory Soil Duplicate Results - Envirolab Report Number 43806 , SGS Report Number SE80060																																			
Initial Sample Ref	BH608 0.3-0.5	<4	LPQL	8	23	27	LPQL	4	58	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0.07	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	290	790	LPQL	LPQL	LPQL	LPQL
Duplicate Sample Ref	Dup 1	3	LPQL	7.2	25	36	LPQL	4	67	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	<0.05	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	270	410	LPQL	LPQL	LPQL	LPQL
Mean Value		2.5	NC	7.6	24	31.5	NC	4	62.5	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	0.0475	NC	NC	NC	NC	NC	NC	NC	NC	280	600	NC	NC	NC	NC
RPD Value		40	NC	11	8	29	NC	0	14	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	95	NC	NC	NC	NC	NC	NC	NC	NC	7	63	NC	NC	NC	NC
Inter-laboratory Soil Duplicate Results - Envirolab Report Number 43806 , SGS Report Number SE80060																																			
Initial Sample Ref	BH608 1.3-1.5	LPQL	LPQL	2	1	5	LPQL	1	620	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	-	-	-	LPQL	76	150	<100	LPQL	LPQL	LPQL	LPQL
Duplicate Sample Ref	Dup 2	LPQL	LPQL	2.9	1.2	5	LPQL	1.1	380	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	-	-	-	LPQL	110	210	88	LPQL	LPQL	LPQL	LPQL
Mean Value		NC	NC	2.45	1.1	5	NC	1.05	500	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	-	-	-	NC	93	180	69	NC	NC	NC	NC
RPD Value		NC	NC	37	18	0	NC	10	48	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	-	-	-	NC	37	33	55	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 G
LABORATORY DUPLICATE RESULTS - GROUNDWATER AND HARBOUR WATER
QA/QC - RELATIVE PERCENTAGE DIFFERENCES
All data in mg/L unless stated otherwise

ANALYTE		HEAVY METALS								PAHs																Total Cyanide	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	0.0002	0.0001	0.0001	0.0001	0.0001	0.005	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	0.0002	0.0001	0.0001	0.0001	0.0001	0.005	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 44007																																			
Initial Sample Ref	MW608	0.003	0.0004	0.002	0.057	0.008	LPQL	0.022	0.17	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	-	LPQL	LPQL	LPQL	0.058	0.45	0.13	LPQL	LPQL	LPQL	LPQL
Duplicate Sample Ref	GW Dup 1	0.003	0.0004	0.002	0.064	0.009	LPQL	0.024	0.17	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	-	LPQL	LPQL	LPQL	<0.05	0.31	<0.1	LPQL	LPQL	LPQL	LPQL
Mean Value		0.003	0.0004	0.002	0.0605	0.0085	NC	0.023	0.17	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	-	NC	NC	NC	0.04	0.38	0.09	NC	NC	NC	NC
RPD Value		0	0	0	12	12	NC	9	0	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	-	NC	NC	NC	79	36	88	NC	NC	NC	NC
Intra-laboratory Groundwater Duplicate Results - Envirolab Report Number 43817																																			
Initial Sample Ref	SW A	0.002	0.0002	LPQL	0.005	LPQL	LPQL	<0.001	0.026	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	SW Dup	0.003	0.0002	LPQL	0.012	LPQL	LPQL	0.001	0.025	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		0.0025	0.0002	NC	0.0085	NC	NC	0.0008	0.0255	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		40	0	NC	82	NC	NC	67	4	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 44007, SGS Report Number SE80198																																			
Initial Sample Ref	MW605	0.004	LPQL	LPQL	LPQL	LPQL	LPQL	<0.001	0.012	0.0001	<0.0001	0.0019	0.0014	0.0016	0.0002	0.0001	<0.0001	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0.0046	LPQL	0.06	0.35	LPQL	LPQL	LPQL	LPQL	LPQL
Duplicate Sample Ref	GW Dup 2	<0.001	LPQL	LPQL	LPQL	LPQL	LPQL	0.002	0.005	0.0003	0.0001	0.0036	0.0027	0.0029	0.0006	0.0002	0.0001	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0.0043	LPQL	<0.1	0.355	LPQL	LPQL	LPQL	LPQL	LPQL
Mean Value		0.0023	NC	NC	NC	NC	NC	0.0013	0.0085	0.0002	8.00E-05	0.00275	0.00205	0.00225	0.0004	0.00015	8.00E-05	NC	NC	NC	NC	NC	NC	NC	NC	NC	0.00445	NC	0.055	0.3525	NC	NC	NC	NC	NC
RPD Value		156	NC	NC	NC	NC	NC	120	82	100	67	62	63	58	100	67	67	NC	NC	NC	NC	NC	NC	NC	NC	NC	7	NC	18	1	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: Acenaphthylene
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 H
LABORATORY RESULTS
QA/QC - TRIP SPIKES, TRIP BLANKS AND RINSATES
All data in mg/kg unless stated otherwise

ANALYTE			PETROLEUM HYDROCARBONS								
			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			25	50	100	100	0.5	0.5	1	2	1
PQL - Water			0.01	0.05	0.1	0.1	0.001	0.001	0.001	0.002	0.001
Date	**Report**	**Sample ref**	**Trip Spikes**								
20/07/2010	43806	Trip Spike A[S]	-	-	-	-	100%	101%	102%	102%	101%
21/07/2010	43806	Trip Spike B[S]	-	-	-	-	102%	110%	116%	116%	117%
22/07/2010	43818	SS Trip Spike[S]	-	-	-	-	93%	85%	84%	84%	84%
22/07/2010	43817	SW Trip Spike[W]	-	-	-	-	88%	86%	85%	74%	88%
27/07/2010	44007	GW Trip Spike[W]	-	-	-	-	116%	119%	122%	117%	121%
Field Rinsates											
20/07/2010	43806	Rinsate A[W]	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
21/07/2010	43806	Rinsate B[W]	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Trip Blanks											
20/07/2010	43806	Trip Blank A[S]	LPQL	-	-	-	LPQL	LPQL	LPQL	LPQL	LPQL
21/07/2010	43806	Trip Blank B[S]	LPQL	-	-	-	LPQL	LPQL	LPQL	LPQL	LPQL
27/07/2010	44007	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

