ASHBURY FMBM PTY LTD

DETAILED SITE INVESTIGATION REPORT
PROPOSED MIXED-USE DEVELOPMENT
149-163 MILTON STREET, ASHBURY

Report E22851 AA Rev0
25 February 2016

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REPORT DISTRIBUTION

Detailed Site Investigation Report
Proposed Mixed-use Development
149-163 Milton Street, Ashbury

EI Report No.: E22851 AA Rev0
Date: 25 February 2016

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EXECUTIVE SUMMARY

Background

Ashbury FMBM Pty Ltd engaged Environmental Investigations Australia Pty Ltd (EI) to conduct a Detailed Site Investigation Report (Stage 2 DSI) for the commercial property located at 149-163 Milton Street, Ashbury ('the site'). This environmental assessment was undertaken as part of a development application process through Canterbury City Council for the development of six, three to eight-storey residential buildings over a basement carpark.

Based on a previous Stage 1 Preliminary Site Investigation (URS, 2014) the site was historically used for various commercial / industrial land uses including brick making, a former vehicle refuelling area, motor vehicle maintenance and servicing of firefighting equipment.

Objectives

The main objectives of the assessment were to:

- Characterise site environmental conditions in relation to the nature, degree and sources of any soil, vapour and groundwater impacts;
- Target potentially impacted areas identified during the preliminary stages of the assessment for intrusive investigation;
- Understand the influence of site specific, geologic and hydrogeological conditions on the potential fate and transport of any impacts that may be identified;
- Evaluate potential risks that identified impacts may pose to human health and the environment; and
- Where site contamination is confirmed, provide data to assist in the selection and design of appropriate remedial options.

Findings

- The site comprised an irregular shaped block, covering a total area of approximately 1.654 hectares. The site was bound by Milton Street (east), Wagener Oval (west), commercial / residential (south) and residential dwellings (north). At the time of investigation the site was occupied by five, one to three-storey, brick/brick and metal commercial buildings, with the remaining areas of the site covered by concrete or bitumen paved, open car-parking.
- A previous Stage 1, Environmental Site Assessment and a Tank Removal Validation Assessment were undertaken by URS in October, 2014 and identified the following:
  - The site history included various commercial / industrial uses including brick making, a former vehicle refuelling area, motor vehicle maintenance and servicing of firefighting equipment;
  - Potentially contaminating land use activities that were identified included:
    - Brick making- use of glazes in kilns containing heavy metals including lead,
    - Former vehicle refuelling area – potential spills and leaks associated with three former USTs;

- Motor vehicle maintenance: spills and leaks of fuels and oils from vehicles and machinery (including possible winch or hydraulic lift);
- Demolition of possible residential structure (1970 - 1994): potential burial of demolition waste, including asbestos on site;
- Two electrical substations / transformers are present on the site, which may potentially contain polychlorinated biphenyl (PCB) containing transformer oils; and
- Servicing of firefighting equipment – including carbon dioxide and dry powder.

- The Tank Removal Validation Assessment confirmed that three USTs (15,000 L and two 25,000 L) and associated pipework were excavated and removed from the site, with the tank pit validated in a manner consistent with the relevant guidelines, and the tank pit was filled with certified, imported backfill material.

- EI consider a potential source of contamination at the site to be the potential for migration of landfill gas from the adjoining former landfill located immediately south west of the site.
- Soil sampling and analysis was conducted at twenty nine (29) targeted test bore locations down to a maximum depth of 18 m BGL. Sampling regime was considered to be appropriate for investigation purposes and comprised judgemental and systematic sampling patterns, with allowance for structural obstacles (e.g. building walls, underground and overhanging services and other physical obstructions in use by existing operating businesses);
- The sub-surface layers comprised of fill materials averaging 1-2 m thick and consisting of various constituents including bricks and gravels, overlying residual soils and weathered Ashfield shale at depth;
- Groundwater was encountered at depths ranging from 1.77 – 8.315 metres below ground level;
- Results of soil samples analysed identified fibrous asbestos in fill samples at boreholes BH4 and BH19 located within the south western and north eastern portions of the site, respectively. Vertical delineation was achieved in BH19, with the deeper natural soil sample being free of asbestos containing material, indicating that asbestos contamination is likely to be confined to the fill layer within the area.
- Exceedances of the heavy metal nickel, above the adopted EIL criteria was detected in multiple soil samples across the site, at locations outside of the proposed building footprint areas. However, the results are fairly uniform across the site, indicating a widespread / regional variation which is therefore not considered a cause for concern.
- There were no exceedances of PAHs, BTEX,OCPs, OPPs and PCBs in soil samples analysed during this investigation;
- Elevated concentrations of heavy metals were detected in all of the groundwater monitoring wells (BH1M, BH3M, BH4M, BH7M and BH8M), with the highest concentration detected within BH3M. However, the results are indicative of natural background concentrations, with the risk considered to be low;
- Concentrations of Trihalomethanes (THMs) including chloroform, bromodichloromethane and dibromochloromethane were reported in groundwater recovered from all of the groundwater monitoring wells. As the concentrations are relatively uniform across the site, it is considered likely that the source is from a leaking reticulated water pipe on site, and therefore the risk of the reported THMs is considered to be low.

- On review of the Preliminary Conceptual Site Model (CSM) developed as part of this ESA, it was concluded that it is valid for the proposed development. The following data gaps however remain and require closure by further investigations:
  - The vertical and lateral extent of asbestos contamination exceeding adopted human-health criteria at boreholes BH4 and BH19 identified at the site;
  - Potential for landfill gas to be present within sub-surface materials across the site, particularly within the western portion of the site which is immediately adjacent to the former landfill, currently used as the Wagener Oval.
  - The quality of soils located in the footprint of the existing site buildings which were inaccessible during this investigation; and
  - Potential presence of hazardous materials present within the existing structure.

Conclusions and Recommendations

Based on the findings of this report and with consideration of the Statement of Limitations, EI conclude that contamination was identified at the site during this DSI. Concentrations exceeding human health based SILs for asbestos were identified in surface fill material within the south western and north eastern areas of the site. In addition, there is potential landfill gas to be present within the sub-surface material at the site, sourced from the adjacent landfill, which will require further investigation.

While soil and groundwater contamination was identified at the site, EI concludes the site can be remediated in accordance with SEPP 55 to allow the site to be used for low density residential purposes, as outlined in the proposed development plans, subject to the implementation of the following recommendations:

- Prior to site demolition, carry out a Hazardous Materials Survey on existing site structures to identify potentially hazardous building products that may be released to the environment during demolition;
- Preparation and implementation of a Remedial Action Plan (RAP), which should:
  - Outline the remediation requirements for soil identified and to close the existing data gaps identified during this DSI and other contamination that may be identified during data gap closure investigations;
  - Undertake a detailed ground gas investigation to assess the potential risks at the site in accordance with the *Guidelines for the Assessment and Management of Sites Impacted by Hazardous Ground Gases* (EPA , 2012);
  - Provide the requirements and procedure for waste classification assessment, in order to enable classification of site soils to be excavated and disposed off-site, in accordance with the *Waste Classification Guidelines* (EPA, 2014); and
  - Provide a SAQP for the validation of remediation activities performed on-site.
- Undertake supplementary investigations, and subsequent remediation and validation works for the site, as outlined in the RAP. EI note that due to current site constrains, the additional investigations and remediation

works may be conducted after site demolition when access to areas of environmental concern is made available; and

- Preparation of a validation report by a suitably qualified environmental consultant, certifying site suitability of soils and groundwater for the proposed land use.

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1. INTRODUCTION

1.1 BACKGROUND AND PURPOSE

Mr Felex Milgrom of Ashbury FMBM Pty Ltd (the Client) engaged Environmental Investigations Australia Pty Ltd (EI) to conduct a Detailed Site Investigation Report (DSI) for site characterisation purposes within Proposed Mixed-use Development, located at 149-163 Milton Street, Ashbury ('the site').

As shown in **Figure 1**, the site is currently used for commercial purposes, including offices and warehouses and is located approximately 8.5 km southwest of the Sydney central business district comprising Lot B and C DP30778. The site is situated within the Local Government Area of Canterbury City Council and site covers a total area of approximately 1.645 hectares (16, 450m^2) as depicted in the site plan presented as **Figure 2**.

This assessment was conducted in support of a Development Application (DA) to Canterbury City Council and for the purpose of enabling the developer to meet its obligations under the Contaminated Land Management Act 1997 (CLM Act), for the assessment and management of contaminated soil and/or groundwater.

1.2 PROPOSED DEVELOPMENT

Prior to the investigation, the Client supplied EI with:

- Concept architectural drawing prepared by CMT Architects Australia Pty Ltd, Project Residential Development 149-163 Milton St, Ashbury 2193, Drawing Title *Concept & Calcs*, dated 25 January 2016; and
- Detailed survey plan of the site prepared by Dunlop Thorpe & Co. Pty Ltd, Reference No. 18304, dated 21 January 2015.

Based on these concept drawings, EI understands that the proposed development involves the demolition of existing structures and the construction of six, three to eight-storey buildings over a basement carpark.

No details regarding the depth of basement carpark was provided to EI at the time of the investigation. This report must be revised once further details become available. Copied of the development plans are provided in **Appendix A**.

1.3 REGULATORY FRAMEWORK

The following regulatory framework and guidelines were considered during the preparation of this report:

- ANZECC & ARMCANZ (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*;
- DECCW (2009) *Guidelines for Implementing the Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation 2008*, (UPSS Guidelines);
- DEC (2007) *Guidelines for the Assessment and Management of Groundwater Contamination*;
- DEC (2006) *Guidelines for the NSW Site Auditor Scheme (2nd Edition)*;
- EPA (1995) *Sampling Design Guidelines*;
- EPA (2014) *Technical Note: Investigation of Service Station Sites*;
- EPA (2012) *Guidelines for the Assessment and Management of Sites Impacted by Hazardous Ground Gases*;

- NEPC (2013) *Schedule B(1) Guideline on Investigation Levels for Soil and Groundwater*;
- NEPC (2013) *Schedule B(2) Guideline on Site Characterisation*;
- *Contaminated Land Management Act (1997)*;
- State Environment Protection Policy 55 (SEPP 55) – *Remediation of Land*, and
- OEH (2011) *Guidelines for Consultants Reporting on Contaminated Sites*.

1.4 Project Objectives

In accordance with the Development Application requirements, the proponent is required to undertake a detailed contamination assessment for any future development applications. The primary objectives of this investigation were therefore to:

- Characterise site environmental conditions in relation to the nature, degree and sources of any soil, vapour and groundwater impacts;
- Target potentially impacted areas identified during the preliminary stages of the assessment for intrusive investigation;
- Understand the influence of site specific, geologic and hydrogeological conditions on the potential fate and transport of any impacts that may be identified;
- Evaluate potential risks that identified impacts may pose to human health and the environment; and
- Where site contamination is confirmed, provide data to assist in the selection and design of appropriate remedial options.

1.5 Scope of Works

In order to achieve the above objectives and in keeping the project cost-effective while generally complying with the OEH (2011) guidelines for consultants reporting on contaminated sites, the scope of works was as follows:

1.5.1 Desktop Study

- A review of the pervious Environmental Site Assessments undertaken for the site;
- A review of existing underground services on site.

1.5.2 Field Work & Laboratory Analysis

- A detailed site walkover inspection;
- Drilling of boreholes at 26 locations across accessible areas of the site in accordance with the minimum sampling protocol recommended under EPA (1995);
- Installation of five groundwater monitoring wells installed to a maximum depth of 6 m (or prior refusal), constructed to standard environmental protocols to investigate potential groundwater contamination;

- Multiple level soil sampling within fill and natural soils and one round of groundwater sampling from the constructed groundwater monitoring wells; and
- Laboratory analysis of selected soil and groundwater samples for relevant analytical parameters as determined from the site history survey and field observations during the investigation programme.

1.5.3 Data Analysis and Reporting

A DSI report would also be prepared to document desk study findings, the conceptual site model, data quality objectives, investigation methodologies and results. The report would also provide a record of observations made during the detailed site walkover inspection, borehole and monitoring well construction logs and a discussion of laboratory analytical results in regards to potential risks to human health, the environment and the aesthetic uses of the land.

2. SITE DESCRIPTION

2.1 PROPERTY IDENTIFICATION, LOCATION AND PHYSICAL SETTING

The site identification details and associated information are presented in **Table 2-1**, while the site locality is shown in **Figure 1**.

Table 2-1 Site Identification, Location and Zoning

Attribute	Description
Street Address	149-163 Milton Street, Ashbury
Location Description	Approx. 8.5 km south west of Sydney CBD, an irregular shaped block bound by Milton Street (east), Wagener Oval (west), commercial / residential (south) and residential dwellings (north). Northeast corner of site: GDA94-MGA55 Easting:881044.427, Northing: 6241778.495 (Source: http://maps.six.nsw.gov.au)
Site Area	The site is approximately 1.645 ha (Dunlop Thorpe & Co. Pty Ltd)
Site Owner	Ashbury FMBM Pty Ltd
Lot and Deposited Plan (DP)	Lot B and C DP30778
State Survey Marks	One State Survey Mark (SSM) is situated in close proximity to the site: SS137399 on the Corner of Constitution Drive and Gale Street and SS122875 on the corner of Milton Street, adjacent to the north eastern area of the site (Source: http://maps.six.nsw.gov.au)
Local Government Authority	Canterbury City Council
Parish	Petersham
County	Cumberland
Current Zoning	IN2 – Light Industrial Development (Canterbury Local Environment Plan, 2012)
Current Land Uses	At the time of in investigation the site was occupied by five, one to three-storey, brick/brick and metal commercial buildings, the remaining areas were covered in concrete or bitumen paved, open car-parking.

The site location is provided in **Figure 1** with the assessment area is illustrated in **Figure 2.**

2.2 SURROUNDING LAND USE

The site is situated within an area of mixed land uses and current uses. Current uses of surrounding land are described in **Table 2-2.**

Table 2-2 Surrounding Land Uses

Direction Relative to Site	Land Use Description
North	Single-storey brick residential dwellings. The closest residential dwellings lie immediately adjacent to the northern site boundary.
South	A large warehouse facility and associated two-storey brick office space. The warehouse is set back about 9m from the southern site boundary.
East	A large warehouse facility and associated two-storey brick office space. The warehouse is set back about 9m from the southern site boundary.
West	Open recreational space ("Wagener Oval"). Wagener Oval was previously used as a brick pit which was filled with landfill waste and re-developed into an oval.

