JVMC Pty Ltd

Site A: Precinct 75 Commercial (Buildings 1, 2, 6 & 7) and Site B: Precinct 75 Mixed Use Redevelopment (Buildings A, B, C & 8) Remedial Action Plan

50 and 52 Edith Street, 67 and 73 Mary Street and 43 Robert Street, St Peters, NSW, 2044

25 August 2017
53113/110630 Revision 0

JBS&G Australia Pty Ltd

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Abbreviations

Term	Definition
ACM	Asbestos Containing Material
AGMG	Australian Groundwater Modelling Guidelines
AHD	Australian Height Datum
AMP	Asbestos Management Plan
ASRIS	Australian Soil Resource Information System
ASS	Acid Sulfate Soils
ASSMP	Acid Sulfate Soil Management Plan
AST	Aboveground Storage Tank
bgs	Below Ground Surface
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes
CEC	Cation Exchange Capacity
COC	Chain of Custody
COPC	Contaminants of Potential Concern
Council	The Inner West Council
CSM	Conceptual Site Model
DA	Development application
DGI	Data Gap Investigation
DO	Dissolved Oxygen
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
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
F&T	Fate and Transport
GIL	Groundwater Investigation Levels
GME	Groundwater Monitoring Event
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
K_{oc}	Organic Carbon Partition Coefficient
LCS	Laboratory Control Sample
LEP	Local Environmental Plan
LNAPL	Light Non-Aqueous Phase Liquid
LOR	Limit of Reporting
CH_4	Methane
MNA	Monitored Natural Attenuation
NAPL	Non-Aqueous Phase Liquid
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

Term	Definition
PCB	Polychlorinated Biphenyls
PCR	Primary Contact Recreation
pH	Potential of Hydrogen
PID	Photo-ionisation Detector
ppm	Parts Per Million
PSH	Phase-separated Hydrocarbon
QA/QC	Quality Assurance / Quality Control
RAP	Remedial Action Plan
RL	Relative Level
RPD	Relative Percent Difference
RSW	Restricted Solid Waste
SWL	Standing Water Level
RWPs	Remedial Works Plan
SAS	Site Audit Statement
SAQP	Sampling, Analysis and Quality Plan
SP	Strata Plan
SPOCAS	Suspension Peroxide Oxidation Combined Acidity and Sulfur
SO4	Sulfate
TCE	Trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
TPH	Total Petroleum Hydrocarbons
TRH	Total Recoverable Hydrocarbons
UCL	Upper Confidence Limit
UPSS	Underground Petroleum Storage System
UST	Underground Storage Tank
VOC	Volatile Organic Compounds

1. Introduction

1.1 Introduction and Background

JBS&G Australia Pty Ltd (JBS&G) has been engaged by JVMC Pty Ltd (JVMC, the client) for the provision of environmental services associated with the remediation/validation and development of Site A: Precinct 75 Commercial (Buildings 1, 2, 6 & 7) and Site B: Precinct 75 Mixed Use Redevelopment (Buildings A, B, C & 8), herein referred to as the site.

The site is located at 50 and 52 Edith Street, 67 and 73[1] Mary Street and 43 Robert Street, St Peters, NSW, is legally identified as Lot 1 Deposited Plan (DP) 745657, Lot 1 DP 745014, Part Lot 1 DP 180958, Lot 1 DP 556914, Lot A DP 331215 and Lot 1 DP 87885 and occupies an area of approximately 1.5 hectares (ha), as shown on **Figures 1** and **2**.

The site has been subject to a number of previous investigations which have identified historical industrial land uses from the 1920s until the mid-1960s, followed more recently by light commercial/industrial land uses (vehicle mechanic workshop, beer brewery, coffee roaster, furniture manufacturing, offices, workshops and design studios). Site activities were reported to have historically comprised the manufacturing of paints, varnish manufacturing and drum washing associated with a Taubmans paint factory (**Figure 3**). The balance of the site has been used for residential land uses since the 1930s.

Soil impact has been identified as follows:

- Associated with historical petroleum/chemical storage and handling;
- Hot-spots of volatile to non-volatile petroleum/chlorinated hydrocarbons associated with historical manufacturing activities and/or storage;
- Polycyclic aromatic hydrocarbons (PAH) and/or heavy metals, associated with fill materials historically used across the site or resultant from historical site storage/manufacturing activities; and
- Isolated asbestos impact in fill.

Historical petroleum/chemical infrastructure is still present on site (**Figure 2**).

