JBS&G

Southern Metropolitan Cemeteries Trust

Preliminary Site Investigation
Bumborah Point, NSW

4 May 2018

54725/114752 Rev 0

JBS&G Australia Pty Ltd

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Abbreviations

Term	Definition
ACM	Asbestos Containing Material
AHD	Australian Height Datum
ASS	Acid Sulfate Soils
ASSMP	Acid Sulfate Soil Management Plan
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes
CEC	Cation Exchange Capacity
COC	Chain of Custody
COPC	Contaminants of Potential Concern
CSM	Conceptual Site Model
DA	Development application
DP	Deposited Plan
DPI	Department of Primary Industry
DQI	Data Quality Indicator
DQO	Data Quality Objective
EC	Electrical Conductivity
Eh	Redox Potential
EIL	Ecological Investigation Levels
EIS	Environmental Investigation Services Pty Ltd
Envirolab	Envirolab Services Pty Ltd
EPA	NSW Environmental Protection Authority
ESA	Environmental Site Assessment
ESL	Ecological Screening Levels
Eurofins	Eurofins MGT
Fe^{2+}	Ferrous Iron
F_{oc}	Fraction of Organic Carbon
GPS	Global Positioning Unit
Ha	Hectare
HHERA	Human Health and Ecological Risk Assessment
HIL	Health Investigation Levels
HSL	Health Screening Levels
HZ	Hazardous Waste
JBS&G	JBS&G Australia Pty Ltd
LCS	Laboratory Control Sample
LEP	Local Environmental Plan
LOR	Limit of Reporting
NATA	National Association of Testing Authorities
OCP	Organochlorine Pesticides
OEH	Office of Environment and Heritage
PASS	Potential Acid Sulfate Soils
PAH	Polycyclic Aromatic Hydrocarbons
PARCCS	Precision, Accuracy, Representativeness, Comparability, Completeness and Sensitivity
PCB	Polychlorinated Biphenyls
pH	Potential of Hydrogen
PID	Photo-ionisation Detector
ppm	Parts Per Million
QA/QC	Quality Assurance / Quality Control
RL	Relative Level
RPD	Relative Percent Difference
RSW	Restricted Solid Waste
SAQP	Sampling, Analysis and Quality Plan
SO4	Sulfate
TCLP	Toxicity Characteristic Leaching Procedure
TPH	Total Petroleum Hydrocarbons
TRH	Total Recoverable Hydrocarbons
UCL	Upper Confidence Limit
VOC	Volatile Organic Compounds

Executive Summary

JBS&G Australia Pty Ltd (JBS&G) was engaged by Ubris Pty Ltd on behalf of Southern Metropolitan Cemeteries Trust (SMCT, the client) to conduct a Preliminary Site Investigation (PSI) of a parcel of land located at 21-29 Fishburn Road, Port Botany, Bumborah Point Road, Port Botany, and 5-35R Kooringai Avenue, Phillip Bay, NSW, herein referred to as the site (**Figure 1**).

The site occupies an area of approximately 5 hectares (ha) and is legally identified as Lot 4858 Deposited Plan (DP) 752015, Lot 7301 DP 1139143, Part Lot 7302 DP 1139143, Part Lot 52 DP 1182618 and includes land between Lot 4858 and the adjacent cemetery to the north-east and east, as shown on **Figure 2**.

The site currently comprises Bumborah Point/Gwea Reserve and is used for recreational purposes. It is understood that the site is proposed to be rezoned to allow an extension of the adjoining Eastern Suburbs Memorial Park cemetery (commercial land use).

State Environmental Planning Policy No. 55 (SEPP 55) and DUAP/EPA (1998) Planning Guidelines require consideration of contamination issues when rezoning land. If rezoning allows a change of use that may increase the risk to health or the environment from contamination, then the planning authority must be satisfied that the land is suitable for the proposed use or can be remediated to make it suitable. As such, a PSI of potential land contamination is required to support the rezoning application, as per the requirements of SEPP 55 and in accordance with NEPC (2013).

The objectives of the investigation were to assess the potential for contamination based on current and historical site activities and to draw conclusions regarding the potential contamination status of the site to support the rezoning application, as per the requirements of SEPP 55.

It is noted that the objective of the investigation was not to determine site suitability, rather to assess potential contamination issues that may preclude the rezoning of the site, specifically, contamination issues that cannot be readily addressed during the development application (DA) stages for redevelopment.

The agreed scope of works completed for this assessment comprised:

- A review of available site history and background information to identify potential areas of environmental concern (AECs) and associated contaminants of potential concern (COPC), including:
  - Section 149 certificate for Lot 4858 was obtained from Randwick City Council (Council);
  - Historical aerial photographs obtained from Land and Property Information Division of the Department of Finances and Services;
  - Current and historical land title records for Lot 4858 to gain an understanding of potential land use prior to historical aerial photographic records;
  - Records of environmental incidents or former environmental licenses as held by the EPA;
  - Review of previous environmental reports made available by the client; and
  - Licensed bores present within a 1.5 km radius of the site available on the online NSW Department of Primary Industries.
- Review of the environmental setting including a review of the topography, geology and hydrogeology of the site and surrounding areas;
- Detailed site inspection to identify potential AECs and confirm desktop findings;

- Development and documentation of a conceptual site model (CSM) based on the available information;
- Advancement of 21 sample locations across the site and subsequent collection of soil samples to provide a limited assessment of the environmental condition of the site; and
- Preparation of a PSI report in general accordance with relevant EPA made or endorsed guidelines.

Based on the findings of this investigation, and subject to the limitations in **Section 10**, the following conclusions were made:

- The site has a long history of disturbance, having been topographically altered/raised as a result of material importation/land reclamation, and has been subject to extensive development of subsurface infrastructure.
- The preliminary site investigation and sampling event identified fill materials comprising silty sand/gravelly sand with anthropogenic inclusions of brick, concrete, metal, plastic, slag, glass, asbestos containing material (ACM) and ash.
- Fill materials were generally reported/encountered across the entire site ranging from a shallow (0.60 m) fill soil profile to 2.6 m in depth at the locations investigated.
- Fill materials have been shown to contain elevated concentrations of benzo(a)pyrene, exceeding the adopted ecological criteria. Elevated total recoverable hydrocarbon (TRH) fractions were noted in one location, exceeding both the adopted ecological and management criteria. Nickel concentrations were elevated at one location, exceeding the adopted ecological criterial. Elevated asbestos concentrations were noted to varying degrees, with two locations exceeding the adopted human health criteria.
- Based on the desk top review, potential remains for site soils to be impacted with per- and polyfluoroalkyl substances (PFAS) given the past range of industrial operations in the area and site land reclamation activities.
- Potential remains for groundwater to be impacted with heavy metals, TRH, PFAS, volatile organic compounds (VOCs), however, not necessarily as a result of site contamination, rather as a result of surrounding industrial land use activities.
- Whilst the investigation identified the potential for soil and groundwater impacts to be present at the site, the investigation did not identify the potential for gross or widespread contamination which may preclude rezoning of the site for the intended use. Identified potential soil and groundwater impacts are considered representative of common contaminants and potentially contaminating land use activities which can be readily dealt with during the DA stage (i.e. including completion of preliminary and detailed site investigations consistent with relevant Council development control plans (DCPs) and SEPP 55 requirements) for redevelopment and assessment for site suitability.
- In the absence of gross or widespread contamination, the requirements of the DUAP/EPA (1998) *Managing Land Contamination: Planning Guidelines* for this type of rezoning are considered to have been satisfied, namely that the rezoning can proceed, "provided that measures are in place to the ensure that the potential for contamination and the suitability of the land for any proposed use are assessed once detailed proposals are made" (s.4.1.2 DUAP 1998).

It is recommended that upon submission of development application(s) within the site, a detailed site investigation be undertaken consistent with SEPP 55 requirements and EPA made or endorsed guidelines.

1. Introduction

1.1 Introduction and Background

JBS&G Australia Pty Ltd (JBS&G) was engaged by Ubris Pty Ltd on behalf of Southern Metropolitan Cemeteries Trust (SMCT, the client) to conduct a Preliminary Site Investigation (PSI) of a parcel of land located at 21-29 Fishburn Road, Port Botany, Bumborah Point Road, Port Botany and 5-35R Kooringai Avenue, Phillip Bay, NSW, herein referred to as the site (**Figure 1**).

The site occupies an area of approximately 5 hectares (ha) and is legally identified as Lot 4858 Deposited Plan (DP) 752015, Lot 7301 DP 1139143, Part Lot 7302 DP 1139143, Part Lot 52 DP 1182618 and includes land between Lot 4858 and the adjacent cemetery to the north-east and east, as shown on **Figure 2**.

The site currently comprises Bumborah Point/Gwea Reserve (Artefact 2017[1]) and is used for recreational purposes. It is understood that the site is proposed to be rezoned to allow an extension of the adjoining Eastern Suburbs Memorial Park cemetery (commercial land use).

State Environmental Planning Policy No. 55 (SEPP 55[2]) and DUAP/EPA (1998[3]) Planning Guidelines require consideration of contamination issues when rezoning land. If rezoning allows a change of use that may increase the risk to health or the environment from contamination, then the planning authority must be satisfied that the land is suitable for the proposed use or can be remediated to make it suitable. As such, a PSI of potential land contamination is required to support the rezoning application, as per the requirements of SEPP 55 and in accordance with NEPC (2013[4]).

