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Abbreviations

Term	Definition
ACM	Asbestos containing material
AECs	Areas of environmental concern
AF/FA	Asbestos fines and friable asbestos
AHD	Australian height datum
ARIS	Australian Soil Recourse Information System
ASC NEPM	Assessment of Site Contamination National Environmental Protection Measure
ASS	Acid sulfate soils
BTEX	Benzene, toluene, ethylbenzene and xylenes
CCR	UNSW's Cliffbrook Campus Redevelopment
CEC	Cation exchange capacity
CLM	Contaminated Land Management
COPCs	Contaminants of potential concern
CSM	Conceptual site model
DEC	Department of Environment and Conservation
DQOs	Data quality objectives
EIL	Ecological based Investigation Levels
EPA	Environment Protection Authority
ESL	Ecological Screening Level
Fe	Iron
Ha	Hectare
HIL	Health based Investigation Levels
HSL	Health Screening Levels
JBS&G	JBS&G Australia Pty Ltd
LEP	Local Environmental Plan
OCPs	Organochlorine pesticides
PAHs	Polycyclic aromatic hydrocarbons
PCBs	Polychlorinated biphenyls
POEO	Protection of the Environment Operations
PSI	Preliminary Site Inspection
PSM	Pells Sullivan Meynink
QA/QC	Quality Assurance / Quality Control
TRH	Total recoverable hydrocarbons
SAQP	Sampling, Analytical and Quality Plan
UNSW	University of New South Wales

Executive Summary

JBS&G Australia Pty Ltd (JBS&G) was engaged by Pells Sullivan Meynink (PSM, the client) to conduct a Preliminary Site Investigation (PSI) in conjunction with geotechnical investigations PSM completed for the University of New South Wales (UNSW). The investigations are to inform the UNSW's Cliffbrook Campus Redevelopment (CCR) Project, located at the corner of Battery and Beach Streets, Coogee, NSW (the site).

The overall UNSW property comprises Lot 1 DP 109530 (the majority) and Lots 1 and 8 DP 8162, covering approximately 1.2 hectares (ha), however it is understood the western portion of the property is where building redevelopment works are proposed.

The site comprised an irregular parcel of land that fronted on to Battery Street to the west of the site. At the time of the inspection the site was occupied by UNSW and is home to UNSW Press Limited. The site layout and boundary is defined in **Figure 2**.

Based on the site inspection and desktop review of local and regional background environmental information, and available historical information, areas of environmental concern (AEC) identified were associate with former structures at the site and potential use of fill material of unknown origin. Associated contaminants of potential concern (COPC) at the site included Heavy metals, total recoverable hydrocarbons (TRH), benzene, toluene, ethylbenzene and xylenes (BTEX), polycyclic aromatic hydrocarbons (PAH), organochlorine pesticides (OCP) and asbestos.

A total of seven sampling locations, including three boreholes and four hand auger holes were completed, for a preliminary investigation of potential contamination in soil. The site surface was comprised of either pavers, road base, asphalt or grass/garden bed. Fill was encountered to depths ranging between 0.1 m to 0.7 m depth. Fill materials typically consisted of dark grey to grey gravelly or clayey with inclusions of sandstone, igneous gravels, plastic, tile and metal.

The fill material was underlain by natural grey to brown clayey sand or sand with no inclusions. Observations during geotechnical investigations indicated that the natural sand was underlain at approximately 1.6 m by brown with red and orange clayey sand (weathered sandstone).

ACM, odours or staining indicative of hydrocarbon or chemical contamination, were not observed in fill or natural materials during field works.

Concentrations of COPC in all samples analysed were reported below the adopted human health and ecological criteria, with the exception of a PAH at location BH03, and ACM in fill at location HA02. While the PAH concentrations at BH03 exceeded adopted human health and ecological criteria, it is considered that the PAH is associated with bituminous fragments introduced into the samples from overlying roadbase and asphalt (bituminous concrete) pavement at this location, as no other potential source of PAH contamination was identified.

The ACM reported in the surface soil sample from HA02, was associated with the fill material within the berm constructed along the southern edge of the site. Currently this material is heavily vegetated and therefore ACM is unlikely to be released into the air by normal surface activities. Although the material is in bonded form, and no asbestos fibres or fibrous asbestos (AF/FA) was reported in this area, if vegetated surfaces along the berm are disturbed there is the potential for small ACM fragments to be exposed. The presence of FA in fill at HA04 was identified below reporting limits and below the adopted health-based criterion and does not pose an unacceptable health risk.

Prior to development of the site, further intrusive investigation consistent with EPA made or endorsed guidelines and SEPP 55 planning guidelines is recommended to assess the extent and management requirements for identified asbestos in soil, and to confirm the suitability of the site with respect to soil contamination.

1. Introduction

1.1 Background

JBS&G Australia Pty Ltd (JBS&G) was engaged by Pells Sullivan Meynink (PSM, the client) to conduct a Preliminary Site Investigation (PSI) in conjunction with geotechnical investigations PSM completed for the University of New South Wales (UNSW). The investigations are to inform the UNSW's Cliffbrook Campus Redevelopment (CCR) Project, located at the corner of Battery and Beach Streets, Coogee, NSW (the site).

The overall UNSW property comprises Lot 1 DP 109530 (the majority) and Lots 1 and 8 DP 8162, covering approximately 1.2 hectares (ha), however it is understood the western portion of the property is where building redevelopment works are proposed.

It is understood that no development is proposed within the residential property (Lot 8 DP 8162), and this area was not accessed at the time of investigation.

1.2 Objectives

The objective of the investigation was to investigate the potential for contamination based on historical activities at the site, and to provide a preliminary assessment of soil contamination and acid sulfate soil conditions at the site.

1.3 Scope of Works

The scope of works for the assessment included;

- Desktop review of local and regional background environmental information, and available historical background information;
- Development of a conceptual site model (CSM) to identify potential areas of environmental concern (AECs) and associated contaminants of potential concern (COPCs);
- Development of the data quality objectives (DQOs) for the investigation;
- Development of a brief Sampling, Analytical and Quality Plan (SAQP);
- A detailed site inspection / walkover, including photographs;
- Implementation of a site investigation program including soil sampling from seven locations, and analysis of selected samples for identified COPCs;
- Compare collected data against relevant Environment Protection Authority (EPA) endorsed criteria in relation to assessment, from a contamination perspective, in relation to the intended land use; and
- Preparation of this PSI report in general accordance with guidelines made or approved by the EPA.

2. Site conditions and Surrounding Environment

2.1 Site Identification

The location of the site is shown in **Figure 1**, and the current layout is shown in **Figure 2**. The site details are summarised in **Table 2.1**.

Table 2.1: Site Details

Lot/DP Number	Lot 1 DP 109530 and Lot 1 and 8 DP 8162
Street Address	Corner of Battery and Beach Streets, Coogee, NSW
Local Government Authority	Randwick City Council
Site Area	1.2 ha
Current Zoning	Zone SP2 (Infrastructure) and Zone RE2 (Private Recreation)
Geographic Coordinates	Easting: 339208.57 Northing: 6246013.08
Previous Land Use	Residential
Current Land Use	University with open space areas
Proposed Land Use	University with open space areas

2.2 Site Description

A detailed site inspection was undertaken on 31 May 2016 by an experienced JBS&G environmental consultant. Site observations as discussed below and a photographic log is included as **Appendix B**.

The site comprised an irregular parcel of land that fronted on to Battery Street to the west of the site. At the time of the inspection the site was occupied by UNSW and is home to UNSW Press Limited. The site layout and boundary is defined in **Figure 2**.

Along northern and western boundary of the site is the heritage listed sandstone fence. The western boundary was constructed in squared and coursed sandstone with a soft lime mortar containing uncalcified lenses of lime. The gate opening (the main entrance to the site) has been in the same location since 1893 (**Photograph 1** and **3**). The northern boundary again is constructed from irregular sandstone similar to those in the western boundary (**Photograph 2**).

The heritage listed cottage (Building CC1) was observed in the middle of the western portion of the site. It is a two storey brick building with sandstone detailing. The sandstone detail can be observed in the three patios on the southern, northern and eastern side, the corners of the building and between the first and second storeys (**Photograph 4** and **6**). The cottage is surrounded by a manicured hedge (**Photograph 5**).

The garage (Building CC3) comprised a small two car building to the north west of the cottage, constructed out of recycled sandstone and cement mortar (**Photograph 7**). The asbestos and the petrol pump noted in the historical information were not identified during this inspection. To the north of the garage there was a small pedestrian entrance through the sandstone fence.

A small building along the western boundary south of the garage was observed. This building appeared to have been built from the similar brick to the main building (**Photograph 9**). The former use of the building is not known, however at the time of investigation the building appeared disused, and no staining was observed on the foundations (**Photograph 10**).

The carpark along the western boundary of the site is partially asphalt and bricked (**Photograph 12**). Storm water drains were observed in the asphalted area (**Photograph 11**).

The building to the north west of the cottage (Building CC2) was a single storey brick building, which was observed to have suspected asbestos containing material (ACM) within the eaves (**Photograph 15** and **Photograph 16**). Concrete stair access was observed on the southern side (**Photograph 17**).

The UNSW Press Building (Building CC4) was a three storey brick building with a metal sheet roof (**Photograph 18** and **Photograph 19**). It is assumed again that the eaves present within this building may contain asbestos (**Photograph 20** and **Photograph 23**).

The residential building the north east of the site appears to be a single storey concrete rendered brick buildings (**Photograph 34**). At the top of the northern edge of the property there is a single car garage that again appears to be concrete rendered brick building (**Photograph 33**). This property is completely fenced off from the university and was inaccessible at the time of the inspection.

The grassed area in southern portion of the site contained manicured gardens and lawns with pine mulch observed on some of the garden beds (**Photograph 27**). The area in the southern portion of the site was fenced off from the main university and contained a trampoline. A berm was noticed to run along the southern boundary to the east of Building CC4 to the road access in the western portion of the site (**Photograph 28**).

2.3 Surrounding Land

The surrounding land uses have been identified as follows:

- North – The eastern portion of the site is bound to the north by residential. The western portion of the site is bound to the north by Battery Street. Further afield are residential properties.
- East – The open space southeast portion of the site is bound to the east by a public path from Tower Street across from which are residential properties. The northeast portion of the site is bound by residential properties along Battery Street.
- South – To the west of the site is a mixture of residential properties and the reserve surrounding Gordons Bay.
- West – The site is bound to the west by Beach Street across from which are residential properties.

Based on the general observations of surrounding properties, it was considered the potential for contamination to be migrating onto the site from surrounding areas is low.

2.4 Environmental Setting

2.4.1 Topography

Review of the regional topography maps from SIX maps[1] indicates that the site has an approximate elevation of between 25 and 30 m above the Australian Height Datum (AHD).

2.4.2 Geology

Based on the Sydney 1:100,000 Geological Sheet[2] 9130 Edition 1 (1983) the site is located in an area underlain by Quaternary age sediments and Triassic age Hawkesbury Sandstone. Typical geological characteristics of the Quaternary sediment profile are medium to fine grained marine sands and/or coarse quartz sand with varying amounts of shell fragments, with Hawkesbury Sandstone typified by medium to coarse grained quartz sandstone with minor shale and laminite lenses.

Based on eSPADE[3] Soil Landscape information, soils at the site are part of the Lambert landscape characterised by undulating to rolling rises and low hills on Hawkesbury Sandstone. Local relief 20-120 m, slopes usually around 20%. Landforms can include broad ridges, gently to moderately inclined slopes, wide rock benches with low broken scarps and small hanging valleys with areas of poor drainage. Vegetation is usually open and closed heathland, scrub and occasional low eucalypt

[1] SIX Maps http://maps.six.nsw.gov.au / (accessed 21 June 2016)
[2] Sydney 1:100,000 Geological Sheet[2] 9130 Edition 1 (1983)
[3] eSPADE http://www.environment.nsw.gov.au/eSpadeWebApp/ (accessed 21 June 2016)

open-woodland. Limitations of this soil type include very high soil erosion hazard, rock outcrop, seasonally perched water tables, shallow, highly permeable soil and very low soil fertility.