Groundwater has been identified to be affected with petroleum/chlorinated hydrocarbons, and heavy metals, albeit limited in extent. In addition, trichloroethene (TCE) soil vapour impacts were identified in an isolated area exceeding the screening criteria for commercial and industrial land-use applicable to this portion of the site (beneath north-western extent of Building1, refer to **Figure 2**). The extent of historical environmental investigations has been restricted by the occurrence of buildings/structures at the site.

Review of architectural plans (**Appendix A**) indicates that the site is proposed to be developed as a mixed-use precinct including residential apartments (with a single multi-level integrated car parking basement in areas), adaptive reuse of some existing buildings for commercial land uses, and public domains (landscaping/parks and paved extents), as shown on **Figure 4A**.

Two development applications (DAs) are proposed to be lodged for the redevelopment of the site:

- Site A: Precinct 75 Commercial (Buildings 1, 2, 6 & 7); and
- Site B: Precinct 75 Mixed Use Redevelopment (Buildings A, B, C & 8).

The extent of these two development areas is shown on **Figure 4A**.

[1] Also known as 75 Mary Street

Remediation/management is required to address contamination and aesthetic issues identified in previous site investigations in order for the site to be considered suitable for the proposed land uses.

Sufficient data has been collected to characterise the site and detail the remedial works required to make the site suitable for proposed land uses, however, further environmental data is required to support the preparation of a Human Health and Ecological Risk Assessment (HHERA) and refine/confirm the remedial extents/requirements.

This document presents a Remedial Action Plan (RAP) that outlines the principles of remedial works required for the site, that when completed, will make the site suitable for the proposed development.

This RAP has been prepared with reference to relevant guidelines made or endorsed by the NSW Environment Protection Agency (EPA) inclusive of NEPC (2013[2]) and also the requirements of SEPP 55[3].

It is anticipated that staged remediation and progressive validation signoffs will be required, with Site Audit Statements/Reports required prior to be issue of progressive occupation certificates, with construction of the built form in some instances servicing as the remedial strategy (i.e. pavements in landscaped areas, the basement internal fit out will serve as part of the remedial strategy and/or construction of the built form serving as a physical barrier to retained fill).

1.2 Objective

The objectives of this RAP are to:

- Characterise and document the known extent of environmental impact within the site via presentation of a conceptual site model (CSM);
- Identify the requirements for additional investigations and supplementary reports;
- Identify the remedial strategy(ies)/framework to be adopted by an assessment of remedial options and development objectives; and
- Document the procedures and standards to be followed in order to remove the risks posed by contaminated soils, soil vapour and groundwater to make the site suitable for suitable for the proposed development, while ensuring the protection of human health and the surrounding environment.

[2] *National Environment Protection (Assessment of Site Contamination) Measure, Amendment No 1 (2013*). National Environment Protection Council (NEPC 2013)

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

2. Proposed Development Details

Review of architectural plans (**Appendix A**) indicates that the site is proposed to be developed as a mixed-use precinct including residential apartments (with a single multi-level integrated car parking basement in areas), adaptive reuse of a number of existing buildings for commercial land uses, and public domains (landscaping/parks and paved extents), as shown on **Figure 4A**.

Two development applications (DAs) are proposed to be lodged for the redevelopment of the site:

- Site A: Precinct 75 Commercial (Buildings 1, 2, 6 & 7); and
- Site B: Precinct 75 Mixed Use Redevelopment (Buildings A, B, C & 8).

The extent of these two development areas are shown on **Figure 4A**.

As discussed above, it is anticipated that staged remediation and progressive validation signoffs will be required, with Site Audit Statements/Reports required prior to be issue of progressive occupation certificates, with construction of the built form in some instances servicing as the remedial strategy (i.e. pavements in landscaped areas, the basement internal fit out will serve as part of the remedial strategy and/or construction of the built form serving as a physical barrier to retained fill).

2.1 Site B: Precinct 75 Mixed Use Redevelopment (Buildings A, B, C & 8)

Architectural plans (**Appendix A**) show three multi-storey residential buildings (Building A to Building C, refer to **Figure 4A**) with a single multi-level integrated car parking basement (occupying an area of approximately 6,825m^2) underlying the majority of the Site B: Precinct 75 Mixed Use Redevelopment. Ground floor retail is proposed in portions of Buildings A, B and C. It is understood residential apartments are proposed to be built above the existing commercial studios in Building 8 (i.e. additions to the built form to accommodate residential apartments).