The investigation has been completed in accordance with guidelines made or approved by the NSW Environment Protection Authority (EPA) and relevant Australian Standards.

1.2 Objective

The objectives of the investigation are to assess the potential for contamination based on current and historical site activities and to draw conclusions regarding the potential contamination status of the site to support the rezoning application, as per the requirements of SEPP 55.

It is noted that the objective of the investigation was not to determine site suitability, rather to assess potential contamination issues that may preclude the rezoning of the site, specifically, contamination issues that cannot be readily addressed during the development application (DA) stages for redevelopment.

1.3 Scope of Work

The agreed scope of works completed for this assessment comprised:

- A review of available site history and background information to identify potential areas of environmental concern (AECs) and associated contaminants of potential concern (COPC), including:
    - Section 149 certificate for Lot 4858 was obtained from Randwick City Council (Council);

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1 *Eastern Suburbs Memorial Park, Draft Aboriginal Heritage Due Diligence Assessment, Artefact Project 160368.* , Report to Southern Metropolitan Cemeteries Trust, Artefact Heritage, March 2017.

2 *Managing Land Contamination. Planning Guidelines SEPP 55 – Remediation of Land.* Department of Urban Affairs and Planning. Environment Protection Authority 1998 (SEPP 55)

3 *Managing Land Contamination: Planning Guidelines.* NSW Department of Urban Affairs and Planning, August 1998 (DUAP 1998)

4 National Environment Protection (Assessment of Site Contamination) Measure No. 1 2013. National Environment Protection Council (NECP 2013)

- Historical aerial photographs obtained from Land and Property Information Division of the Department of Finances and Services;
- Current and historical land title records for Lot 4858 to gain an understanding of potential land use prior to historical aerial photographic records;
- Records of environmental incidents or former environmental licenses as held by the EPA;
- Review of previous environmental reports made available by the client; and
- Licensed bores present within a 1.5 km radius of the site available on the online NSW Department of Primary Industries.

- Review of the environmental setting including a review of the topography, geology and hydrogeology of the site and surrounding areas;
- Detailed site inspection to identify potential AECs and confirm desktop findings;
- Development and documentation of a conceptual site model (CSM) based on the available information;
- Advancement of 21 sample locations across the site and subsequent collection of soil samples to provide a limited assessment of the environmental condition of the site;
- Preparation of a PSI report in general accordance with relevant EPA made or endorsed guidelines; and
- To assess the potential for contamination based on current and historical site activities and to draw preliminary conclusions regarding the potential contamination status of the site to support the rezoning application, as per SEPP 55 and where the contamination may be present, the investigation is required to provide a basis for a more detailed investigation.

2. Site Condition and Surrounding Environment

2.1 Site Identification

The site is known as Bumborah Point and is located in the suburb of Port Botany, bound by Prince of Wales Drive and Simblist Road to the west, Military Road to the north, Eastern Suburbs Memorial Park cemetery to the east, and Yarra Bay/Botany Bay to the south (**Figure 2**). The north eastern extremity of the site lies within the suburb of Matraville. The site is also referred to as Gwea Reserve.

The site details are summarised **Table 2.1** and described in detail in the following sections.

Table 2.1: Summary Site Details

Lot/DP	Lot 4858 DP 752015, Lot 7301 DP 1139143 Part Lot 7302 DP 1139143 Part Lot 52 DP 1182618
Address	21-29 Fishburn Road, Port Botany Bumborah Point Road, Port Botany 5-35R Kooringai Avenue, Phillip Bay
Local Government Authority	Randwick Council
Site Zoning	RE1 – Public Recreation
Approximate Co-ordinates (MGA 56) of the Centre of the Site	E: 335985.835 N: 6239140.773
Current Use	Recreational
Previous Use	Recreational and Military/Battery Reserve
Proposed Use	Extension to Eastern Suburbs Memorial Park cemetery (commercial)
Site Area	Approximately 5 ha

2.2 Site Condition

A detailed site inspection was conducted on the 4th April 2018, by Christopher Kauffman, one of JBS&G's trained and experienced environmental consultants and Matthew Bennett, a JBS&G Principal and the Project Director.

The site layout and key features are shown on **Figure 2** and described below. A series of photographs taken during the site inspection are presented in **Appendix B**.

2.2.1 Vegetation, Surface Soil and Other Surfaces

The site is for the most part thickly vegetated with coastal dune vegetation and invasive species, offering little to no ready access to large portions of the site. There were few large areas where bare soil was exposed, other than where tracks had been formed for access, such as the sand walking tracks in the south east providing access to the Caltex valve pit and beach, and walking tracks cutting through thick vegetation running from the north of the site to the south (**Figure 2**). Where surface soils were exposed, these were sandy in nature, with some shell fragments and occasional anthropogenic materials (e.g., plastic, glass, wood, metal, etc.). Some erosion of vegetation and sand has occurred away from the access road in the south east and gravels have been placed over sand soils in these areas. These gravels include largely igneous (blue metals) gravel with some asphalt and crushed rock.

A bitumen-sealed access road passes through the north east to south east of the site, via an access drive from Military Road. From this access road there are two gravel surfaced vehicular access ways into the site, one in the north west which provides access to underground gas pipeline infrastructure, and one in the south east which provides access to Caltex valve pit infrastructure. Gravels used include predominantly igneous (blue metal) gravel, with some asphalt and crushed rock.

One area of exposed sandstone bedrock was observed in the south west of the site. Otherwise, sandstone bedrock was also exposed in the cliffs along the southern boundary, which extend east from the concrete break wall to just east of the large concrete water intake structures central to the southern site boundary. Seepage water was observed in bedding plane joints exposed at the sandstone cliffs.

2.2.2 Services

It is known that petroleum pipelines owned by Caltex run at unknown depth beneath the site, from the western side of Bumborah Road, which cross Botany Bay to the Caltex refinery site at Kurnell. The corridor is marked by a set of five signs at the site's western boundary at Simblist Road warning of the presence of high pressure oil pipelines and providing contact number for Caltex Refineries (NSW) Pty Ltd. Two steel posts protrude from the top of the bank above (southeast) of the signs, near a small section of wire fence, and one of the posts has a sign indicating Caltex Refineries.

On the ground near these posts described above is what appears to be a concrete cable box for Telstra communications. Based on the survey plan, telecommunications enter the site at the north west (near the oil pipeline corridor) and then split with one branch going southeast toward the aboveground Caltex valve pit infrastructure, and the other branching north east toward the cemetery.

Sewer infrastructure crosses the site, following a similar alignment to the Caltex pipelines. There is a surface access point in the central east of the site, a section of exposed pipe at the top of the dune and a large concrete block at the base of the dune at the southern boundary with the beach. Smaller sewer infrastructure may also pass through the north of the site and along the boundary with the cemetery.

Water circulation tunnels/and sea water intake pipes also pass beneath the site. The concrete-formed tunnel entrance at the southern site boundary has been blocked with large sandstone boulders.

The approximate locations of services are shown in the survey in **Appendix C**.

2.2.3 Observed Waste Materials & Contamination Indicators

Some waste materials were observed at various accessible locations of the site. Fly-tipping of litter appears common along the western boundary at the footpath along Military Road and Prince of Wales Drive. Two fragments of bonded asbestos containing material (ACM) were observed in an embankment at the site's northern boundary where the northern access road enters from Military Road. These fragments may be associated with fill forming the embankment that runs along the northwest boundary of the site, as the fragments were observed where erosion of the embankment due to surface water runoff had occurred. A further ACM fragment was observed in a small soil stockpile at the site's southwest boundary, just off the footpath along Prince of Wales Drive. Bonded asbestos sheeting was noted in small fly tipped stockpiles of building material toward the centre of the site, at the end of the north western gravelled access road. Surficial waste in this area consisted of metal roofing, piping, electrical wiring, bricks and concrete.

Fly-tipping of waste materials was also evident along the site's northern boundary with the adjacent cemetery. The waste consisted of plastic flowers and other materials that appear to have originated from the existing cemetery. Waste materials including small piles of household rubbish and some building and demolition waste, were observed adjacent the gravel access in the northwest, which included an area accessed by a winding trail through vegetated areas leading into the centre of the site that appeared to have been used as a camp site. Food cans, a tyre, plastic bags and camping groundsheets were observed in this area.

There were no surface indicators of widespread or gross contamination of the site, based on observations in accessible areas. No widespread asbestos contamination was observed, other than

ACM fragments in stockpiled material and fly tipped waste, as noted above. No staining or odours were noted, and anthropogenic materials were generally of a minor nature, other than at the north and western edges of the site. As noted previously, large portions of the site were inaccessible for inspection due to thick vegetation.

2.3 Surrounding Land Use

At the timer of reporting the current land use of adjacent properties or properties across adjacent roads is summarised below.

- North - The site is bound to the north and north west by Military Road/Prince of Wale Drive, across which are several commercial/industrial allotments associated with Port Botany Industrial Park. The site is bound to the north east by Eastern Suburbs Memorial Park cemetery;
- East - Eastern Suburbs Memorial Park cemetery;
- South - The southern margin of the site is bound by Yarra Bay, a small coved inlet of the greater Botany Bay water body; and
- West –Prince of Wales Drive and Simblist Road, across which are several allotments associated with Port Botany Industrial Park. Several aboveground storage tanks (ASTs, presumably housing liquefied petroleum gas, diesel, firefighting foams and other fuels) were apparent along with an electrical substation.