The following sensitive land uses were identified to be present within close proximity to the site:

- Ashbury Public School located approximately 330 m south;
- Woodstock Childcare Centre located approximately 320 m north west; and
- St. Francis Xavier's Primary School Ashbury located approximately 450 m west of the site.

2.3 Regional Setting

Regional topography, geology, soil landscape and hydrogeological information are summarised in **Table 2-3**.

Table 2-3 Regional Setting Information

Attribute	Description
Topography	The regional topography typically comprises a north-northwest trending spur line running along the alignment of Milton Street. Site topography slopes downwards to the west, from an RL of approximately 40.8m AHD at the eastern side of the site, to approximately 33.2m AHD at the north-west corner of the site (Dunlop Thorpe & Co. Pty Ltd).
Site Drainage	Consistent with the general slope of the site, stormwater is assumed to flow west via drainage systems discharging to various stormwater easements and the municipal stormwater system.
Regional Geology	Information on regional sub-surface conditions, referenced from the Department of Mineral Resources Geological Map Sydney 1:100,000 Geological Series Sheet 9130 (DMR 1991) indicates the site to be underlain by Ashfield Shale of the Wianamatta Group, which typically comprises black to dark grey shale and laminite. Ashfield Shale generally weathers into silty clay of medium to high plasticity. The site is located approximately 100m to the north of the Fairfield Basin anticline.
Previous Wagener Oval	The area to the immediate west of the site was used as a brick pit and brick works as shown in 1943 aerial photography of the site available from SIX Maps (maps.six.nsw.gov.au). The site was presumably subsequently used as a landfill and is currently in use as public recreational space (WH Wagener Oval).

Attribute	Description
Soil Landscapes	The Soil Conservation Service of NSW Soil Landscapes of the Sydney 1:100,000 Sheet (Chapman and Murphy, 1989) indicates that the site overlies the Blacktown (bt) Erosional Landscape, which typically includes gently undulating rises on Wianamatta Group Shales and Hawkesbury Shale. Soils are generally shallow to moderately deep (>100 cm) red and brown podzolic soils on crests, upper slopes and well-drained areas. Deeper (150-300 cm) yellow podzolic soils and soloths on the lower slopes and in areas of poor drainage.
Acid Sulfate Soil Risk	With reference to the Botany Bay Acid Sulfate Soil Risk Map (1:25,000 scale; Murphy, 1997), the subject land lies within the map class description of *No Known Occurrence*. In such cases, acid sulphate soils (ASS) are not known or expected to occur and "land management activities are not likely to be affected by ASS materials". The Canterbury City Council Local Environmental Plan 2012- Acid Sulfate Soils Risk Class 1:1,000 scale Map indicates that the site lies within an area of no known occurrences. However, the site is located within close proximity to a Class 5 ASS area. Based on the regional geology of the area which includes the Ashfield Shale, the risk of ASS on site is considered to be low.
Nearest Surface Water Feature	Cooks River which is located approximately 1.21 km south west of the site and forms the nearest receiving surface water body in relation to the site. This part of the river is considered to be tidally influenced and is therefore classed as a marine water ecosystem.
Groundwater Flow Direction	Groundwater is anticipated to flow in the direction of Cooks River located towards the south west of the site, which ultimately drains to Botany Bay approximately 7.5 km south of the site.
Hydraulic Conductivity	Groundwater flow through the Ashfield Shale is documented to be influenced by the bedrock fracture system with hydraulic conductivities estimated to be <1 L/s or 0.1 ML/day (McNally, 2004).

2.4 GROUNDWATER BORE RECORDS AND LOCAL GROUNDWATER USE

An online search of registered groundwater bores was conducted by EI on the 22nd of February 2016 through the NSW Office of Water (Ref. http:// realtimedata.water.nsw.gov.au/water.stm). There were no registered bores within a 500 m radius of the site.

2.5 Site Walkover Inspection

A detailed site walkover inspection was undertaken by EI on 20 February, 2016. The following observations were made:

- The site was occupied by five, one to three-storey, brick/brick and metal commercial buildings, the remaining areas were covered in concrete or bitumen paved, open car-parking (**Photo 1, 2** and **3**);
- Vegetation present on site was in good condition, with no obvious signs of distress;
- Concrete / bitumen was identified to be in good condition across the site;
- The site buildings were observed to be in good condition;
- Two electrical sub-stations were identified within the central portion of the site (**Figure 2**);
- A potential Underground Petroleum Storage System (UPSS) was identified within the northern portion of the site (refer to **Figure 2**), with evidence of a sump in the ground and potential for the building to have been used as a previous mechanical workshop; and
- A former landfill was identified as being present along the south western boundary of the site, with the potential for off-site migration of landfill gas (**Photo 4**).

A detailed photo log is provided in **Appendix B.**

3. PREVIOUS INVESTIGATIONS

3.1 AVAILABLE DOCUMENTS

The following previous environmental site assessments were provided to EI for review:

- URS (2014a) *Phase 1 Environmental Site Assessment at 149 – 163 Milton Street, Ashbury NSW* (Ref. URS Report No. 43218503/0/1, 10 October 2014); and
- URS (2014b) *Tank Removal Validation Assessment, Chubb Security Site, 149-155 Milton Road, Ashfield NSW* (Ref. URS Report No. 43217264, 27 October, 2014)

A summary of URS's works and key findings is outlined in **Table 3-1**.

Table 3-1 Summary of Previous Investigation Works and Findings

Assessment Details	Project Tasks and Findings
***Phase 1 Environmental Site Assessment* (URS, 2014a)**	
Work Objectives	To undertake a desktop review of available information for the site including a site walkover reconnaissance and a search of historical records to provide an overall indication of the potential for contamination to be present on the site.
Scope of Works	• A review of current and historical Certificates of Title to provide a history of ownership and land use; • Review of the following – Aerial photographs – selected historical aerial photographs of the site available for review from the Department of Lands to provide evidence of the history of development of the site and indications of potential sources of contamination; – Details of groundwater bores registered on the groundwater bore database maintained by the New South Wales (NSW) Natural Resource Atlas (www.nratlas.nsw.gov.au) and located within 500 m of the site; – Review of topographical, geological and soil maps of the areas; and – Search of the database managed by the NSW Environmental Protection Authority for information on notices issued under the Contaminated Land Management Act, 1997. • Review of available site records; • Site inspection – to provide further information, via visual inspection, of potential sources and areas of significant environmental liability..

Assessment Details	Project Tasks and Findings
Conclusions and Recommendations	Based on the limited site history investigation URS made the following conclusions: • Based on the historic operations on the site, the following activities may have resulted in soil and/or groundwater contamination: – Brick making- use of glazes in kilns containing heavy metals including lead, – Former vehicle refuelling area – potential spills and leaks associated with three former USTs; – Motor vehicle maintenance: spills and leaks of fuels and oils from vehicles and machinery (including possible winch or hydraulic lift); – Demolition of possible residential structure (1970 0 1994): potential burial of demolition waste, including asbestos on site; – Two electrical substations / transformers are present on the site, which may potentially contain polychlorinated biphenyl (PCB) containing transformer oils; – Servicing of firefighting equipment – including carbon dioxide and dry powder; • Historic operations at the site included a refuelling area for vehicles. Infrastructure from this refuelling area has been excavated and removed from the site in 2005 and the resultant tank pit was validated and reinstated in accordance with the NSW EPA guidelines; • Anecdotal evidence suggested that no fire extinguishers containing aqueous film forming foam (AFFF) were used on the site; and • There was potential for some filling material to be present beneath the concrete paving and building floors on the site, however 'cut-and-fill' civil works during establishment of the site are considered unlikely to have resulted in significant volumes of imported fill material to be present at the site.
***Tank Removal Validation Assessment* (URS, 2014b)**	
Work Objectives	URS were engaged to undertake decommissioning and removal of three underground storage tanks (USTs) and associated infrastructure at the Chubb facility located at 149-155 Milton Street, Ashfield NSW.
Scope of Works	The scope of works involved the following: – Attendance to the site during excavation and removal of tanks and infrastructure; – Sampling of the soils within the resultant excavation pit; – Sampling of the excavated tank backfill sands forming the stockpile; – Sampling of imported materials; – Reinstatement of excavation with excavated sandstone imported virgin excavated natural material (VENM); and – Preparation of a detailed report outlining the findings of the UST removal project.

Assessment Details	Project Tasks and Findings
Conclusions and Recommendations	• Three USTs and associated pipework were excavated and removed from the site. These included Tank 1 '(15,000 L UST), Tank 2 (25, 000 L UST) and Tanks 3 (25,000 L UST) and associated pipework. All tanks and pipework were noted to be in good condition; • All excavated soil was stockpiled on-site and sampled to assess the potential for re-instatement back into the tank pit; • All soil samples collected and analysed from the UST excavation has concentrations of chemicals of potential concern below the adopted investigation levels. The samples were collected from both the base and walls of the tank pit excavation at depths between one and three meters below ground surface; • Stockpiled materials from the tank pit recorded hydrocarbon odours and PID readings at maximum concentrations of 230 parts per million; • All soil samples collected and analysed from the stockpile has concentrations of chemicals of potential concern below the adopted investigation levels. The stockpile material was subsequently re-instated back into the tank pit; • Approximately 85 m^3 of imported fill material (crushed sandstone) was transported to site and reinstated in the former tank pit. Sampling analytical results from imported fill material had concentrations of potential concern below the site investigation levels and or laboratory practical quantitation limits; and • The above sampling program indicates that the tank pit has been validated in a manner consistent with the relevant guidelines.

3.2 SUMMARY OF CONTAMINATION

The following potential sources of contamination were identified at the site:

- Imported filling of unknown origin distributed across the site;
- Impacts from previous commercial / industrial land uses, including brick making, vehicle refuelling, motor vehicle maintenance and servicing of firefighting equipment;
- Potential for hazardous buildings to be present on site, including from the demolition of former buildings; and
- Potential localised impacts from two electrical sub-stations located on the site.

In addition, EI consider a potential source of contamination at the site to be the potential for migration of landfill gas from the adjoining former landfill located immediately south west of the site. Landfill gas presents explosive and/or asphyxiation hazards, particularly from methane gas migration.

4. CONCEPTUAL SITE MODEL

In accordance with NEPM (2013) *Schedule B2 – Guideline on Site Characterisation* and to aid in the assessment of data collection for the site, EI developed a preliminary conceptual site model (CSM) assessing plausible pollutant linkages between potential contamination sources, migration pathways and receptors. The CSM provides a framework for the review of the reliability and useability of the data collected and to identify data gaps in the existing site characterisation.

4.1 CHEMICAL HAZARDS AND CONTAMINATION SOURCES

On the basis of site history and search findings (described in **Section 5**) EI consider potential chemical hazards and onsite contamination sources to be as follows:

- Imported fill soils of unknown origin distributed across the site;
- Impacts from previous commercial / industrial manufacturing activities at the site including brick making, vehicle refuelling, motor vehicle maintenance and servicing of firefighting equipment;
- Painted surfaces in relation to the structures (buildings) that are currently present on the site;
- Hazardous materials, including potential asbestos-containing materials (ACM) from building products and potential buried building materials from demolition;
- Potential localised impacts from two electrical substations located on the site;
- Potential migration of hazardous landfill gas to the site from the adjacent former landfill, currently identified as the Wagener Oval;
- Deeper, natural soils containing residual impacts, representing potential secondary sources of contamination; and
- The former onsite presence of underground petroleum storage systems (UPSS).

4.2 CHEMICALS OF CONCERN

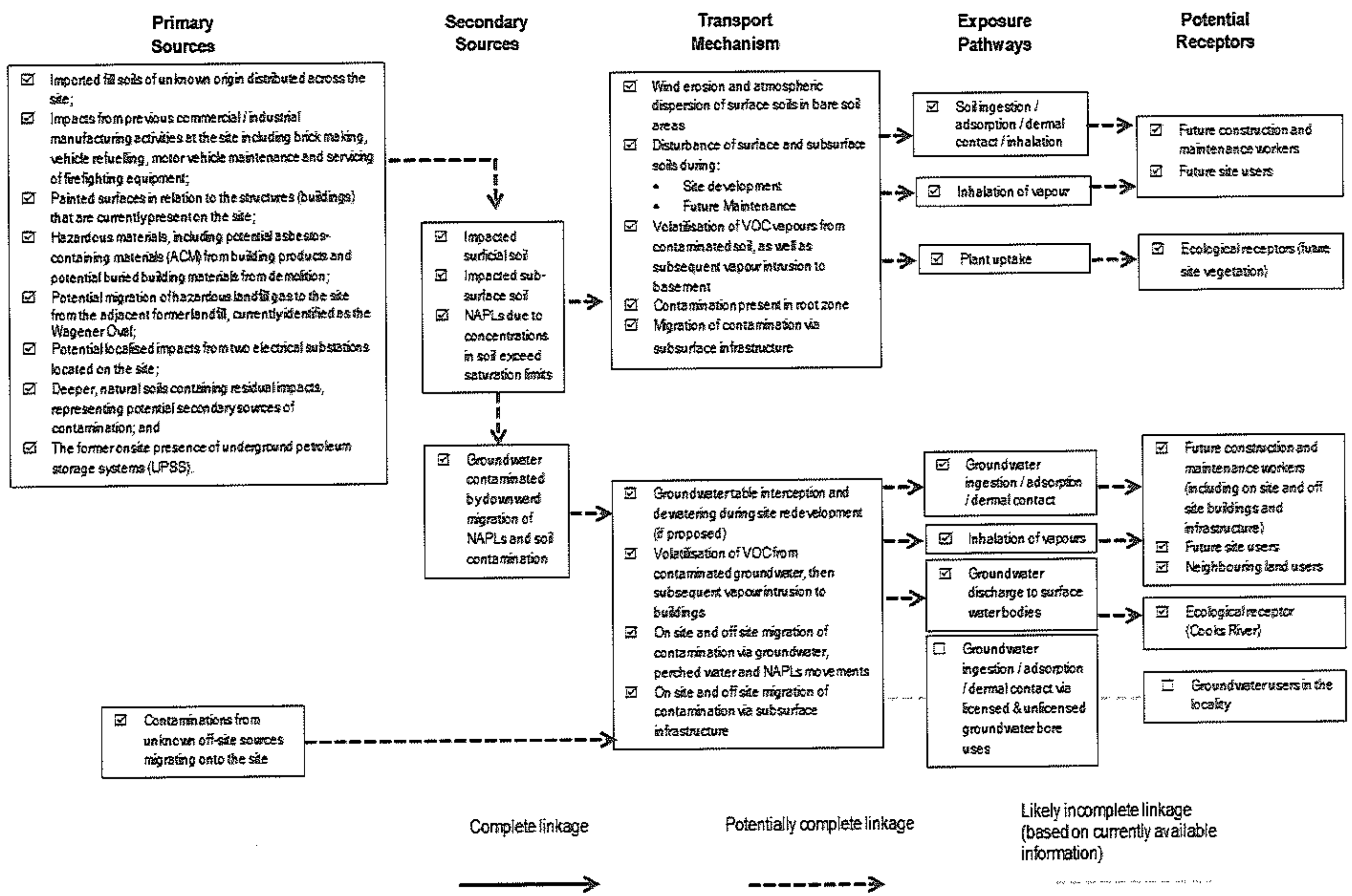
Based on the findings of the site contamination appraisal the chemicals of concern (COC) at the site are considered to be:

- Soil – heavy metals (HMs), total recoverable hydrocarbons (TRH), polycyclic aromatic hydrocarbons (PAH), monocyclic aromatic hydrocarbon compounds - *benzene, toluene, ethylbenzene and xylenes* (BTEX), organochlorine and organophosphate pesticides (OCP/ OPP), polychlorinated biphenyls (PCB) and asbestos.
- Groundwater – HMs, TRH, BTEX, PAH and volatile organic compounds (VOC), including chlorinated VOC (VOCC) such as trichloroethylene (TCE).;
- Air Quality – Landfill gases including Methane (CH_4), Carbon Dioxide (CO_2), Carbon Monoxide (CO) and Hydrogen Sulfide (H_2S).