E24125Krpt
August 2010

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

Location	Depth in metres	DESCRIPTION	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
BH601[M]	0.3-0.5	Fill: Silty sandy clay	9.1	LPQL	7.6	LPQL	LPQL	0.25	0.013	0.047	LPQL
BH601	1.3-1.5	Fill: Silty clayey sand	9.1	LPQL	7.8	LPQL	LPQL	0.18	0.016	0.016	LPQL
BH601	2.8-3.0	Fill: Silty sand	7.7	LPQL	**4.9**	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
BH601	4.2-4.5	Fill: Silty sand	8.5	LPQL	**2.6**	**238**	**238**	0.032	0.028	**0.610**	21
BH601[F]	5.8-6.0	Silty clay / Clayey silt	8.8	LPQL	**3**	**283**	**283**	0.44	0.15	**1.400**	35
BH605	0.3-0.5	Fill: Silty sand	9.3	LPQL	7.3	LPQL	LPQL	0.12	0.008	0.008	LPQL
BH605	2.8-3.0	Silty sand	7.0	LPQL	**2.5**	**288**	**288**	0.017	0.005	**0.590**	24
BH606[M]	0.3-0.5	Fill: Silty clayey sand	9.6	LPQL	7.6	LPQL	LPQL	0.38	0.006	LPQL	LPQL
BH606[M]	0.8-1.0	Fill: Silty clayey sand	9.1	LPQL	7.4	LPQL	LPQL	0.076	0.006	0.014	LPQL
BH608	0.3-0.5	Fill: Silty sand	5.6	LPQL	**4**	**20**	17	LPQL	LPQL	0.013	0.82
SSA[M]	-	Sediment	8.9	LPQL	7.2	LPQL	LPQL	0.81	0.12	**0.93**	4.5
SSB[M]	-	Sediment	8.8	LPQL	**4.2**	**92**	**92**	0.66	0.15	**1.20**	24
SSC[M]	-	Sediment	8.7	LPQL	**2.9**	**185**	**185**	0.14	0.082	**0.72**	21

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

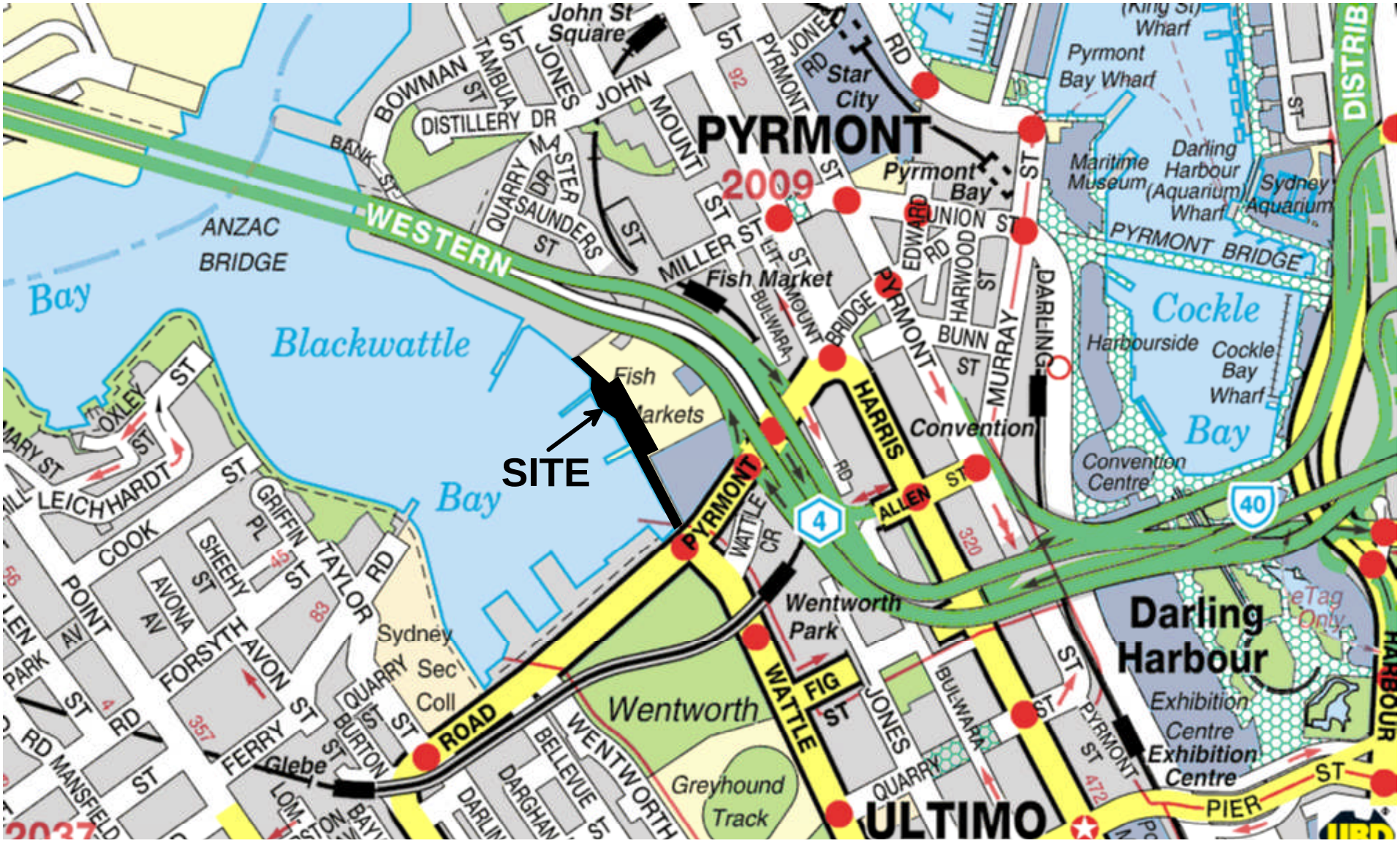
Action criteria for samples marked as 'M' (medium textured soils - sandy loams to light clays):
  pH < 5
  TAA/TSA/TPA (pH 5.5) > 36mol H^+/tonne
  S_{pos} > 0.06% sulfure oxidisable