2.4 Topography

A review of the regional topographic data (Six Maps[5]) indicates that the site lies between an elevation of 0 and 15 m Australian Height Datum (AHD).

Land within the site slopes towards the south in all directions from a central high point, as is evident from the survey plan in **Attachment C**. Topography is varied across the site, with steep slopes in places, particularly where the land drops away towards the bay in the south, and towards the road to the west. Some artificial adjustment of topography has occurred at the site, with placement of low elongated stockpiles along a portion of the access road in the north east of the site and filling across the site to variable depths as discussed in **Section 8.1**.

2.5 Geology and Soils

According to the *1:100,000 Geological Series Sydney Geological Survey of NSW Sheet 9130 (1983[6])* the site is underlain by two geological units being Triassic Aged Hawkesbury Sandstone and Quaternary Marine Sediments.

Hawkesbury Sandstone is characterised by medium to coarse grained quartz consolidated sandstone with very minor shale and laminate lenses. Evidence of sandstone bedrock exists within the site as occasional outcrops (one in particular is evident in the south west of the site) and in the exposed cliffs beneath the south west edge of the site.

The Quaternary Marine Sediments are commonly referred to as the Botany Sand Beds (BSBs) and is comprised of unconsolidated to semi-consolidated permeable sands. The sands are fine to medium grained quartz marine sands with minor shell fragments and podzols. The sand is interspersed with lenses of layers of peat, peaty sands, silts and clays, which become more common in the lower part of the sequence. The BSBs can be up to 30 to 60 m thick and are generally underlain with Hawkesbury Sandstone.

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5 *Six Maps website, https://maps.six.nsw.gov.au/* accessed 22 December 2016

6 *1:100 000 Sydney Geological Map Sheet 9130 Edition 1.* Department of Mineral Resources, Published 1983 (DMR 1983)

Marine/dune sands are evident particularly along the south east of the site. Sandy soils are present beneath vegetation and in cleared areas across the site.

Reference to the eSPADE NSW Soil and Land Information database (OEH 2018[7]) indicates that most of the study area is underlain by two soil landscapes: Newport and Disturbed Terrain. The Woy Woy Park Soil Landscape covers only a small area on the south east of the site, Lot 7302 DP 1139143, but has been included for completeness. Details of the soil landscapes are summarised in **Table 2.2** below.

Table 2.2 - Soil Landscapes within the proposed Bumborah Point study area

Soil Landscape	Geology	Landscape Type	Position	Vegetation	Soil Material	Limitations
Newport (np)	Newport and Garie Formation (shale and sandstone)	Aeolian	Gently undulating plains to rolling rises.	Cleared low open woodland, scrub and open heathland.	Siliceous sands, yellow Podzolic Soils, sandy soils on crests with deep Podzols in depressions.	Very high soil erosion hazard, steep slopes, very low fertility, non-cohesive topsoils.
Disturbed Terrain (xx)	Artificial fill, dredged estuarine sand and mud, demolition rubble, industrial/ household waste.	N/A	Level plain to hummocky terrain, extensively disturbed by human activity.	Original vegetation completely cleared. Bare or covered with opportunistic weeds.	Turfed fill areas capped with 40cm of sandy loam, compact clay or waste material.	Dependent on nature of fill material. Movement hazard, unconsolidated material, poor drainage, low fertility and toxic materials.
Woy Woy (ww)	Holocene sediments, coarse to fine quartz sand, with shell fragments and silt.	N/A	Level to gently undulating non-tidal beach ridges on marine sands.	Extensively cleared vegetation, with occasional scrub.	Siliceous sands, occasional Podzols, and Humus Podzols in areas with poor drainage. Calcareous Sands near beaches.	High water tables, localised flooding, periodic waterlogging, very low to low soil fertility, localised areas of high erosion hazard.

2.6 Acid Sulfate Soils

Review of the *Acid Sulfate Soil Risk Map for Botany Bay*[8] indicates that there is a low probability of acid sulfate soils (ASS) within the majority of the site, although there may be localised occurrences in areas where the natural terrain has been disturbed such as where filling has occurred using imported materials (Murphy, 1997[9]).

Parts of the land are identified on Acid Sulfate Soils Maps as Classes 1 or 2 under Randwick Council local environmental plan (LEP), as such any acid sulfate soils that may be present and disturbed should be managed in accordance with the Acid Sulfate Soils Manual.

2.7 Hydrology

The nearest surface water receptor is Yarra Bay, a small coved inlet of the greater Botany Bay water body located immediately south of the site.

7 *'eSPADE NSW Soil and Land Information'*, NSW Office of Environment and Heritage, Accessed 09 April 2018, http://www.environment.nsw.gov.au/eSpade2Webapp

8 *Acid Sulfate Soil Risk Map – Botany Bay, Edition 2, 1997.* 1:25 000 Ref: 91 30S3. NSW DLWC

9 Botany Bay Acid Sulfate Soil Risk Map – Edition Two, Department of Land and Water Conservation, C. L. Murphy, December 1997.

As discussed in **Section 2.2**, the site largely unsealed. As such, in areas surfaced with permeable surfaces it is anticipated surface water generated during periods of rainfall is likely to result in infiltration into the ground surface at a rate reflective of the underlying gravelly sand soil. Excess surface water within the site is expected to follow the topographic gradient and migrate off-site (Yarra Bay).

2.8 Hydrogeology

As discussed in **Section 2.5**, the site lies within the BSBs. Two main groundwater systems are anticipated to operate in the vicinity of the site and more broadly across the BSBs:

- A deeper, confined groundwater system resident in the fractures/porous Hawkesbury Sandstone which form the basement of the Botany Basin aquifer; and
- A shallow unconfined to semi-confined aquifer system resident within the unconsolidated sediments of the BSBs.

At a regional level, groundwater flow within the shallow aquifer system is through primary porosity, where water flows between the grains of sediments. The inflows, outflows and storage of the BSBs define the water balance. Recharge is predominantly through rainfall infiltration although some water is also imported into the basin from Sydney Water's reticulated mains supply.

Consistent with the historical extensive use of groundwater in the Botany Sands aquifer, a significant number of registered groundwater wells have previously been identified in proximity of the site. A review of the Botany Groundwater Management Zones map (DNR 2009[10]) indicates that the site is located within Zone 4 of the Botany Sands Aquifer Embargo Area. DNR (2009) indicates that the Embargo Area "incorporates localities with known or suspected contamination from past industrial activity". Residents of properties situated within this zone are advised that groundwater use is now banned, especially for drinking water, watering gardens, washing windows and cars, bathing or to fill swimming pools. Industrial users are required to test the bore water at least annually and provide the results to the Department of Primary Industry (DPI) and the Office of Environment and Heritage (OEH).

Licensed groundwater bore information was obtained from the NSW Department of Primary Industries groundwater mapping portal (NSW DPI 2018[11]). A review of the licensed bore information indicated that there are 30 groundwater wells within 1.5 km of the study area. Based on the data from the registered bores, groundwater in the vicinity of the site is likely shallow (<5 m). Based on local topography and geographic position, groundwater is likely to flow south towards Yarra Bay/Botany Bay. Shallow groundwater seepage from bedding joints was observed in the cliff face at the southern site boundary.

Regional groundwater movement in the deeper confined sandstone/shale bedrock underlying the site is expected to flow in a southerly direction consistent with the topography to Yarra Bay/Botany Bay.

2.9 Meteorology

The Sydney area has a humid to temperate climate with a seasonal rainfall maximum during the summer and autumn months. The average rainfall for Sydney Airport Station is 1107mm. Rainfall ranges from 522mm to 2025mm for Sydney Airport (DLWC 2000[12]).

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[10] *Botany Groundwater Management Zones map*. www.water.nsw.gov.au/water-management/water-quality/groundwater/botany-sand-beds-aquifer/Botany-Sands-Aquifer/default.aspx NSW Department of Natural Resources (DNR 2009)

[11] *NSW Department of Primary Industries, 2018*. Groundwater Monitoring Overview Map. Http://allwaterdata.water.nsw.gov.au/water.stm. Accessed 23 February 2018.

[12] http://www.bom.gov.au/climate/averages/tables/cw_066037.shtml. Commonwealth of Australia, 2011 Bureau of Meteorology, Product IDCJCM0028 prepared at 26 April 2018 and accessed by JBS&G on 26 April 2018

The area has a history of droughts, which are broken by periods of heavy rainfall resulting in significant recharges to groundwater resources. The 1940's and 1980's and the current decade are observed to be dry periods, while the early 1970's and 1990's were wet periods.

Summer winds are north-easterly with southerly thunderstorms common. Winter winds are westerly.

3. Site History

3.1 Aerial Photographs

Historical aerial photographs dated 1930, 1943, 1951, 1961, 1970, 1982, 1991, 1998, 2009 were obtained from the Land and Property Information Division of the Department of Finances and Services. Aerial photography from 2018 was obtained from SIX Maps imagery. All aerials were reviewed for this assessment (**Appendix D**). The aerial photograph review identified the following features in relation to the history of the site:

1930 The aerial photograph shows the site consisting of a relatively low sand dune and rock promontory-type structure with dune vegetation. The surface of the site shows substantial disturbance in the form of tracks and cleared areas that link to a main vehicle track entering the northern boundary. There is a man-made salt water intake tunnel evident on the southern site extent.