4.3 POTENTIAL SOURCES, EXPOSURE PATHWAYS AND RECEPTORS

Potential contamination sources, exposure pathways and human and environmental receptors that were considered relevant for this assessment are summarised along with a qualitative assessment of the potential risks posed by complete exposure pathways in **Table 4-1**.

Table 4-1 Preliminary Conceptual Site Model



Preliminary Conceptual Site Model – Pre Fieldwork

Source: based on NEPM schedule B4 HRA Methodology

4.4 DATA GAPS

Based on information from the site walkover inspection and site history review, EI considered a programme of intrusive investigation was warranted to conduct targeted sampling at locations of known, potential sources of contamination (as listed in **Section 5.1**), with systematic sampling coverage in site areas where operational site history was not documented.

5. SAMPLING, ANALYTICAL AND QUALITY PLAN (SAQP)

The SAQP plays a crucial role in ensuring that the data collected as part of this, and ongoing environmental works carried out at the site are representative, and provide a robust basis for site assessment decisions. This SAQP includes the following:

- Data quality objectives, including a summary of the objectives of the ESA;
- Investigation methodology including media to be sampled, details of analytes and parameters to be monitored and a description of intended sampling points;
- Sampling methods and procedures;
- Field screening methods;
- Analysis Methods;
- Sample handling, preservation and storage; and
- Analytical QA/QC.

5.1 DATA QUALITY OBJECTIVES (DQO)

In accordance with the USEPA (2006) *Data Quality Assessment* and the DEC (2006) *Guidelines for the NSW Site Auditor Scheme*, the process of developing Data Quality Objectives (DQO) was used by the EI assessment team to determine the appropriate level of data quality needed for the specific data requirements of the project. The DQO process that was applied for this assessment is documented in **Table 5-1**.

Table 5-1 Summary of Project Data Quality Objectives

DQO Steps (NSW DEC, 2006)	US EPA (2006) (modified)	Details	Comments (changes during investigation)
1. State the Problem Summarise the contamination problem that will require new environmental data, and identify the resources available to resolve the problem; develop a conceptual site model	Give a concise description of the problem Develop a conceptual model of the environmental hazard to be investigated. Identify resources available.	• The site is to be redeveloped for high-density residential housing, with accessible soil areas. • Historical information and site inspection identified the potential for contamination to be present in site soil and/or groundwater, contributed by various potential sources listed in **Section 4.1**. Based on the site history information collected, a preliminary conceptual site model of the site has been developed, and is present in **Section 4**. • The investigation sampling must provide supportive information on the environmental conditions of the site to determine the site's suitability for the proposed development.	
2. Identify the Goal of the Study (Identify the decisions) Identify the decisions that need to be made on the contamination problem and the new environmental data required to make them	Identify principal study question(s). Consider alternative outcomes or actions that may result from answering the question(s). For decision problems, develop decision statement(s), organise multiple decisions. For estimation problems, state what needs to be estimated and key assumptions.	Based on the objectives outlined in **Section 1.4**, the decisions that need to be made are: • Has the nature, extent and source of any soil, vapour and/or groundwater impacts onsite been defined? • What impact do the site specific, geologic and hydrogeological conditions have on the fate and transport of any impacts that may be identified? • Does the level of impact coupled with the fate and transport of identified contaminants represent an unacceptable risk to identified human and/or environmental receptors on or offsite? • Does the collected data provide sufficient information to allow the selection and design of an appropriate remedial strategy, if necessary?	

DQO Steps (NSW DEC, 2006)	US EPA (2006) (modified)	Details	Comments (changes during investigation)
3. Identify Information Inputs (Identify inputs to decision) Identify the information needed to support any decision and specify which inputs require new environmental measurements	Identify types and sources of information needed to resolve decisions or produce estimates. Identify the basis of information that will guide or support choices to be made in later steps of the DQO Process. Select appropriate sampling and analysis methods for generating the information.	Inputs to the decision making process include: • Site history information from the previous URS (2014) investigation; • Areas of concern identified by URS (2014) and during the site inspection prior to intrusive investigations; • National and NSW EPA guidelines under the NSW Contaminated Land Management Act 1997; • Investigation sampling to verify the presence of onsite contamination and to evaluate the potential risks to sensitive receptors; • Laboratory analysis of selected soil and groundwater samples will comprise contaminants of concern presented in **Section 4.2**; and At the end of the assessment, a decision must be made regarding whether the soils and groundwater are suitable for the proposed development, or if additional investigation or remedial works are required to make the site suitable.	An additional two soil boreholes were drilled. Boreholes BH25, BH27 and BH28 did not achieve the target depth of natural soils, due to hand auger refusal on impenetrable fill material.
4. Define the Boundaries of the Study Specify the spatial and temporal aspects of the environmental media that the data must represent to support decision	Define the target land-use and receptors of interest and its relevant spatial boundaries. Define what constitutes a sampling unit. Specify temporal boundaries and other practical constraints associated with sample/data collection. Specify the smallest unit on which decisions or estimates will be made.	• Lateral – The investigation will be conducted within the cadastral site boundaries; which defines the extent of the investigation • Vertical – From existing ground surface, underlying fill and natural soil horizons, to underlying groundwater water-bearing zone(s); and Temporal – The results will be valid on the day samples are collected and will remain valid as long as no changes occur on site or contamination (if present) does not migrate on site or on to the site from off-site sources.	
5. Develop the Analytic Approach (Develop a decision rule) To define the parameter of interest, specify the action level, and integrate previous DQO outputs into a single statement that describes a logical basis for choosing from alternative actions	Specify appropriate land-use parameters for making decisions or estimates. For decision problems, choose a workable Action Level and generate an "If then else" decision rule which involves it. For estimation problems, specify the methodology and the estimation procedure.	The decision rules for the investigation were: • If the concentrations of contaminants in the soils data exceed the land use criteria; then assess the need to further investigate the extent of impacts onsite, and • Decision criteria for QA/QC measures are defined by the Data Quality Indicators (DQI) in **Table 5-2.**	

DQO Steps (NSW DEC, 2006)	US EPA (2006) (modified)	Details	Comments (changes during investigation)
6. Specify Performance or Acceptance Criteria (Specify limits on decision errors) Specify the decision-maker's acceptable limits on decision errors, which are used to establish performance goals for limiting uncertainties in the data	For decision problems, specify the decision rule as a statistical hypothesis test, examine consequences of making incorrect decisions from the test, and place acceptable limits on the likelihood of making decision errors. For estimation problems, specify acceptable limits on estimation uncertainty.	Specific limits for this project are to be in accordance with the National and NSW EPA guidance, and appropriate indicators of data quality and standard procedures for field sampling and handling. This should include the following points to quantify tolerable limits: • The null hypothesis for the investigation is that: – The 95% Upper Confidence Limits (UCL) of the mean for contaminants of concern exceed residential (with accessible soil) land use criteria across the site. • Sampling on a 20.5 m grid will allow detection of a circular hotspot with a nominal diameter of 24 m with 95% certainty; • The acceptance of the site will be based on the probability that – The 95% UCL of the mean of the data will satisfy the given site criteria. Therefore a limit on the decision error will be 5% that a conclusive statement may be incorrect; and – The standard deviation of the results is less than 50% of the relevant remediation acceptance criterion; and – No single results exceeds the remediation acceptance criteria by 250% or more; and • Soil concentrations for chemicals of concern that are below investigation criteria made or approved by the NSW EPA will be treated as acceptable and indicative of suitability for the proposed land use(s); and • If contaminant concentrations in groundwater exceed the adopted criteria, further investigation will be considered prudent. If no contamination is detected in groundwater, further action will not be warranted.	

DQO Steps (NSW DEC, 2006)	US EPA (2006) (modified)	Details	Comments (changes during investigation)
7. Develop the Detailed Plan for Obtaining Data (Optimise the design for obtaining data) Identify the most resource-effective sampling and analysis design for general data that are expected to satisfy the DQOs	Compile all data and outputs generated in Steps 1 to 6. Use this information to identify alternative sampling designs that fit your intended use Select and document a design that will yield data to best achieve your data quality.	• The site area (16,450 m^2) required 26 sampling points according to EPA (1995); • Soil sampling locations were set using a systematic sampling pattern across the accessible areas of the site; • An upper soil profile sample (or soil extracted immediately beneath the concrete hardstand / pavement) will be collected at each borehole location and tested for chemicals of concern, to assess the conditions of fill layer, and impacts from activities above ground. Further sampling would also be carried out at deeper soil layers. These samples would be selected for testing based on field observations (including visual and olfactory evidence, as well as soil vapour screening in headspace samples) whilst giving consideration to characterise the subsurface stratigraphy; • Five groundwater monitoring wells were proposed to characterise groundwater quality within the site; and • Written instructions will be issued to guide field personnel in the required fieldwork activities.	

5.2 DATA QUALITY INDICATORS

To ensure that the investigation data collected was of an acceptable quality, the investigation data set was assessed against the data quality indicators (DQI) outlined in **Table 5-2**, which related to both field and laboratory-based procedures. The assessment of data quality is discussed in **Section 7**.

Table 5-2 Data Quality Indicators

Data Quality Objective	Data Quality Indicator	Acceptable Range
Accuracy	Field – Trip blank (laboratory prepared) Laboratory – Laboratory control spike and matrix spike	< laboratory limit of reporting (LOR) Prescribed by the laboratories
Precision	Field – Blind replicate and spilt duplicate Laboratory – Laboratory duplicate and matrix spike duplicate	< 30 % relative percentage difference (RPD [%]) Prescribed by the laboratories
Representativeness	Field – Trip blank (laboratory prepared) Laboratory – Method blank	< laboratory limit of reporting (LOR) Prescribed by the laboratories
Completeness	Completion (%)	-

6. ASSESSMENT METHODOLOGY

6.1 Sampling Rationale

With reference to the preliminary CSM described in **Section 5**, soil and groundwater investigation works were planned in accordance with the following rationale:

- Sampling fill and natural soils from 28 test bore locations located systematically across the site using a grid-based sampling pattern and at targeted locations to assess for the presence of residual soil contamination. It should be noted that 26 boreholes were planned in accordance with the minimum sampling requirements, however an additional two boreholes were drilled;
- Sampling groundwater during a single groundwater monitoring event (GME) at five monitoring wells located close to the up gradient and down gradient site boundaries to assess for potential groundwater impacts; and
- Laboratory analysis of representative soil and groundwater samples for the identified chemicals of concern.

6.2 Investigation Constraints

The number of test bores drilled and monitoring wells installed during the investigation phase achieved the planned investigation scope described in **Section 7.1**. However, the however, the following investigation constraints were encountered:

- Limited access to internal areas of the buildings and therefore characterisation of the majority of material within the existing building footprints could not be achieved;
- Limited head-clearance for the mechanical drilling rig; and
- Buried impenetrable materials (buried deep slabs and rock boulders), which caused auger refusal in boreholes BH25, BH27 and BH28.

6.3 Assessment Criteria

The assessment criteria proposed for this project are outlined in **Table 6-1**. These were selected from available published guidelines that are endorsed by national or state regulatory authorities, with due consideration of the exposure scenario that is expected for various parts of the site, the likely exposure pathways and the identified potential receptors.

Table 6-1 Adopted Investigation Levels for Soil and Groundwater

Environmental Media	Adopted Guidelines	Rationale
Soil	NEPM, 2013 Soil HILs, EILs, HSLs, ESLs & Management Limits for TPHs	**Soil Health-based Investigation Levels (HILs)** All samples to be assessed against the NEPM 2013 HIL-B thresholds for residential sites with limited access to soils **Ecological Investigation Levels (EILs)** Soil samples from boreholes BH1M, BH3M, BH4M, BH5, BH6, BH7M, BH11, BH15, BH16, BH17, BH21, BH22, BH24, BH27, BH28 and BH29 would also be assessed against the NEPM 2013 EILs for arsenic, copper, chromium (III), nickel, lead, zinc, DDT and naphthalene, which have been derived for protection of terrestrial ecosystems. **Soil Health-based Screening Levels (HSLs)** The NEPM 2013 Soil HSL-A&B thresholds for low-high density residential sites for vapour intrusion would be applied to assess for potential human health impacts from residual vapours resulting from petroleum, BTEX & naphthalene. Soils asbestos results to be assessed against the NEPM 2013 Soil HSL thresholds for "all forms of asbestos". **Ecological Screening Levels (ESLs)** Soil samples from boreholes BH1M, BH3M, BH4M, BH5, BH6, BH7M, BH11, BH15, BH16, BH17, BH21, BH22, BH24, BH27, BH28 and BH29 to be assessed against the NEPM 2013 ESLs for selected petroleum hydrocarbons & TRH fractions for protection of terrestrial ecosystems. **Management Limits for Petroleum Hydrocarbons** Should the ESLs and HSLs be exceeded for petroleum hydrocarbons, soil samples from all boreholes would also assessed against the NEPM 2013 *Management Limits* for the TRH fractions F1 – F4 to assess propensity for phase-separated hydrocarbons (PSH), fire and explosive hazards & adverse effects on buried infrastructure. **Ground Gas** Hazardous ground gases associated with Landfills include methane, carbon dioxide, carbon monoxide and hydrogen sulfide will be managed through the NSW Environmental Protection Authority (2012) *Guidelines for the Assessment and Management of Sites Impacted by Hazardous Ground Gases*, November, 2012.