Bulk excavation associated with the basement is anticipated to progress to a relative level (RL) of 11.8m Australian height datum (AHD) to 8.4m AHD for the first basement level and 8.75m AHD to 7.2m AHD for the second level basement (where present). The extent of the basement and basement depths/levels are shown on **Figure 4A**. The basement will terminate in bedrock (shale), as shown on **Figure 4B**.

The basement is off-set from the Site B: Precinct 75 Mixed Use Redevelopment boundaries (in areas) with surface treatments external to the basement comprising minor landscaped areas (inclusive of the north-western extent of Central Park) and/or pavements (including the foundations of the built form), as shown on **Figure 4A**.

A Pocket Park is proposed in the south-eastern Site B: Precinct 75 Mixed Use Redevelopment extent (Part Lot 1 DP 180958, Lot A DP 331215 and Lot 1 DP 87885), as shown on **Figure 4A** and will occupy an area of approximately 600 m^2.

Residual areas to the basement envelope are proposed to be validated as environmentally suitable without ongoing management and/or subject to the fill retention strategy presented in **Section 6**.

To accommodate the proposed fill retention strategy (**Section 6**), natural soils (clay) and in turn bedrock (shale) are proposed to be over excavated beneath the basement envelope to an RL of 6.2m AHD, as shown on **Figure 4B**. Virgin excavated natural material (VENM) is proposed to be either beneficially reused on site within landscaped areas/as engineered fill to establish site levels, or taken to a facility lawfully able to accept the material.

Following establishment of excavation levels, environmentally suitable soils/fill, as confirmed through preparation of a HHERA, are proposed to be emplaced beneath the basement within the

excavation void surrounded by low transmissive units (i.e. low permeability clay/shale) reducing the potential for contaminant leachate generation potential.

Construction of the Site B: Precinct 75 Mixed Use Redevelopment will require demolition of Buildings 3 to Building 5, Buildings 9 to Building 12 and residential dwellings at 43 Roberts Street, 50 and 52 Edith Street and 67 Mary Street, as shown on **Figure 3**.

2.2 Site A: Precinct 75 Commercial (Buildings 1, 2, 6 & 7)

As shown in **Appendix A** (architectural plans) Building 1, Building 2, Building 6 and Building 7 are proposed for adaptive reuse for commercial land use.

Development will largely comprise refurbishment/alterations to building interiors, with the majority of hardstands/foundations proposed to be retained. Some minor landscaping and pavement modifications are proposed along with the addition of minor landscaped areas.

3. Site Condition & Surrounding Environment

3.1 Site Identification

The site is situated approximately 6.1 kilometres (km) south-west of the Sydney central business district (CBD), within the local government area of the Inner West Council (Council[4]). The site is a vibrant creative precinct comprising twelve-character buildings (refer to **Figure 3**) remaining from past industrial land use activities and four residential allotments over 1.5ha.

The site is bound by Edith Street to the north-east, low density residential allotments to the south- east, Mary Street to the south-west and low density residential allotments to the north-west.

The location of the site and surrounds is shown in **Figure 1.** The current layout is shown in **Figure 2**. The historical site layout and proposed site development layout is shown on **Figures 3** and **4**, respectively. Site details are summarised in **Table 2.1** and discussed in detail in the following section.