The surrounding area appeared to be comprise:

- Vacant open grass fields to the north east and in turn agricultural plots; and
- A large power station was evident to the north of the site. Stockpiled materials were apparent. The land between the site and power station appeared cleared/vacant.

1943 The quality of the aerial photograph precluded a detail review of historical land uses, however, the site appeared to have been cleared of the majority of the site's vegetation. In addition, the site's topography appears to have been altered, with the central portion of the site being more elevated, with steep sloping gradients apparent along the south eastern boundary.

The surrounding area appeared similar to the previous aerial photograph with notable extension of a cemetery to the north east and an expansion of the power station to the north of the site. An increase in stockpiled materials was also apparent (presumably coal) within the grounds of the power station.

1951 The site appeared similar to the previous aerial photograph. The aerial photograph shows the site to be largely re-vegetated. Several tracks were apparent providing access to the foreshore, the salt water intake tunnel and a lookout within the southern site extents.

The surrounding area appeared more developed with a notable expansion of the power station to the north and cemetery to the north east. A residential estate was apparent to the south east along with industrial allotments to the north and north west.

1961 The site appeared similar to the previous aerial photograph with the notable exception of a potential structure in the eastern portion of the site.

The cemetery to the north east and east appeared similar to the current configuration (i.e. experienced an expansion compared to the previous aerial photograph). Land to the north and north east appeared heavily industrial. Land uses to the south east appeared to comprise quarrying activities and in turn residential allotments.

1970 The aerial photograph shows the site to have been altered topographically, with the highest point (central site extent) having been cleared of vegetation and levelled. A structure was apparent within this portion of the site. The site's topography also appeared altered (filling) within the southern site extent, adjacent the sea water intake tunnel entrance and eastern site extent where the site's topography appeared to have been cut into the south sloping terrain providing access to the beach.

The site's surrounds appeared similar to the previous aerial photograph.

1982 Land reclamation activities adjacent to the site resulted in significant augmentations to the site's topography along the western and north western site extents (i.e. filling). The eastern portion of the site appeared to have been recontoured providing a gentler access gradient to the beach. The rest of the site appeared relatively unchanged, although still largely devoid of vegetation.

Land to the west of the site had been reclaimed and developed as Port Botany Industrial Park. Several ASTs were apparent. The power station appeared to be in the process of demolition/decommissioning, with the area immediately north of the site largely vacant. Some previously visible structures were no longer apparent/present.

1991 The site appeared similar to the previous aerial photograph, with an increase in overall vegetation. There was some evidence of ground disturbance, possible filling in the north of the site, west of the main entrance road. The road within the north east site extent appeared more defined.

The surrounding area appeared similar to the previous aerial photograph with the notable exception of the majority of the power station infrastructure was no long apparent. Port Botany Industrial Park appeared more developed, with an increase in building density and associated infrastructure, including the number of ASTs (presumably liquefied petroleum gas, diesel, firefighting foams and other fuels).

1998 The general site appeared similar to the previous aerial photograph, with the majority of the site being covered in vegetation. A cleared area was apparent within the elevated central portion of the site, with trails leading to the north, south and east, and the cleared area where the northern access road enters and traverses the north east of the site. A cleared area was visible where the current Caltex valve pit is located at ground level (**Figure 2**), with a trail leading to the beach.

The surrounding areas appeared similar to the previous aerial photograph.

2009 The site appeared similar to the previous aerial photograph with a few notable changes. The vegetation in the site's western corner appeared more established. The entrance to the site off Military Road appeared to have been sealed (asphaltic pavement). The central east of the site appeared to have been disturbed, between the most elevated section (central site extent) and the access road to the north, including clearance of some vegetation, creation of walking tracks and possible material storage or dumping.

The surrounding area appeared more developed with industrial style building occupying the former power plant. A compound was apparent near the corner of Bumborah Point Road and Simblist to the north west of the site (current Caltex gas pipelines).

2018 The site appeared similar to the previous aerial photograph, with thick vegetation have re-established itself across previously disturbed areas.

The surrounds appeared similar to the previous aerial photograph.

3.1 Title Records

The title documentation is included in **Appendix E**. A summary of the title documentation records is provided below.

Table 3.2 – Summary of Land Title Records for the Study Area

Date of Acquisition and Term Held	Registered Proprietor(s) & Occupations (where available)	Reference to Title at Acquisition and Sale
25.10.1892 (1892 to 1969)	State of New South Wales? (1892 to 1901) Now Commonwealth of Australia (1901 to 1969) (Dedicated for Defence Purposes)	Government Gazette 25.10.1892 Now Revoked by Government Gazette 03.10.1969
03.10.1969 (1969 to Date)	The State of New South Wales (Current Registered Proprietor) (Reserve R87429 for Public Recreation)	Government Gazette 03.10.1969 Now 4858/752015

Title documents indicate the following easements exist:

- 25.07.1929 (Commonwealth Government Gazette) – Easement to Construct Circulating Water Tunnels
- 28.06.1937 (Book 1784 No. 979) – Easement for Circulating Water Tunnels, Manholes and Inlets – expires 28.06.2036
- (Q822546) – Easement for Sewerage 4.265 wide
- (Q949422) – Easement for Services 18.29 wide (Caltex pipelines, Telstra)
- (Q949422) – Easement for Salt Water Intake 3.05, 4.42 & 10.73 wide

These are consistent with other documentation reviewed and reported herein.

3.2 EPA Records

A search of the NSW EPA's public register maintained under the *Protection of the Environment Operations Act 1997* (*POEO Act 1997*) was undertaken for the site and surrounding properties. The results of the search are presented in **Appendix F**. The search identified that there were no current or former prevention, clean-up or prohibition notices for the site or properties immediately adjacent.

A search was also undertaken through the EPAs public contaminated land register (**Appendix F**). The search identified that there have been no notices issued under the *Contaminated Land Management Act 1997* (*CLM Act 1997*) for the site and immediate surrounds.

There are sites in Port Botany or nearby areas of Matraville that have been notified to EPA, and are either under assessment by EPA or has been assessed and do not require regulation under the CLM Act. Based on their locations relative to the site, potential contamination associated with those facilities is considered unlikely to impact on the site.

Bunnerong Power Station was formerly regulated by the EPA under the *Environmentally Hazardous Chemicals (EHC) Act*, however *EHC Act* orders for this site were revoked in 1992.

Review of the EPA's list of NSW Contaminated Sites Notified to OEH (**Appendix F**) identified that the site has not been notified under Section 60 of the *CLM Act 1997*. There are sites in Port Botany or nearby areas of Matraville that have been notified to EPA, however, based on their locations relative

to the site, potential contamination associated with those facilities is considered unlikely to impact on the site.

A search of the EPA's public per- and poly- fluoroalkyl substances (PFAS) register indicated that there were no records pertaining to the site. Notwithstanding, preliminary sampling undertaken by Port Botany Industrial Park companies in late 2016 identified the presence of PFAS in groundwater, surface water and sediment samples collected from within and adjacent the Port Botany Industrial Park. This is not unexpected given the past use of PFAS-containing fire-fighting foams for Port Botany Industrial Park fire-fighting training, as well as the range of industrial operations in the area.

It is understood that groundwater impacts in the Botany region are already being actively managed through contamination controls in place as part of the Orica Groundwater Clean-up Project.

The offsite PFAS contamination has been found in the Groundwater Extraction Exclusion Area, where there has been a ban on use of groundwater for domestic purposes for many years (as discussed in **Section 2.8**), and in Penrhyn Estuary (north of the subject site) where fishing bans are in place. On this basis, potential remains for the site's soils and groundwater to be impacted with PFAS.

3.3 Council Zoning Certificate

JBS&G obtained a Planning Certificate for Lot 4858 DP 752015, issued by Randwick City Council under Section 149 of the *Environmental Planning and Assessment Act 1979* (*EP&A Act*). A copy of the planning certificate is included in **Appendix G**.

The following information gained from the s149 certificate relates to potential contamination matters:

- The land is affected by Council's Contaminated Land Policy, as is all land within Randwick Council's jurisdiction, so does not specifically identify the land as contaminated;
- Within the meaning of the *Contaminated Land Management Act 1997* (*CLM Act*), the land is not significantly contaminated land, subject to a management order, approved voluntary management proposal or ongoing maintenance order, and Council has not received a site audit statement pertaining to the land; and
- The land is within the groundwater extraction embargo area declared under the *Water Act 1912*.

Additional information below may influence future management of potential contamination, if required:

- The land is located in a heritage conservation area under the Randwick LEP 2012, although the land itself is not listed as a heritage item on the Randwick LEP, nor on the State Heritage Register; and
- Parts of the land are identified on Acid Sulfate Soils Maps as Classes 1 or 2 under Randwick LEP, as such any acid sulfate soils that may be present and disturbed should be managed in accordance with the Acid Sulfate Soils Manual.

3.4 Heritage

3.4.1 Australian and NSW Heritage Register

A search of the Australian Heritage Trust database and the NSW Heritage Inventory did not reveal any Heritage listed items at the site.

There are sites in Port Botany or nearby areas of Matraville that have been notified as having heritage value including Port Botany Revetment Wall located Prince of Wales Drive, Port Botany. The wall is of significance as the revetment wall is an integral feature of the Botany Bay Port and is

reported as being one of the most striking landmarks in the area and demonstrates the massive investment of materials and energy required to re-engineer a landscape.