Environmental Media	Adopted Guidelines	Rationale
Groundwater	NEPM, 2013 GILs for Marine Waters	**Groundwater Investigation Levels (GILs) for Marine Water** NEPM 2013 provides GILs for typical, slightly-moderately disturbed aquatic ecosystems, which are based on the ANZECC & ARMCANZ 2000 Trigger Values (TVs) for the 95% level of protection of aquatic ecosystems; however, the 99% TVs were applied for the bio-accumulative metals *cadmium* and *mercury*. The marine criteria were considered relevant as the closest, potential surface water receptor was Cooks River, located 1.21 km south west of the site and understood to be tidally influenced.
	NEPM, 2013 Groundwater HSLs for Vapour Intrusion	**Health-based Screening Levels (HSLs)** The NEPM 2013 groundwater HSLs for vapour intrusion were used to assess for potential human health impacts from residual vapours resulting from petroleum, BTEX and naphthalene impacts. The *HSL A* and *HSL B* thresholds for low and medium-density residential sites were applied for groundwater.
	NEPM, 2013 GILs for Drinking purposes	**Drinking Water GILs** The NEPM (2013) GILs for drinking water quality were applied for specific parameters, for which freshwater/marine GILs were not provided. These were based on the Australian Drinking Water Guidelines (Ref. NHMRC, 2011).

Table 7-2 Generic and Derived Ecological Investigation Levels

Metal	Assumed Values [1]	EIL (mg/kg) [2]
Arsenic	Generic EIL	100
Chromium (III)	ABC - 15 mg/kg (assumes an old NSW high traffic suburb) ACL - 190 mg/kg (assumes clay content <1 %)	205
Copper	ABC - 30 mg/kg (assumes an old NSW high traffic suburb) ACL - 60 mg/kg (assumes pH 4.5)	90
DDT	Generic EIL	180
Lead	ABC - 160 mg/kg (assumes an old NSW high traffic suburb) ACL – 1,100 mg/kg	1,260
Naphthalene	Generic EIL	170
Nickel	ABC - 5 mg/kg (assumes an old NSW high traffic suburb) ACL - 30 mg/kg (assumes CEC 5)	35
Zinc	ABC - 120 mg/kg (assumes an old NSW high traffic suburb) ACL - 70 mg/kg (assumes pH 4 & CEC 5)	190

Notes:
ACL - added contaminant limit; ACLs for Urban residential and public open space were used for this project
ABC - ambient background concentration
The most stringent ACL values were adopted for Chromium (III), Copper, Lead, Nickel and Zinc, as site soil physiochemical properties (i.e. pH, CEC and clay content) were not tested (Ref. NEPM 2013 Schedule B1, Tables 1B(1), 1B(2), 1B(3) and 1B(4) *Soil-specific added contaminant limits*)
[1] Assumed values are based on NEPM 2013 Schedule B5(c) *Guideline on Ecological Investigation Levels for Arsenic, Chromium (III), Copper, DDT, Lead, Naphthalene, Nickel & Zinc*

[2] EIL = ABC + ACL, unless Generic EIL is applicable

For the purposes of this investigation, the adopted soil assessment criteria are referred to as the Soil Investigation Levels (SILs) and the adopted groundwater assessment criteria are referred to as the Groundwater Investigation Levels (GILs). SILs and GILs are presented alongside the analytical results in the corresponding summary tables, which are discussed in **Section 8**.

6.4 Soil Investigations

The soil investigations conducted at the site are described in **Table 6-3**. Test bore locations are illustrated in **Figure 2**.

Table 6-3 Summary of Soil Investigation Methodology

Activity/Item	Details
Fieldwork	The site investigation was carried out on the following dates: • Drilling of boreholes BH1M on 20 January, 2016; • Drilling of borehole BH4M on 18 January, 2016; • Drilling of boreholes BH7M, BH3M and BH6 on 19 January, 2016; • Drilling of boreholes BH5, BH9 – BH29 on 20 January, 2016; and • Drilling of borehole BH8M on 21 January, 2016. Boreholes BH1M, BH3M, BH4M, BH7M and BH8M were converted to groundwater monitoring wells. All of the planned test bores achieved the target depth of natural soils, with the exception of boreholes BH25, BH27 and BH18 due to hand auger refusal in impenetrable fill material.

Activity/Item	Details
Drilling Method & Investigation Depth	Boreholes BH1M, BH2, BH3, BH4M, BH5, BH6, BH7M and BH8M were drilled by Chadwick Geotechnics Pty Ltd using a Hanjin DB8 (model), mechanical, track-mounted, drilling rig using 200 mm diameter, solid flight augers. It should be noted that these boreholes were also drilled for Geotechnical investigation purposes (refer. E22851 GA). Boreholes BH9 – BH24, BH26, and BH28 were drilled by HartGeo Pty Ltd using a mechanical, track-mounted, drilling rig using 200 mm diameter, solid flight augers. Boreholes BH25, BH27 and BH29 were drilled by hand auger due to drilling rig height and access restrictions to onsite buildings. Final bore depths were: • 8.4 m BGL for BH1M, • 13.18 m BGL for BH3M; • 18.0 m BGL for BH4M; • 16.75 m BGL for BH7M; • 12.0 m BGL for BH8M; • 4.1 m BGL for BH9; • 2.4 m BGL for BH10; • 2.3 m BGL for BH11; • 3.0 m BGL for BH12; • 2.0 m BGL for BH13, BH14, BH15, BH16, BH17, BH21, BH22, BH24 and BH29 • 1.6 m BGL for BH18; • 3.1 m BGL for BH19; • 2.5 m BGL for BH20; • 4.0 m BGL for BH23; • 0.5 m BGL for BH25; • 1.5 m BGL for BH26; • 0.6 m BGL for BH27; and • 0.7 m BGL for BH28.
Soil Logging	Drilled soils were classified in the field with respect to lithological characteristics and evaluated on a qualitative basis for odour and visual signs of contamination. Soil classifications and descriptions were based on Unified Soil Classification System (USCS) and Australian Standard (AS) 4482.1-2005. Bore logs are presented in **Appendix C**.
Field Observations (including visual and olfactory signs of potential contamination)	A summary of field observations is provided, as follows: • fibre cement sheet fragments were not observed in any drilling cuttings; • no signs of ash or charcoal materials were detected in any of the drilled boreholes; and • No visual signs of contamination were observed and no suspicious odours were detected during any stage of the field investigation programme.
Soil Sampling	• Soil samples were collected using a dry grab method (unused, dedicated nitrile gloves) & placed into laboratory-supplied, acid-washed, solvent-rinsed glass jars. • Blind field duplicates was separated from the primary samples and placed into glass jars. • A small amount of duplicate was collected from each soil samples and placed into zip-lock bag for Photo-ionisation Detector (PID) screening. • A small amount of duplicate was separated from all fill samples and placed into a zip-lock bag for asbestos analysis.

Activity/Item	Details
Decontamination Procedures	*Drilling Equipment* - The drilling rods were decontaminated between sampling locations with potable water until the augers were free of all residual materials. *Sampling Equipment* – Samples were collected via hand with a new pair of dedicated nitrile gloves for each sample and placed into laboratory prepared and pre-labelled sample jars.
Sample Preservation	Samples were stored in a refrigerated (ice-filled) chest, whilst on-site and in transit to the laboratory. All samples were submitted and analysed within the required holding period, as documented in laboratory reports discussed in a later section.
Management of Soil Cuttings	Soil cuttings were used as backfill for completed boreholes.
Quality Control & Laboratory Analysis	A number of soil samples were submitted for analysis of previously-identified COPC by SGS Laboratories (SGS). QA/QC testing comprised intra-laboratory duplicates ('field duplicates') tested blind by SGS and an inter-laboratory field duplicate tested blind by Envirolab Services (Envirolab). All samples were transported under strict Chain-of-Custody (COC) conditions and COC certificates and laboratory sample receipt documentation were provided to EI for confirmation purposes, as discussed in **Section 9.**
Soil Vapour Screening	Screening for potential VOCs in collected soil samples was conducted using a Photo-ionisation Detector (PID), as volatile odours were not detected at any sampling location during the course of the fieldwork.

6.5 GROUNDWATER INVESTIGATIONS

The groundwater investigations conducted at the site are described in **Table 6-4**. Monitoring well locations are illustrated in **Figure 2**.

Table 6-4 Summary of Groundwater Investigation Methodology

Activity/Item	Details
Fieldwork	Groundwater monitoring wells were installed and developed on following dates: • 18 January 2016 for BH4M; • 19 January 2016 for BH3M and BH7M; • 20 January 2016 for BH1M; • 21 January 2016 for BH8M. Whereas, water level gauging, well purging, field testing and groundwater sampling was conducted on 28 January, 2016.
Well Construction	Test bores were converted to groundwater monitoring wells as follows: • one, 8.4 m deep, onsite, up-gradient well identified as BH1M; • two, 12 m deep, onsite, up-gradient wells identified as BH3M and BH8M; • one, 9.0 m deep, onsite, down-gradient well identified as BH7M and • one, 12 m deep, offsite, up-gradient well identified as BH4M. Monitoring wells BH3M, BH4M, BH7M and BH8M drilled by Chadwick Geotechnics Pty Ltd using a track-mounted, Hanjin DB8 (model), mechanical, track-mounted, drilling rig using 200 mm diameter, solid flight augers. Monitoring well BH1M was installed by HartGeo Pty Ltd using a mechanical, track-mounted, drilling rig using 200 mm diameter, solid flight augers. Well construction details are tabulated in **Table 9-2** and documented in the bore logs presented in **Appendix C**. Both wells were installed to screen the sand aquifer within the interval 3.0 to 6.0 m bgl and were seated in silty sandy soils.
Well Construction (continued)	Well construction was in general accordance with the standards described in NUDLC, 2012 and involved the following: • 50 mm, Class 18 uPVC, threaded, machine-slotted screen and casing, with slotted intervals in shallow wells set to screen to at least 500 mm above the standing water level to allow sampling of phase-separated hydrocarbon product, if present; • base and top of each well was sealed with a uPVC cap; • annular, graded sand filter was used to approximately 300mm above top of screen interval; • granular bentonite was applied above annular filter to seal the screened interval; • drill cuttings were used to backfill the bore annulus to just below ground level; and • surface completion comprised a steel road box cover set in neat cement and finished flush with the concrete slab level.
Well Development	Well development was conducted for each well directly following installation. This involved agitation within the full length of the water column using a dedicated, HDPE, disposable bailer, followed by removal of water and accumulated sediment using a 12V, HDPE submersible bore pump (Proactive Environmental, model Super Twister). Pumping was continued until no further reduction in suspended sediment was observed (i.e. after removal of several well volumes).
Well Survey (Elevation and location)	Well elevations at ground level were extrapolated from the spot elevations marked on the survey plan provided by the client. Well elevations at ground level were extrapolated in metres relative to Australian Height Datum (m AHD).

Activity/Item	Details
Well Gauging & Groundwater Flow Direction	Monitoring wells were gauged for standing water level (SWL, depth to groundwater) prior to well purging at the commencement of the GME on 28 January 2016, all measured SWLs are shown in **Table 9-2.** A transparent HDPE bailer was used to visually assess for the presence PSH prior to the commencement of well purging at each well. PSH was not detected in any of the wells. Based on the reduced water levels (RWLs, i.e. SWLs corrected to AHD) calculated at each monitoring well (**Table 9-3**) the direction of groundwater flow in the shallow aquifer was inferred to be in a southwest direction. This is consistent with the general slope of the site and considering the nearest surface water body is the Cooks River which is located approximately 1.21 km south west of the site.
Well Purging, Field Testing & Groundwater Sampling	All groundwater monitoring wells were purged and sampled using low-flow/minimal drawdown sampling method with a MicroPurge kit (MP15) and a portable MicroPurge pump following well gauging. The MicroPurge system incorporates a low density poly-ethylene (LDPE) pump bladder, and a Teflon-lined LDPE sample delivery tube. The system used for this investigation employed pressurised carbon dioxide gas to regulate groundwater flow. Pump pressure and pumping cycles were adjusted accordingly to regulate extraction flow rate, and to avoid causing excessive drawdown of water level during the sampling process. Field measurement of water quality parameters was conducted continuously on purged groundwater with a water quality meter (Hanna Multi Parameter 9829) positioned within an open flow-through cell. Groundwater parameters tested in the field were Dissolved Oxygen (DO), Electrical Conductivity (EC), Redox, Temperature and pH. The measured parameters were recorded onto a field data sheet (**Appendix D**), along with the purged water volume at the time of measurement. Groundwater sampling was performed when three consecutive readings of groundwater parameter indicated stabilisation; as per the specified ranges detailed below: • Electrical Conductivity: ± 3% of the read value; • Redox: ± 20 mV; • DO: ± 20% of the read value; and • pH: ± 0.2 pH unit. Total water volume purged and stabilised groundwater parameters at each groundwater monitoring well are summarised in **Table 9-3.**
Decontamination Procedure	• All sample containers were supplied by the laboratory for the particular project and only opened once immediately prior to sampling. • While ice was used to keep the samples cool, all melt water was continuously drained from the Esky to prevent cross-contamination of samples. • The MicroPurge Pump, water level probe and water quality kit probes were washed in a solution of potable water and Decon 90 and then rinsed with potable water between measurements/wells.
Sample Preservation	Sample containers were supplied by the laboratory with the following preservatives: • one, 1 litre amber glass, acid-washed and solvent-rinsed bottle; • two, 40ml glass vials, pre-preserved with dilute hydrochloric acid, Teflon-sealed; and • one, 250mL, HDPE bottle, pre-preserved with dilute nitric acid (1 mL). Samples for metals analysis were field-filtered using 0.45 µm pore-size filters. All containers were filled with sample to the brim then capped and stored in ice-filled chests, until completion of the fieldwork and during sample transit to the laboratory.