Table 2.1: Summary of Site Details

Site Legal Identifier (as shown on **Figure 2**)	Lot 1 DP 745657 Lot 1 DP 745014 Part Lot 1 DP 180958 Lot 1 DP 556914 Lot A DP 331215 Lot 1 DP 87885
Site Address	Lot 1 DP 745657 – 50 Edith Street, St Peters, NSW, 2044 Lot 1 DP 745014 – 52 Edith Street, St Peters, NSW, 2044 Part Lot 1 DP 180958 – 67 Mary Street, St Peters, NSW, 2044 Lot 1 DP 556914 – 73[5] Mary Street, St Peters, NSW, 2044 Lot A DP 331215 – 43 Roberts Street, St Peters, NSW, 2044 Lot 1 DP 87885 – 43 Roberts Street, St Peters, NSW, 2044
Site Area	Approximately 1.5ha
Site B: Precinct 75 Mixed Use Redevelopment (Buildings A, B, C & 8)	Approximately 1ha (refer to **Figure 4A** and **Section 2.1**)
Site A: Precinct 75 Commercial (Buildings 1, 2, 6 & 7)	Approximately 0.5ha (refer to **Figure 4A** and **Section 2.2**)
Approximate Relative Level (RL) m Australian Height Datum (AHD)	16.3 m AHD – north site extent 9.8 m AHD south-western site extent
Local Government Authority	Inner West Council
County/Parish	Petersham/Cumberland County
Site Geographic Coordinates (MGA 56)	Refer to **Figure 2**
Current Zoning (Marrickville Local Environmental Plan (LEP) 2011, last updated 5 August 2016)	Lot 1 DP 745657 – R2 Low Density Residential Lot 1 DP 745014 – R2 Low Density Residential Part Lot 1 DP 180958 – R2 Low Density Residential Lot 1 DP 556914 – IN2 Light Industrial Lot A DP 331215 – R2 Low Density Residential Lot 1 DP 87885 – R2 Low Density Residential
Proposed Zoning	It is understood a rezoning application has been submitted for the site. The planning proposal request seeks to rezone the site land to B4 Mixed Use with a small area of RE1 Public Recreation (Part Lot 1 DP 180958, Lot A DP 331215 and Lot 1 DP 87885)
Current Land Owner(s)	JVM Holding Pty Ltd Chalak Holding Pty Ltd
Developer/Builder	JVMC Pty Ltd
Previous Land Uses	Industrial and Residential (manufacturing of paints, varnishing manufacturing and drum washing associated with a Taubmans paint factory, refer to **Figure 3** and areas of residential land use within the southern site extents)

[4] Formerly known as Marrickville Council
[5] Also known as 75 Mary Street, St Peters, NSW

Current Land Uses	Light Commercial/Industrial and Residential Land Uses (vehicle mechanic workshop, beer brewery, coffee roaster, furniture manufacturing, offices, workshops, design/dance studios and residential and uses within the southern site extents)
Proposed Land Uses	Mixed-use Precinct (residential apartments (with areas of ground floor retail) with basement parking in areas, adaptive reuse of existing commercial buildings for commercial land uses, and public domains (landscaping, parks and paved extents). It is understood that Building 8 for adaptive commercial reuse will also include apartments above the existing commercial suits)

3.2 Current Site Condition

The majority of the site (Lot 1 DP 556914) has historically been used for industrial purposes, in particular, a large portion of the site was previously used for paint and varnish manufacturing (Taubmans) from the 1920s until the mid-1960s. Lot 1 DP 556914 has subsequently been used for various light industrial/commercial purposes. The balance of the site (Lot 1 DP 74567, Lot 1 DP 745014, Part Lot 1 DP 180958, Lot A DP 331215 and Lot 1 DP 87885) has historically, and is currently used for residential land uses.

The majority of Lot 1 DP 556914 is currently covered by a mix of large brick (one to three storeys in height) and metal warehouse structures and pavement (concrete or asphalt). An unpaved area covered by roadbase aggregate is used for car parking as present at the south-eastern site extent. Current commercial/industrial site activities identified during the JBS&G site inspection within Lot 1 DP 556914 included, but were not limited to, a vehicle maintenance and mechanics workshop (south-east portion of the site), beer brewery, coffee roaster, cellar door, furniture manufacturer, offices, workshops and design studios over seventy tenancies ranging from 50 square meters (sqm) to 740 sqm.

Access at the time of inspection to Lot 1 DP 556914 was via a driveway off Mary Street, and two separate driveways on Edith Street (adjacent to the site carpark, and corridor north-east of the site). Lot 1 DP 556914 slopes gently to the south-west.

Historical records reported in EIA (2015[6]) indicate that several underground storage tanks (USTs) were potentially present within Lot 1 DP 556914. Historical records suggest multiple USTs within three separate areas (Pits 1 to Pit 3, refer to **Figures 2** and **3**). During the site inspection numerous fill points were apparent within these areas. It is noted that site inspections have been limited to accessible areas outside buildings with the exception of buildings along the north-western site boundary. As discussed herein, one UST was identified by JBS&G in proximity to Pit 2 (refer to **Figure 2**) and potential remains for two USTs to the north-west of Pit 1 (refer to **Figure 2**).

Landscaped areas (grass and trees) surround the residences within the southern site extent. A pool is present in the rear yard of Lot 1 DP 745014. As discussed herein, 67 Mary Street, 43 Roberts Street and 50 and 52 Edith Street appear to have been used for residential land uses since the 1930s.