2.4.3 Acid Sulfate Soils

A review of the Australian Soil Resource Information System (ASRIS) – Acid Sulfate Soils Risk Map[4] indicated that the site falls within an area with "no known occurrence" of acid sulfate soils (ASS). This was confirmed by the Randwick City Council Section 149 for the site, and is consistent with the geology and topographic setting of the site.

2.4.4 Hydrology

The western portion of the site is predominately sealed, precipitation falling on this portion of the site is expected to drain through the stormwater infrastructure pits observed. Run off from this portion of the site would be directed to the council stormwater infrastructure on Beach or Battery Street.

The southern portion of the site is an open space within highly vegetated areas along the southern boundary. Run-off is expected to flow south towards Gordons Bay and be diverted east by a land berm along the southern boundary.

The closest waterbody is the Gordons Bay, located approximately 50m south of the site.

2.4.5 Hydrogeology

Review of the NSW Department of Primary Industries, Office of Water's Groundwater Monitoring overview map[5] revealed 7 registered groundwater wells within approximately 1 km of the site. Five of the wells were located in a cluster 1.06 km to the south west of the site. Available information for the 7 wells are summarised below in **Table 2.2**.

Table 2.2 Hydrogeological Wells within 1 km of the site

Well ID	Distance from Site	Direction from Site	Depth	Standing water level	Purpose
GW108862	0.37 km	North east	186 m	32 m	Recreation
GW042800	0.91 km	North west	14.6 m	No information provided	Recreation
GW113105	1.06 km	South west	No information provided	No information provided	Monitoring
GW113106	1.06 km	South west	No information provided	No information provided	Monitoring
GW113107	1.06 km	South west	No information provided	No information provided	Monitoring
GW113108	1.06 km	South west	No information provided	No information provided	Monitoring
GW113109	1.06 km	South west	No information provided	No information provided	Monitoring

Details of the groundwater bores are provided in **Appendix C**.

The ground water within GW108862 was located within the sandstone bedrock. The ground water within GW042800 was within sand at 13.11 m, and the record for this well indicates three sources of ground water were crossed, the first at within sand 1.22 m, second within grey sand at 5.49 m and the third within yellow sand 8.84 m.

Based on regional topography and the geological setting of the site, there may be shallow groundwater beneath the site above sandstone bedrock which would likely follow the topography, as well as deeper aquifers in the bedrock. Based on the site's geological setting, portions in the west of the site may be located on the northeast fringe of the Botany Sands aquifer.

[4] Australian Soil Recourse Information System http://www.asris.csiro.au/ (accessed 21 June 2016)

[5] NSW Department of Primary Industries, Office of Water's Groundwater Monitoring overview map http://allwaterdata.water.nsw.gov.au/water.stm (accessed 21 June 2016)

3. Site History

3.1 Previous Investigation

No previous investigation reports were made available to JBS&G for review, and it is understood that no previous Environmental Site Assessments (ESAs) have been conducted on the site.

3.2 Aerial Photographs

Historical aerial photographs are shown in **Appendix D** and discussed below.

- **1930 (black and white)** – The site comprised one residential building in the north-western corner, adjacent to which is the UNSW press building (CC4), to the north is a long skinny building (CC2) surrounded by three smaller buildings, a large cottage within the centre of the western portion (CC1) and an addition building to the south west of this. A road around the campus is clearly visible with pathways to Building CC4, Building CC2 and Building CC1. The southern portion of the site is largely densely vegetated within the exception of a small field just off the Building CC4. The surrounding area comprises low density residential and the reserve surrounding Gordons Bay.
- **1943 (black and white)** – The site remained similar to the 1930 aerial within the exception of the removal Building CC4, the removal of the residential building in the north-western corner and 13 small structures are apparent within the area. In addition, the southern portion of the site appears to have been cleared. The surrounding area has remained the same with the expectation of large cleared areas and developed flat levels leading to the ocean to the south of the site.
- **1961 (black and white)** – the site remained similar to the 1943 aerial within the exception of the Building CC4 and the residential building in the north-western corner appearing apparent and the 13 small structures being removed. The southern portion of the site has been revegetated and within the exception of the field apparent to the south of the UNI press building. The surrounding area has remained the same.
- **1970 (black and white)** – the site has remained similar to the 1961 aerial within the exception of the widening of Building CC4, the additional building to south of residential building in north-western corner and a track through the vegetated area to the top of the cliff above Gordons Bay. The surrounding area has remained the same.
- **1982 (colour)** – the site has remained similar to the 1970 aerial with the exception of the disappearance of the road to the top of the cliff above Gordons bay and the clearing of the vegetated area in the south of the site. The surrounding area has remained the same with the expectation of the construction of a club house and tennis courts to the south of the site.
- **1993 (colour)** – the site and surrounding area remained the same as 1982 aerial.
- **2001 (colour)** – the site and surrounding area remained similar to 1993 aerial with the exception of the dense vegetation in the southern portion of the site and the removal of the building to the south west of the cottage.
- **2014 (colour)** – the site and surrounding area remained similar to 2001 aerial with the expectation of the Building CC4 roof being painted with a sign that read “UNSW PRESS”.

3.3 Historical Land Titles

A search of the historical land titles for the site was undertaken on 7 June 2016 (**Appendix E**).

Lot 8, the residential property in the north western corner of the site, has had multiple site owners since 1916. Owners of the site included the Governor of the Commonwealth Bank of Australia and an architect, bank officer and a married woman. The UNSW overtook ownership of the site in 2002.

Lot 1 DP8162 and Lot 1 DP109530, the remainder of the site, again has had multiple site owners since 1918. Owners include the Governor of the Commonwealth Bank of Australia, an engineer, widow, investor, grazier, picture theatre proprietor and chemist. The Commonwealth of Australia took ownership of the site in 1949, and it then passed to the Australian Atomic Energy Commission in 1959. The Commonwealth of Australia is reported as taking ownership of the site again in 1990, and it then passed to the UNSW in 1997.

3.4 EPA Records

Search of the NSW EPA database was undertaken on 21 June 2016 (**Appendix F**) for the site and immediate surroundings. The search consisted of the:

- NSW EPA Protection of the Environment Act public register of licence, applications and notices (maintained under Section 308 of the Protection of the Environment Operations Act 1997 (POEO Act));
- NSW EPA contaminated land public register of record of notices (under Section 58 of the Contaminated Land Management Act 1997 (CLM Act)); and
- NSW contaminated sites notified to the EPA (under Section 60 of the CLM Act).

No prevention, clean-up or prohibitions notices have been issued under the POEO Act for the site and immediate surroundings.

3.5 Council Records

A copy of the s149 Planning Certificate for Lot 1 DP 8162 and Lot 1 DP 109530 was obtained from the Randwick City Council, and is included in (**Appendix G**). Relevant information for the site is summarised below.

- The site is currently zone SP2 (Infrastructure) and RE2 (Private Recreational) under the Randwick Local Environmental Plan (LEP) 2012.
- The land does not include or comprise a critical habitat area under the Threatened Species Conservation Act 1995.
- The land is not located in a heritage conservation area under the Randwick LEP 2012.
- The land is listed as a heritage item under the under the Randwick LEP 2012. The land is listed on the State Heritage Register under the Heritage Act 1977.
- Complying development may not be carried out on the land as the land comprises an item that is listed on the State Heritage Register under the Heritage Act 1997 or on which such an item is located.
- Council has not been notified by the Department of Services, Technology and Administration that the land is affected by the operation of Section 38 or 39 of The Coastal Protection Act 1979.
- An order has not been made under Part 4D and council has not been notified under Section 55X of the Coastal Protection Act 1979 in relation to emergency coastal protection works.
- The land is not proclaimed to be a mine subsidence district within the meaning of Section 15 of the Mine Subsidence Compensation Act 1961.
- The land is not affected by any road widening, road realignment under Division 2 and 3 or the Roads Act 1993 and the Randwick LEP.

- The land is affected by a policy adopted by the council:
    - Contaminated land Policy – the policy does not specifically identify the subject land as contaminated. The policy does, however, apply to all land in the City of Randwick. The policy requires council to consider the possibility of land contamination and its implications for any proposed or permissible future used of the land, including all rezoning, subdivision and development applications.
- The land is not subjected to Council's policy "Former Incinerator Land Matraville". This Policy identifies land which is, or may contain contaminated ash material due to the operation of, the former (Reico) incinerator at Matraville.
- The land is not affected by a policy that restricts the development of the land because of the likelihood of land slip, bushfire, (other than flooding), tidal inundation, subsidence, acid sulphate soils or any other risk.
- Development on the land for the purposes of dwelling houses, dual occupancies, multi dwelling housing or residential flat buildings is not subject to flood related development controls (provided that such development is permissible on the land with or without development consent).
- The land is not biodiversity certified land (within the meaning of Part 7AA of the Threatened Species Conservation Act 1995).
- Council has not been notified of any biobanking agreement under Part 7A of the Threatened Species Conservation Act 1995 relating to the land.
- The land is not bush fire prone land (or defined in the act).
- Council has not been notified of any property vegetation plan under the Native Vegetation Act 2003 applying to the land.
- The land is not significantly contaminated land within the meaning of the Contaminated Land Management Act 1997.
- The land is not subject to a management order within the meaning of the Contaminated Land Management Act 1997.
- The land is not the subject of an approved voluntary management proposal within the meaning of the Contaminated Land Management Act 1997.
- The land is not the subject to an ongoing maintenance order within the meaning of the Contaminated Land Management Act 1997.
- Council has not received a copy of a site audit statement, within the meaning of the Contaminated Land Management Act 1997, for this land.
- The land is identified and mapped as "Foreshore Area" within the Randwick LEP 2012 Foreshore Building Line Map.

3.6 Australian and NSW Heritage Register

A search of the Australian and NSW Heritage Inventory on 21 June 2016 (**Appendix H**) revealed that Cliffbrook House, Stables and Stone Walls located on the site is protected by both the Australian and NSW heritage register.

The Cliffbrook House is described in the Australian Heritage Register as a two storey house in the Federations Free Classical style, with brick walls and stone porticos on three sides and other stone trims. The roof is slate. There is a maple staircase of Georgian design, Art Deco leadlights to the stair window and one door, marble chimney pieces probably from and earlier house, marble window sills

and Adam Revival Plaster ceilings. The sandstone stables, garage and perimeter stone walls date from and earlier house on the site.

It is noted that the NSW Heritage description of the house includes asbestos cement and caneite ceiling panels are in poor condition. It additional notes a petrol pump standing by the south eastern corner is of an early vintage but is now non-functional. As noted earlier, a petrol pump was not observed during inspection of accessible site areas during this investigation.

3.7 WorkCover NSW

A search of Storage of Hazardous Chemical records held by SafeWork NSW indicated that there were no records pertaining to the site (**Appendix I**).

3.8 Integrity Assessment

The information obtained from the historical sources reviewed has been found to be in general agreement. It is therefore considered that the information provided in this historical assessment has an acceptable level of accuracy.

4. Conceptual Site Model

Based on the desktop review and observations from the site inspection, the following conceptual site model (CSM) has been developed for the site.

4.1 Potential Areas of Environmental Concern

Based on the objectives of the assessment, desktop review and observations made during the site inspection prior to the completion of intrusive investigation works at the site, AEC and associated COPC were identified at the site, as noted in **Table 4.1**. Further discussion based on the results of field works and laboratory results are discussed in **Section 8**.