Activity/Item	Details
Quality Control & Laboratory Analysis	All groundwater samples were submitted for analysis of previously-identified chemicals of concern by SGS Laboratories (SGS). QA/QC testing comprised intra-laboratory duplicates ('field duplicates') tested blind by SGS and an inter-laboratory field duplicate tested blind by Envirolab Services (Envirolab). All samples were transported under strict Chain-of-Custody (COC) conditions and COC certificates and laboratory sample receipt documentation were provided to EI for confirmation purposes.
Sample Transport	After sampling, refrigerated sample chests were transported to SGS Australia Pty Ltd using strict Chain-of-Custody (COC) procedures. Inter-laboratory duplicate (ILD) samples were forwarded to Envirolab Services Pty Ltd (Envirolab) for QA/QC analysis. A Sample Receipt Advice (SRA) was provided by each laboratory to document sample condition upon receipt. Copies of SRA and COC certificates are presented in **Appendix E**.

7. DATA QUALITY ASSESSMENT

The assessment of data quality is defined as the scientific and statistical evaluation of environmental data to determine if these data meet the objectives of the project (Ref. USEPA 2006). Data quality assessment includes an evaluation of the compliance of the field sampling and laboratory analytical procedures and an assessment of the accuracy and precision of these data from the laboratory quality control measurements obtained.

The data quality assessment process for this assessment included a review of analytical procedures to confirm compliance with established laboratory protocols and an assessment of the accuracy and precision of analytical data from a range of quality control measurements. The QC measures generated from the field sampling and analytical program were as follows:

- suitable records of fieldwork observations including borehole logs;
- relevant and appropriate sampling plan (density, type, and location);
- use of approved and appropriate sampling methods;
- preservation and storage of samples upon collection and during transport to the laboratory;
- complete field and analytical laboratory sample COC procedures and documentation;
- sample holding times within acceptable limits;
- use of appropriate analytical procedures and NATA-accredited laboratories; and
- required LOR (to allow for comparison with adopted IL);
- frequency of conducting quality control measurements;
- laboratory blanks;
- field duplicates;
- laboratory duplicates;
- matrix spike/matrix spike duplicates (MS/MSDs);
- surrogates (or System Monitoring Compounds);
- analytical results for replicated samples, including field and laboratory duplicates and inter-laboratory duplicates, expressed as Relative Percentage Difference (RPD); and
- checking for the occurrence of apparently unusual or anomalous results, e.g. laboratory results that appear to be inconsistent with field observations or measurements.

The findings of the data quality assessment in relation to the soil and groundwater investigations at the site are discussed in detail in **Appendix G**. QA/QC policies and DQOs are presented in **Appendix H.**

On the basis of the analytical data validation procedure employed the overall quality of the soil and groundwater analytical data produced for the site were considered to be of an acceptable standard for interpretive use.

8. RESULTS

8.1 SOIL INVESTIGATION RESULTS

8.1.1 Site Geology and Subsurface Conditions

The general site geology encountered during the drilling of the soil investigation boreholes, installation of monitoring wells may be described as a layer of anthropogenic filling overlying Residual Clays, with Ashfield Shale at depth. The geological information obtained during the investigation is summarised in **Table 8-1** and borehole logs from these works are presented in **Appendix C**.

Table 8-1 Generalised Subsurface Profile (m BGL)

Layer	Description	Depth to top & bottom of layer (m BGL)
		BH1M, BH3M, BH4M, BH7M, BH8M, BH9 – BH29
Fill	Silty Clay, high plasticity, dark grey-brown, with some fine sub-angular gravel, no odour.	0.0 – 2.3
	Silty SAND, fine / fine to medium grained, grey / brown / dark grey with some fine to coarse sub-angular to sub-rounded concrete and brick gravels, with clay (BH20).	0.2 – 1.8
	Silty Sandy CLAY, medium plasticity, brown, sand is fine grained, with some fine to medium sub-angular concrete gravel.	0.4 – 0.8 (BH3M)
	SANDSTONE; orange – brown, with fine to coarse sandstone gravel, well compacted, no odour, sub-angular bricks from 3.4 m.	0.1 – 3.9 (BH7M)
	Gravelly Sandy SILT; medium grained, dark brown, no odour.	0.4 – 0.5
	Gravelly Silty SAND; fine to medium grained, pink, no odour,	1.1 – 2.4 (BH23) 0.6 – 0.8 (BH15)
Residual Clay	CLAY; high plasticity, brown/red/orange, with trace gravel, no odour.	0.2 – 1.6+ (BH18) 0.6 – 2.0+
Bedrock	Shale, extremely weathered, brown, no odour.	0.6 – 18+

Notes: + Termination depth of borehole

8.1.2 Field Observations and PID Results

Soil samples were obtained from the test bores at various depths ranging between 0.0 m to 18.0 m bgl. All examined soil samples were evaluated on a qualitative basis for odour and visual signs of contamination (e.g. hydrocarbon odours, oil staining, petrochemical filming, asbestos fragments, ash, charcoal) and the following observations were noted:

- No visual or olfactory evidence of hydrocarbon impacts were noted at any of the borehole locations investigated during this assessment;
- fibre cement sheet fragments were not observed in any drilling cuttings;
- no signs of ash or charcoal materials were detected in any of the drilled boreholes; and
- No visual signs of contamination were observed and no suspicious odours were detected during any stage of the field investigation programme.
- Potential for landfill gas to be present in sub-surface material located near the western boundary associated with the former landfill, currently the Wagener Oval.
- Elevated VOC concentrations ranging from 0.2 to 1262.6 parts per million (ppm) were detected in soil headspace samples BH22 – BH28, which were field-screened using a portable PID fitted with a 10.9 eV lamp. The PID results are shown in the borehole logs (**Appendix C**) and the samples showing higher PID values were therefore assigned for laboratory VOC and SVOC analysis. It should be noted that no PID readings were collected for samples in boreholes BH1M, BH3M– BH21 and BH29. In addition, monitoring of methane / landfill gas within the soils at the site was not carried out during the investigation.

8.2 GROUNDWATER INVESTIGATION RESULTS

8.2.1 Monitoring Well Construction

A total of five groundwater monitoring wells were installed across the site. Well construction details for the installed groundwater monitoring wells are summarised in **Table 8-2**.

Table 8-2 Monitoring Well Construction Details

Well ID	Bore Depth (m BGL)	RL (GL)	RL (TOC)	Screen Interval (m bgl)	Lithology Screened
BH1M	8.4	33.60	33.470	5.4 – 8.4	Shale
BH3M	12.0	40.50	40.490	9.0 –12.0	Shale
BH4M	12.0	36.70	36.615	9.0 – 12.0	Shale
BH7M	9.0	37.20	37.300	6.0 – 9.0	Shale
BH8M	12.0	40.40	40.285	9.0 – 12.0	Shale

Notes:
m bgl = metres below ground level.
RL = Reduced Level – Surveyed elevation in metres relative to Australian Height Datum (m AHD).
TOC = top of well casing
RL (TOC) = Surveyed elevation at TOC in m AHD.

8.2.2 Field Observations and Water Test Results

A single GME was conducted on all wells in 28 January 2016. On this date, standing water levels (SWLs) were measured within each well prior to well purging, the results of which were recorded with well purge volumes and field-based water test results. A summary of the recorded field data is presented in **Table 8-3** and copies of the completed Field Data Sheets are included in **Appendix D**.

Table 8-3 Groundwater Field Data (GME date 28 January, 2016)

Well ID	SWL (m BTOC)	RL (TOC)	WL† (m AHD)	Purge Volume (L)	DO (mg/L)	Field pH	Field EC (µS/cm)	Temp (°C)	Redox (mV)	Odours / Turbidity
BH1M	3.850	33.470	29.62	3.0	0.35	5.70	2478	23.59	72.5	None / low
BH3M	3.270	40.490	37.22	3.0	0.16	5.70	7375	23.36	97.9	None / low
BH4M	8.315	36.615	28.30	3.0	0.46	5.59	4264	22.98	77.9	None / high
BH7M	7.580	37.300	29.72	2.5	0.99	5.07	4072	24.81	109.9	Hydrocarbon odour / low
BH8M	1.77	40.285	38.52	3.0	0.38	6.16	5413	22.83	46.1	None / moderate

Notes:
GME – Groundwater monitoring event.
SWL – Standing Water Levels as measured from TOC (top of well casing) prior to groundwater sampling.
m BTOC – metres below top of well casing.
RL (TOC) – Reduced Level, elevation at TOC in metres relative to Australian Height Datum (m AHD).
† WL = Calculated groundwater level, in m AHD (calculated as RL – SWL) Note: these values were used for groundwater contouring analysis.
L – litres (referring to volume of water purged from the well prior to groundwater sample collection).
EC – groundwater electrical conductivity as measured onsite using portable EC meter.
µS/cm – micro Siemens per centimetre (EC units).
DO – Dissolved Oxygen in units of milligrams per litre (mg/L)
All groundwater parameters (pH, EC and DO) were tested on site.
* Well not found, presumed damaged.

With reference to **Table 8-3**, the field pH data indicated that the groundwater was slightly acidic (pH ranged from 5.70 to 6.16) with oxidising conditions present in all wells. Electrical Conductivity (EC) measurements were recorded in the range 2478 to 7375 µS/cm indicating that the groundwater was marginal to saline in terms of water salinity.

8.3 LABORATORY ANALYTICAL RESULTS

8.3.1 Soil Analytical Results

A summary of laboratory results showing test sample quantities, minimum/maximum analyte concentrations and samples found to exceed the SILs, is presented in **Table 8-4**. More detailed tabulations of results showing the tested concentrations for individual samples alongside the adopted soil criteria are presented in **Table T1** at the end of this report. Completed documentation used to track soil sample movements and laboratory receipt (i.e. COC and SRA forms) are provided in **Appendix E** and all laboratory analytical reports for tested soil samples are presented in **Appendix F**.

Table 8-4 Summary of Soil Analytical Results

No. of primary samples	Analyte	Min. Conc. (mg/kg)	Max. Conc. (mg/kg)	Sample locations exceeding investigation levels
Hydrocarbons				
41	F1 TRH	<25	<25	None
41	F2 TRH	<25	<25	None
41	F3 TRH	<90	760	None
41	F4 TRH	<120	150	None
41	Benzene	<01	0.2	None
41	Toluene	<0.1	0.2	None
41	Ethyl benzene	<0.1	<0.1	None
41	Total xylenes	<0.3	<0.3	None
PAHs				
28	Carcinogenic PAHs (as B(a)P TEQ)	<0.2	0.3	None
28	Benzo(a)pyrene	<0.1	0.2	None
28	Total PAHs	<0.8	1.9	None
Pesticides				
28	OCPs	ND	ND	None
28	OPPs	ND	ND	None
Heavy Metal				
41	Arsenic	<3	28	None
41	Cadmium	<0.3	0.6	None
41	Chromium (Total)	2.5	120	None
41	Copper	3.6	390	None
41	Lead	2	270	None
41	Mercury	<0.01	0.06	None

No. of primary samples	Analyte	Min. Conc. (mg/kg)	Max. Conc. (mg/kg)	Sample locations exceeding investigation levels
41	Nickel	0.01	100	Exceedances above the EIL criteria for samples BH3_0.2-0.3 (61 mg/kg), BH5_0.2-0.5 (60 mg/kg), BH6_0.2-0.3 (36 mg/kg), BH13_0.2-0.3 (100 mg/kg), BH15_0.2-0.3 (82 mg/kg), BH16_0.2-0.3 (79 mg/kg), BH17_0.2-0.3 (84 mg/kg), BH21_0.2-0.3 (50 mg/kg), BH24_0.2-0.3 (95 mg/kg) and BH27_0.2-0.3 (99 mg/kg).
41	Zinc	4.3	120	None
PCBs				
28	Total PCBs	ND	ND	None
Asbestos				
28	Asbestos	No asbestos detected	Asbestos detected	Asbestos detected in samples: BH4_0.4-0.5 (<0.01 % w/w); and BH19_0.2-0.3 (>0.01 % w/w).

8.3.2 Groundwater Analytical Results

A summary of laboratory results showing test sample quantities, minimum/maximum analyte concentrations and samples found to exceed the GILs, is presented in **Table 8-5**. More detailed tabulations of results showing the tested concentrations for individual samples alongside the adopted groundwater criteria are presented in **Table T2** at the end of this report. Completed documentation used to track groundwater sample movements and laboratory receipt (COC and SRA forms) are copied in **Appendix E**. Copies of the laboratory analytical reports are attached in **Appendix F**.

Table 8-5 Summary of Groundwater Analytical Results

No. of primary samples	Analyte	Min. Conc. (mg/kg)	Max. Conc. (mg/kg)	Sample locations exceeding investigation levels
Hydrocarbons				
5	F1 C_6–C_{10}	<50	<50	None
5	F2 C_{10}-C_{16}	<60	<60	None
5	F3 C_{16}-C_{34}	<500	<500	None
5	F4 C_{34}-C_{40}	<500	<500	None
5	Benzene	<0.5	<0.5	None
5	Toluene	<0.5	<0.5	None
5	Ethyl benzene	<0.5	<0.5	None
5	o-xylene	<0.5	<0.5	None
5	Total xylenes	<1	<1	None
PAHs				
5	Total PAHs	<1	<1	None
5	Benzo(a)pyrene	<0.1	<0.1	None
5	Naphthalene	<0.1	<0.1	None
Heavy Metal				
5	Arsenic	<1	2	None
5	Cadmium	<0.1	2.7	Exceedance of the GILs: BH3M (2.7 µg/L)
5	Chromium (Total)	<1	<1	None
5	Copper	4	13	Exceedance of the GILs: BH1M (7 µg/L), BH3M (5 µg/L), BH4M (13 µg/L), BH7M (10 µg/L) and BH8M (4 µg/L).
5	Lead	<1	<1	None
5	Mercury	<0.1	<0.1	None
5	Nickel	4	24	Exceedance of the GILs for BH3M (24 µg/L), and BH4M (12 µg/L).
5	Zinc	21	110	Exceedance of the GILs for BH1M (37 µg/L), BH3M (110 µg/L), BH4M (46 µg/L), BH7M (59µg/L) and BH8M (21 µg/L).
VOCs				
5	Chloroform	1.3	16	Exceedance above the USEPA Region 9 SSL for BH1M (7.6 µg/L), BH3M (13 µg/L) and BH7M (16 µg/L)
5	Bromodichloromethane (THM)	<0.5	3.7	Exceedance above the USEPA Region 9 SSL for BH3M (3.6 µg/L), BH4M (0.6 µg/L) and BH7M (3.7µg/L)
5	Dibromochloromethane (THM)	<0.5	0.7	Exceedance above the USEPA Region 9 SSL for BH3M (0.6µg/L) and BH7M (0.7 µg/L).