A copy of the heritage search results is included in **Appendix H**.

3.4.2 Randwick Local Environmental Plan 2012

As noted in **Section 3.3**, the site is located in a heritage conservation area under the Randwick LEP 2012, although the land itself is not listed as a heritage item on the Randwick LEP.

3.5 WorkCover Dangerous Goods

Based on the current understanding of the site, records of stored Dangerous Goods held by SafeWork NSW were not obtained, as it is considered no such licenced storage has occurred.

3.6 Historical Activities

Review of a draft Aboriginal Heritage Due Diligence Assessment for the Eastern Suburbs Memorial Park (Artefact 2017), suggests the following, with respect to potential historical activities that may have caused contamination of the site:

- The site has been subject to significant disturbance resulting from installation of multiple subsurface infrastructure, and possible placement of fill material sourced from the former Bunnerong Power Station that was located north of the site.
- Historical maps from the late 1800s show a small area known as Yarra Point that was much smaller than the current Bumborah Point outline, indicating substantial reclamation and filling has occurred to develop the current landform over time.
- The point was marked as military/battery reserve in the 1890s but appears only to have been an area (possibly level at the time) where guns could be placed when required. No other evidence of Defence use was obtained. Land title records indicate that in 1969 the Minister of Lands revoked the 1892 dedication of land for 'Defence Purposes' because 'the purpose of the dedication of the area...has failed', and instead indicated his intention to reserve the land for public recreation.
- Substantial excavation and reworking of the site would have been required to install the water intake tunnel for the former Bunnerong Power Station, located north of the site on land across Military Road. The tunnel was reportedly constructed by removing overlying sands and then tunnelling and/or cut and fill through bedrock. Rail lines may have been constructed at surface for use in this process.
- While it was reported the majority of spoil and waste from the power station was used elsewhere (Banksmeadow) for land reclamation, some spoil may have been placed at the site, given its proximity to the power station. The site may have been used as an ancillary area possibly for stockpiling of waste and fuel (coal).
- Following construction of the power station the site appears to have been unused.
- It is noted there is other subsurface infrastructure beneath the site, and there appears to be some lack of clarity regarding the power station inlet tunnel and another tunnel feature suggested as either military or water tunnels. Based on photographs and aerial images (in Artefact 2017), the major tunnel linking to the large concrete structure at the southern edge of the site seems well aligned to have supplied water to the power station, with the alignment shown on maps to be somewhat arbitrary, and potentially incorrect. Artefact found no documented evidence of military tunnels in this area.

- Other infrastructure includes Caltex high-pressure fuel lines linking the Banksmeadow terminal with Kurnell, sewer mains and telecommunications. Each of these would have also resulted in disturbance of the ground and potential imported fill.

3.7 Site History Summary

Table 3.3: Site History Summary

Period	Activity	Source
1800	Site known as Yarra Point	Parish Maps
1890s	Site marked as a military/battery reserve.	Land Title Record
1900s to2018	Site largely unused, evidence of extensive disturbance, stockpiling of material and subsurface service implementation. Evidence of paths, roadways and lookout points indicating recreational activities.	Aerial Photographs

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

4.1 Potential Areas of Environmental Concern

Based on the history review and observations made during the site inspection, AECs and associated COPC have been identified and presented in **Table 4.1** and shown on **Figure 2** (where appropriate).

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

Areas of Environmental Concern (AEC)	Contaminants of Potential Concern (COPC)
AEC 1: Land reclamation activities along the western and northern site extents	Heavy metals, polycyclic aromatic hydrocarbons (PAHs), total recoverable hydrocarbons (TRH), benzene, toluene, ethylbenzene and xylenes (BTEX), volatile organic compounds (VOCs), organochlorine pesticide (OCPs), polychlorinated biphenyl (PCBs), PFAS and asbestos
AEC 2: Fill material used to create former/existing site levels	Heavy metals, PAHs, TRH, BTEX, VOCs, PFAS, OCPs, PCBs and asbestos
AEC 3: Rubbish and stockpiled materials	Heavy metals, PAHs, TRH/BTEX and OCPs/PCBs and asbestos
AEC 4: Historical site structures	Lead paint and asbestos
AEC 5 Groundwater	Heavy metals, PAHs, TRH, BTEX, VOCs and PFAS

4.2 Potentially Contaminated Media

Potentially contaminated media present at the site includes:

- Fill material;
- Surface soils;
- Natural soils;
- Groundwater.

Historical review identified substantial disturbance and filling at the site. Importation of fill materials is likely to have occurred to form the current topography, to facilitate installation of services, and during reclamation of the western extremity of the site. While there are no specific historical records identifying fill material importation at the site, it is assumed that fill material may have been imported onto the site from the previous Bunnerong Power Station. As such, fill material is considered to be a potentially contaminated media.

Stockpiled materials observed during the detailed site inspection have the potential to contain hazardous materials. As such, stockpiled materials and surface soils beneath stockpiled material are considered potentially contaminated medium.

There is evident fly-tipping of surficial fill materials (waste/rubbish), in addition to the presence of an onsite camp area, as such, surface soils are considered to be potentially contaminated media.

Based on potential leachability of contaminants within fill materials/surface soils, vertical migration of contamination from the fill material/surface soils into the underlying natural soils may have occurred. As such, the natural soils are considered to be potentially contaminated media.

The potential for groundwater to be contaminated medium will depend upon the actual nature, occurrence and characteristics of contamination within the overlying fill material and natural soils. Given the high permeability of local soils, groundwater is considered to be a potentially contaminated media.

4.3 Potential for Migration

Contaminants generally migrate from site via a combination of windblown dusts, rainwater infiltration, groundwater migration and surface water runoff. The potential for contaminants to migrate is determined by the following factors:

- The nature of the contaminants (solid/liquid and mobility characteristics);
- The extent of the contaminants (isolated or widespread);
- The location of the contaminants (surface soils or at depth); and
- The site topography, geology, hydrology and hydrogeology.

The potential contaminants identified as part of the site history are generally in either a solid form (e.g. heavy metals, asbestos, etc) and liquid form (e.g. fuel, PFAS, pesticides, etc), however, dependent upon concentrations, there is the potential for impacts from TRH/VOC impacts to occur in a vapour form also in soils and groundwater underlying the site.

As the site is primarily surfaced with thick dune vegetation, the potential for windblown dust migration of contamination from the site is generally low. The potential for contamination migration via surface water movement and infiltration of water and subsequent migration through the soil profile is considered generally to be high given the lack of impermeable pavements at the site.

Given the potential for perched groundwater along the soil-rock interface and/or within fill material associated with the reclamation of low lying areas, migration of contamination via groundwater movement is considered to be a potential migration pathway for contaminants. As such, migration of contamination via groundwater movement is considered to be a potential migration pathway.

The vapour generation potential associated with volatile and semi-volatile potential contaminants of concern (TRH, BTEX, VOCs) is identified as a potential migration pathway, particularly in areas of subsurface infrastructure and services that underlie the site, and within areas identified to contain fill materials.

4.4 Potential Exposure Pathways

Based on COPC identified in various media, as discussed above, and proposed future use, the exposure pathways for the site during and following rezoning include:

- Inhalation of COPC vapours migrating upwards from fill material of unknown origins or impacted surface soils resulting from historical land uses; and/or
- Potential dermal and oral contact to impacted soils as present at shallow depths and/or accessible by future service excavations across the extent of the site; and/or
- Potential oral and dermal contact to shallow groundwater as accessible by potential future service excavations and/or installed services pits; and/or
- Potential contaminant uptake by vegetation within landscaped areas.

4.5 Receptors

Potential receptors of environmental impact present within the site which will need to be addressed with respect to the suitability of the site for the proposed use include:

- Future workers and visitors whom may potentially be exposed to COPC through direct contact with impacted soils and/or inhalation of dusts/fibres associated with impacted soils; and/or
- Flora species to be established on the vegetated areas of the site; and/or
- The marine ecosystem of Yarra Bay/Botany Bay which is located hydro-geologically down gradient of the site.

Where petroleum or other volatile hydrocarbon compound impact is identified, potential inhalation exposure to vapours will need to be considered.

4.6 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 COPC as either liquids or gasses.

Man-made preferential pathways are present throughout the site, generally associated with fill materials present beneath existing ground surface, and at near surface depths over the remainder of the site. Fill materials are anticipated to have a higher permeability than the underlying natural soil and/or bedrock.

Sub-surface services are also present throughout the site at near surface depths. Preferential pathways can be formed by the generally higher permeability backfill used to re-instate these services.

Preferential pathways are also important in the assessment of potential off-site sources of COPC. Preferential pathways are potentially present in the adjoining road network, as associated with service easements.

5. Sampling and Analysis Plan

5.1 Data Quality Objectives

Data Quality Objectives (DQO's) were established for the investigation. As discussed in the following sections.

5.1.1 State the Problem

It is understood that the site is proposed to be rezoned (expansion of the existing Eastern Suburbs Memorial cemetery) and a PSI is required to support the rezoning application, as per the requirements of SEPP 55.

The site is currently used for recreational purposes and zoned under the Randwick City Council Local Environmental Plan 2012.

It is noted that the objective of the investigation was not to determine site suitability, rather to assess potential contamination issues that may preclude the rezoning of the site, specifically, contamination issues that cannot be readily addressed during the DA stages for redevelopment.