Action Criteria for samples marked as 'F' (fine textured soils - medium to heavy clays and silty clays):
  pH < 5
  TAA/TSA/TPA (pH 5.5) > 62mol H^+/tonne
  S_{pos} > 0.1% 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

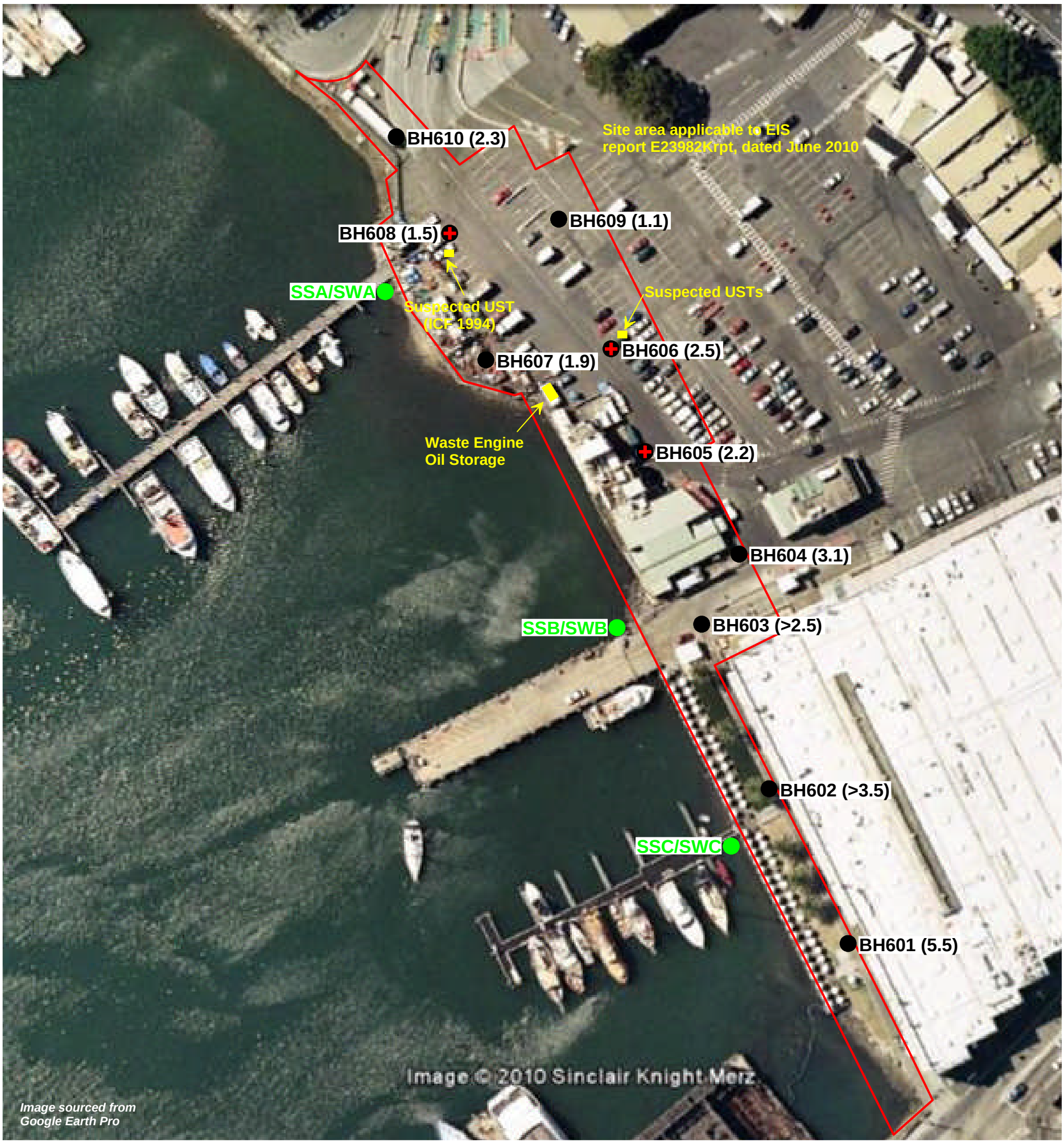
Sydney Fish Markets
56-60 Pyrmont Bridge Road, Pyrmont, NSW

EIS

ENVIRONMENTAL INVESTIGATION SERVICES

Job No: E24125Krpt
Figure: 1

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



LEGEND:

- **BH601 (5.5)** — **BOREHOLE LOCATION, NUMBER AND DEPTH OF FILL (m)**
- **MONITORING WELL LOCATION**
- **SWA/SSA** — **SEDIMENT AND HARBOUR WATER SAMPLING LOCATION AND SAMPLE REFERENCE**
- **APPROXIMATE SITE BOUNDARY**

Approximate Scale (m)