Table 4.1: Areas of Environmental Concern and Associated Contaminants of Potential Concern

Area of Environmental Concern (AEC)	Contaminant of Potential Concern
Historical site uses, including weed/pest control, and potential presence of hazardous building materials in former structures.	Heavy metals, total recoverable hydrocarbons (TRH), benzene, toluene, ethylbenzene and xylenes (BTEX), polycyclic aromatic hydrocarbons (PAH), organochlorine pesticides (OCP) and asbestos.
Imported fill materials/bitumen hardstand	Heavy metals, TRH/BTEX, PAH, OCP, polychlorinated biphenyls (PCB), asbestos.

4.2 Potentially Contaminated Media and Migration

Based on the identified AEC/COPC and site observations, potentially contaminated media at the site is considered to be limited primarily to surface and near surface soil, including potential fill material and natural soils.

Potential for downward migration of contaminants through fill and natural soils into groundwater is considered low given the historical low density residential and university use of the site.

Surface water runoff may occur where excess rainfall cannot infiltrate, however, given the dense vegetation along the southern portion of the site and the nature of the pavement at the site there is low potential for migration of impacted media via surface water movement.

There is a low potential for contaminant migration via windblown dust from minor unsealed vegetated areas within the eastern portion of the site and the gardens through the western portion.

4.3 Potential Exposure Pathways

Based on the COPC identified at the site as discussed above, and with consideration to permissible site uses, the considered exposure pathways for the site during and following development works include:

- Potential dermal, inhalation and oral exposure to impacted soils present at varying depths and/or accessible by future service excavations at the site;
- Potential ingestion and inhalation exposure to airborne dusts containing contaminants; and/or
- Potential dermal and oral exposure to workers from potential seepage water within excavations.

4.4 Human and Ecological Receptors

Potential human receptors present within the site include site occupants/university attendants and site development workers, who may potentially be exposed to COPC through direct contact with site soils and seepage water and/or inhalation of dusts/fibres associated with soils.

Potential ecological receptors include flora present at the site and in nearby topographically down-gradient areas.

4.5 Preferential Pathways

For the purpose of this assessment, preferential pathways have been identified as natural and/or man-made pathways that result in the preferential migration of COPCs as either liquids, gasses or fibres.

Man-made preferential pathways may be present within the site, associated with underground infrastructure related to stormwater or service trenches. Preferential pathways can be formed by the generally higher permeability backfill used to re-instate these excavations.

Near surface fill material may also act as a preferential pathway compared to the underlying natural soil as fill materials are anticipated to have a higher permeability than the underlying natural soil and/or bedrock.

Preferential pathways are also important in the assessment of potential off-site sources of COPCs, although based on the desktop review, site inspection and geographical setting, off-site impacts are considered unlikely.

5. Sampling and Analytical Plan

5.1 Data Quality Objectives

Data Quality Objective (DQO) were developed for the investigation, as discussed in the following sections.

5.1.1 State the Problem

The site has historically been associated with either the Commonwealth of Australia or as a residential property. More recently, the site has been utilised by the UNSW as a teaching facility. Plans for redevelopment of a portion of the site are currently being assessed.

The site is being investigated to provide an assessment of the potential contamination risk at the site.

Information on potential site contamination conditions inferred from the desktop review, previous site investigation, and observations made during site inspection resulted in the conceptual site model information presented in **Section 4**.

5.1.2 Identify the Decisions

Based on the decision making process for assessing urban sites detailed in Department of Environment and Conservation (DEC 2006), the following decisions must be made:

- Are there any unacceptable risks to likely potential future onsite receptors?
- Are there any issues relating to local area background soil concentrations that exceed the appropriate soil criteria?
- Are there any impacts of chemical mixtures?
- Are there any aesthetic issues at the site?
- Is there any evidence of, or potential for, migration of contaminants from the site?

5.1.3 Identify Inputs to the Decisions

Inputs identified to provide sufficient data to make the decisions nominated above include:

- Desktop review;
- Detailed site inspection/walkover;
- Physical observations and interpretation of fill and natural material through the collection of soil samples and laboratory chemical analysis results;
- Development of appropriate assessment criteria for evaluation of soil impacts;
- Laboratory analysis of soil samples of potentially contaminated media for COPC; and
- Confirmation that data generated by sample analysis are of an acceptable quality to allow reliable comparison to assessment criteria by assessment of quality assurance / quality control as per the data quality indicators established in **Table 5.2**.

Specifically, sufficient data need to be collected from each of the identified potentially impacted media in the identified AEC for the associated COPC (**Table 4.1**).

5.1.4 Define the Study Boundaries

The study boundaries are limited to the site boundaries as described in **Section 2.1** and shown on **Figure 2**. The vertical extent of the soil investigation by JBS&G was 3.8 m. It is noted concurrent geotechnical investigations extended to a maximum of 8 m deep.

Due to the project objectives, seasonality was not assessed as part of this investigation. Data are therefore representative of the timing and duration of the current investigation.

5.1.5 Develop a Decision Rule

Soil analytical data was assessed against the adopted criteria as described in **Section 6.** Statistical analyses of the data was completed, where necessary, in accordance with relevant guidance documents. The following statistical criteria were adopted:

- The upper 95% confidence limit on the average concentration for each analyte (calculated for samples collected from consistent soil horizons, stratigraphy or material types) must be below the adopted criterion;
- No single analyte concentration shall exceed 250% of the adopted criterion; and
- The standard deviation of the results must be less than 50% of the criterion.

The decision rules adopted to answer the decisions identified in **Section 5.1.2** are summarised in **Table 5.1**.

Table 5.1: Summary of Decision Rules

Decisions Required to be Made	Decision Rule
1. Are there any unacceptable risks to likely potential future onsite receptors?	Analytical data was compared against EPA endorsed criteria. Statistical analysis of the data was completed, where necessary, in accordance with relevant guidance documents, as appropriate, to facilitate the decisions. The criteria in **Section 6**., and the following statistical criteria were adopted with respect to soils: Either: the reported concentrations were all below the site criteria; Or: the average site concentration for each analyte was below the adopted site criterion; no single analyte concentration exceeded 250% of the adopted site criterion; and the standard deviation of the results was less than 50% of the site criterion. And: the 95% upper confidence limit (UCL) of the average concentration for each analyte was below the adopted site criterion. If the statistical criteria stated above were satisfied, the answer to the decision was No. If the statistical criteria were not satisfied, the answer to the decision was Yes.
2. Are there any issues relating to local area background soil concentrations that exceed the appropriate soil criteria?	Analytical data in natural soil samples were compared to the background levels for urban areas of NSW as described in ASC NEPM. Where concentrations were less than the background levels, the answer to the decision was No. Otherwise the answer to the decision was Yes.
3. Are there any impacts of chemical mixtures?	Was there more than one group of contaminants present which increase the risk of harm? If there was, the answer to the decision was Yes. Otherwise, the answer to the decision was No.
4. Are there any aesthetic issues at the site?	If there were any ACM fragments on the ground surface, any unacceptable odours, any soil discolouration, or excessive amounts of anthropogenic material, the answer to the decision was Yes. Otherwise, the answer to the decision was No.
5. Is there any evidence of, or potential for, migration of contaminants from the site?	Based on assessment results, was there any evidence of, or the potential for, unacceptable contaminant concentrations to migrate from the site? If yes, the answer to the decisions was Yes. Otherwise, the answer to the decision was No.

5.1.6 Specific Limits on Decision Errors

This step is to establish the decision maker's tolerable limits on decision errors, which are used to establish performance goals for limiting uncertainty in the data. Data generated during this project must be appropriate to allow decisions to be made with confidence.

Specific limits for this project have been adopted in accordance with the appropriate guidance from the NSW EPA, ASC NEPM (2013) and standard JBS&G procedures for field sampling and handling.

To assess the usability of the data prior to making decisions, the data was assessed against predetermined date quality indicators (DQIs) for precision, accuracy, representativeness,

comparability, completeness and sensitivity (PARCCS parameters). The acceptable limit on decision error is 95% compliance with DQIs.

The pre-determined DQIs established for the project are discussed below in relation to the PARCCS parameters, and are shown in **Table 5.2**.

- **Precision** - measures the reproducibility of measurements under a given set of conditions. The precision of the laboratory data and sampling techniques is assessed by calculating the Relative Percent Difference (RPD) of duplicate samples.
- **Accuracy** - measures the bias in a measurement system. The accuracy of the laboratory data that are generated during this study is a measure of the closeness of the analytical results obtained by a method to the 'true' value. Accuracy is assessed by reference to the analytical results of laboratory control samples, laboratory spikes and analyses against reference standards.
- **Representativeness** – expresses the degree which sample data accurately and precisely represent a characteristic of a population or an environmental condition. Representativeness is achieved by collecting samples on a representative basis across the site, and by using an adequate number of sample locations to characterise the site to the required accuracy.
- **Comparability** - expresses the confidence with which one data set can be compared with another. This is achieved through maintaining a level of consistency in techniques used to collect samples; and ensuring analysing laboratories use consistent analysis techniques; and reporting methods.
- **Completeness** – is defined as the percentage of measurements made which are judged to be valid measurements. The completeness goal is set at there being sufficient valid data generated during the study.
- **Sensitivity** – expresses the appropriateness of the chosen laboratory methods, including the limits of reporting, in producing reliable data in relation to the adopted site assessment criteria.

Table 5.2: Summary of Data Quality Indicators

Data Quality Indicators	Frequency	Data Quality Criteria
Precision		
Split duplicates (intra laboratory)	1 / 20 samples	<50% RPD[1]
Blind duplicates (inter laboratory)	1 / 20 samples	<50% RPD[1]
Laboratory Duplicates	1 / 20 samples	<50% RPD[1]
Accuracy		
Surrogate spikes	All organic samples	70-130%
	Phenols	30-130%
Laboratory control samples	1 per lab batch	70-130%
Matrix spikes	1 per lab batch	70-130% (phenols 30-130%)
Representativeness		
Sampling appropriate for media and analytes	All samples	-[2]
Samples extracted and analysed within holding times.	-	Soil: organics (14 days), inorganics (6 months)
Laboratory Blanks	1 per lab batch	<LOR
Trip spike	1 per lab batch	70-130% recovery
Storage blank	1 per lab batch	<LOR
Rinsate sample	1 per sampling event/media	<LOR
Comparability		
Standard operating procedures for sample collection & handling	All Samples	All Samples
Standard analytical methods used for all analyses	All Samples	NATA accreditation

Consistent field conditions, sampling staff and laboratory analysis	All Samples	All samples[2]
Limits of reporting appropriate and consistent	All Samples	All samples[2]
Completeness		
Sample description and Chain of Custody (COCs) completed and appropriate	All Samples	All samples[2]
Appropriate documentation	All Samples	All samples[2]
Satisfactory frequency and result for QC samples		95% compliance
Data from critical samples is considered valid	-	Critical samples valid
Sensitivity		
Analytical methods and limits of recovery appropriate for media and adopted site assessment criteria	All samples	LOR<= site assessment criteria

[1] If the RPD between duplicates is greater than the pre-determined data quality indicator, a judgment will be made as to whether the excess is critical in relation to the validation of the data set or unacceptable sampling error is occurring in the field.

[2] A qualitative assessment of compliance with standard procedures and appropriate sample collection methods will be completed during the DQI compliance assessment.

5.2 Optimise the Design of Obtaining Data

Various strategies for developing a statistically based sampling plan are identified in *Contaminated Sites: Sampling Design Guidelines* (EPA 1995), including judgemental, random, systematic and stratified sampling patterns. The adopted sampling methodology is discussed in the following sections.

5.2.1 Soil Investigation Methodology

The assessment of potential soil contamination was undertaken based on a targeted sampling approach. Three locations were completed coincidental with the geotechnical investigation within the western portion of the site, with an additional four targeted locations in readily accessible grassed areas in the eastern portion of the site. The locations provided a reasonable preliminary assessment across accessible areas of the site. It is noted no sampling was completed in the heavily vegetated eastern area, nor within the residential property (Lot 8) east of Building CC4.