5.1.2 Identify the Decision

To meet the specific project objectives and the requirements of SEPP 55, the following decisions must be made:

- Are there any contamination issues from historical and/or current potentially contaminating activities that would prohibit the rezoning of the site?

5.1.3 Identify Inputs to the Decision

Inputs to the decision are:

- Historical and environmental information regarding site area as described in **Section 2** and **Section 3**;
- Observations made during the detailed site inspection;
- Limited environmental data collected by JBS&G including the sampling and analysis of targeted soil samples from within the subject site;
- Assessment criteria to be applied to the collected data based on the proposed intended land use and project objectives, as defined by assessment criteria nominated in **Section 6**; and
- Confirmation that data generated by sampling and analysis are of an acceptable quality to allow reliable comparison to assessment criteria as undertaken by assessment of quality assurance / quality control (QA/QC) as per the data quality indicators (DQIs) established in **Section 5.1.6**.

5.1.4 Define the Site Boundaries

The lateral site extent/study boundaries are legally identified as Lot 4858 DP 752015, Lot 7301 DP 1139143, Part Lot 7302 DP 1139143, Part Lot 52 DP 1182618 and includes land between Lot 4858 and the adjacent cemetery to the north east and east, as shown on **Figure 2**.

The vertical extent of the investigation was 3 m below ground surface (bgs) and extended into natural soils.

Due to the project objectives, seasonality has not been assessed as part of this investigation. Data will therefore be representative of the timing and duration of the current investigation.

5.1.5 Develop a Decision Rule

Laboratory analytical data were assessed against EPA endorsed criteria as identified in **Section 6**.

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

Decision Required to be made	Decision Rule
1. Are there any contamination issues from historical and/or current potentially contaminating activities that would preclude the rezoning of the site?	Based on the findings of the PSI, the site inspection and the limited sampling, were there any areas where the potential for gross contamination is such that the rezoning of land is considered unsuitable? If the answer is no, then recommendations for further investigation are not required prior to the rezoning of the land. If the answer is yes, then further investigation may be required prior to rezoning.

5.1.6 Specify the Limits of Decision Error

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 NSW EPA, NEPC (2013), appropriate indicators of data quality (DQIs) established for the project as discussed below in relation to precision, accuracy, representativeness, comparability, completeness and sensitivity (PARCCS parameters). The acceptable limit on decision error is 95% compliance with DQIs.

The DQIs and data assessment criteria are summarised 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** – measure 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 collected 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; 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 field and laboratory methods, including the limits of reporting, in producing reliable data in relation to the adopted site assessment criteria.

Given the preliminary nature of the assessment duplicate and triplicate samples were only submitted for heavy metals, TRH, BTEX and PAH. This is considered appropriate with respect to the project objectives.

Table 5.2: Summary of Data Quality Indicators

Data Quality Objectives	Frequency	Data Quality Indicator
Precision		
Blind 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%
Laboratory control samples	1 per lab batch	70-130%
Matrix spikes	1 per lab batch	70-130%
Representativeness		
Sampling appropriate for media and analytes		-[2]
Samples extracted and analysed within holding times.	-	Soil: organics (14 days), inorganics (6 months)
Trip spike	1 per sampling event	70-130% recovery
Storage blank	1 per sampling event	<LOR
Rinsate blank	1 per sampling data where reusable equipment is used	<LOR
Method blank (soil vapour only)	1 per lab batch	<LOR
Equipment blank (soil vapour only)	1 per lab batch	<LOR
Laboratory blanks[1]	1 per lab batch	<LOR
Comparability		
Standard operating procedures for sample collection & handling	All Samples	All samples[2]
Standard analytical methods used for all analyses	All Samples	All samples[2]
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 COCs completed and appropriate	All Samples	All samples[2]
Appropriate documentation	All Samples	All samples[2]
Satisfactory frequency and result for QC samples	All QA/QC samples	-[2]
Data from critical samples is considered valid	-	Critical samples valid[2]
Sensitivity		
Analytical methods and limits of recovery appropriate for media and adopted site assessment criteria	All Samples	All samples

[1] If the RPD between duplicates is greater than the pre-determined data quality indicator, a judgment was 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 was completed during the DQI compliance assessment.

If any of the DQIs were not met, further assessment was necessary to determine whether the non-conformance significantly affected the usefulness of the data. Corrective actions might have included requesting further information from samplers and/or analytical laboratories, downgrading of the quality of the data or alternatively, re-collection of the data.

5.1.7 Optimise the Decision for Obtaining Data

Various strategies for developing a statistically based sampling plan are identified in EPA (1995[13]), including judgemental, random, systematic and stratified sampling patterns.

[13] *Sampling Design Guidelines.* Environmental Protection Authority NSW September 1995 (EPA 1995).

Based on the site inspection, known site history and project objectives, a limited soil sampling program was conducted as part of the PSI. The soil sampling locations were selected in order to target some AECs whilst providing broad site coverage also (i.e. systematic sample locations).

This is considered appropriate with respect to the project objectives. Sample locations are shown on **Figure 3**.

5.2 Soil Sampling Methodology

5.2.1 Soil Sampling

A total of 21 sample locations were advanced across the site, as shown on **Figure 3**. Soil samples were collected from a combination of manually advanced bore holes using a hand auger or test pits via the use of a backhoe. Soil samples were generally collected from the near ground surface (0-0.1 m bgs) and subsurface (0.3 m bgs / 0.5 m bgs / 1.0 m bgs and every 0.5 m interval after) to a max depth of 3 m bgs or prior refusal.

During the collection of soil samples, features such as seepage, discolouration, staining, odours and other indicators of contamination, if present, were noted. Field logs are included in **Appendix I**.

Collected samples were immediately transferred to laboratory supplied sample jars/zip-lock bags. The sample jars/zip-lock bags were transferred to a chilled ice box 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. Preservation of the primary soil and QA/QC samples obtained during this investigation was completed in accordance with the protocols outlined in NEPC (2013).

Soil samples were analysed in accordance with the laboratory schedule (**Table 5.3**). Not all soil samples collected were analysed. All samples will remain at the primary laboratory for a period of two months if future analysis is required following receipt of sample results, providing analytes are within holding times.

5.2.2 Field Screening

Soil samples were screened on site during works using a photo-ionisation detector (PID) to assess the potential presence of VOCs including petroleum hydrocarbons. Samples obtained for PID screening were placed in a sealed plastic bag for a period of approximately 5 minutes to equilibrate, prior to a PID being attached to the bag. Readings were then monitored for a period of approximately 1 minute or until values stabilised and the stabilised/highest reading was recorded. PID screening results were recorded on the field logs included as **Appendix I**. PID calibration records are included **Appendix J**.

5.2.3 Decontamination

Prior to the commencement of soil sampling activities, non-disposable sampling equipment, including augers, hand tools, etc were cleaned with a 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. A rinsate sample was collected during the sampling event to demonstrate the effectiveness of decontamination procedures.

5.2.4 Duplicate and Triplicate Sample Preparation

Field soil duplicate and triplicate samples were obtained during sampling using the above sampling methods. The collected samples were then divided laterally into three samples within minimal disturbance to reduce the potential for loss of volatiles and placed in three glass jars or sample bags as appropriate. Each sample was then labelled with a primary, duplicate or triplicate sample identification before being placed in the same chilled esky for laboratory transport.

5.3 Laboratory Analyses

JBS&G subcontracted Eurofins MGT Ltd (Eurofins) at Lane Cove, NSW as the primary laboratory for the required analyses. The secondary laboratory for the works was Envirolab Services Pty Ltd (Envirolab) at Chatswood. Both laboratories are NATA accredited for the required analyses. Laboratory analysis of samples was conducted with reference to COPCs identified for the site. The analytical schedule adopted for the investigation is summarised in **Table 5.3** below.

Table 5.1: Analytical Schedule

Sample Media	No. of Sampling Locations	No. of Analyses (excl. QA/QC)
Soil	21	Heavy metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Zn) – 15 samples TRH/BTEX/PAH – 15 samples Asbestos – 12 samples OCPs – 10 samples PCBs – 6 samples ASLP/TCLP (metals/PAHs) – 2 samples % Clay content, CEC & pH – 4 samples

6. Assessment Criteria

6.1 Regulatory Guidelines

The investigation was undertaken with consideration to aspects of the following guidelines, as relevant:

- *National Environment Protection (Assessment of Site Contamination) Measure 2013 (as amended 2013).* National Environment Protection Council (NEPC 2013).
- *Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites.* NSW EPA, 2011 (OEH 2011).
- *Contaminated Land Management: Guidelines for the NSW Site Auditor Scheme*, 3rd Edition. NSW EPA, 2006 (EPA 2017).
- *Environmental Health Risk Assessment: Guidelines for assessing human health risks from environmental hazards.* Department of Health and Ageing and EnHealth Council, Commonwealth of Australia, June 2002 (EnHealth 2002).
- *Waste Classification Guidelines Part 1: Classifying Waste*. NSW EPA, November 2014 (EPA 2014).
- *Acid Sulfate Soil Manual.* NSW Acid Sulfate Soil Management Advisory Committee. August 1998 (ASSMAC 1998).

6.2 Assessment Criteria

As per the decision process for assessment assessing urban sites (EPA 2017), a set of human health and ecological assessment thresholds derived from NEPC (2013) was used for evaluation of the site contamination data collected for this assessment.