[6] *Detailed Site Investigation Report 67 &75 Mary Street, 43 Roberts Street, 50 and 52 Edith Street, St Peters, NSW*. Environmental Investigations Australia Pty Ltd dated 18 September 2015 reference E22317 AA_Rev 3 (EIA 2015)

3.3 Surrounding Land Uses

The surrounding land uses have been identified as follows:

- North-east - The site is bound to the north-east by Edith Street, across which are low density residential allotments. To the north, the site is bound by Edith Street and in turn Unwins Bridge Road, across which are serval industrial allotments;
- South-east - The site is bound to the south-east by low density residential allotments;
- South-west - The site is bound to the south-west by Mary Street across which are low density residential allotments and several commercial allotments; and
- North-west - The site is bound to the north-west by residential allotments and in turn Unwins Bridge Road, across which is an Inner West Council depot.

The closest environmental receptor is Alexandria Canal located approximately 800m south, south-west of the site.

3.4 Topography

A review of the 1:25,000 Botany Bay Topographic Map 9130-3-S (LPI 2013[7]) indicates that the site lies at an elevation of approximately 10m AHD. The regional topography consists of gently undulating rises with local relief to 30m, slopes are usually <5% with broad rounded crests with gentle incised slopes.

The site slopes gently towards the south-west with the highest level being approximately 15.6m AHD at MW01 (**Figures 5A** and **5B**) in the north and 11.1m AHD in the south-west (MW11, **Figures 5A** and **5B**) fronting Mary Street. A slight ridge line with a north-east/south-west axis through MW06/MW04 is present. The car cark in the south-east is relatively level.

In the vicinity of the site, regional ground levels fall gently toward the south/south-west, generally toward Alexandra Canal, located approximately 800m to the south, south-west of the site.

The site appears to have been subject to minor cut and fill activities to facilitate construction of the historical/current built form and/or to accommodate sub-surface infrastructure. Potential remains for fill materials of unknown origin to have been imported, or use of site waste material resultant from historical manufacturing activities to create former/existing site levels.

3.5 Geology & Soils

According to the 1:100,000 Geological Series Sydney Geological Survey of NSW Sheet 9130 (1983[8]), the site is underlain by Ashfield Shales of the Wianamatta Group which consists of black to dark-grey shale and laminite. Ashfield Shale generally weathers into silty clays of medium to high plasticity. A dyke is present in the vicinity of the site to the south.

A review of the regional soil map (DLWC 2002[9]) indicated that the site is underlain by the Blacktown Landscape Group. Soils are characterised as generally shallow to moderately deep (<1m) red and brown podzolic soils on upper slopes; deep (150-300cm) yellow podzolic soils and soloths on lower slopes.

A summary of the encountered site lithology during previous investigations (**Section 5**) is presented in **Table 2.2** below and graphically represented in **Figures 6A** and **6B**.

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7 *1:25 000 Botany Bay Topographic Map 9130-3-S Sheet 9130 (third edition*). Department of Land and Property Information 2013 (DPI 2013)

8 *1:100 000 Sydney Geological Map Sheet 9130 Edition 1.* Department of Mineral Resources, Published 1983 (DMR 1983)

9 *1:100 000 Sydney Soil Landscape Series Sheet 9130 (2nd Edition)*. Department of Land and Water Conservation 2002 (DLWC 2002)

Table 2.2: Summary of Lithology within Lot 1 DP 556914

Lithologic Type	Depth (m bgs)	Lithologic Description
Concrete	0.0-0.5	Concrete
Fill	0.4-1.8	Gravelly clay/gravelly sand, grey to brown, heterogeneous, damp, medium to high plasticity, including ash, brick fragments and glass
Clay/Silty Clay	0.4-2.9	Silty clay, brown to red, stiff, homogeneous, damp, medium to high plasticity
Weathered Shale	1.5-9	Shale, grey to brown

In summary, based on recent site investigation works, shallow fill material (incl. of pavements), typically between 0.1m to 1.8m below ground surface (bgs), is inferred to be present across the site, comprising of gravelly clays, silty gravels and sands with minor anthropogenic materials (brick, ash, glass). Fill material was observed to be underlain by silty clays/clay from 0.4m to 2.9m bgs, followed by shale to the maximum depth of investigation (9m bgs).

There is limited site geological information beneath the footprints of existing buildings and no geological information for the residential properties.

3.6 Acid Sulfate Soils

Review of the *Acid Sulfate Soil Risk Map for Botany Bay*[10] indicates that the site is located within an area classed as "No Known Occurrence" of acid sulfate soils (ASS).