The area of the site as identified on **Figure 2**, is approximately 1.2 ha. For sites of 1.2 ha the Contaminated Sites: Sampling Design Guidelines (EPA 1995) recommends a minimum sampling density of 22 locations for a detailed investigation of contamination. Given the objective of this PSI to preliminarily assess the potential contamination risk at the site, the 7 sample locations are considered to provide an indicative assessment of the potential contamination of soils underlying the site, consistent with EPA and SEPP55 guidelines for a PSI.

The soil sampling and analysis program is presented in **Table 5.3**.

5.2.2 Soil Sampling Methodology

Soil sampling was completed via solid flight augers using a drill rig for three of the bore holes (BH01 to BH03). For the remaining four locations, shovel and hand auger were used to collect soil samples (HA01 to HA04). Soil samples were collected from the fill materials underlying the hardstand or grass (to depth of 0.7m) and then sampling was collected into the natural materials (at depths from 1.0m to 0.3m), or to prior refusal, whichever was shallower.

During the collection of soil samples, features such as seepage, discolouration, staining, odours and other indicators of contamination (e.g. presence of ACM) were noted if present. Observations and field screening results were recorded. Borelogs are provided in **Appendix J**.

Soil samples were collected using a trowel or a hand auger and fresh pair of nitrile gloves at each location and immediately transferred to laboratory supplied sample jars and bags. The sample containers were then transferred to a chilled esky for sample preservation prior to and during shipment to the testing laboratory. A chain-of-custody form was completed and forwarded with the samples to the testing laboratory. Laboratory documentation has been provided in **Appendix K**.

Based upon field observations, samples were analysed in accordance with the analytical schedule (**Table 5.3**). Not all samples from all locations have been analysed for the full suite of COPC.

5.2.3 Decontamination

Prior to the commencement of sampling activities, the non-disposable sampling equipment (trowel and hand auger) was cleaned with a high pressure water/detergent spray, rinsed with water and then air dried. The equipment was then inspected to ensure that no soil, oil, debris or other contaminants were apparent on the equipment prior to the commencement of works.

Soil samples were collected straight from the solid flight auger. A new pair of disposable nitrile gloves were used to collect each sample.

Sampling equipment was then subsequently decontaminated using the above process between each sampling location. Decontamination documentation has been provided in **Appendix L**.

5.2.4 Laboratory Analysis

Soil samples were submitted to Eurofins MGT for laboratory analysis. Eurofins MGT utilise analyses consistent with ASC NEPM requirements. In addition, the laboratory were required to meet JBS&G's internal accredited Quality Assurance requirements.

The following analytical schedule has been developed in accordance with the current knowledge of the site.

Table 5.1: Analytical Schedule

Sample Type	No. of Sampling Locations	Primary Lab Analyses (exc. QA/QC)
Site	7 boreholes	Heavy metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Zn) – 8 samples PAH – 8 samples OCPs/PCBs – 5 samples TRH and BTEX – 8 samples Asbestos – 8 samples (500 mL per ASC NEPM) Ecological parameters (pH, CEC, clay, Fe) – 2 samples

In addition to the above primary analyses, to address the DQIs, a field duplicate soil sample was analysed at a rate of at least one per 20 primary samples. A rinsate sample was obtained from non-disposable soil sampling equipment, plus a single trip spike and single trip blank accompanied the sample batch.

6. Assessment Criteria

6.1 Regulatory Guidelines

Development of site assessment criteria and the associated scope of investigation was undertaken with consideration to aspects of the following guidelines, as relevant:

- *National Environment Protection (Assessment of Site Contamination) Measure*, National Environment Protection Council, 1999 (as amended 2013) (ASC NEPM 2013);
- *Contaminated Sites: Sampling Design Guidelines*, NSW EPA, 1995 (EPA 1995);
- *Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites*, NSW OEH, 2011 (OEH 2011);
- *Contaminated Sites: Guidelines for the NSW Site Auditor Scheme, 2nd Edition*, NSW EPA, 2006 (DEC 2006); and
- Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia, Western Australia Department of Health (WA DoH 2009).

6.2 Site Contamination Assessment Criteria

As per the decision process for assessment of urban development site (DEC 2006), a set of health and ecological assessment thresholds derived from ASC NEPM was used for evaluation of site contamination data collected for this preliminary assessment. For the purposes of this assessment, and based on the historic and proposed site use, sensitive generic land use soil criteria in ASC NEPM were adopted as the site criteria.

The soil data were compared against ASC NEPM land use criteria consistent with residential land use scenario with minimal opportunities for access to soils, including dwellings and permanently paved yard space such as high rise buildings and apartments, which is considered appropriate for the current and proposed use of the site.

The following criteria have been adopted for the site based on the above land use scenario:

- Health based Investigation Levels (HILs) as provided in the ASC NEPM for residential with minimal opportunities for access to soils (HIL-B);
- Health Screening Levels (HSLs) as provided in the ASC NEPM for petroleum hydrocarbons considering potential for vapour intrusion, sand for low-high density residential land use (HSL A & HSL B);
- Ecological Investigation/Screening Levels (EILs/ESLs) for urban residential land use; and
- Health screening levels for asbestos contamination in soil for residential land use with minimal access to soils (HSL B).

Where there are no NSW EPA endorsed thresholds for individual COPC the laboratory limit of reporting (LOR) was adopted as an initial screening value for the purposes of this assessment.

The results of asbestos analysis were assessed in general accordance with ASC NEPM including DoH (2009[6]) guidance.

Assessment criteria are included with summary laboratory results in **Table A**.

[6] Guidelines for the Assessment Remediation and Management of Asbestos-Contaminated Sites in Western Australia, May 2009. Western Australia Department of Health (DOH) (DOH 2009)

7. Quality Assurance / Quality Control

7.1 QA/QC Results

The QA/QC results for soil samples collected at the site are summarised in **Table 7.1** and discussed in **Section 7.2** below. Detailed QA/QC results are included in the laboratory reports in **Appendix K** and tabulated QA/QC information is presented in **Appendix M.**

Table 7.1: Data Quality Indicator Assessment

Data Quality Indicator	Results	DQO met?
Precision		
Blind duplicates (intra laboratory)	0-33% RPD Blind duplicates were analysed at a rate of 1 in 7 samples.	Yes
Laboratory Duplicates	<30% RPD	Yes
Accuracy		
Surrogate spikes	68 - 141% recovery	Yes
Laboratory control samples	70-128% recovery	Yes
Matrix spikes	74 – 130% recovery	Yes
Representativeness		
Samples extracted and analysed within holding times.	All primary and duplicate samples were extracted within holding times with the exception of BH030 0.9-1.0 and BH030 0.4-0.5.	*Partial
Trip spike	94 – 101% recovery	Yes
Storage blank	<LOR	Yes
Rinsate blank	<LOR with the exception of copper and zinc	*Partial
Method blank	<LOR	Yes
Standard operating procedures for sample collection & handling	Field scientist used the same standard operating procedures throughout works.	Yes
Comparability		
Standard analytical methods used for all analyses	Standard analytical methods used as listed on laboratory reports.	Yes
Consistent field conditions, sampling staff and laboratory analysis	Sampling was conducted by the same field scientist. Standard operating procedures were conducted throughout the works. Field conditions remained the same throughout the works. The primary lab remained consistent throughout the investigation.	Yes
Limits of reporting appropriate and consistent	Soil limits of reporting were consistent and appropriate.	Yes
Completeness		
Soil description and COCs completed and appropriate	All excavation logs and COCs were completed appropriately.	Yes
Appropriate documentation	All appropriate field documentation is included in the Appendices.	Yes
Satisfactory frequency and result for QC samples	The QC results are considered adequate for the purposes of the investigation.	Yes
Data from critical samples	Samples were analysed at locations where potential for contamination was observed.	Yes
Sensitivity		
Analytical methods and limits of recovery appropriate for media and adopted site assessment criteria	Analytical methods and limits of recovery were considered appropriate for media and adopted site assessment criteria for all soil analytes.	Yes

* Discussion in **Section 7.2.**

7.2 QA/QC Discussions

7.2.1 Precision

Soil Duplicate (intra-laboratory) Samples

The primary soil sample was in agreement with the duplicate sample for all analytes. The RPDs for intra-laboratory duplicates as presented in **Appendix M**.

Laboratory duplicate RPDs were within the acceptable range of <50%.

7.2.2 Accuracy

Surrogate Spikes

Surrogate spike recoveries were within the acceptable range of 70-130% and 30-130% for phenol compounds.

Laboratory Control Samples

Laboratory control sample (LCS) recoveries were within the acceptable range of 70-130%.

Matrix Spikes

Matrix spike recoveries were within the acceptable range of 70-130%.

7.2.3 Representativeness

Sampling appropriate for media and analytes

All sampling works completed during the investigation were conducted in accordance with JBS&G standard operating procedures. Sampling was conducted as described in **Section 5.2.2**. It is noted the use of solid flight augers for three boreholes can lead to some cross-contamination of deeper samples with shallower material, which can fall back into the borehole. For a preliminary investigation however, this is not considered to unduly influence the investigation findings.

Holding Times

The extraction and analysis of selected samples was completed within the recommended holding times for all selected analytes with the exception of additional samples analysed from BH03. This is not considered to affect the reliability of the results achieved as no volatile contamination was identified in any of the locations completed.

Rinsate Blank

Concentrations were reported at or below the laboratory LOR for all selected analytes with the exception of coper and zinc. This is not considered to affect the reliability of the results achieved as no raised levels of copper or zinc were identified within the samples.

Trip Spike

Trip spike recoveries were reported within the acceptable range of 70 – 130%.

Storage Blank

There were no reported concentrations of BTEX compounds above the laboratory LOR.

Decontamination and Calibration

All field equipment was decontaminated appropriately.

7.2.4 Comparability

An experienced JBS&G field scientist undertook all sampling in accordance with standard JBS&G sampling methods. Field works and sampling were undertaken by the same JBS&G field scientist for each medium type throughout the duration of works.

All field documentation was appropriately completed. The nominated laboratories undertook all analysis in accordance with the relevant National Association of Testing Authorities (NATA) accredited methods.

7.2.5 Completeness

Samples were transported under full COC documentation. The COC documentation was completed correctly and the selected analyses were correctly conducted.

All field documentation was completed appropriately including borehole logs, decontamination sheets, COCs and daily field logs.

The frequency of analysis and result for all QC samples were appropriate.

7.2.6 Sensitivity

Laboratory analysis methods for all contaminants in soil adopted during the investigation used limits of reporting significantly less than the site assessment criteria to ensure the contaminant concentrations could be confidently identified as being less than the adopted site assessment criteria.

7.3 QA/QC Conclusions

The field sampling and handling procedures across the site produced QA/QC results which indicate that soil data collected is of an acceptable quality.

The NATA certified laboratory results sheets from contracted laboratories indicate that the project laboratory was achieving levels of performance within its recommended control limits during the period when the samples of this program were analysed.

On the basis of the results of the field and laboratory QA/QC program, the soil data is of an acceptable quality upon which to draw conclusions regarding the PSI for the site.

8. Results

8.1 Observations

Soil sampling was conducted on the 31 May 2016 at the sampling locations shown on **Figure 2**. Bore logs are included in **Appendix I**.

The site surface was comprised of either pavers, road base, asphalt or grass/garden bed. Fill was encountered to depths ranging between 0.1 m to 0.7 m depth. Fill materials typically consisted of dark grey to grey gravelly or clayey with inclusions of sandstone, igneous gravels, plastic, tile and metal.

The fill material was underlain by natural grey to brown clayey sand or sand with no inclusions. Observations during geotechnical investigations indicated that the natural sand was underlain at approximately 1.6 m by brown with red and orange clayey sand (weathered sandstone).

ACM, odours or staining indicative of hydrocarbon or chemical contamination, were not observed in fill or natural materials during field works.

8.2 Analytical Results

Summary analytical results are presented in **Table A**. Laboratory documentation is included in **Appendix J**.

8.2.1 Heavy Metals

All individual heavy metal concentrations were reported at concentrations less than the adopted health and ecological based assessment criteria for all soil samples selected for analysis.