As noted in **Section 1.1**, the site is proposed to be redeveloped to accommodate an expansion of the Eastern Suburbs Memorial Park cemetery (commercial land use). As such, compounds in soils have been compared against published guidelines for commercial land use. as outlined below:

- Health Investigation Levels: HIL D – Commercial/Industrial Land Use (NEPM 2013);
- Health Screening Levels: HSL D – Commercial/Industrial Land Use (NEPM 2013);
- Ecological Investigation/Screening Levels (EIL/ESL): Commercial/Industrial Land Use (NEPM 2013);
- Management Limit Levels for Commercial/Industrial Land Use; and
- Aesthetic considerations as per NEPC (2013).

The adopted criteria are presented in summary tables included in **Appendix A**.

A coarse grained soil texture, based on observed site conditions, was used when considering relevant criteria adopted. Adopted ecological criteria was derived using site specific pH, CEC and clay content as per the NEPC (2013) guidance.

7. Quality Assurance / Quality Control

7.1 Soil QA/QC Results

An assessment of QA/QC was undertaken by calculation of DQIs for the data generated as part of the assessment activities. As discussed in **Section 5.1.6,** given the preliminary nature of the assessment duplicate and triplicate samples were only submitted for heavy metals, TRH, BTEX and PAH. This is considered appropriate with respect to the project objectives.

Compliance with the pre-determined DQIs established for characterisation of the site is discussed in **Appendix K** in relation to PARCCS parameters presented in **Section 5.1.6** and the project objectives.

The field sampling, inspection and handling procedures produced QA/QC results which indicated that the data set is of an acceptable quality and suitable for use in site characterisation.

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

On the basis of the results of the field and laboratory QA/QC program, the data set is of an acceptable quality upon which to draw conclusions regarding the environmental condition of the assessment area.

8. Discussion of Investigation Results

8.1 Soil Observations

Soil encountered at the site during the field works is summarised below. Borelogs are included in **Appendix I**.

Fill materials were generally encountered at the sampling locations ranging from shallow (0.7 m) fill soil profile to a depth of 2.6 m. It is noted that a number of sample locations terminated in fill. Trends in depth of fill are not evident, although the vertical extent of fill is likely greatest toward the centre of the site, as a result of historical activity and importation of fill materials to establish the current site topography. Fill materials were noted to generally comprise of brown grey silty sand/gravelly sand. Anthropogenic inclusions were reported within the fill soil profile at a number of locations and included bitumen, road base gravels, brick, concrete, metal, plastic and sandstone. Slag and ash were apparent in silty sand fill material at sampling locations between the central north, central south, and to the north east of the site. Bonded ACM was noted within the soil profile, collected from surface/ subsurface samples (0.0 m – 0.3 m bgs) at BH01, BH09, BH11. Bonded ACM was noted in stockpiled embankment material in surface samples (0.0-0.1 m bgs) and at depth (1.0-1.1 m bgs) at BH13; and in surface samples of SP02.

No odours or staining was noted during soil investigations. Field PID screening results were low, ranging from 0.0 to 0.2 ppm, and not indicative of volatile organic impacts in the vicinity of the soil samples collected.

Reworked dredge fill sands were apparent along the western margin of the site, comprising fine medium sands with inclusions of calcareous shell material.

Natural soils encountered at the site were comprised of loose, brown light grey fine to medium grained sand with minor inclusions of shell material in some locations consistent with that reported in **Section 2.5**.

8.2 Soil Analytical Results

The soil sampling locations are shown in **Figure 3** and summarised laboratory results are presented in **Tables A** and **B** (**Appendix A**). The soil analytical results are discussed in the following sections.

8.2.1 Metals

All concentrations were below the adopted human health and ecological criteria with the exception of sample TP02 0.3-0.4 with a nickel concentration of 110 mg/kg, exceeding the adopted nickel ecological criterion of 55 mg/kg. This is likely a result of igneous (blue metal) gravels with naturally elevated nickel concentrations.

8.2.2 BTEX

All BTEX concentrations were all reported below the laboratory limit of reporting (LOR) and the adopted human health and ecological criteria.

8.2.3 TRH

All TRH concentrations were below the adopted site human health and ecological criteria with the exception of:

- Sample BH04 0.5-0.6 with TRH >C_{34}-C_{40} (4400 mg/kg) concentrations exceeding the ecological criteria of 3300 mg/kg. In addition, TRH >C_{16}-C_{34} (30 000 mg/kg) exceeded the adopted ecological criterion of 1700 mg/kg, and the management limit criterion of 3500 mg/kg.

No odours or staining was observed in fill at this location. The presence of slag and roadbase materials was noted and may present potential sources of reported mid-heavy fraction hydrocarbons.

8.2.4 PAH

All PAH concentrations were below the adopted human health and ecological criteria with the exception of:

- Sample BH02 0.3-0.4 with a benzo(a)pyrene concentration of 6.7 mg/kg, exceeding the adopted ecological criterion of 1.4 mg/kg.
- Sample BH04 0.5-0.6 with a benzo(a)pyrene concentration of 8.9 mg/kg, exceeding the adopted ecological criterion of 1.4 mg/kg.
- Sample BH14 0.5-0.6 with a benzo(a)pyrene concentration of 1.4 mg/kg, exceeding the adopted ecological criterion of 1.4 mg/kg.
- Sample TP04 0.5-0.6 with a benzo(a)pyrene concentration of 4.4 mg/kg, exceeding the adopted ecological criterion of 1.4 mg/kg.
- Sample TP05 0.3-0.4 with a benzo(a)pyrene concentration of 2.3 mg/kg, exceeding the adopted ecological criterion of 1.4 mg/kg.

8.2.5 These five locations are clustered toward the south east of the site. Slag, bitumen and roadbase gravels within the fill soil profile, observed in the surface and to a depth of 1.2 m bgs may be a potential source of PAH's. OCPs

All OCP concentrations were all reported below or close to the laboratory LOR and below the adopted assessment criteria.

8.2.6 PCBs

All PCB compounds were all reported below the laboratory LOR and the adopted site criterion.

8.2.7 Asbestos

As discussed in **Section 8.1** and **2.2,** ACM was observed on the ground surface and/or within the fill soil profile at sample locations BH01, BH09, BH11, BH13 and SP02**.** The presence of asbestos in surface soils exceeds the health screening levels for asbestos contamination in soil (NEPM 2013).

Representative soils sample were submitted for asbestos analysis. All concentrations were below the adopted site criteria with the exception of the following:

- Sample BH11 0-0.1 with an asbestos concentration in ACM of 0.2984% w/w, exceeding the adopted ACM HSL criterion for bonded asbestos in soil of 0.05% w/w.
- Sample SP02 with an asbestos concentration in ACM of 0.086% w/w, exceeding the adopted ACM HSL criterion for bonded asbestos in soil of 0.05% w/w.

It is noted that trace levels of asbestos fines/fibrous asbestos (AF/FA) below the adopted site criterion were reported at sample locations BH01 0.-0.1, BH13 0-0.1, BH13 1-1.1 and TP01 0.3-0.4. Trace levels of bonded asbestos was also reported at sample location BH09 0-0.1.

8.2.8 Clay Content, CEC and PH

Clay content was 1.3% in all four samples submitted for analysis. Cation Exchange Capacity (CEC) and pH were as follows:

- Sample BH06 0.5-0.6 with a PH of 7.7 and a CEC of 3.9 (meq/100g).
- Sample BH10 0-0.1 with a PH of 7.8 and a CEC of 2.3 (meq/100g).

- Sample BH15 0-0.1 with a PH of 7.3 and a CEC of 18 (meq/100g).

Sample BH10 1-1.1 with a PH of 7.4 and a CEC of 5.8 (meq/100g). Elevated CEC at BH15 is likely a result of increased plant organic matter (roots/rootlets) within the surface soil profile at this sample location.

8.2.9 ASLP and TCLP Leachate Testing

ASLP leachate analysis of PAHs and nickel was undertaken to assess the potential for contaminant migration and leaching from water seepage. Analytical TCLP leachate testing was completed to provide preliminary waste classification.

Leachable concentrations of PAHs by both ASLP and TCLP were below the LOR in all samples submitted for analysis (BH02 0.3-0.4, BH04 0.5-0.6 and TP04 0.5-0.6).

ASLP and TCLP for nickel was conducted on sample TP02 0.3-0.4:

- ASLP analysis returned a nickel concentration of 0.04 mg/L, indicative of minor potential for nickel to be leached by water seepage through the soil profile.
- TCLP analysis returned a nickel concentration of 0.02 mg/L, falling within the General Solid Waste (GSW, non-protrusible) (EPA 2014) waste classification.

8.2.10 Preliminary Waste Classification

It is noted that slag inclusions in fill material have been identified at a portion of locations, slag inclusions are inferred to be a significant source of COPCs (e.g. heavy metals and PAHs). On this basis, it is appropriate to apply the associated NSW EPA general immobilisation approvals (EPA 2009[14]) when consideration is given to evaluating a waste classification(s) for material required to be excavated during the site development works.

As shown in **Table B, Appendix A** fill materials contain low leachate properties.

Based on review of the analytical results (**Appendix A**), fill materials at the site generally fall within the GSW (non-protrusible) NSW Waste Classification (EPA 2014) thresholds. Where asbestos is present, fill materials are classified as GSW Special (asbestos). It is noted at sample location BH04 0.5-0.6 a TRH concentration of 30 000 mg/kg was reported, exceeding the GSW TRH criterion of 10000 mg/kg, with fill materials within this portion of the site classified as Restricted Solid Waste (RSW non-protrusible).