9. SITE CHARACTERISATION DISCUSSION

9.1 CONCEPTUAL SITE MODEL

On the basis of investigation findings the preliminary CSM discussed in **Section 5** was considered to appropriately identify contamination sources, migration mechanisms and exposure pathways, as well as potential onsite and offsite receptors. Previously known data gaps, as outlined in **Section 5.4** have largely been addressed; however, the following remaining data gaps need to be addressed in subsequent investigation works:

- Additional soil investigations are required underneath the existing building footprints which were inaccessible, this can be completed after demolition works, to adequately characterise environmental conditions in the northwest part of the site;
- Potential for landfill gas to be present within sub-surface materials across the site, particularly within the western portion of the site which is immediately adjacent to the former landfill, currently used as the Wagener Oval.

9.2 ASBESTOS RISK

Asbestos was reported in fill material in samples BH4_0.2-0.3 and BH19_0.2-0.3. Fibrous asbestos was detected at both locations with 1-3 mm length fibre bundles found loose in sample BH4_0.2-0.3 and five, 2-6 mm length fibre bundles found loose in sample BH19_0.2-0.3. Vertical delineation was achieved for BH19, with no asbestos detected in the deeper natural soil sample BH19_1.7-1.8, indicating that the asbestos contamination is likely to be confined to the upper layer of fill material in that area. Vertical delineation could not be achieved in borehole BH4. Given the history of the site, the source of asbestos contamination within soil is likely to be associated with the previous demolition of site buildings.

As free asbestos fibres in soils have been identified, there is a potential risk of exposure to receptors should free fibres become airborne. EI recommend that further investigation of asbestos contamination identified at BH4M and BH19 is completed to further characterise and delineate the extent of asbestos for establishing the most suitable methodology for remediation.

9.3 HEAVY METALS IN SOIL

Heavy metal concentrations detected above the adopted ecological criteria for nickel were identified at the following locations:

- BH3_0.2-0.3 (61 mg/kg);
- BH5_0.2-0.5 (60 mg/kg);
- BH6_0.2-0.3 (36 mg/kg);
- BH13_0.2-0.3 (100 mg/kg);
- BH15_0.2-0.3 (82 mg/kg);
- BH16_0.2-0.3 (79 mg/kg);
- BH17_0.2-0.3 (84 mg/kg);

- BH21_0.2-0.3 (50 mg/kg);
- BH24_0.2-0.3 (95 mg/kg); and
- BH27_0.2-0.3 (99 mg/kg).

Vertical delineation was only achieved in borehole BH15, with the deeper natural sample (BH115_1.1-1.2) containing concentrations of nickel below the EIL criteria.

As these exceedances are relatively uniform across the site, it is likely that this is associated with widespread or regional soil conditions and is therefore not considered a cause for concern.

9.4 TRH, BTEX and PAHs in Soil

No exceedances of TRH, BTEX or PAHs above the HIL-B or EIL criteria were detected in soil samples analysed during this investigation.

9.5 OCPs & OPPs in Soil

No exceedances of OCPs or OPPs above the HIL-B or EIL criteria were detected in soil samples analysed during this investigation.

9.6 Heavy Metals and TRH in Groundwater

The following elevated heavy metal concentrations were identified in the groundwater monitoring wells installed at the site:

- Exceedances of cadmium in BH3M (2.7 µg/L);
- Exceedances of copper in BH1M (7µg/L), BH3M (5 µg/L), BH4M (13 µg/L), BH7M (10 µg/L), and BH8M (4 µg/L);
- Exceedances of nickel in BH3M (24µg/L) and BH4M (12µg/L); and
- Exceedances of zinc in BH1M (37µg/L), BH3M (110 µg/L), BH4M (46 µg/L), BH7M (59 µg/L), and BH8M (21 µg/L).

The results of the groundwater investigation indicate that slightly elevated concentrations of nickel and zinc are present in groundwater in BH3M, compared to remaining monitoring wells (BH1M, BH4M, BH7M and BH8M). As the concentrations are fairly uniform across the site, it is likely that these exceedances are associated with a regional variability within the groundwater. EI therefore consider the risks associated with groundwater to be low.

No exceedances of TRH or BTEX were detected in groundwater monitoring wells sampled during this investigation.

9.7 VOCs in Groundwater

Trihalomethanes (THMs) including chloroform, bromodichloromethane and dibromochloromethane were reported in groundwater recovered from all monitoring wells. There were no exceedances of the default GIL (Australian Drinking

Water Guidelines); however the concentrations exceeded the USEPA Region 9 SSL criteria. The source of the THMs is likely to be associated with leaking reticulated water pipes on site. The risk is therefore considered to be low.

9.8 AESTHETICS

During this investigation, some bricks / sandstone blocks were observed within fill material at the site. Based on the site history, it is likely that materials associated with the demolition (bricks, sharps, general rubble etc.) of previous site buildings will be uncovered during development works and may present an aesthetic issue. EI note that, these would be removed during the remediation process and are not considered to have an impact on the site.

10. CONCLUSIONS

The property located at 165 Milton Street, Ashbury NSW was the subject of a Stage 2 Detailed Site Investigation that was conducted in order to assess the nature and degree of on-site contamination associated with current and former uses of the property. Based on the findings of this assessment it was concluded that:

- The site comprised an irregular shaped block, covering a total area of approximately 1.654 hectares. The site was bound by Milton Street (east), Wagener Oval (west), commercial / residential (south) and residential dwellings (north). At the time of investigation the site was occupied by five, one to three-storey, brick/brick and metal commercial buildings, with the remaining areas of the site covered by concrete or bitumen paved, open car-parking.
- A previous Stage 1, Environmental Site Assessment and a Tank Removal Validation Assessment were undertaken by URS in October, 2014 and identified the following:
  - The site history included various commercial / industrial uses including brick making, a former vehicle refuelling area, motor vehicle maintenance and servicing of firefighting equipment;
  - Potentially contaminating land use activities that were identified included:
    - Brick making- use of glazes in kilns containing heavy metals including lead,
    - Former vehicle refuelling area – potential spills and leaks associated with three former USTs;
    - Motor vehicle maintenance: spills and leaks of fuels and oils from vehicles and machinery (including possible winch or hydraulic lift);
    - Demolition of possible residential structure (1970 - 1994): potential burial of demolition waste, including asbestos on site;
    - Two electrical substations / transformers are present on the site, which may potentially contain polychlorinated biphenyl (PCB) containing transformer oils; and
    - Servicing of firefighting equipment – including carbon dioxide and dry powder.
  - The Tank Removal Validation Assessment confirmed that three USTs (15,000 L and two 25,000 L) and associated pipework were excavated and removed from the site, with the tank pit validated in a manner consistent with the relevant guidelines, and the tank pit was filled with certified, imported backfill material.
- EI consider a potential source of contamination at the site to be the potential for migration of landfill gas from the adjoining former landfill located immediately south west of the site.
- Soil sampling and analysis was conducted at twenty nine (29) targeted test bore locations down to a maximum depth of 18 m BGL. Sampling regime was considered to be appropriate for investigation purposes and comprised judgemental and systematic sampling patterns, with allowance for structural obstacles (e.g. building walls, underground and overhanging services and other physical obstructions in use by existing operating businesses);
- The sub-surface layers comprised of fill materials averaging 1-2 m thick and consisting of various constituents including bricks and gravels, overlying residual soils and weathered Ashfield shale at depth;

- Groundwater was encountered at depths ranging from 1.77 – 8.315 metres below ground level;
- Results of soil samples analysed identified fibrous asbestos in fill samples at boreholes BH4 and BH19 located within the south western and north eastern portions of the site, respectively. Vertical delineation was achieved in BH19, with the deeper natural soil sample being free of asbestos containing material, indicating that asbestos contamination is likely to be confined to the fill layer within the area.
- Exceedances of the heavy metal nickel, above the adopted EIL criteria was detected in multiple soil samples across the site, at locations outside of the proposed building footprint areas. However, the results are fairly uniform across the site, indicating a widespread / regional variation which is therefore not considered a cause for concern.
- There were no exceedances of PAHs, BTEX,OCPs, OPPs and PCBs in soil samples analysed during this investigation;
- Elevated concentrations of heavy metals were detected in all of the groundwater monitoring wells (BH1M, BH3M, BH4M, BH7M and BH8M), with the highest concentration detected within BH3M. However, the results are indicative of natural background concentrations, with the risk considered to be low;
- Concentrations of Trihalomethanes (THMs) including chloroform, bromodichloromethane and dibromochloromethane were reported in groundwater recovered from all of the groundwater monitoring wells. As the concentrations are relatively uniform across the site, it is considered likely that the source is from a leaking reticulated water pipe on site, and therefore the risk of the reported THMs is considered to be low.
- The Preliminary Conceptual Site Model (CSM) developed for this site included shallow impacted fill overlying residual clays and weathered shale bedrock, former UST's and potential landfill gas. It was concluded that the model remains valid for the proposed development. The following data gaps however remain and require closure by further investigations:
  - The vertical and lateral extent of asbestos contamination exceeding adopted human-health at boreholes BH4 and BH19 identified at the site;
  - Potential for landfill gas to be present within sub-surface materials across the site, particularly within the western portion of the site which is immediately adjacent to the former landfill, currently used as the Wagener Oval.
  - The quality of soils located in the footprint of the existing site buildings which were inaccessible during this investigation; and
  - Potential presence of hazardous materials present within the existing structure.

Based on the findings of this report and with consideration of the Statement of Limitations (**Section 12**), EI conclude that contamination was identified at the site during this DSI. Concentrations exceeding human health based SILs for asbestos were identified in surface fill material within the south western and north eastern areas of the site. In addition, there is potential landfill gas to be present within the sub-surface material at the site, sourced from the adjacent landfill, which will require further investigation.

While soil and groundwater contamination was identified at the site, EI concludes the site can be remediated in accordance with SEPP 55 to allow the site to be used for low density residential purposes, as outlined in the proposed development plans, subject to the implementation of the recommendations outline in **Section 11.**

11. RECOMMENDATIONS

Based on the findings of this investigation, the following recommendations are provided:

- Prior to site demolition, carry out a Hazardous Materials Survey on existing site structures to identify potentially hazardous building products that may be released to the environment during demolition;
- Preparation and implementation of a Remedial Action Plan (RAP), which should:
  - Outline the remediation requirements for soil identified and to close the existing data gaps identified during this DSI and other contamination that may be identified during data gap closure investigations;
  - Undertake a detailed ground gas investigation to assess the potential risks at the site in accordance with the *Guidelines for the Assessment and Management of Sites Impacted by Hazardous Ground Gases* (EPA , 2012);
  - Provide the requirements and procedure for waste classification assessment, in order to enable classification of site soils to be excavated and disposed off-site, in accordance with the *Waste Classification Guidelines* (EPA, 2014); and
  - Provide a SAQP for the validation of remediation activities performed on-site.
- Undertake supplementary investigations, and subsequent remediation and validation works for the site, as outlined in the RAP. EI note that due to current site constrains, the additional investigations and remediation works may be conducted after site demolition when access to areas of environmental concern is made available; and
- Preparation of a validation report by a suitably qualified environmental consultant, certifying site suitability of soils and groundwater for the proposed land use.

12. STATEMENT OF LIMITATIONS

This report has been prepared for the exclusive use of [the client], who is the only intended beneficiary of EI's work. The scope of the investigations carried out for the purpose of this report is limited to those agreed with Ashbury FMBM Pty Ltd on 23 December 2015.

No other party should rely on the document without the prior written consent of EI, and EI undertakes no duty, or accepts any responsibility or liability, to any third party who purports to rely upon this document without EI's approval.

EI has used a degree of care and skill ordinarily exercised in similar investigations by reputable members of the environmental industry in Australia as at the date of this document. No other warranty, expressed or implied, is made or intended. Each section of this report must be read in conjunction with the whole of this report, including its appendices and attachments.

The conclusions presented in this report are based on a limited investigation of conditions, with specific sampling locations chosen to be as representative as possible under the given circumstances.

EI's professional opinions are reasonable and based on its professional judgment, experience, training and results from analytical data. EI may also have relied upon information provided by the Client and other third parties to prepare this document, some of which may not have been verified by EI.

EI's professional opinions contained in this document are subject to modification if additional information is obtained through further investigation, observations, or validation testing and analysis during remedial activities. In some cases, further testing and analysis may be required, which may result in a further report with different conclusions.