0 10 20 30 40 50

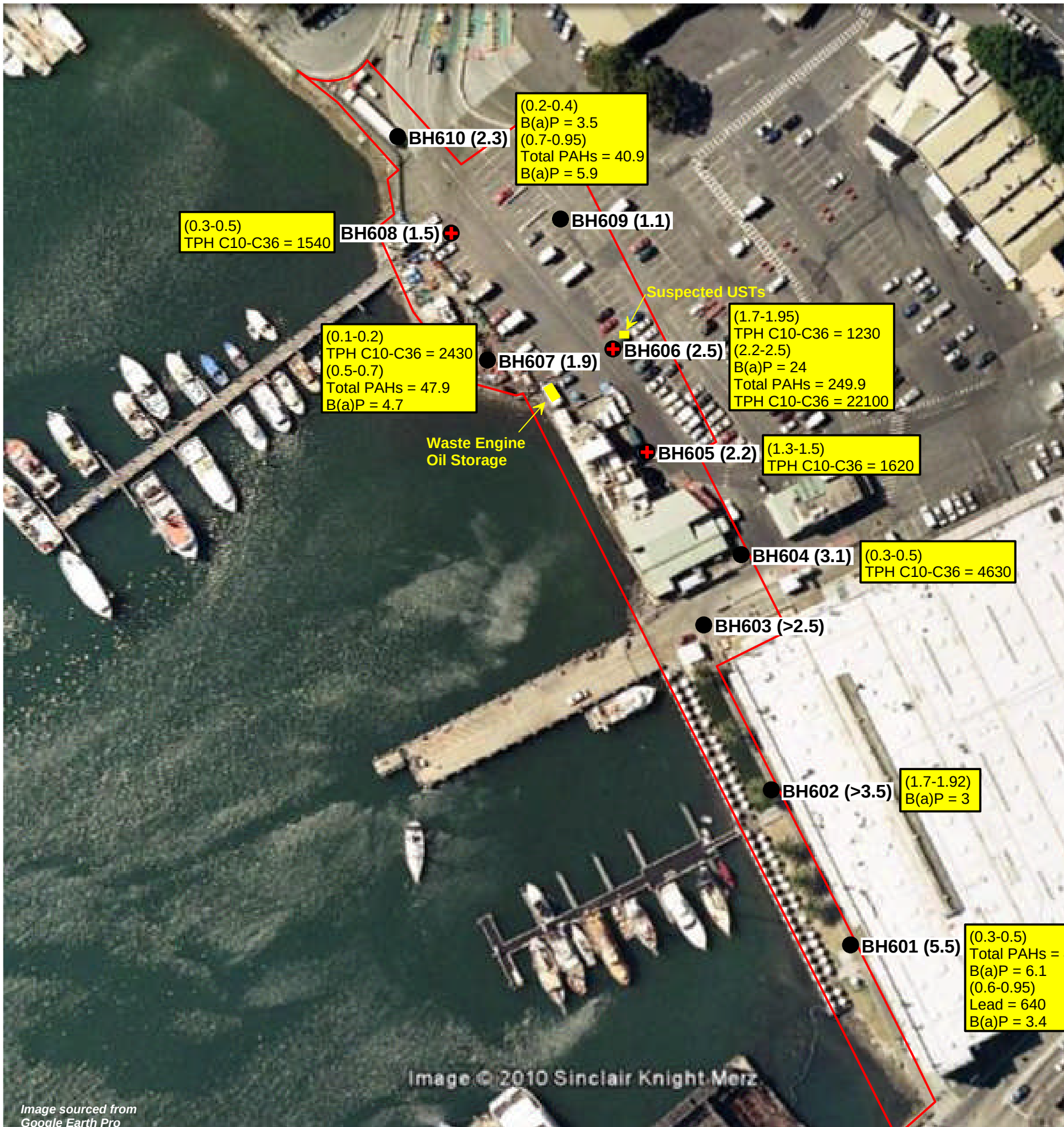
Note: Reference should be made to the text for a full understanding of this plan.

BOREHOLE AND SAMPLING LOCATION PLAN

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

Job No: E24125Krpt
Figure: 2

ENVIRONMENTAL INVESTIGATION SERVICES



LEGEND:

BH601 (5.5) **BOREHOLE LOCATION, NUMBER AND DEPTH OF FILL (m)**

MONITORING WELL LOCATION

APPROXIMATE SITE BOUNDARY

(0.3-0.5)
B(a)P = 5
TPH = 1000

SAMPLE DEPTH (m)
SOIL CONTAMINANT AND CONCENTRATION ABOVE SAC (mg/kg)

Approximate Scale (m)

0 10 20 30 40 50

Note: 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 Road, Pyrmont, NSW

ENVIRONMENTAL INVESTIGATION SERVICES

Job No: E24125Krpt
Figure: 3

LEGEND:

- **BH601 (5.5) BOREHOLE LOCATION, NUMBER AND DEPTH OF FILL (m)**
- **MONITORING WELL LOCATION**
- **APPROXIMATE SITE BOUNDARY**
- Arsenic = 0.004 TPH C10-C36 = 0.6 — **GROUNDWATER CONTAMINANT AND CONCENTRATION ABOVE SAC (mg/L)**

Approximate Scale (m)