Review of the Marrickville LEP 2011 ASS Map – Sheet ASS-04, the site falls within a category classified as Class 5 ASS. Council consent is required for development works within 500m of adjacent Class 1, 2, 3 or 4 land that is below 5m AHD, and the works are likely to lower the water table to below 1m AHD on adjacent Class 1, 2, 3 or 4 land. Two Class 2 ASS zones were found within 500m of the site, one located across the Illawarra Railway approximately 250m north-west of the site, the other located approximately 350m south of the site beyond the Princes Highway.

The nearest occurrence of identified/confirmed ASS comprises the sediments of the Alexandra Canal, located approximately 800m to the south, south east of the site.

During previous investigations (**Section 5**), natural soils were assessed for the potential of ASS/potential acid sulfate soils (PASS) properties. Although some samples were reported to have peroxide oxidisable sulphur over 0.03% and total sulfidic acidity over 18 mol H+/tonne, it was reported it was unlikely that ASS/PASS were present at the site.

With consideration to the geological and soil characteristics, in addition to the elevation of the site, management of development activities is not required to address the potential for impact on ASS/PASS.

3.7 Hydrology

Existing pavements/structures are present across approximately 90% of the site. As such, rainfall runoff is anticipated to be controlled by the current storm water network, draining towards Mary Street and Roberts Road site boundaries and then into the regional stormwater system. It is understood that regional stormwater flow occurs via below ground infrastructure to Alexandra Canal.

Alexandra Canal is a constructed waterway approximately 4.5km in length. The canal begins in Alexandra and discharges into the Cooks River and receives stormwater from the industrial and residential areas of Waterloo, Alexandria, Redfern and Moore Park. The water quality in Alexandra Canal is recognised as poor due to its industrial and urban catchment.

Overall, infiltration of precipitation at the site is expected to be low due to significant hardscape and buildings present, however, limited infiltration into the subsurface is likely to occur in unsealed areas

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

(i.e. car park in the south-east portion of the site and landscaped areas surrounding residential dwellings), and where deteriorating conditions (i.e. cracks) on the concrete hardstand are present.

3.8 Hydrogeology

Groundwater is inferred to be present underlying the site in intermittent zones within residual clays, and more broadly within underlying shales. This is supported by observations during the previous investigations (**Section 5**) that noted shallow fill and clays were relatively dry until an inferred semi-confined water bearing unit was encountered at approximately 4m to 5m bgs.

Groundwater recharge is inferred to be related to local rainfall infiltration, though there is also potential for input from surface water features (e.g. water supply system, drains).

Shallow groundwater flow at the site is inferred to be generally towards the south-west/west. At the eastern extent of the site, groundwater flow potentially has a more southerly direction, and at the western property extent groundwater flow has a more westerly component, following the pattern of surface topography. Deeper groundwater in the site area is inferred to flow towards local surface water features (i.e. Alexandra Canal). The presence of a dyke indicated on geological maps to the south of the site may also influence local groundwater flow. Groundwater flow direction is shown on **Figure 7**.

Groundwater flow is expected to predominantly occur within fractures and joints within weathered shales. Flow within shallower residual clays is expected to be limited based on observations in previous investigations (**Section 5**) and the expected[11] low transmissivity of this unit.

July 2015 groundwater gauging data from onsite monitoring wells indicated the standing water level ranged from approximately 0.7 to 3.4m bgs (8.69 to 12.94m AHD).

Consistent with the historical extensive use of groundwater in the Botany 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[12]) indicates that the site is located within Zone 2 of the Botany Sand Aquifer Embargo Area. The DNR 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) – Office of Water and the NSW Office of Environment and Heritage (OEH).

3.9 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 522 mm to 2025 mm for Sydney Airport (DLWC 2000[13]).

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.

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[11] Based on range of hydraulic conductivities in *Groundwater* by Freeze and Cherry (1979)

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

[13] http://www.bom.gov.au/climate/averages/tables/cw_066037.shtml. Commonwealth of Australia, 2011 Bureau of Meteorology, Product IDCJCM0028 prepared at 05 July 2017 and accessed by JBS&G on 05 July 2017

4. Site History

A complete assessment of the site history is presented in **Appendix A**. A summary of this information is presented below.

4.1 Site History Summary

The majority of the site has historically been used for industrial land uses from the 1920s until the mid-1960s, followed more recently by light commercial/industrial land uses (vehicle mechanic workshop, beer brewery, coffee roaster, furniture manufacturing, offices, workshops and design studios). Site activities were reported to have historically comprised the manufacturing of paints, varnish manufacturing and drum washing associated with a Taubmans paint factory (**Figure 3**). The balance of the site has been used for residential land uses since the 1930s.