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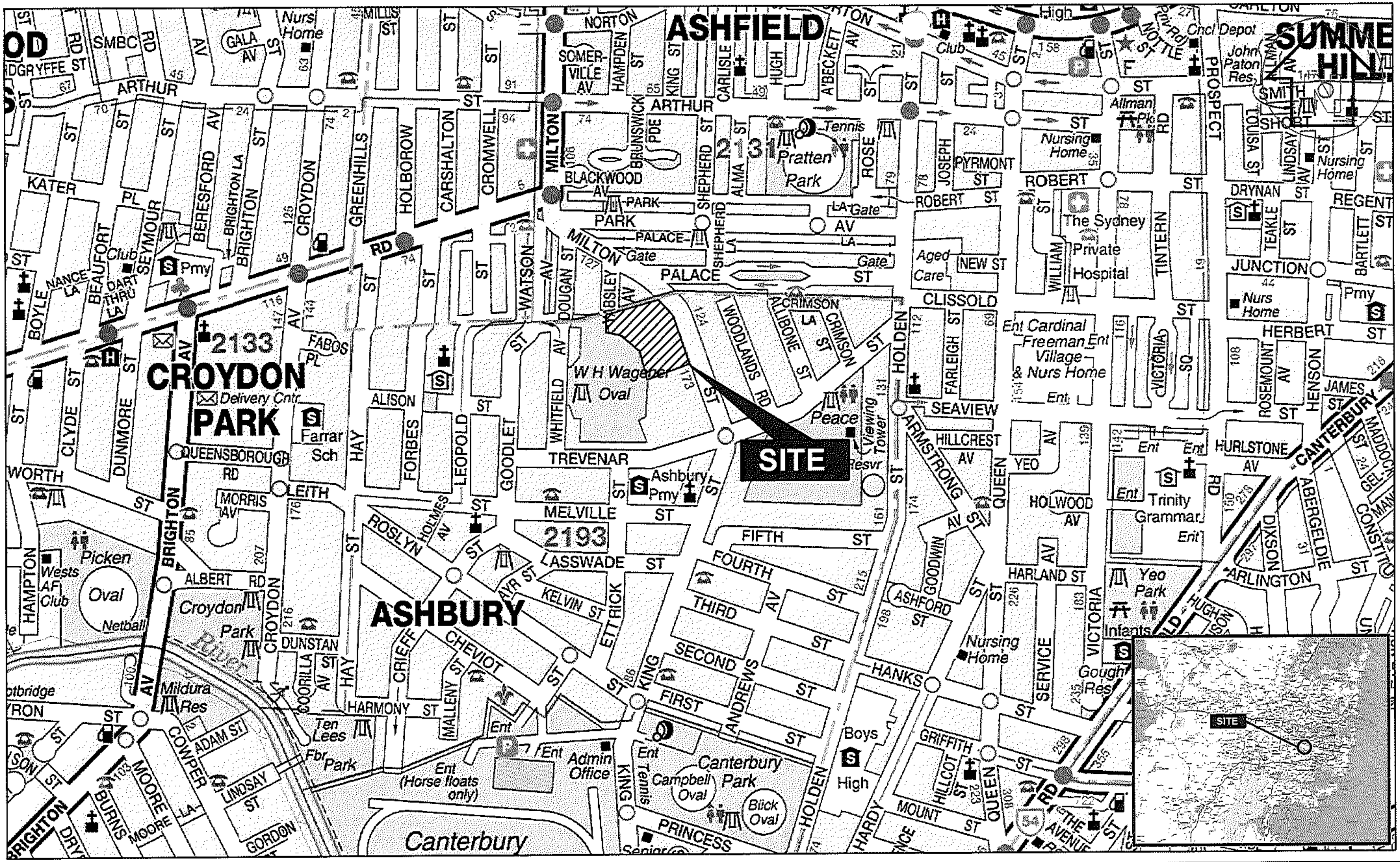
ABBREVIATIONS

ACM	Asbestos-containing materials
ASS	Acid sulfate soils
ANZECC	Australian and New Zealand Environment Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
B(a)P	Benzo(a)Pyrene (a PAH compound)
BH	Borehole
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
COC	Chain of Custody
DEC	Department of Environment and Conservation, NSW (see OEH)
DECC	Department of Environment and Climate Change, NSW (see OEH)
DECCW	Department of Environment, Climate Change and Water, NSW (see OEH)
DA	Development Application
DO	Dissolved Oxygen
DP	Deposited Plan
EC	Electrical Conductivity
Eh	Redox potential
EPA	Environment Protection Authority
EMP	Environmental Management Plan
F1	TRH $C_6 - C_{10}$ less the sum of BTEX concentrations (Ref. NEPM 2013, Schedule B1)
F2	TRH $>C_{10} - C_{16}$ less the concentration of naphthalene (Ref. NEPM 2013, Schedule B1)
GIL	Groundwater Investigation Level
GME	Groundwater Monitoring Event
HIL	Health-based Investigation Level
HSL	Health-based Screening Level
km	Kilometres
LNAPL	Light, non-aqueous phase liquid (also referred to as PSH)
DNAPL	Dense, non-aqueous phase liquid
EIL	Ecological Investigation Level
ESL	Ecological Screening Level
LFG	Landfill Gas (mixture of methane, carbon dioxide, carbon monoxide, hydrogen sulfide and ammonia and other trace organic and inorganic compounds
m	Metres
m AHD	Metres Australian Height Datum
m BGL	Metres Below Ground Level
mg/m^3	Milligrams per cubic metre
mg/L	Milligrams per litre
µg/L	Micrograms per litre
mV	Millivolts
MW	Monitoring well
NATA	National Association of Testing Authorities, Australia
NEPC	National Environmental Protection Council

NSW	New South Wales
OEH	Office of Environment and Heritage, NSW (formerly DEC, DECC, DECCW)
PAHs	Polycyclic Aromatic Hydrocarbons
pH	Measure of the acidity or basicity of an aqueous solution
PSH	Phase-separated hydrocarbons (also referred to as LNAPL)
PQL	Practical Quantitation Limit (limit of detection for respective laboratory instruments)
QA/QC	Quality Assurance / Quality Control
RAP	Remediation Action Plan
SRA	Sample receipt advice (document confirming laboratory receipt of samples)
SWL	Standing Water Level
TDS	Total dissolved solids (a measure of water salinity)
TCLP	Toxicity Characteristics Leaching Procedure
TPH	Total Petroleum Hydrocarbons (superseded term equivalent to TRH)
TRH	Total Recoverable Hydrocarbons (non-specific analysis of organic compounds)
UCL	Upper Confidence Limit of the mean
USEPA	United States Environmental Protection Agency
UPSS	Underground Petroleum Storage System
UST	Underground Storage Tank
VOCs	Volatile Organic Compounds (specific organic compounds which are volatile)
VOCCs	Volatile Organic Chlorinated Compounds (a sub-set of the VOC analysis suite)

FIGURES

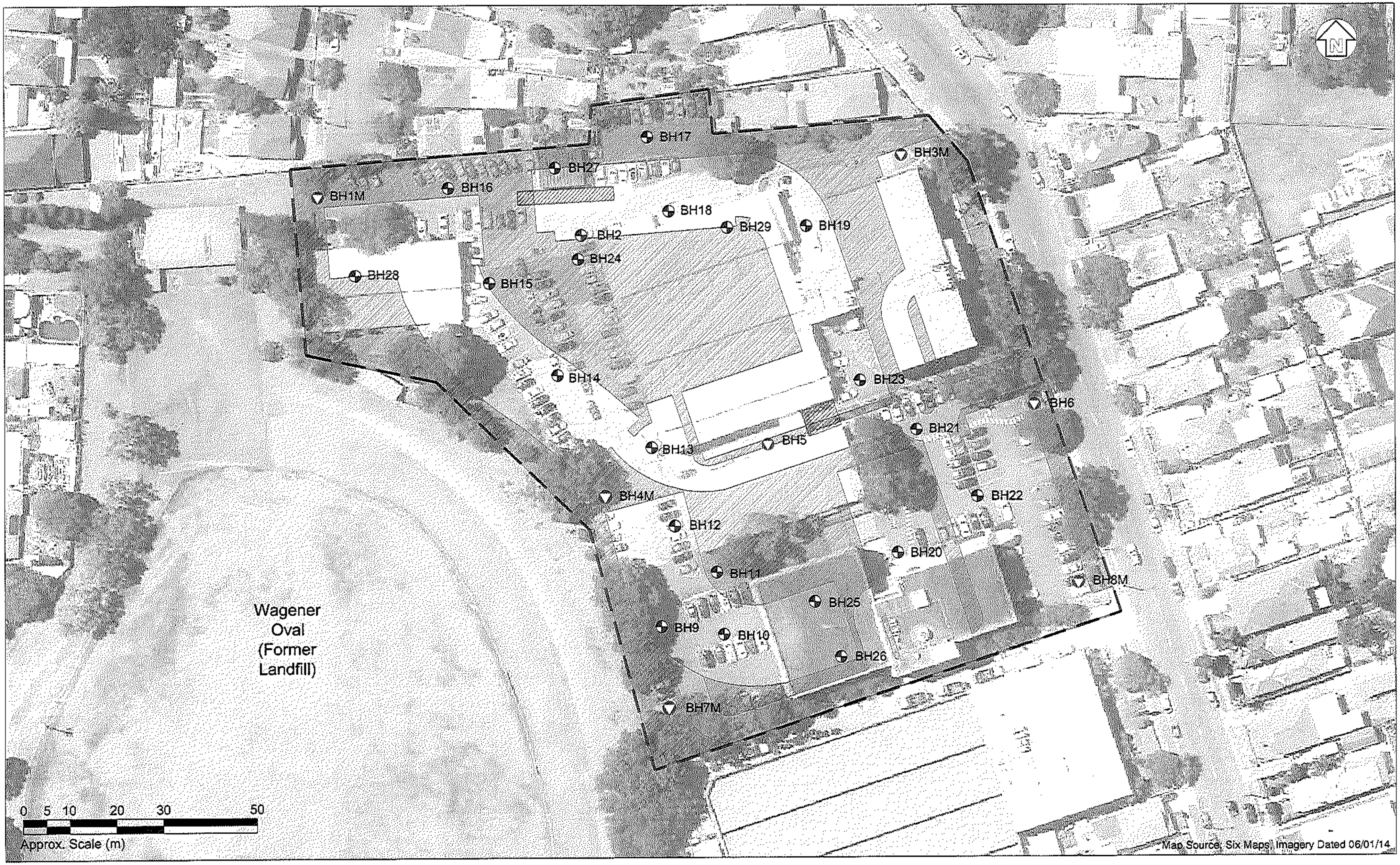


Environmental Investigations Australia Contamination | Remediation | Geotechnical	Drawn:	D.R.
	Approved:	J.S.
	Date:	23-02-16
Suite 6.01, 55 Miller Street, PYRMONT 2009 Ph (02) 9516 0722 Fax (02) 9518 5088	Approx Scale:	N.T.S

Ashbury FMBM Pty Ltd
Detailed Site Investigation
149-163 Milton Street, Ashbury, NSW
Site Location Plan

Figure: 1

Project: E22851 AA



LEGEND

- Approximate Geotechnical Borehole Location
- Approximate Borehole Location
- Approximate Borehole / Monitoring Well Location
- Approximate site boundary
- Outside Proposed Building Footprint
- Approximate Former UST Location
- Approximate Electrical Substation Location

Environmental Investigations Australia
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Drawn:	D.R.
Approved:	J.S.
Date:	23-02-16
Approx Scale:	@ A3 shown

Ashbury Developments Pty Ltd
Detailed Site Investigation
149-163 Milton Street, Ashbury NSW
Sampling Location Plan

Figure: 2

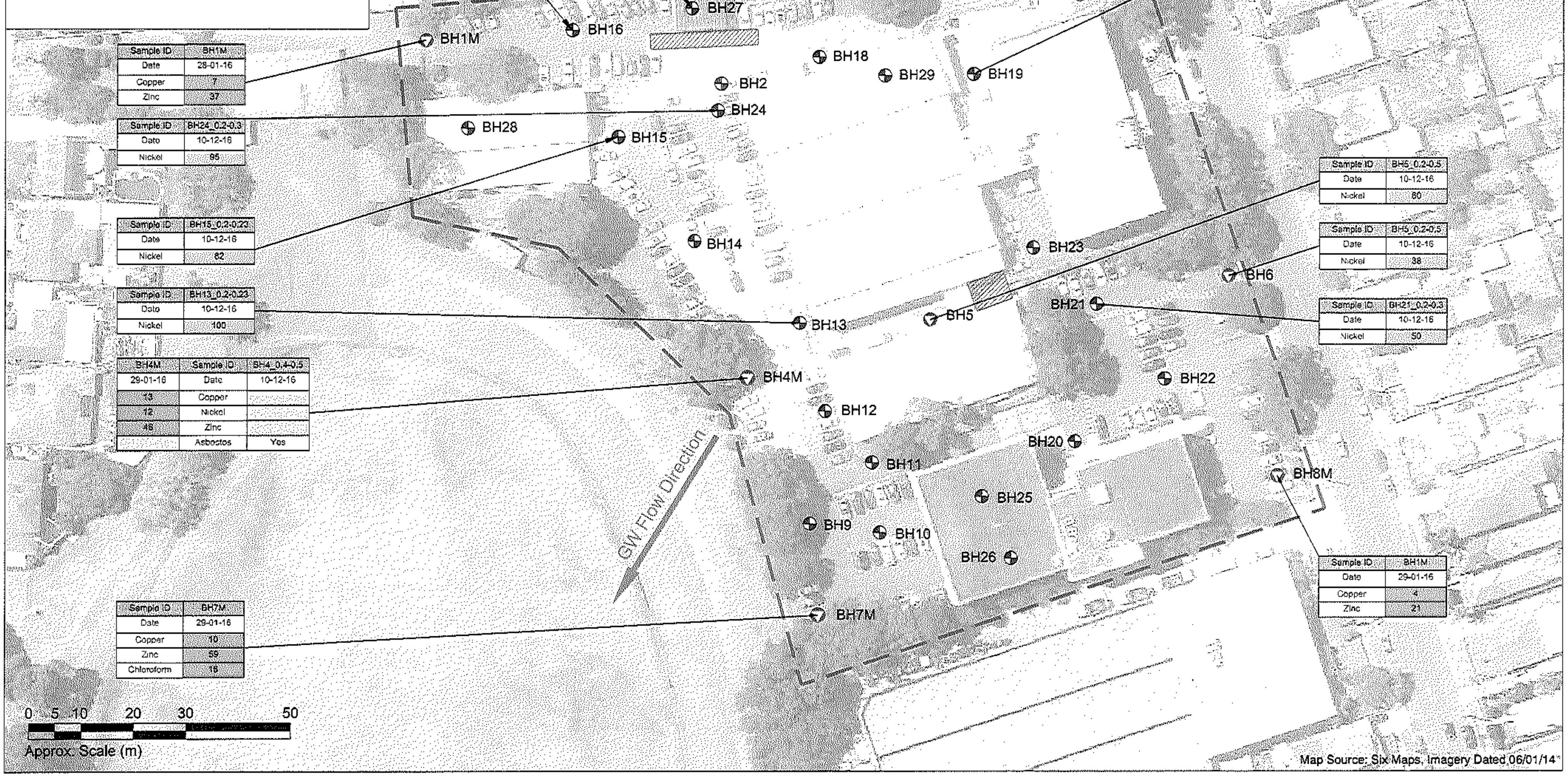
Project: E22851 AA

KEY

MW ID	Sample ID	BH ID
dd-mm-yy	Date	dd-mm-yy
	cPAH	4
0.2	Cadmium	
1.4	Copper	
3.4	Lead	
11	Nickel	
8	Zinc	