0 10 20 30 40 50

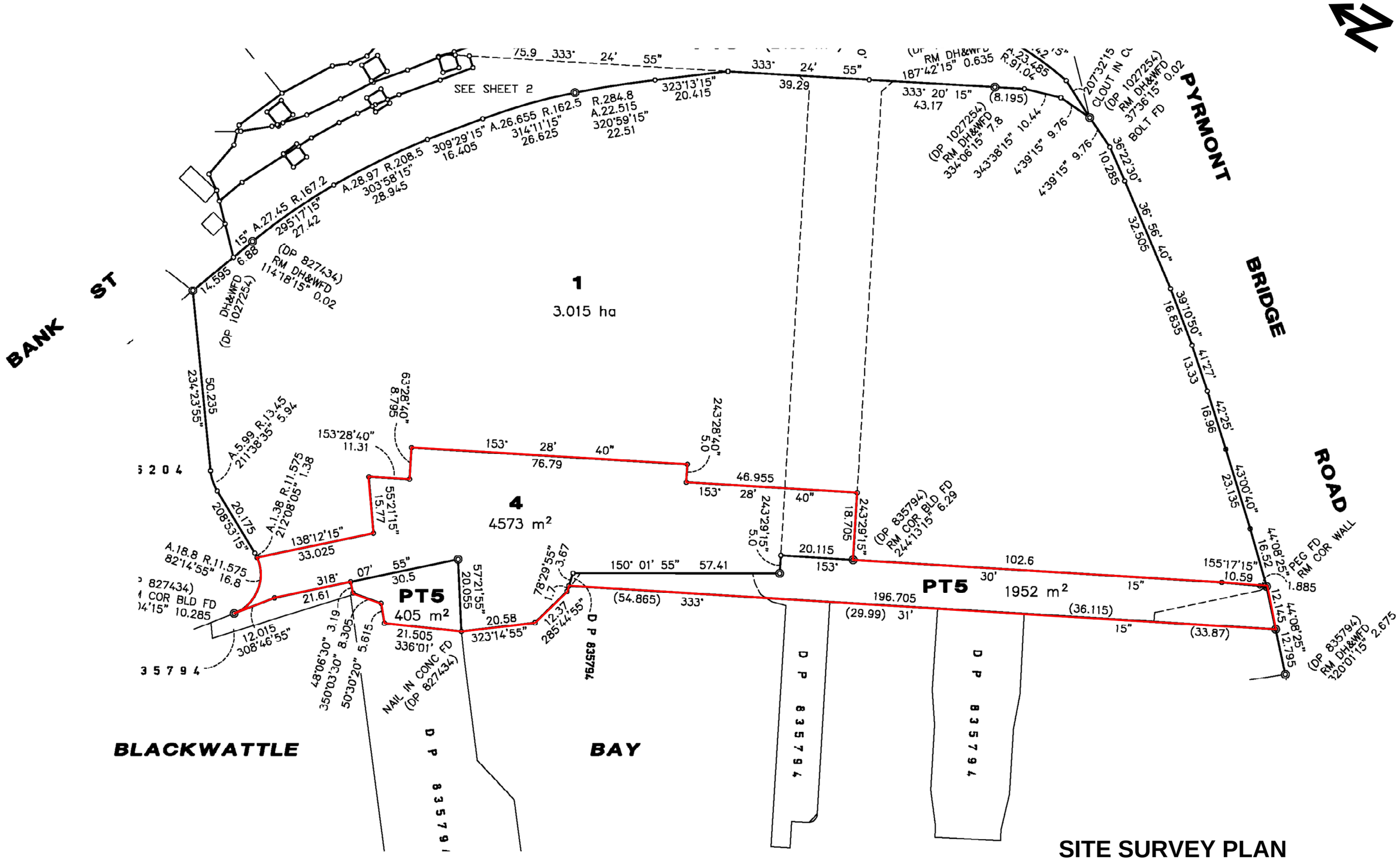
Note: Reference should be made to the text for a full understanding of this plan.

BOREHOLE LOCATION PLAN AND GROUNDWATER CONTAMINATION DATA

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

Job No: E24125Krpt
Figure: 4

ENVIRONMENTAL INVESTIGATION SERVICES



LEGEND:

SITE BOUNDARY

Approximate Scale (m)

0 10 20 30 40 50

Note: Reference should be made to the text for a full understanding of this plan. Plan has been recreated from survey ref: 40269103A-RL, dated 2 July 2010

SITE SURVEY PLAN

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

EIS
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Job No: E24125Krpt
Figure: 5

APPENDIX A

(Borehole Logs and Geotechnical Explanatory Notes)

ENVIRONMENTAL INVESTIGATION SERVICES

CONSULTING ENVIRONMENTAL ENGINEERS

ENVIRONMENTAL LOG

Borehole No. 601 1/1

Environmental logs are not to be used for geotechnical purposes

Client: LAND AND PROPERTY MANAGEMENT AUTHORITY

Project: PROPOSED REDEVELOPMENT - WATERFRONT

Location: SYDNEY FISH MARKETS, 56-60 PYRMONT BRIDGE ROAD, PYRMONT, NSW

Job No. E24125K **Method:** SPIRAL AUGER JK250 **R.L. Surface:** N/A

Date: 21-7-10 **Datum:**

Logged/Checked by: B.P./

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0			CONCRETE: 200mm.t				15mm DIA. REINFORCEMENT, 150mm TOP COVER
								-	FILL: Silty sand, brown.	M	-	-	
									FILL: Silty sandy clay, medium plasticity, grey brown, with igneous gravel and a trace of slag and ash.	MC≈PL			
					N = 15 3,3,12	1			FILL: Silty clayey sand, fine to medium grained, brown, with a trace of sandstone gravel, ash and slag.	M			
					N = 23 8,10,13	2			as above, but also with a trace of organic material.				ORGANIC MATERIAL INCLUDED GRASS/ STRAW
					N = 12 ?,4,8	3			FILL: Silty sand, fine to medium grained, light brown, with sandstone gravel.	M			SPT SANK 150mm UNDER SELF WEIGHT
ON COMPLET -ION					N = 19 4,9,10	4			as above, but dark grey brown, with sandstone gravel and cobbles.	W			
						5		CL	SILTY CLAY/CLAYEY SILT: low to medium plasticity, dark grey, with organic material and shell fragments.	MC>PL	-	-	
						6			END OF BOREHOLE AT 6.0m				
						7							