4.2 Land Titles

Lot 1 DP 556914 was found to consist of eight allotments previously. A consolidation of these allotments took place in 1973.

In summary, at the beginning of the 20th century most land parcels were privately owned. One lot was registered under Taubmans Limited, known to be a paint manufacturer, which started acquiring other allotments from the early 1920s. By the late 1920s, Taubmans had acquired 5 allotments. During the 1940s Taubmans Limited underwent another expansion and acquired the balance of Lot 1 DP 556914.

Taubmans ownership over the current Lot 1 DP 556914 was transferred to Genimpex Pty Ltd in 1965. In 2013, JVM Holding Pty Ltd and Chalak Holdings Pty Ltd acquired the lot jointly.

Search results identified that Lot 1 DP 745667, Lot 1 DP 745014, Part Lot 1 DP 180958, Lot A DP 331215 and Lot 1 DP 87885 were owned by various individual from the 20th century up until 2014/2015, except for 43 Roberts Street (both lots) which was registered to different individuals until 1951 when Taubmans Industries Limited acquired the lots and in turn Genimpex in 1965 and the joint venture of JVM Holding Pty Ltd and Chalak Holdings Pty Ltd in 2013.

4.3 Aerial Photographs

Based on review of the aerial photographs, the majority of the site has been used for industrial purposes. The north-eastern site extent was used of residential land use until the 1960s, following which it was used as a car park. 43 Roberts Street, 67 Mary Street and 50 and 52 Edith Street appears to have been used for residential land uses since the 1930s.

4.4 Council Archive Records

Council records indicate the site was used for the manufacturing of paint, varnish manufacturing and drum washing by Taubmans Pty Ltd. Manufacturing activities by Taubmans Pty Ltd also appear to have occurred across Mary Street, in which lacquer, nitrocotton manufacturing and storage were carried out. A fire occurred in the 1950s. It is unclear if the fire was isolated to building located across Mary Street or resulted in damage to the subject site.

Several buildings across Mary Street were noted to be of asbestos fibre cement sheeting construction.

Following divestment of the site by Taubmans Pty Ltd, records show Genimpex Pty Ltd acquired the site and leased the site to various tenants for a number of land use activities including: motor manufacturing and repairs, furniture manufacturing, wood working, yarn/cloth manufacturing and storage, paper lamination, styrene moulding for food models, sign writing and motor vehicle detailing, storage of metal spray equipment, forklift repair and servicing, manufacturing of fibre glass products, wielding and wrought iron production, neon sign manufacturing and jewellery and casting manufacturing.

4.5 Council Planning Certificates

The planning certificate for Lot 1 DP 556914 included the following information regarding the site.

- The land is zoned IN2 – Light Industrial under the Marrickville LEP 2011;
- The land is identified as being subject to ASS under clause 6.2 of Marrickville Local Environmental Plan 2011. Development on land that is subject to ASS risk requires development consent and the preparation of an acid sulfate soil management plan (ASSMP) subject to a preliminary assessment of the proposed works prepared in accordance with the Acid Sulfate Soil Manual (ASSMAC 1998[14]). Development consent is not required where the works involve the disturbance of less than 1 tonne of soil or are not likely to lower the water table.
- The land to which this certificate relates is not significantly contaminated within the meaning of the *CLM Act* (*1997*);
- The land to which this certificate relates is not subject to a management order within the meaning of the *CLM Act* (*1997*);
- The land to which this certificate relates is not the subject of an approved voluntary management proposal within the meaning of the *CLM Act* (*1997*);
- The land to which this certificate relates is not subject to an ongoing maintenance order within the meaning of the *CLM Act* (*1997*); and
- The land to which this certificate relates is not the subject of a site audit statement within the meaning of the *CLM Act* (*1997*).

4.6 WorkCover Search

Records pertaining to historical storage of dangerous goods on site were not identified on the Stored Chemical Information Database (SCID) or the microfiche records held by WorkCover.

Historical records indicate that several USTs were potentially present within Lot 1 DP 556914. Historical records suggest multiple USTs within three areas (Pits 1 to 3, refer to **Figures 2** and **3**). During the site inspection numerous fill points in these areas were apparent. No USTs were identified in the Pits able to be inspected,

One UST was identified by JBS&G in proximity to Pit 2 (refer to **Figure 2**) and potential remains for two USTs to the north-west of Pit 1 (refer to **Figure 2**).

4.7 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 A**. The search identified that there were no current or former prevention, clean-up or prohibition notices for the site or for properties directly adjacent the site. It is noted a number of properties hydrogeologically downgradient of the site have been issued clean-up or prohibition notices.