8.2.2 PAHs

Total PAH and carcinogenic PAHs reported as benzo(a)pyrene toxicity equivalent (B(a)P TEQ) values for all analysed samples were reported at concentration less than the adopted health based assessment criteria with the exceptions of BH03 0.40-0.50 m, which returned a B(a)P TEQ concentration of 5.35 mg/kg, exceeding the adopted HIL-B criterion of 4 mg/kg. Leachate results for the sample location reported PAH concentrations below or close to the LOR.

The reported BaP concentrations were below LOR and adopted ESL with the exception of samples from BH03, with concentrations of 3.7 and 1.1 mg/kg exceeding the adopted ESL of 0.7 mg/kg.

It is noted this sample was collected from fill material including roadbase materials beneath a bituminous concrete (asphalt) surface, and as no other evidence of contamination was observed, it is considered likely the result relates to bituminous material in the roadbase, and not to soil contamination. Similarly, minor PAH concentrations in the underlying material are considered a result of roadbase material falling into the borehole and cross-contaminating the deeper sample of natural soils collected.

8.2.3 TRH and BTEX

Concentration of all TRH fractions and BTEX were reported below the LOR and/or adopted health and ecological based assessment criteria in all soil samples selected for analysis.

8.2.4 OCPs and PCBs

Concentration of all OCP and PCB compounds were reported below the adopted health and ecological based assessment criteria in all soil samples selected for analysis.

8.2.5 Asbestos

Asbestos was not detected above the laboratory LOR in soil samples submitted to the laboratory for analysis with the exception of HA02 0.0-0.1 m, with a minor amount (2.34 grams) of small-sized ACM

identified within the laboratory sample at a concentration of 0.066 %w/w, which exceeds the adopted HSL-B criterion of 0.04 %w/w.

The ACM reported in this sample comprised small fibre cement (bonded ACM) fragments. During sampling, no visible ACM was observed in the fill material at HA02.

It is noted that fibrous asbestos (FA) reported as less than 0.02 grams of weather fibre cement fragments, was detected in a shallow soil sample from HA04 (0.2-0.3 m), however the reported concentration was below the adopted HSL and the limit of reporting (0.001% w/w). Again, no visible ACM was observed during sampling at this location.

9. Site Characterisation

Based on the decision making process for assessing an education facility detailed in DEC (2006) and discussed in **Section 5**, the decisions required to be made are below.

9.1 Potential Risk to Current or Future Onsite Receptors

Concentrations of COPC in all samples analysed were reported below the adopted human health and ecological criteria, with the exception of a PAH at location BH03, and ACM in fill at location HA02. While the PAH concentrations at BH03 exceeded adopted human health and ecological criteria, it is considered that the PAH is associated with bituminous fragments introduced into the samples from overlying roadbase and asphalt (bituminous concrete) pavement at this location, as no other potential source of PAH contamination was identified.

The ACM reported in the surface soil sample from HA02, was associated with the fill material within the berm constructed along the southern edge of the site. Currently this material is heavily vegetated and therefore ACM is unlikely to be released into the air by normal surface activities. Although the material is in bonded form, and no asbestos fibres or fibrous asbestos (AF/FA) was reported in this area, if vegetated along the berm is disturbed there is the potential for small ACM fragments to be exposed. The presence of FA in fill at HA04 was identified below reporting limits and below the adopted health-based criterion and does not pose an unacceptable health risk.

9.2 Background Soil Concentrations

In-situ natural soils were encountered from below fill at various depths across the site. The soil samples collected from natural soils were reported to have contaminant concentrations within typical urban background concentration ranges, as described in ASC NEPM. On this basis, there are no issues relating to local area background conditions that require /consideration.

9.3 Chemical Mixtures

There were no soils identified with significant concentrations of more than one contaminant of concern and so no potential chemical mixtures identified during the investigation that may pose an unacceptable contamination risk at the site with respect to current site users.

9.4 Aesthetic Issues

There were no visible ACM, odours, stains or other aesthetic concerns identified on the ground surface or fill during the investigation. Samples for HA02 and HA04 identified asbestos cement fragments smaller than the visible range. As this asbestos was identified within the surface material it may pose an unacceptable aesthetic issue at the site with respect to ground maintenance activities under the current or permissible land uses.

9.5 Potential for Migration of Contaminants

As the area around HA02 is grassed and the area of HA04 is mulched, and based on the absence of significant contaminant mass in soils identified during the current investigation, the potential for contaminant migration is unlikely for normal use of the site. Should surface cover be disturbed, there is the potential for ACM to become exposed and susceptible to migration via wind-blown dust.

10. Conclusions and Recommendations

10.1 Conclusions

Based on the information provided in this report and the scope of intrusive investigations, and in accordance with the limitations in **Section 11**, there is no evidence of historical activities resulting in gross or widespread contamination of the site. However asbestos was detected by laboratory analysis of shallow/surface soils at two locations, including one within the berm along the southern boundary where the ACM concentration exceeds the adopted health-based criterion. It is considered the presence of asbestos in soils at this location is unlikely to pose an exposure risk under normal site use, provided the soils remain covered and are not disturbed.

10.2 Recommendations

Prior to development of the site, further intrusive investigation consistent with EPA made or endorsed guidelines and SEPP 55 planning guidelines is recommended to assess the extent and management requirements for identified asbestos in soil, and to confirm the suitability of the site with respect to soil contamination.

11. Limitations

This report has been prepared for use by the client who has commissioned the works in accordance with the project brief only, and has been based in part on information obtained from the client and other parties.

The advice herein relates only to this project and all results conclusions and recommendations made should be reviewed by a competent person with experience in environmental investigations, before being used for any other purpose.

JBS&G accepts no liability for use or interpretation by any person or body other than the client who commissioned the works. This report should not be reproduced without prior approval by the client, or amended in any way without prior approval by JBS&G, and should not be relied upon by other parties, who should make their own enquires.

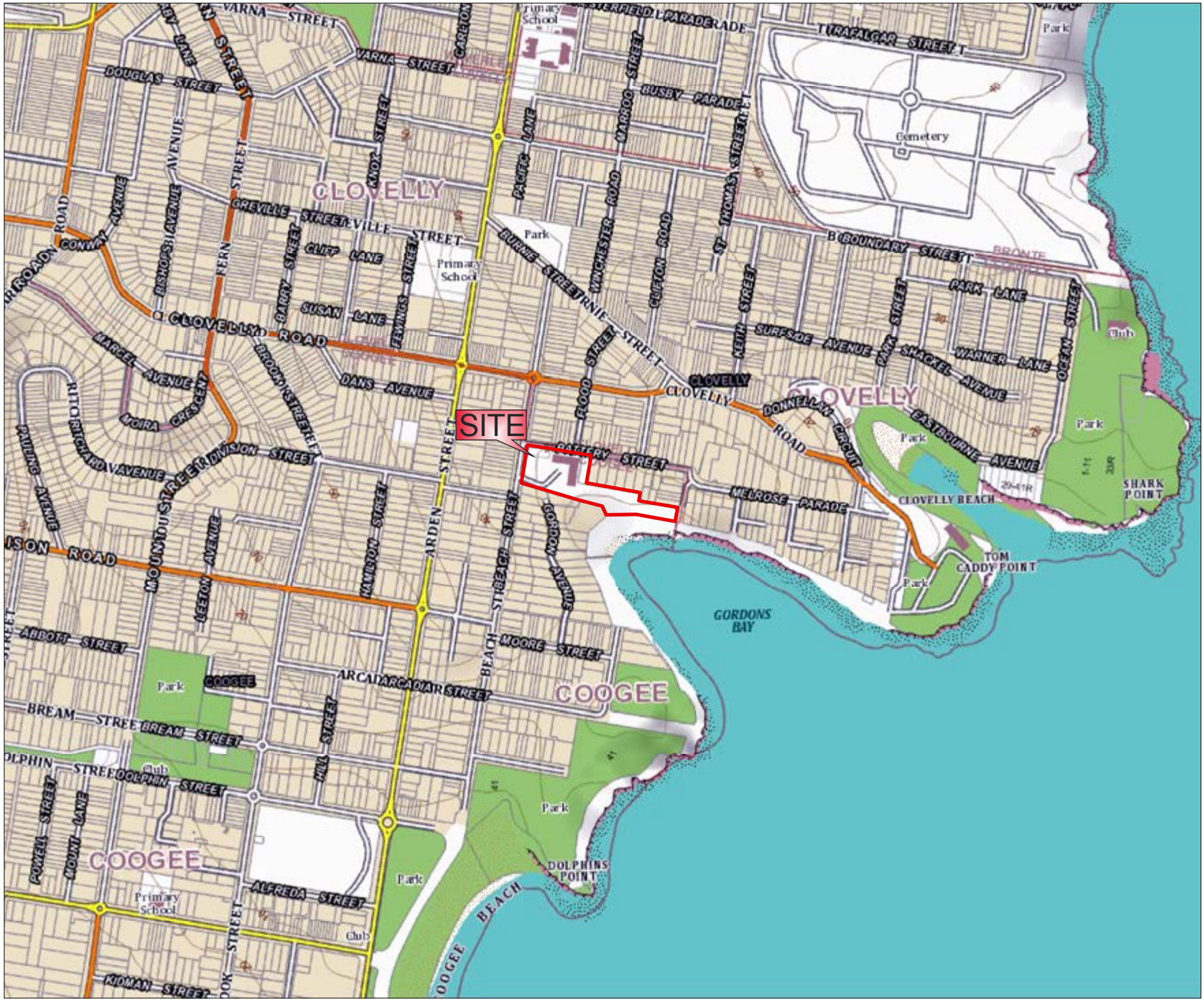
Sampling and chemical analysis of environmental media is based on appropriate guidance documents made and approved by the relevant regulatory authorities. Conclusions arising from the review and assessment of environmental data are based on the sampling and analysis considered appropriate based on the regulatory requirements.

Limited sampling and laboratory analyses were undertaken as part of the investigations undertaken, as described herein. Ground conditions between sampling locations and media may vary, and this should be considered when extrapolating between sampling points. Chemical analytes are based on the information detailed in the site history. Further chemicals or categories of chemicals may exist at the site, which were not identified in the site history and which may not be expected at the site.

Changes to the subsurface conditions may occur subsequent to the investigations described herein, through natural processes or through the intentional or accidental addition of contaminants. The conclusions and recommendations reached in this report are based on the information obtained at the time of the investigations.

This report does not provide a complete assessment of the environmental status of the site, and it is limited to the scope defined herein. Should information become available regarding conditions at the site including previously unknown sources of contamination, JBS&G reserves the right to review the report in the context of the additional information.