ENVIRONMENTAL INVESTIGATION SERVICES

CONSULTING ENVIRONMENTAL ENGINEERS

ENVIRONMENTAL LOG

Borehole No. 602 1/1

Environmental logs are not to be used for geotechnical purposes

Client: LAND AND PROPERTY MANAGEMENT AUTHORITY

Project: PROPOSED REDEVELOPMENT - WATERFRONT

Location: SYDNEY FISH MARKETS, 56-60 PYRMONT BRIDGE ROAD, PYRMONT, NSW

Job No. E24125K **Method:** SPIRAL AUGER JK250 **R.L. Surface:** N/A

Date: 21-7-10 **Datum:**

Logged/Checked by: B.P./

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0			CONCRETE: 220mm.t				15mm DIA. REINFORCEMENT, 150mm TOP COVER
					N = 4 1,2,2			-	FILL: Silty sandy clay, medium plasticity, light brown, with sandstone gravel and a trace of ash.	MC≈PL	-	-	
						1			FILL: Silty sand, fine to medium grained, brown, with brick and sandstone gravel, and a trace of ash and slag.	M			
					N > 50 12,25, 25/130mm REFUSAL	2			as above, but light brown, with clay fines, brick, slag and ash absent.				
					N > 28 6,28/ 100mm REFUSAL	3							
									END OF BOREHOLE AT 3.5m				'TC' BIT REFUSAL ON OBSTRUCTION IN FILL
						4							
						5							
						6							
						7							

ENVIRONMENTAL INVESTIGATION SERVICES

CONSULTING ENVIRONMENTAL ENGINEERS

EIS

ENVIRONMENTAL LOG

Borehole No. 603 1/1

Environmental logs are not to be used for geotechnical purposes

Client: STATE PROPERTY AUTHORITY C/- GOVERNMENT ARCHITECTS OFFICE

Project: PROPOSED REDEVELOPMENT - WATERFRONT

Location: SYDNEY FISH MARKETS, 56-60 PYRMONT BRIDGE ROAD, PYRMONT, NSW

Job No. E24125K **Method:** SPIRAL AUGER JK250 **R.L. Surface:** N/A

Date: 21-7-10 **Datum:**

Logged/Checked by: B.P./

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■	■				0			CONCRETE: 230mm.t				10mm DIA. REINFORCEMENT, 95mm TOP COVER
	■	■			N = 13 3,7,6			-	FILL: Sandy gravel, fine to medium grained sub angular, grey, igneous gravel, fine to medium grained sand.	M	-	-	
	■	■				1			FILL: Silty sand, fine to medium grained, light brown.	D-M			APPEARS WELL COMPACTED
	■				N = 2 1,1,1				as above, but grey, with a trace of igneous gravel.				APPEARS POORLY COMPACTED
	■					2							
									END OF BOREHOLE AT 2.5m				'TC' BIT REFUSAL ON OBSTRUCTION IN FILL (POSSIBLY CONCRETE)
						3							
						4							
						5							
						6							
						7							

ENVIRONMENTAL INVESTIGATION SERVICES

CONSULTING ENVIRONMENTAL ENGINEERS

EIS

ENVIRONMENTAL LOG

Borehole No. 604 1/1

Environmental logs are not to be used for geotechnical purposes

Client: LAND AND PROPERTY MANAGEMENT AUTHORITY

Project: PROPOSED REDEVELOPMENT - WATERFRONT

Location: SYDNEY FISH MARKETS, 56-60 PYRMONT BRIDGE ROAD, PYRMONT, NSW

Job No. E24125K **Method:** SPIRAL AUGER JK250 **R.L. Surface:** N/A

Date: 21-7-10 **Datum:**

Logged/Checked by: B.P./

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0			CONCRETE: 170mm.t				6mm DIA. REINFORCEMENT, 100mm TOP COVER
	■	■						-	FILL: Sandy gravel, fine to coarse grained sub angular igneous gravel, grey, fine to medium grained sand.	M	-	-	
						1			FILL: Silty clayey sand, fine to medium grained, brown, with a trace of igneous and sandstone gravel.				
	■	■			N = 4 4,1,3								
▶						2							SLIGHT HYDROCARBON ODOUR
	■	■			N = 2 1,1,1	3		ML	CLAYEY SILT: medium plasticity, dark grey, with a trace of shell fragments and organic material	MC>PL	-	-	
								SM	SILTY SAND: fine to medium grained, dark grey brown, with a trace of shell fragments.	W			
						4			END OF BOREHOLE AT 3.45m				
						5							
						6							
						7							

ENVIRONMENTAL INVESTIGATION SERVICES

CONSULTING ENVIRONMENTAL ENGINEERS

EIS

ENVIRONMENTAL LOG

Borehole No. 605 1/1

Environmental logs are not to be used for geotechnical purposes

Client: LAND AND PROPERTY MANAGEMENT AUTHORITY

Project: PROPOSED REDEVELOPMENT - WATERFRONT

Location: SYDNEY FISH MARKETS, 56-60 PYRMONT BRIDGE ROAD, PYRMONT, NSW

Job No. E24125K **Method:** SPIRAL AUGER JK300 **R.L. Surface:** N/A

Date: 20-7-10 **Datum:**

Logged/Checked by: B.P./

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0			ASPHALTIC CONCRETE: 90mm.t CONCRETE: 200mm.t				
					N = 7 9,4,3	1		-	FILL: Silty sand, fine to medium grained, dark brown, with sandstone gravel.	M	-	-	
					N = 3 1,2,1	2			FILL: Silty gravel, fine to coarse grained sub angular igneous gravel, grey, fine to medium grained sand. FILL: Silty sand, fine to medium grained, dark brown, with sandstone gravel.	W M			HYDROCARBON ODOUR
ON COMPLET -ION					SPT 0	3		SM	SILTY SAND: fine to medium grained, dark grey brown, with a trace of shell fragments.	W	-	-	HYDROCARBON ODOUR SPT SUNK 450mm UNDER SELF WEIGHT
						4							MONITORING WELL INSTALLED TO 6m, CLASS 18 50mm DIA. PVC FROM 6m TO 3m, CASING FROM 3m TO SURFACE, 2mm SAND FILTER PACK TO 1m, BENTONITE SEAL FROM 1m TO 0.5m, BACKFILLED WITH CUTTINGS TO SURFACE AND COMPLETED WITH A STEEL GATIC COVER AND LOCKABLE CAP
						5		CL	SILTY CLAY: medium plasticity, orange brown, with sand.	MC > PL	-	-	
						6			END OF BOREHOLE AT 6.0m				
						7							