As per the Scheduled Chemical Waste Chemical Control Order (SCW CCO) (EPA 2004[15]), an OCP result at BH14 (>2 mg/kg) needs to be considered. The result is less than 50 mg/kg and the site-wide average is less than 2 mg/kg, as such CCO requirements for storage, conveying or disposing of SCW are not considered applicable based on the current data.

[14] *General Approval of the Immobilisation of Contaminants in Waste – 2009/07. Metallurgical furnace slag or metallurgical furnace slag contaminated natural excavated materials.* (EPA 2009).

[15] *Chemical Control Order in Relation to Scheduled Chemical Wastes.* Environmental Protection Authority, June 2004. (EPA 2004)

9. Conclusion and Recommendations

9.1 Conclusions

Based on the findings of this investigation, and subject to the limitations in **Section 10**, the following conclusions are made:

- The site has a long history of disturbance, having been topographically altered/raised as a result of material importation/land reclamation, and has been subject to extensive development of subsurface infrastructure.
- The site is proposed to be rezoned to allow for an extension of the existing Eastern Suburbs Memorial Park cemetery (commercial land use). The site is currently used of recreational land uses.
- The preliminary site investigation and sampling event identified fill materials comprising silty sand/gravelly sand with anthropogenic inclusions of brick, concrete, metal, plastic, slag, glass, ACM and ash.
- Fill materials were generally reported/encountered at the locations investigated ranging from a shallow (0.60 m) fill soil profile to 2.6 m in depth.
- Fill materials have been shown to contain elevated concentrations of benzo(a)pyrene, exceeding the adopted ecological criteria. Elevated TRH fractions were noted in one location, exceeding both the adopted ecological and management criteria. Nickel concentrations were elevated at one location, exceeding the adopted ecological criterial. Elevated asbestos concentrations were noted to varying degrees, with two locations exceeding the adopted human health criteria.
- Based on the desk top review, potential remains for site soils to be impacted with PFAS given the past range of industrial operations in the area and site land reclamation activities.
- Potential remains for groundwater to be impacted with heavy metals, TRH, PFAS, VOCs, however, not necessarily as a result of site contamination, rather as a result of surrounding industrial land use activities. The site is located within Zone 4 of the Botany Sands Aquifer Embargo Area, which "incorporates localities with known or suspected contamination from past industrial activity". Residents of properties situated within this zone are advised that groundwater use is now banned, especially for drinking water, watering gardens, washing windows and cars, bathing or to fill swimming pools.
- Whilst the investigation identified the potential for soil and groundwater impacts to be present at the site, the investigation did not identify the potential for gross or widespread contamination which may preclude rezoning of the site. Identified potential soil and groundwater impacts are considered representative of common contaminants and potentially contaminating land use activities which can be readily dealt with during the DA stage (i.e. including completion of preliminary and detailed site investigations consistent with relevant Council development control plans (DCPs) and SEPP 55 requirements) for redevelopment and assessment for site suitability.
- In the absence of gross or widespread contamination, the requirements of the DUAP/EPA (1998) *Managing Land Contamination: Planning Guidelines* for this type of rezoning are considered to have been satisfied, namely that the rezoning can proceed, "provided that measures are in place to the ensure that the potential for contamination and the suitability of the land for any proposed use are assessed once detailed proposals are made" (s.4.1.2 DUAP 1998).

9.2 Recommendations

It is recommended that upon submission of development application(s) within the site, a detailed site investigation be undertaken consistent with SEPP 55 requirements and EPA made or endorsed guidelines.

10. 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.

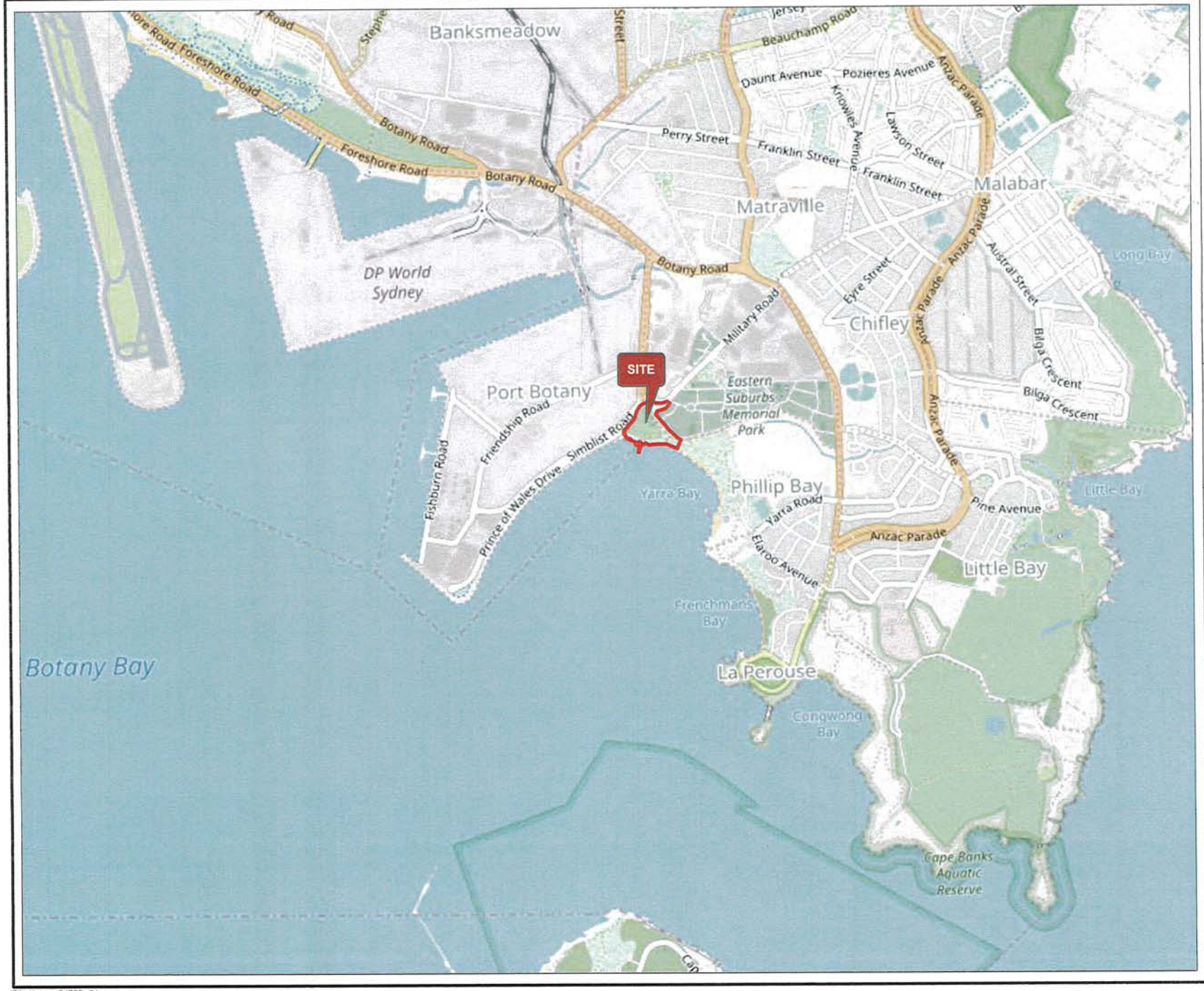
Sampling and chemical analysis of environmental media is based on appropriate guidance documents made and approved by the relevant regulatory authorities. Conclusions arising from the review and assessment of environmental data are based on the sampling and analysis considered appropriate based on the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

JBS&G

Job No: 54725	
Client: Urbis Pty Ltd	
Version: Misc	Date: 20-Mar-2018
Drawn By: AV	Checked By: CK
Scale 1:30,000	

0 0.5 1
Kilometers

Coor. Sys. GDA 1994 MGA Zone 56

Bumborah Point
Port Botany, NSW 2036

SITE LOCATION

FIGURE: 1

File Name: 54725_01

Legend:

Approximate Investigation Area

Lot Boundary (4858 DP752015)

JBS&G

Job No: 54725	
Client: Urbis Pty Ltd	
Version: Misc	Date: 03-May-2018
Drawn By: AV	Checked By: CK
Scale 1:2,200	

0 25 50

metres

Coor. Sys. GDA 1994 MGA Zone 56

Bumborah Point
Port Botany, NSW 2036

SITE LAYOUT & FEATURES

FIGURE: 2

File Name: 54725_02
Reference: www.nearmap.com.au. Imagery Date: 24/06/2017.

Legend:

- Approximate Investigation Area
- Lot Boundary (4858 DP752015)
- Hand Auger Location
- Test Pit Location
- Stockpile Sample Location

JBS&G

Job No: 54725	
Client: Urbis Pty Ltd	
Version: Misc	Date: 20-Apr-2018
Drawn By: RF	Checked By: CK
Scale 1:2,200	

0 25 50
metres

Coor. Sys. GDA 1994 MGA Zone 56

Bumborah Point
Port Botany, NSW 2036

SAMPLE LOCATIONS

FIGURE 3

File Name: 54725_03
Reference: www.nearmap.com.au. Imagery Date: 24/06/2017.