Figures



Legend:

Approximate Site Boundary

JBS&G

Job No: 51707	
Client: Pells Sullivan Meynink	
Version: R01 Rev A	Date: 03-Jun-2016
Drawn By: SE	Checked By: LB
Scale 1:8,500	

0 100 200
metres

Coor. Sys. GDA 1994 MGA Zone 56

UNSW Cliffbrook Campus
Coogee, NSW

SITE LOCATION

FIGURE 1

File Name: 51707_01
Reference: SIX Maps www.maps.six.nsw.gov.au, imagery date 06-01-2014, accessed 03-06-2016

Legend:

- Approximate Site Boundary
- Heritage Listed Fence

JBS&G

Job No: 51707

Client: Pells Sullivan Meynink

Version: R01 Rev A	Date: 29-Jun-2016
Drawn By: SE	Checked By: KS

Scale 1:1,250

0 10 20
metres

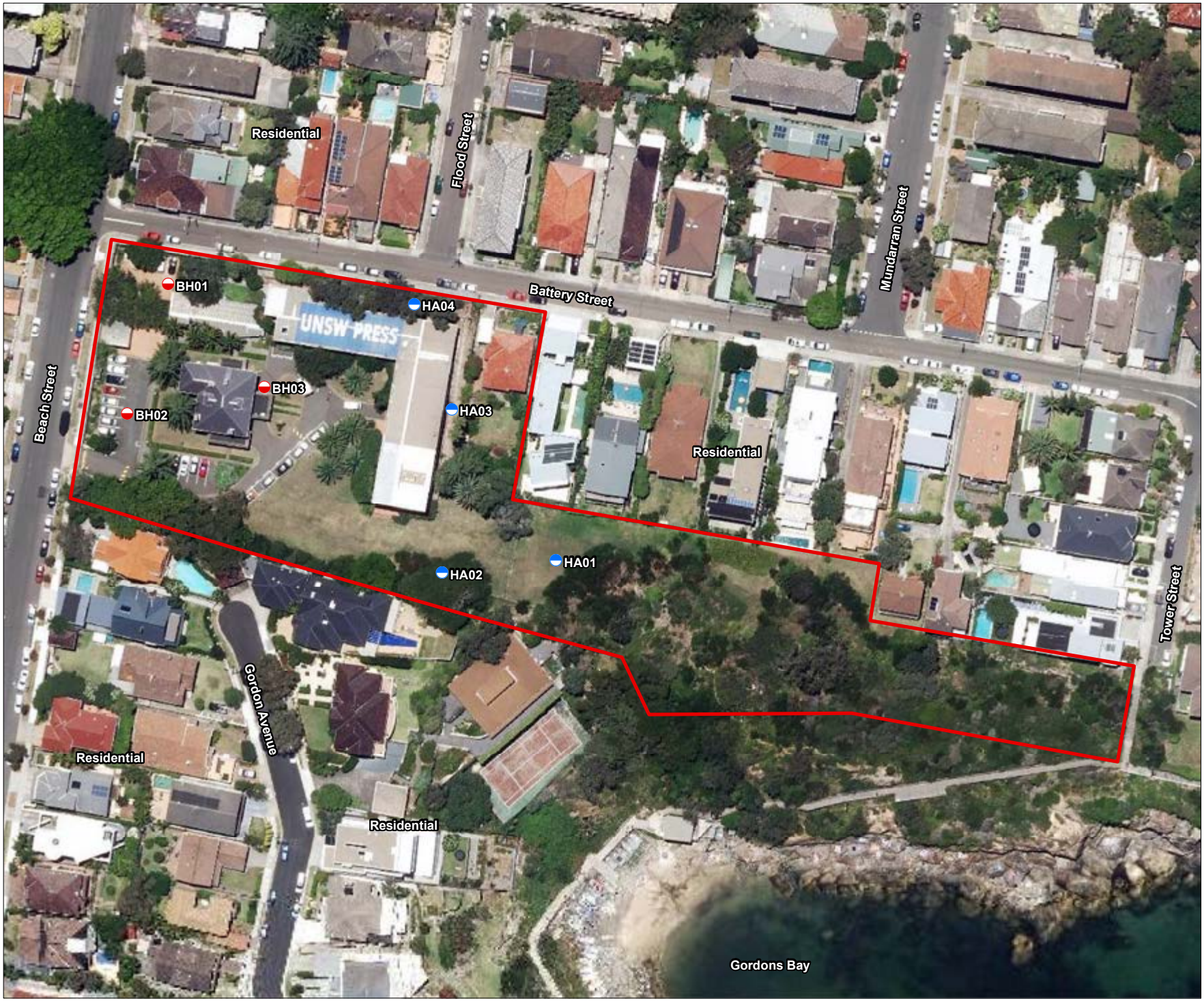
Coor. Sys. GDA 1994 MGA Zone 56

UNSW Cliffbrook Campus
Coogee, NSW

SITE LAYOUT

FIGURE 2

File Name: 51707_02
Reference: SIX Maps www.maps.six.nsw.gov.au, imagery date 06-01-2014, accessed 03-06-2016



Legend:

- Approximate Site Boundary
- Borehole Location
- Hand Auger Location

JBS&G

Job No: 51707

Client: Pells Sullivan Meynink

Version: R01 Rev A	Date: 03-Jun-2016
Drawn By: SE	Checked By: LB

Scale 1:1,250

0 10 20
metres

Coor. Sys. GDA 1994 MGA Zone 56

UNSW Cliffbrook Campus
Coogee, NSW

SAMPLE LOCATIONS

FIGURE 3

File Name: 51707_03
Reference: SIX Maps www.maps.six.nsw.gov.au, imagery date 06-01-2014, accessed 03-06-2016

Appendix A Summary Tables

Table A
Project Number: 51707
Project Name: UNSW Cliffbrook Campus PSI

					Metals & Metalloids									TPHs (NEPC 1999)					TRHs (NEPC 2013)						BTEX					
					Arsenic (Total)	Cadmium	Chromium (Total)	Copper	Iron	Lead	Mercury (Inorganic)	Nickel	Zinc	C6-C9 Fraction	C10-C14 Fraction	C15-C28 Fraction	C29-C36 Fraction	C10-C36 Fraction (Total)	>C10-C16 Fraction	>C16-C34 Fraction	>C34-C40 Fraction	C6-C10 Fraction	C6 - C10 less BTEX (F1)	>C10 - C16 less Naphthalene (F2)	Benzene	Ethylbenzene	Toluene	Xylene (m & p)	Xylene (o)	Xylene (Total)
					mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL					2.00	0.40	1.00	1.00	5.00	1.00	0.05	1.00	1.00	20.00	20.00	50.00	50.00	50.00	50.00	100.00	100.00	20.00	20.00	50.00	0.10	0.10	0.10	0.20	0.10	0.30
NEPC 2013 EIL, EILs Aged Sediment					100			110		1100		400	330																	
NEPM 2013 ESL Urban Residential and Public Open Space, Coarse Soil																			120[#1]	300[#2]	2800[#2]	180[#3]	180[#1]	120[#1]	50[#2]	70[#2]	85[#2]			105[#2]
NEPM 2013 HSL Asbestos in Soil - Bonded ACM - Residential - HSL B																														
NEPM 2013 HSL Asbestos in Soil - FA & AF - HSL																														
NEPM 2013 Soil HIL B					500[#6]	150	500[#7]	30000		1200[#8]	120[#9]	1200	60000																	
NEPM 2013 Soil HSL A & HSL B for Vapour Intrusion - Sand 0 to <1m																							45[#12]	110[#13]	0.5	55	160			40
NSW EPA 2014 General Solid Waste (No Leaching)					100	20				100	4	40		650				10000							10	600	288			1000
LocCode	Depth (m)	Sampled_Date-Time	Sample Code	Lab #																										
BH01 0.40-0.50	0.4-0.5	31/05/2016	S16-Jn00241	502667	<2	<0.4	<5	5.8	-	43	0.08	<5	100	<20	<20	<50	<50	<50	<50	<100	<100	<20	<20	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3
BH02 0.20-0.30	0.2-0.3	31/05/2016	S16-Jn00242	502667	<2	<0.4	8.1	25	-	6.1	<0.05	21	25	<20	<20	<50	<50	<50	<50	<100	<100	<20	<20	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3
BH03 0.40-0.50	0.4-0.5	31/05/2016	S16-Jn00243	502667	<2	<0.4	5.8	<5	-	18	<0.05	<5	28	<20	<20	170	77	247	<50	250	<100	<20	<20	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3
BH03 0.90-1.0	0.9-1	31/05/2016	S16-Jn00244	502667	-	-	-	-	5600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH03 0.9-1.0	0.9-1	31/05/2016	S16-Jn07502	503683	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA01 0.00-0.10	0-1	31/05/2016	S16-Jn00245	502667	2.5	<0.4	<5	8.9	-	57	0.05	<5	70	<20	<20	<50	<50	<50	<50	<100	<100	<20	<20	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3
HA02 0.00-0.10	0-1	31/05/2016	S16-Jn00246	502667	3.5	<0.4	<5	15	-	89	0.09	<5	110	<20	<20	<50	<50	<50	<50	<100	<100	<20	<20	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3
HA02 0.2-0.3	0.2-0.3	31/05/2016	S16-Jn07504	503683	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA02 0.00-0.10	0-1	31/05/2016	S16-Jn00247	502667	3.5	<0.4	<5	21	-	86	0.09	<5	99	<20	<20	<50	<50	<50	<50	<100	<100	<20	<20	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3
HA03 0.0-0.10	0-0.1	31/05/2016	S16-Jn00248	502667	2.1	<0.4	<5	12	3400	41	<0.05	<5	160	<20	<20	<50	<50	<50	<50	<100	<100	<20	<20	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3
HA04 0.20-0.30	0.2-0.3	31/05/2016	S16-Jn00249	502667	5.3	<0.4	<5	7.6	-	31	<0.05	<5	71	<20	<20	<50	<50	<50	<50	<100	<100	<20	<20	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3
QC01/A		31/05/2016	147764-1	147764	<4	<0.4	6	17	-	73	<0.1	2	99	<25	<50	<100	<100	-	<50	<100	<100	<25	<25	<50	<0.2	<1	<0.5	<2	<1	-

Env Stds Comments

#1:ESLs are of moderate reliability.
#2:ESLs are of low reliability.
#3:ESLs are of moderate reliability. To obtain F1 subtract the sum of BTEX from C6-C10.
#4:Residential B with minimal opportunities for soil access; includes dwellings with fully and permanently paved yard space such as high-rise buildings and apartments.
#5:The screening level of 0.001% w/w asbestos in soil for FA and AF (i.e. non-bonded/friable asbestos) only applies where the FA and AF are able to be quantified by gravimetric procedures (refer Section 4.10). This screening level is not applicable to free fibres.
#6:Key limitations of HSL should be referred to prior to application in Friebel and Nadebaum (2011b and 2011d).
#7:TV adopted from Chromium (VI)
#8:Assumptions of HSL are presented in Friebel and Nadebaum (2011a and 2011b).
#9:Refer to HSL and soil saturation concentration limit.
#10:TV maybe be multiplied by a factor to account for biodegradation of vapour
#11:HIL relates to non-dioxin-like PCBs only. If PCB source is suspected a site-specific assessment should be untertaken
#12:To obtain F1 subtract the sum of BTEX from C6-C10.
#13:To obtain F2 subtract naohthalene from >C10-C16.
#14:TV adopted from Endosulfan

Data Comments

#1 ESDAT Combined with Non-Detect Multiplier of 0.5. Some Analytes are missing from this Combined Compound.
#2 ESDAT Combined. Some Analytes are missing from this Combined Compound.
#3 ESDAT Combined with Non-Detect Multiplier of 0.5.
#4 No respirable fibres detected
#5 Chrysotile asbestos detected
#6 Organic fibres detected.
#7 ESDAT Combined.
#8 ACM:
#9 Nil
#10 FA:

Table A
Project Number: 51707
Project Name: UNSW Cliffbrook Campus PSI

	Polycyclic Aromatic Hydrocarbons																							Chlorinated Benzenes
	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(a)pyrene TEQ (lower bound)*	Benzo(a)pyrene TEQ (medium bound)*	Benzo(a)pyrene TEQ (upper bound)*	Benzo(b,j)fluoranthene	Benzo(b,k)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Carcinogenic PAHs as B(a)P TPE	Phenanthrene	Pyrene	PAHs (Total)	Total Positive PAHs	Hexachlorobenzene
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL	0.10	0.10	0.10	0.10	0.05	0.50	0.50	0.50	0.50		0.10	0.50	0.10	0.10	0.10	0.10	0.10	0.10		0.10	0.10	0.50		0.05
NEPC 2013 EIL, EILs Aged Sediment																		170						
NEPM 2013 ESL Urban Residential and Public Open Space, Coarse Soil					0.7[#2]																			
NEPM 2013 HSL Asbestos in Soil - Bonded ACM - Residential - HSL B																								
NEPM 2013 HSL Asbestos in Soil - FA & AF - HSL																								
NEPM 2013 Soil HIL B																			4			400[#10]		15
NEPM 2013 Soil HSL A & HSL B for Vapour Intrusion - Sand 0 to <1m																		3						
NSW EPA 2014 General Solid Waste (No Leaching)					0.8																			