ENVIRONMENTAL INVESTIGATION SERVICES

CONSULTING ENVIRONMENTAL ENGINEERS

EIS

ENVIRONMENTAL LOG

Borehole No. 606 1/1

Environmental logs are not to be used for geotechnical purposes

Client: LAND AND PROPERTY MANAGEMENT AUTHORITY

Project: PROPOSED REDEVELOPMENT - WATERFRONT

Location: SYDNEY FISH MARKETS, 56-60 PYRMONT BRIDGE ROAD, PYRMONT, NSW

Job No. E24125K **Method:** SPIRAL AUGER JK300 **R.L. Surface:** N/A

Date: 20-7-10 **Datum:**

Logged/Checked by: B.P.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0		-	ASPHALTIC CONCRETE: 40mm.t	-	-	-	9mm DIAMETER REINFORCEMENT, 60mm TOP COVER
									CONCRETE: 150mm.t				
					N = 9 7,5,4				FILL: Silty clayey sand, fine to medium grained, brown, with sandstone gravel and a trace of ash and slag.	M	-	-	
						1							
					N = 6 7,3,3				as above, but grey and brown, ash and slag absent.				HYDROCARBON ODOUR
						2			as above, but dark grey.	W			VERY STRONG HYDROCARBON ODOUR
ON COMPLET -ION								-	SANDSTONE: fine to medium grained, light grey.	DW	-	-	LOW TO MODERATE 'TC' BIT RESISTANCE SLIGHT HYDROCARBON ODOUR
						3							
						4			END OF BOREHOLE AT 4.0m				MONITORING WELL INSTALLED TO 4m, CLASS 18 50mm DIA. PVC FROM 4m TO 1m, CASING FROM 1m TO SURFACE, 2mm SAND FILTER PACK TO 4m, BENTONITE SEAL FROM 0.7m TO 0.3m, BACKFILLED WITH CUTTINGS TO SURFACE AND COMPLETED WITH A STEEL GATIC COVER AND LOCKABLE CAP
						5							
						6							
						7							

ENVIRONMENTAL INVESTIGATION SERVICES

CONSULTING ENVIRONMENTAL ENGINEERS

EIS

ENVIRONMENTAL LOG

Borehole No. 607 1/1

Environmental logs are not to be used for geotechnical purposes

Client: LAND AND PROPERTY MANAGEMENT AUTHORITY

Project: PROPOSED REDEVELOPMENT - WATERFRONT

Location: SYDNEY FISH MARKETS, 56-60 PYRMONT BRIDGE ROAD, PYRMONT, NSW

Job No. E24125K **Method:** SPIRAL AUGER JK300 **R.L. Surface:** N/A

Date: 20-7-10 **Datum:**

Logged/Checked by: B.P./

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0		-	ASPHALTIC CONCRETE: 60mm.t	D	-	-	
									FILL: Gravelly silty sand, fine to medium grained, red brown, fine to medium grained sub angular igneous gravel, with a trace of slag.	MC < PL			
						1			FILL: Sandy clay, medium plasticity, brown, fine to medium grained sand, with a trace of sandstone gravel.				
					N = 4 3,3,1				as above, but orange brown, red brown and light brown.	MC≈PL			
ON COMPLET -ION						2		SC	SILTY CLAYEY SAND: fine to medium plasticity, dark grey, with a trace of shell fragments and organic material.	W			SLIGHT HYDROCARBON ODOUR AND ORGANIC ODOUR
					N = 1 1/450mm	3							SPT SANK 450mm AFTER 1 BLOW
									END OF BOREHOLE AT 3.45m				
						4							
						5							
						6							
						7							

ENVIRONMENTAL INVESTIGATION SERVICES

CONSULTING ENVIRONMENTAL ENGINEERS

EIS

ENVIRONMENTAL LOG

Borehole No. 608 1/1

Environmental logs are not to be used for geotechnical purposes

Client: LAND AND PROPERTY MANAGEMENT AUTHORITY

Project: PROPOSED REDEVELOPMENT - WATERFRONT

Location: SYDNEY FISH MARKETS, 56-60 PYRMONT BRIDGE ROAD, PYRMONT, NSW

Job No. E24125K **Method:** SPIRAL AUGER JK250 **R.L. Surface:** N/A

Date: 20-7-10 **Datum:**

Logged/Checked by: B.P./

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0			ASPHALTIC CONCRETE: 150mm.t				
					N = 25 7,13,12			-	FILL: Silty sand, fine to medium grained, light brown, with sandstone gravel.	D-M	-	-	
						1			as above, but with a trace of slag.	M-W			SLIGHT HYDROCARBON ODOUR
						2		-	SANDSTONE: fine to medium grained, orange brown.	XW	-	-	LOW 'TC' BIT RESISTANCE
						3			as above, but light brown.	DW			MODERATE RESISTANCE
									SANDSTONE: fine to coarse grained, orange brown.				
▼ ON COMPLET -ION						4							MODERATE TO HIGH RESISTANCE
						5							MONITORING WELL INSTALLED TO 6m, CLASS 18 50mm DIA. PVC FROM 6m TO 3m, CASING FROM 3m TO SURFACE, 2mm SAND FILTER PACK FROM 6m TO 2m, BENTONITE SEAL FROM 2m TO 1.6m, BACKFILLED WITH CUTTINGS TO SURFACE AND COMPLETED WITH A STEEL GATIC COVER AND LOCKABLE CAP
						6			END OF BOREHOLE AT 6.0m				
						7							