Notes:
All soil concentrations are in mg/kg. The table above shows exceedance criteria for HIL-B: *medium - high density residential with minimal accessible soils*.
= Exceedance of NEPM(2013) HIL-B threshold
= Exceedance of adopted ecological criteria

All groundwater concentrations are in µg/L. The table above shows exceedance criteria for GILs for Marine Water environments.
= Exceedance of NEPM(2013) GIL Criteria



Sample ID	BH16_0.2-0.23
Date	10-12-16
Nickel	79

Sample ID	BH27_0.2-0.3
Date	10-12-16
Nickel	99

Sample ID	BH17_0.2-0.23
Date	10-12-16
Nickel	84

BH3M	Sample ID	BH3_0.2-0.3
29-01-16	Date	10-12-15
2.7	Cadmium	
5	Copper	
24	Nickel	61
110	Zinc	
13	Chloroform	

Sample ID	BH19_0.2-0.23
Date	10-12-16
Asbestos	Yes

Sample ID	BH1M
Date	29-01-16
Copper	7
Zinc	37

Sample ID	BH24_0.2-0.3
Date	10-12-16
Nickel	95

Sample ID	BH15_0.2-0.23
Date	10-12-16
Nickel	82

Sample ID	BH13_0.2-0.23
Date	10-12-16
Nickel	100

BH4M	Sample ID	BH4_0.4-0.5
29-01-16	Date	10-12-16
13	Copper	
12	Nickel	
46	Zinc	
	Asbestos	Yes

Sample ID	BH7M
Date	29-01-16
Copper	10
Zinc	59
Chloroform	16

Sample ID	BH5_0.2-0.5
Date	10-12-16
Nickel	80

Sample ID	BH6_0.2-0.5
Date	10-12-16
Nickel	38

Sample ID	BH21_0.2-0.3
Date	10-12-16
Nickel	50

Sample ID	BH1M
Date	29-01-16
Copper	4
Zinc	21

LEGEND
- Approximate Former UST Location
- Approximate Electrical Substation Location
- Approximate Geotechnical Borehole Location
- Approximate Borehole Location
- Approximate Borehole / Monitoring Well Location
- Approximate site boundary

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Drawn:	D.R.
Approved:	J.S.
Date:	23-02-16
Approx Scale:	1:750 @ A3 or as shown

Ashbury Developments Pty Ltd
Detailed Site Investigation
149-163 Milton Street, Ashbury NSW
Soil and Groundwater Sample Exceedance Plan

Figure: 2

Project: E22851 AA

TABLES

Table T1 - Summary of Soil Analytical results

Sample ID	Sampling Date	Heavy Metals								PAHs				BTEX				TRHs				OCPs	OPPs	Total PCBs	Asbestos
		As	Cd	Cr#	Cu	Pb	Hg	Ni	Zn	Carcinogenic PAHs (as B(a)P TEQ)	Benzo(a)pyrene	Total PAHs	Naphthalene	Benzene	Toluene	Ethylbenzene	Total Xylenes	F1[1]	F2[1]	F3 ($>C_{16}$-C_{34})	F4 ($>C_{34}$-C_{40})				
BH1_0.1-0.2	10/12/2015	5	0.4	35	15	23	0.02	30	28	0.3	0.2	1.9	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	ND	ND	ND	No
BH3_0.2-0.3		<3	0.3	73	24	9	0.01	61	58	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	210	150	ND	ND	ND	No
BH4_0.4-0.5		14	<0.3	5.7	13	8	<0.01	6.3	29	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	ND	ND	ND	Yes
BH5_0.2-0.5		4	<0.3	70	19	8	<0.01	60	43	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	ND	ND	ND	No
BH6_0.2-0.3		6	0.3	30	22	24	0.03	36	42	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	ND	ND	ND	No
BH7_0.2-0.3		6	<0.3	24	17	15	0.03	21	76	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	ND	ND	ND	No
BH7_1.0-1.1		10	0.4	20	14	21	0.04	12	69	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	NA	NA	NA	NA
BH7_3.0-3.1		6	0.4	28	13	11	0.01	19	100	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	NA	NA	NA	NA
BH8_0.2-0.3		13	0.5	38	14	23	0.03	20	44	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	ND	ND	ND	No
BH9_0.2-0.3		13	<0.3	15	13	7	<0.01	14	24	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	ND	ND	ND	No
BH9_1.7-1.8		17	<0.3	15	21	9	<0.01	17	44	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	200	<120	NA	NA	NA	NA
BH9_2.9-3.0		13	<0.3	27	23	13	0.01	25	44	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	94	<120	NA	NA	NA	NA
BH10_0.2-0.3		10	0.5	24	9.3	25	0.02	3.1	39	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	ND	ND	ND	No
BH10_1.1-1.2		14	0.5	25	14	26	0.02	1.5	27	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	NA	NA	NA	NA
BH11_0.2-0.3		28	0.3	17	21	25	0.02	6	86	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	760	<120	ND	ND	ND	No
BH11_1.2-1.3		10	<0.3	11	7.3	12	<0.01	0.6	5.3	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	NA	NA	NA	NA
BH12_0.2-0.3		8	<0.3	8.9	6.9	9	<0.01	6.6	27	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	ND	ND	ND	No
BH12_1.2-1.3		7	<0.3	12	16	14	0.01	2.5	23	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	NA	NA	NA	NA
BH13_0.2-0.3		3	0.5	120	32	10	0.01	100	71	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	ND	ND	ND	No
BH14_0.2-0.3		9	<0.3	4.6	14	7	<0.01	6.7	77	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	ND	ND	ND	No
BH15_0.2-0.3		15	0.5	86	32	29	0.06	82	120	0.3	0.2	1.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	ND	ND	ND	No
BH15_1.1-1.2		8	0.3	28	7.6	22	0.01	3.6	8.5	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	NA	NA	NA	NA
BH16_0.2-0.3		4	0.4	79	33	29	0.05	79	73	<0.3	<0.1	<0.8	0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	120	<120	ND	ND	ND	No
BH17_0.2-0.3		<3	0.4	91	24	8	0.02	84	57	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	ND	ND	ND	No
BH18_0.2-0.3		10	0.3	24	11	21	<0.01	8.2	100	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	ND	ND	ND	No
BH19_0.2-0.3		<3	0.3	31	380	21	0.01	23	76	<0.3	<0.1	0.8	0.2	0.2	0.2	<0.1	<0.3	<25	<25	110	<120	ND	ND	ND	Yes
BH19_1.7-1.8		4	0.4	35	79	21	0.01	21	62	<0.3	<0.1	<0.8	0.1	0.1	0.2	<0.1	<0.3	<25	<25	<90	<120	NA	NA	NA	NA
BH20_0.2-0.3		<3	0.3	28	50	14	0.01	71	60	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	ND	ND	ND	No
BH20_0.7-0.8		6	0.3	26	34	23	0.03	34	84	<0.3	0.1	1.2	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	NA	NA	NA	NA
BH21_0.2-0.3		5	0.4	53	23	14	0.02	50	61	<0.3	<0.1	0.9	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	ND	ND	ND	No
BH21_0.8-0.9		10	<0.3	13	10	13	<0.01	0.6	4.3	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	NA	NA	NA	NA
BH22_0.2-0.3		7	0.3	22	12	15	0.01	12	14	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	ND	ND	ND	No
BH23_0.2-0.3		7	<0.3	57	42	10	0.03	31	38	<0.3	<0.1	1.4	0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	ND	ND	ND	No
BH23_1.1-1.2		10	<0.3	2.5	3.6	2	<0.01	2.5	11	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	NA	NA	NA	NA
BH24_0.2-0.3		3	0.4	120	29	9	0.02	95	66	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	ND	ND	ND	No
BH25_0.1-0.2		6	0.4	86	39	21	0.02	72	96	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	ND	ND	ND	No
BH26_0.1-0.2		4	0.4	80	39	270	0.02	95	80	<0.3	<0.1	<0.8	<0.1	<0.1	0.1	<0.1	<0.3	<25	<25	<90	<120	ND	ND	ND	No
BH26_1.2-1.3		10	0.6	22	11	20	<0.01	3.9	8.8	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	NA	NA	NA	NA
BH27_0.2-0.3		3	0.5	120	33	12	0.01	90	80	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	260	150	ND	ND	ND	No
BH28_0.3-0.4		4	<0.3	17	32	17	0.01	8.3	35	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	ND	ND	ND	No
BH29_0.2-0.3		<3	<0.3	5.1	57	29	0.01	7.8	71	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	ND	ND	ND	No
SILs																									
HIL B - Residential with minimal opportunities for soil access		500	150	500 Cr(VI)	30,000	1,200	120	1,200	60,000	4	1	400										NR	NR	1	
HSL A & HSL B - *Residential*		Source depths (0 m to <1 m, BGL)											3	0.5	160	55	40	45	110						
Soil texture classification –Sand [1]		Source depths (1 m to <2 m, BGL)											NL	0.5	220	NL	60	70	240						
EILs / ESLs - *urban residential and public open space* [1,4]		100	NR	205	90	1,100	NR	35	190	NR	0.7	NR	170	50	85	70	105	180*	120*	300	2800	180	NR	NR	NR
Management Limits – *Residential, parkland and public open space* Coarse grained soil texture[1]																		700	1000	2500	10000				
Asbestos contamination HSL – *Residential B* Bonded ACM (%w/w)																									0.04
Asbestos contamination HSL for																									0.001

Notes:

All results are recorded in mg/kg

Highlighted values indicates concentration exceeds Human Health Based Soil Criteria

Highlighted values indicates concentration exceeds EIL / ESL.

HIL B — NEPC 1999 Amendment 2013 "HIL B" Health Based Investigation Levels applicable for residential exposure settings with minimal opportunities for soil access, including dwellings with fully and permanently paved yard space such as high rise buildings and apartments.

\# — Thresholds are for Chromium VI.

NR — No current published criterion.

NL — Not Limiting' If the derived soil vapour limit exceeds the soil concentration at which the pore water phase cannot dissolve any more of the individual chemical

ND — 'Not detected' i.e. all concentrations of the compounds within the analyte group were found to be below the laboratory limits of detection.

NT — 'Not Tested' i.e. the sample as not analysed.

1 — Coarse Grained soil values were applied, being the most conservative of the material types.

Table T2 – Summary of Groundwater Investigation Results

Sample ID	Heavy Metals								BTEX					TRHs				PAHS			VOCs		
	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury[6]	Nickel	Zinc	Benzene	Toluene	Ethylbenzene	o-xylene	m/p-xylene	F1*	F2**	F3 ($>C_{16}-C_{34}$)	F4 ($>C_{34}-C_{40}$)	Naphthalene	Benzo(a)pyrene	Total PAHs	Chloroform (THM)	Bromodichloromethane (THM)	Dibromochloromethane (THM)
BH1M	<1	<0.1	<1	7	<1	<0.1	4	37	<0.5	<0.5	<0.5	<0.5	<1	<50	<60	<500	<500	<0.1	<0.1	<1	7.6	<0.5	<0.5
BH3M	<1	2.7	<1	5	<1	<0.1	24	110	<0.5	<0.5	<0.5	<0.5	<1	<50	<60	<500	<500	<0.1	<0.1	<1	13	3.6	0.6
BH4M	<1	<0.1	<1	13	<1	<0.1	12	46	<0.5	<0.5	<0.5	<0.5	<1	<50	<60	<500	<500	<0.1	<0.1	<1	2.2	0.6	<0.5
BH7M	<1	<0.1	<1	10	<1	<0.1	6	59	<0.5	<0.5	<0.5	<0.5	<1	<50	<60	<500	<500	<0.1	<0.1	<1	16	3.7	0.7
BH8M	2	<0.1	<1	4	<1	<0.1	4	21	<0.5	<0.5	<0.5	<0.5	<1	<50	<60	<500	<500	<0.1	<0.1	<1	1.3	<0.5	<0.5
Marine Aquatic Ecosystems[1]	24 (AS III) 13 (AS V)	0.2	1 (Cr VI)	1.4	3.4	0.06	11	8	500	180[5]	80[5]	350	200	50[4]	60[4]	500[4]	500[4]	50	0.2		250[5]		
ADWQG[3]	10	2	50 (Cr VI)	2000	10	1	20	NR	1	800	300	600		NR	NR	NR	NR	NR	0.01				
HSL A & B[2]									800	NL	NL	NL		1000	1000			NR	NR				
Region 9 SSL[7]																					0.22	0.1	0.17

Notes: All results are in units of µg/L.

GIL Groundwater Investigation Level. All GIL values sourced from *National Environment Protection (Assessment of Site Contamination) Measure 1999 – Amendment 2013*, *Schedule (B1)* - Guideline on Investigation Levels for Soil and Groundwater, except where noted.

N.R. No current publish criterion.

N.D. Not Detected.

N.A. Not analysed.

* To obtain F1 subtract the sum of BTEX concentrations from the C6-C10 fraction.

** To obtain F2 subtract Naphthalene from the >C10-C16 fraction.

1 NEPM (2013) groundwater investigation level for marine water ecosystems. Indicated threshold value may not protect key species from chronic toxicity, refer to ANZECC & ARMCANZ (2000) for further guidance.

2 NEPM (2013) Table 1A(4) Groundwater HSL A & HSL B for vapour intrusion at the contaminant source depth ranges in sands 2m to <4m.

3 Low relibility trigger value guidelines refer to ANZECC & ARMCANZ (2000) for further guidance.

4 Where GIL is less the than the laboratory reporting limit (LOR), the LOR is adoted as the GIL, as per DEC (2007).

5 Low reliability toxicity data Table 8.3.12, refer to ANZECC & ARMCANZ (2000).

6 Note: Laboratory reporting limit for Mecury dissolved in water is 0.1 µg/L.

7 Region 9 SSLs are screening levels for tap water set by USEPA drinking-water standards that set the maximum permissible level of a contaminant in water that is delivered to any user of a public water system (U.S.EPA, 2006).

Indicates concentration value exceeding the adopted GIL.

Indicates concentration valuse exceeds the adopted Region 9 SSL criteria