LocCode	Depth (m)	Sampled_Date-Time	Sample Code	Lab #																					
BH01 0.40-0.50	0.4-0.5	31/05/2016	S16-Jn00241	502667	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.6	1.2	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1.21[#7]	<0.5	<0.5	<0.5	-	-
BH02 0.20-0.30	0.2-0.3	31/05/2016	S16-Jn00242	502667	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.6	1.2	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1.21[#7]	<0.5	<0.5	<0.5	-	-
BH03 0.40-0.50	0.4-0.5	31/05/2016	S16-Jn00243	502667	<0.5	<0.5	1.1	3.1	3.7	5.4	5.4	5.4	2.7	-	2.3	2.6	3.1	0.6	7.6	<0.5	1.6	<0.5	5.354[#3]	5.8	7.9	42.1	-	-
BH03 0.90-1.0	0.9-1	31/05/2016	S16-Jn00244	502667	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH03 0.9-1.0	0.9-1	31/05/2016	S16-Jn07502	503683	<0.5	<0.5	<0.5	0.9	1.1	1.4	1.7	1.9	0.8	-	0.7	0.9	1.1	<0.5	2.4	<0.5	<0.5	<0.5	1.653[#3]	1.6	2.6	12.1	-	-
HA01 0.00-0.10	0-1	31/05/2016	S16-Jn00245	502667	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.6	1.2	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1.21[#7]	<0.5	<0.5	<0.5	-	<0.05
HA02 0.00-0.10	0-1	31/05/2016	S16-Jn00246	502667	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.6	1.2	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1.21[#7]	<0.5	<0.5	<0.5	-	<0.05
HA02 0.2-0.3	0.2-0.3	31/05/2016	S16-Jn07504	503683	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA02 0.00-0.10	0-1	31/05/2016	S16-Jn00247	502667	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.6	1.2	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1.21[#7]	<0.5	<0.5	<0.5	-	<0.05
HA03 0.0-0.10	0-0.1	31/05/2016	S16-Jn00248	502667	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.6	1.2	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1.21[#7]	<0.5	<0.5	<0.5	-	<0.05
HA04 0.20-0.30	0.2-0.3	31/05/2016	S16-Jn00249	502667	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.6	1.2	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1.21[#7]	<0.5	<0.5	<0.5	-	<0.05
QC01/A		31/05/2016	147764-1	147764	<0.1	0.1	<0.1	0.3	0.3	<0.5	<0.5	<0.5	-	0.5	0.2	-	0.3	<0.1	0.5	<0.1	0.2	<0.1	0.405[#1]	0.2	0.5	-	3.1	<0.1

Env Stds Comments

#1:ESLs are of moderate reliability.
#2:ESLs are of low reliability.
#3:ESLs are of moderate reliability. To obtain F1 subtract the sum of BTEX from C6-C10.
#4:Residential B with minimal opportunities for soil access; includes dwellings with fully and permanently
#5:The screening level of 0.001% w/w asbestos in soil for FA and AF (i.e. non-bonded/friable asbestos) onl
#6:Key limitations of HSL should be referred to prior to application in Friebel and Nadebaum (2011b and 2
#7:TV adopted from Chromium (VI)
#8:Assumptions of HSL are presented in Friebel and Nadebaum (2011a and 2011b).
#9:Refer to HSL and soil saturation concentration limit.
#10:TV maybe be multiplied by a factor to account for biodegradation of vapour
#11:HIL relates to non-dioxin-like PCBs only. If PCB source is suspected a site-specific assessment should be
#12:To obtain F1 subtract the sum of BTEX from C6-C10.
#13:To obtain F2 subtract naohthalene from >C10-C16.
#14:TV adopted from Endosulfan

Data Comments

#1 ESDAT Combined with Non-Detect Multiplier of 0.5. Some Analytes are missing from this Combined Co
#2 ESDAT Combined. Some Analytes are missing from this Combined Compound.
#3 ESDAT Combined with Non-Detect Multiplier of 0.5.
#4 No respirable fibres detected
#5 Chrysotile asbestos detected
#6 Organic fibres detected.
#7 ESDAT Combined.
#8 ACM:
#9 Nil
#10 FA:

Table A
Project Number: 51707
Project Name: UNSW Cliffbrook Campus PSI

	Polychlorinated Biphenyls								Organochlorine Pesticides																								
	Arodor 1016	Arodor 1221	Arodor 1232	Arodor 1242	Arodor 1248	Arodor 1254	Arodor 1260	PCBs (Total)	Aldrin	4,4-DDE	Aldrin + Dieldrin (Sum of Total)	Dieldrin	DDD	alpha-BHC	DDT	beta-BHC	DDT+DDE+DDD (Sum of Total)	alpha-Chlordane	Chlordane	delta-BHC	gamma-Chlordane	Endosulfan alpha	Endosulfan beta	Endosulfan sulphate	Endrin	Endrin aldehyde	Endrin ketone	Heptachlor	Heptachlor Epoxide	Lindane	Methoxychlor	Toxaphene
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.50	0.05	0.05		0.05	0.05	0.05	0.05	0.05			0.10	0.05		0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.10	1.00
NEPC 2013 EIL, EILs Aged Sediment															180																	
NEPM 2013 ESL Urban Residential and Public Open Space, Coarse Soil																																
NEPM 2013 HSL Asbestos in Soil - Bonded ACM - Residential - HSL B																																
NEPM 2013 HSL Asbestos in Soil - FA & AF - HSL																																
NEPM 2013 Soil HIL B								1[#11]			10						600		90						20			10			500	30
NEPM 2013 Soil HSL A & HSL B for Vapour Intrusion - Sand 0 to <1m																																
NSW EPA 2014 General Solid Waste (No Leaching)								50-0														60[#14]	60[#14]	60[#14]								

LocCode	Depth (m)	Sampled_Date-Time	Sample Code	Lab #																														
BH01 0.40-0.50	0.4-0.5	31/05/2016	S16-Jn00241	502667	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH02 0.20-0.30	0.2-0.3	31/05/2016	S16-Jn00242	502667	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH03 0.40-0.50	0.4-0.5	31/05/2016	S16-Jn00243	502667	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH03 0.90-1.0	0.9-1	31/05/2016	S16-Jn00244	502667	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH03 0.9-1.0	0.9-1	31/05/2016	S16-Jn07502	503683	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA01 0.00-0.10	0-1	31/05/2016	S16-Jn00245	502667	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.05	<0.05	<0.1[#7]	<0.05	<0.05	<0.05	<0.05	<0.05	<0.15[#2]	-	<0.1	<0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<1
HA02 0.00-0.10	0-1	31/05/2016	S16-Jn00246	502667	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.05	<0.05	<0.1[#7]	<0.05	<0.05	<0.05	<0.05	<0.05	<0.15[#2]	-	<0.1	<0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<1
HA02 0.2-0.3	0.2-0.3	31/05/2016	S16-Jn07504	503683	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA02 0.00-0.10	0-1	31/05/2016	S16-Jn00247	502667	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.05	<0.05	<0.1[#7]	<0.05	<0.05	<0.05	<0.05	<0.05	<0.15[#2]	-	<0.1	<0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<1
HA03 0.0-0.10	0-0.1	31/05/2016	S16-Jn00248	502667	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.05	<0.05	<0.1[#7]	<0.05	<0.05	<0.05	<0.05	<0.05	<0.15[#2]	-	<0.1	<0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<1
HA04 0.20-0.30	0.2-0.3	31/05/2016	S16-Jn00249	502667	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.09	<0.05	0.36[#3]	0.27	<0.05	<0.05	<0.05	<0.05	<0.15[#2]	-	0.2	<0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<1
QC01/A		31/05/2016	147764-1	147764	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.2[#7]	<0.1	<0.1	<0.1	<0.1	<0.1	<0.3[#2]	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-

Env Stds Comments

#1:ESLs are of moderate reliability.
#2:ESLs are of low reliability.
#3:ESLs are of moderate reliability. To obtain F1 subtract the sum of BTEX from C6-C10.
#4:Residential B with minimal opportunities for soil access; includes dwellings with fully and permanently
#5:The screening level of 0.001% w/w asbestos in soil for FA and AF (i.e. non-bonded/friable asbestos) onl
#6:Key limitations of HSL should be referred to prior to application in Friebel and Nadebaum (2011b and 2
#7:TV adopted from Chromium (VI)
#8:Assumptions of HSL are presented in Friebel and Nadebaum (2011a and 2011b).
#9:Refer to HSL and soil saturation concentration limit.
#10:TV maybe be multiplied by a factor to account for biodegradation of vapour
#11:HIL relates to non-dioxin-like PCBs only. If PCB source is suspected a site-specific assessment should be
#12:To obtain F1 subtract the sum of BTEX from C6-C10.
#13:To obtain F2 subtract naohthalene from >C10-C16.
#14:TV adopted from Endosulfan

Data Comments

#1 ESDAT Combined with Non-Detect Multiplier of 0.5. Some Analytes are missing from this Combined Co
#2 ESDAT Combined. Some Analytes are missing from this Combined Compound.
#3 ESDAT Combined with Non-Detect Multiplier of 0.5.
#4 No respirable fibres detected
#5 Chrysotile asbestos detected
#6 Organic fibres detected.
#7 ESDAT Combined.
#8 ACM:
#9 Nil
#10 FA:

Table A
Project Number: 51707
Project Name: UNSW Cliffbrook Campus PSI

				Ionic Balance			Asbestos											Asbestos - Trace Analysis					Asbestos ID - soils NEPM		Other	
				Cation Exchange Capacity	EC 1:5 soil:water	pH 1:5 soil:water	Approx. Sample Mass	Asbestos from ACM in Soil	Mass ACM	Mass Asbestos in ACM	Asbestos from FA & AF in Soil	Mass FA	Mass Asbestos in FA	Mass AF	Mass Asbestos in AF	Mass Asbestos in FA & AF	Synthetic Fibres - Comment	ACM - Comment	AF - Comment	FA - Comment	Organic Fibres - Comment	Respirable Fibres - Comment	FA and AF Estimation*#2	Total Asbestos#1	% Clay	% Moisture 103oC
				meq/100g	US/CM	ph Units	g	%w/w	g	g	%w/w	g	g	g	g	g	Comment	Comment	Comment	Comment	Comment	Comment	%(w/w)	g/kg	%	%
EQL				0.05	10.00	0.10																			1.00	1.00
NEPC 2013 EIL, EILs Aged Sediment																										
NEPM 2013 ESL Urban Residential and Public Open Space, Coarse Soil																										
NEPM 2013 HSL Asbestos in Soil - Bonded ACM - Residential - HSL B								0.04#4																		
NEPM 2013 HSL Asbestos in Soil - FA & AF - HSL											0.001#5															
NEPM 2013 Soil HIL B																										
NEPM 2013 Soil HSL A & HSL B for Vapour Intrusion - Sand 0 to <1m																										
NSW EPA 2014 General Solid Waste (No Leaching)																										
LocCode	**Depth (m)**	**Sampled_Date-Time**	**Sample Code**	**Lab #**																						
BH01 0.40-0.50	0.4-0.5	31/05/2016	S16-Jn00241	502667	-	-	-	501	0	0	0	0	0	0	0	0	0	1#9	1#9	1#9	1#9	1#6	1#4	-	-	-	6.6
BH02 0.20-0.30	0.2-0.3	31/05/2016	S16-Jn00242	502667	-	-	-	553	0	0	0	0	0	0	0	0	0	1#9	1#9	1#9	1#9	1#6	1#4	-	-	-	5.7
BH03 0.40-0.50	0.4-0.5	31/05/2016	S16-Jn00243	502667	-	-	-	908	0	0	0	0	0	0	0	0	0	1#9	1#9	1#9	1#9	1#6	1#4	-	-	-	6.1
BH03 0.90-1.0	0.9-1	31/05/2016	S16-Jn00244	502667	4.4	25	7.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.5	12
BH03 0.9-1.0	0.9-1	31/05/2016	S16-Jn07502	503683	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.4
HA01 0.00-0.10	0-1	31/05/2016	S16-Jn00245	502667	-	-	-	435	0	0	0	0	0	0	0	0	0	1#9	1#9	1#9	1#9	1#6	1#4	-	-	-	14
HA02 0.00-0.10	0-1	31/05/2016	S16-Jn00246	502667	-	-	-	534	0.0657	2.339	0.3508	0	0	0	0	0	0	1#9	1#8	1#9	1#9	1#6	1#4	-	-	-	8.5
HA02 0.2-0.3	0.2-0.3	31/05/2016	S16-Jn07504	503683	-	-	-	606	0	0	0	0	0	0	0	0	0	1#9	1#9	1#9	1#9	1#6	1#4	-	-	-	-
HA02 0.00-0.10	0-1	31/05/2016	S16-Jn00247	502667	-	-	-	568	0	0	0	0	0	0	0	0	0	1#9	1#9	1#9	1#9	1#6	1#4	-	-	-	13
HA03 0.0-0.10	0-0.1	31/05/2016	S16-Jn00248	502667	8.1	37	6.4	648	0	0	0	0	0	0	0	0	0	1#9	1#9	1#9	1#9	1#6	1#4	-	-	2.5	13
HA04 0.20-0.30	0.2-0.3	31/05/2016	S16-Jn00249	502667	-	-	-	925	0	0	0	0.0008	0.0111	0.0078	0	0	0.0078	1#9	1#9	1#9	1#10	1#6	1#4	-	-	-	3.4
QC01/A		31/05/2016	147764-1	147764	-	-	-	601.8	0.097	0.98	0.68	0	0	0	0	0	0	-	-	-	-	-	-	<0.001	0.9696	-	-