ENVIRONMENTAL INVESTIGATION SERVICES

CONSULTING ENVIRONMENTAL ENGINEERS

ENVIRONMENTAL LOG

Borehole No. 609 1/1

Environmental logs are not to be used for geotechnical purposes

Client: LAND AND PROPERTY MANAGEMENT AUTHORITY

Project: PROPOSED REDEVELOPMENT - WATERFRONT

Location: SYDNEY FISH MARKETS, 56-60 PYRMONT BRIDGE ROAD, PYRMONT, NSW

Job No. E24125K **Method:** SPIRAL AUGER JK300 **R.L. Surface:** N/A

Date: 20-7-10 **Datum:**

Logged/Checked by: B.P./

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	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: 150mm.t				
								-	FILL: Gravelly sand, light brown, fine to coarse grained sub angular igneous and concrete gravel.	D	-	-	
						1			FILL: Bricks	-			
								-	SANDSTONE: fine to medium grained, brown.	DW	-	-	LOW TO MODERATE 'TC' BIT RESISTANCE
									END OF BOREHOLE AT 1.5m				
						2							
						3							
						4							
						5							
						6							
						7							

ENVIRONMENTAL INVESTIGATION SERVICES

CONSULTING ENVIRONMENTAL ENGINEERS

ENVIRONMENTAL LOG

Borehole No. 610 1/1

Environmental logs are not to be used for geotechnical purposes

Client: LAND AND PROPERTY MANAGEMENT AUTHORITY

Project: PROPOSED REDEVELOPMENT - WATERFRONT

Location: SYDNEY FISH MARKETS, 56-60 PYRMONT BRIDGE ROAD, PYRMONT, NSW

Job No. E24125K **Method:** SPIRAL AUGER JK300 **R.L. Surface:** N/A

Date: 20-7-10 **Datum:**

Logged/Checked by: B.P./

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0			ASPHALTIC CONCRETE: 150mm.t				
					N = 11 4,5,6			-	FILL: Gravelly sand, fine to medium grained, dark grey and brown, fine to coarse grained sub angular igneous gravel.	D-M	-	-	
						1			FILL: Silty clayey sand, fine to medium grained, dark brown, with a trace of sandstone gravel and ash.	M			
					N = 2 1,1,1				FILL: Silty clay, medium to high plasticity, grey and brown, with a trace of sandtone gravel.	MC>PL			
▼ ON COMPLET -ION						2		SM	SILTY SAND: fine to medium grained, dark grey.	W	-	-	
					SANK 450mm	3							SPT SANK 450mm UNDER SELF WEIGHT
									END OF BOREHOLE AT 3.45m				
						4							
						5							
						6							
						7							

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

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

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

GROUNDWATER

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

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

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

FILL

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

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

LABORATORY TESTING

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

ENGINEERING REPORTS

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

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

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

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

SITE ANOMALIES

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

REPRODUCTION OF INFORMATION FOR CONTRACTUAL PURPOSES

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

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

REVIEW OF DESIGN

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

SITE INSPECTION

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

Requirements could range from:

i) a site visit to confirm that conditions exposed are no worse than those interpreted, to

ii) a visit to assist the contractor or other site personnel in identifying various soil/rock types such as appropriate footing or pier founding depths, or

iii) full time engineering presence on site.

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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

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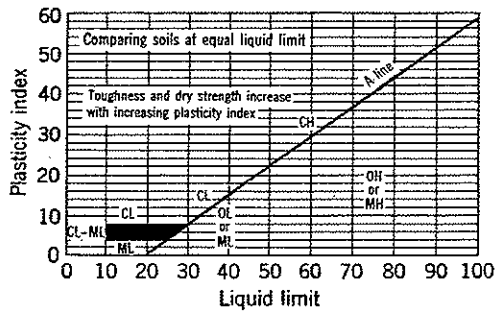
UNIFIED SOIL CLASSIFICATION TABLE

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 For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics Example: *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 Determine percentages of gravel and sand from grain size curve Depending on percentage of fines (fraction smaller than 75 μm sieve size) coarse grained soils are classified as follows: Less than 5% *GW, GP, SW, SP* More than 12% *GM, GC, SM, SC* 5% to 12% *Borderline* cases requiring use of dual symbols	$C_U = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ 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 $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ 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		Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)				
	Silts and clays: liquid limit less than 50		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 For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture and drainage conditions Example: *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.

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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	

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LOG SYMBOLS

LOG COLUMN	SYMBOL	DEFINITION
Groundwater Record		Standing water level. Time delay following completion of drilling may be shown.
		Extent of borehole collapse shortly after drilling.
		Groundwater seepage into borehole or excavation noted during drilling or excavation.
Samples	ES	Soil sample taken over depth indicated, for environmental analysis.
	U50	Undisturbed 50mm diameter tube sample taken over depth indicated.
	DB	Bulk disturbed sample taken over depth indicated.
	DS	Small disturbed bag sample taken over depth indicated.
Field Tests	N = 17 4, 7, 10	Standard Penetration Test (SPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration. 'R' as noted below.
	N_c = 5 7 3R	Solid Cone Penetration Test (SCPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration for 60 degree solid cone driven by SPT hammer. 'R' refers to apparent hammer refusal within the corresponding 150mm depth increment.
	VNS = 25	Vane shear reading in kPa of Undrained Shear Strength.
	PID = 100	Photoionisation detector reading in ppm (Soil sample headspace test).
Moisture Condition (Cohesive Soils)	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 (I_D) 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	300 250	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.
	60	Penetration of auger string in mm under static load of rig applied by drill head hydraulics without rotation of augers.