Env Stds Comments

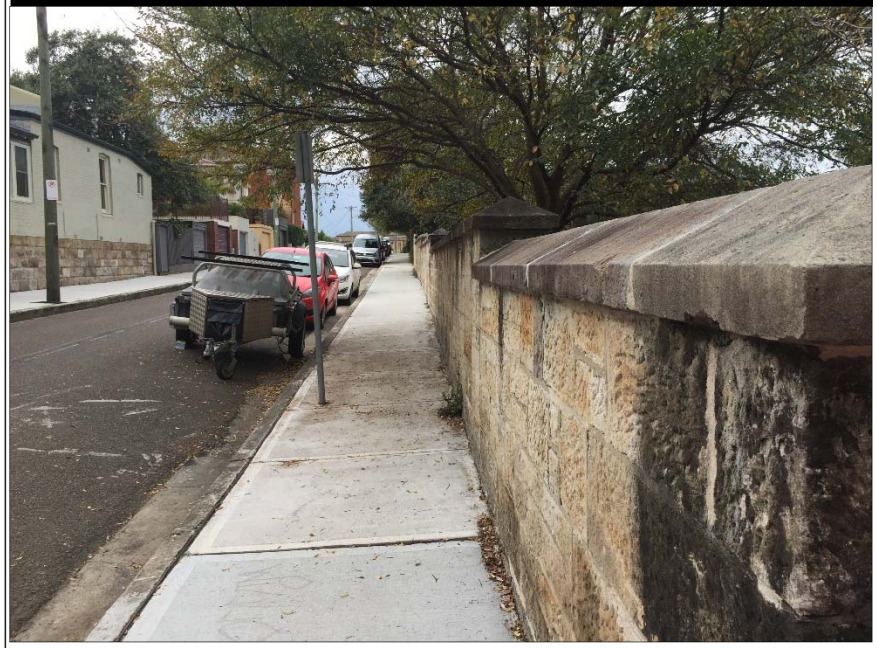
#1:ESLs are of moderate reliability.
#2:ESLs are of low reliability.
#3:ESLs are of moderate reliability. To obtain F1 subtract the sum of BTEX from C6-C10.
#4:Residential B with minimal opportunities for soil access; includes dwellings with fully and permanently
#5:The screening level of 0.001% w/w asbestos in soil for FA and AF (i.e. non-bonded/friable asbestos) onl
#6:Key limitations of HSL should be referred to prior to application in Friebel and Nadebaum (2011b and 2
#7:TV adopted from Chromium (VI)
#8:Assumptions of HSL are presented in Friebel and Nadebaum (2011a and 2011b).
#9:Refer to HSL and soil saturation concentration limit.
#10:TV maybe be multiplied by a factor to account for biodegradation of vapour
#11:HIL relates to non-dioxin-like PCBs only. If PCB source is suspected a site-specific assessment should be
#12:To obtain F1 subtract the sum of BTEX from C6-C10.
#13:To obtain F2 subtract naohthalene from >C10-C16.
#14:TV adopted from Endosulfan

Data Comments

#1 ESDAT Combined with Non-Detect Multiplier of 0.5. Some Analytes are missing from this Combined Co
#2 ESDAT Combined. Some Analytes are missing from this Combined Compound.
#3 ESDAT Combined with Non-Detect Multiplier of 0.5.
#4 No respirable fibres detected
#5 Chrysotile asbestos detected
#6 Organic fibres detected.
#7 ESDAT Combined.
#8 ACM:
#9 Nil
#10 FA:

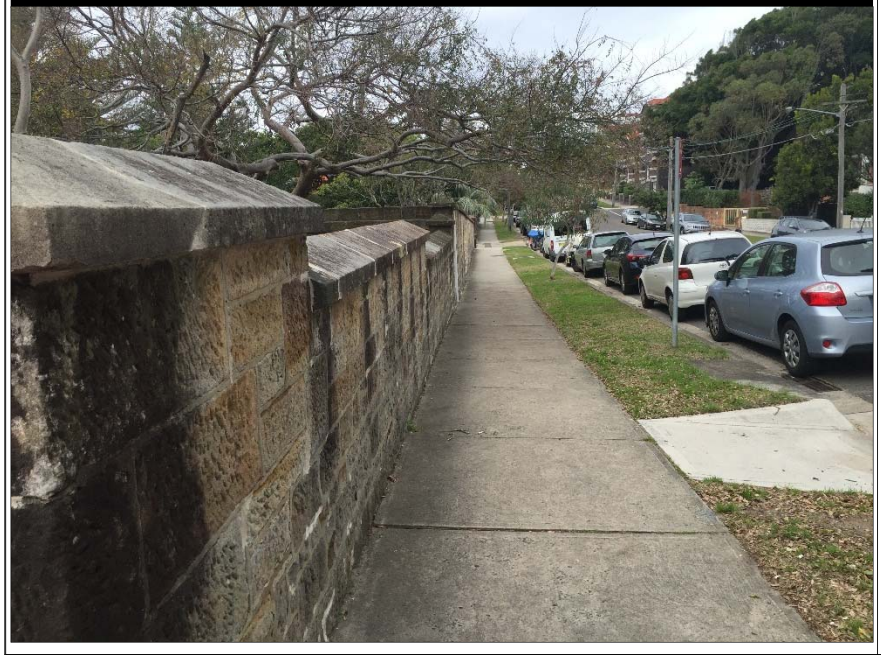
Appendix B Photographic Log

PHOTOGRAPH 1 – HERITAGE LISTED SANDSTONE FENCE NORTHERN BOUNDARY OF THE SITE



PHOTOGRAPH 3 – SITE ENTRANCE AND THE HERITAGE LISTED FENCE SOUTH WESTERN CORNER OF THE SITE

PHOTOGRAPH 2 – HERITAGE LISTED SANDSTONE FENCE WESTERN BOUNDARY OF THE SITE



PHOTOGRAPH 4 – SOUTHERN END OF THE HERITAGE LISTED COTTAGE

JBS&G

Job No: 51707

Client: Pells Sullivan Meynink

Version: R01 Rev A	Date: 27/06/2016
Drawn By: KS	Checked By: MB

Not to Scale

Coord. Sys n/a

UNSW Cliffbrook Campus Coogee, NSW

Photographic Log

APPENDIX B

PHOTOGRAPH 5 – NORTHERN END OF THE HERITAGE LISTED COTTAGE

PHOTOGRAPH 7 – HERITAGE LISTED GARAGE ON THE WESTERN SITE BOUNDARY

PHOTOGRAPH 6 – EASTERN END OF THE HERITAGE LISTED COTTAGE

PHOTOGRAPH 8 – PEDESTRIAN ENTRANCE TO THE NORTH OF THE HERITAGE LISTED GARAGE

JBS&G

Job No: 51707	
Client: Pells Sullivan Meynink	
Version: R01 Rev A	Date: 27/06/2016
Drawn By: KS	Checked By: LB
Not to Scale	
Coord. Sys n/a	

UNSW Cliffbrook Campus Coogee, NSW

Photographic Log

APPENDIX B

PHOTOGRAPH 9 – SMALL BUILDING TO THE SOUTH OF THE GARAGE

PHOTOGRAPH 11 – STORMWATER SYSTEM PRESENT WITHIN THE WESTERN CARPARK

PHOTOGRAPH 10 –FLOOR OF THE SMALL BUILDING

PHOTOGRAPH 12: WESTERN CARPARK FACING NORTH

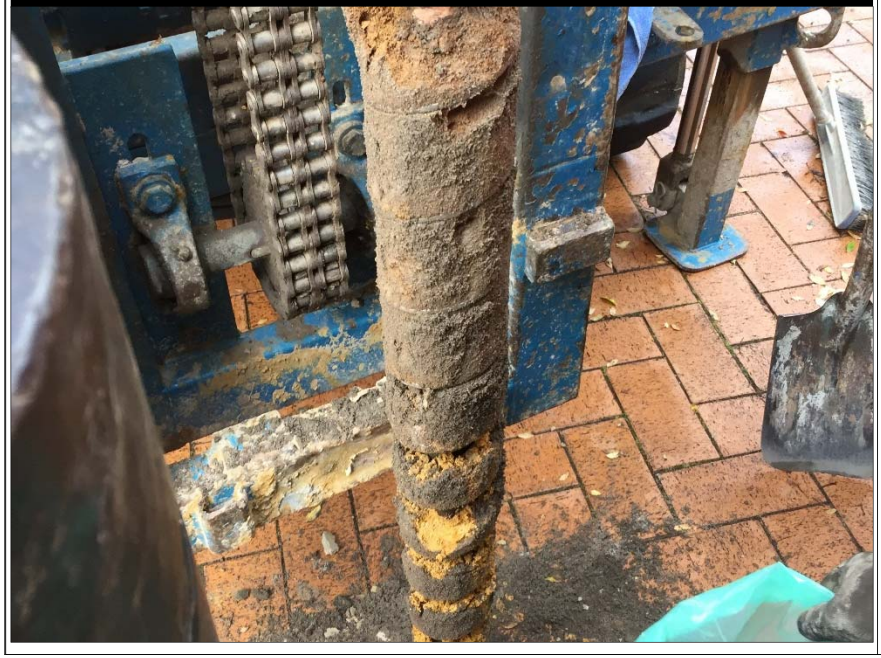
JBS&G

Job No: 51707	
Client:	
Version:	Date:
Drawn By:	Checked By:
Not to Scale	
Coord. Sys n/a	

PHOTOGRAPH 13: BRICKED CARPARK IN THE NORTH WESTERN CORNER AND LOCATIONS OF BH01

PHOTOGRAPH 15: WESTERN END OF UNIVERSITY BUILDING IN NORTH WESTERN CORNER OF THE SITE

PHOTOGRAPH 14: MATERIAL FROM BOREHOLE LOCATION BH01



PHOTOGRAPH 16: SUSPECTED ASBESTOS EVES

JBS&G

Job No:	
Client:	
Version:	Date:
Drawn By:	Checked By:
Not to Scale	
Coord. Sys n/a	