A search was also undertaken through the EPAs public contaminated land register (**Appendix A**). 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.

Review of the EPA's list of NSW Contaminated Sites Notified to OEH (**Appendix A**) identified that the site had been notified under Section 60 of the *CLM Act 1997*, however, the EPA has completed an assessment of the contamination and decided that regulation under the *CLM Act 1997* was not

[14] *Acid Sulfate Soil Manual*. New South Wales Acid Sulfate Soil Management Advisory Committee August 1998 (ASSMAC 1998)

required. It is noted that a number of sites hydrogeologically down gradient of the site have also been notified under Section 60 of the *CLM Act 1997*.

Results of the search are presented in **Appendix A**. A copy of the EPA's determination is also presented in **Appendix A.**

5. Previous Investigations

The following sections provide a summary of the information and site characterisation data presented within available assessment reports. These reports include both historical and information relating to investigations conducted at that time.

Comments in relation to contaminants of potential concern (COPC) are provided in the following text in relation to assessment criteria adopted at the time of report preparation. Exceedances of assessment criteria presented in **Section 10** with respect to proposed land uses are shown in accompanying summary results tables (**Appendix A**) and **Figures 8A** to **8D**.

5.1 Preliminary Geotechnical Investigation (EI 2014[15])

Environmental Investigations Australia Pty Ltd (EIA) was engaged to undertake a Preliminary Geotechnical Investigation (PGI) in conjunction with a detailed site investigation (DSI, EIA 2015), summarised below, to provide preliminary geotechnical advice and recommendations in support of a Council planning application, and the preparation of initial concept designs for a proposed residential development at the site.

The scope of works for EIA (2014) comprised the following:

- Subsurface investigation comprising of drilling, sampling and field testing at six borehole locations (BH1/MW1 to BH5/MW5 and BH6, refer to **Figures 5A** and **5B**) up to 9 m bgs across a portion of the site (Lot 1 DP 556914) to assess the soil profile for geotechnical purposes;
- Laboratory analysis of selected samples collected from the subsurface investigation to assess for engineering properties (i.e. soil moisture content, Atterberg Limits, soil and groundwater aggressivitiy – e.g. pH, chloride and sulfate content and electrical conductivity); and
- Review and interpretation of results and field testing/observations from the site investigation to provide site management recommendations on excavation support requirements, excavation methodologies, building and retaining wall structure foundations, construction constraints, and potential groundwater management requirements.

The general subsurface soil profile observed during the EI (2014) geotechnical investigation included the following:

- Fill (up to 0.7m bgs) - comprising of asphalt or concrete hardstand up to 190mm in thickness, overlying sandy clay, clayey silt, clay, silty gravel, gravelly clay and gravelly sand with minor anthropogenic fragments;
- Silty clay and weathered shale (up to 2.7m bgs) - firm to very stiff, medium to high plasticity clay with sub-rounded ironstone gravel grading to extremely weathered and low strength shale;
- Mudstone and weathered shale (up to 4.7m bgs) - distinctly weathered, very low to low strength mudstone and shale; and
- Shale (up to total investigated depth) - slightly weathered to fresh, low to medium strength shale.

Based on the findings of the investigation, it was reported in EIA (2014) there was a low risk of geotechnical conditions preventing the proposed development, subject to the recommendations provided in EIA (2014) for the preliminary design and construction of the development.

[15] *Preliminary Geotechnical Investigation Report – 75 Mary Street, St Peters, NSW.* Environmental Investigation Australia Pty Ltd dated 9 December 2014 reference E22317 GA (EIA 2014)

5.2 Detailed Site Investigation (EIA 2015)

EIA was engaged to undertake a DSI of the site to assess the environmental conditions and the potential for onsite impacts associated with the identified current and historical land uses, and to establish whether ASS are present on the site.

The scope of works for EIA (2015) comprised the following:

- A review of available site history and background information to identify potential areas of environmental concern (AEC);
- A detailed inspection of the site and surrounds to establish potential AECs prior to investigation works;
- Implementation of a site investigation program including drilling and soil sampling of twenty-three borehole locations (inclusive of the aforementioned EIA (2014) geotechnical locations) across Lot 1 DP 556914 (up to a total depth of 9m bgs) with five borehole locations converted to monitoring wells (BH1/MW1 to BH5/MW5). Due to access constraints, the program adopted a targeted/judgemental sampling pattern;
- Groundwater sampling from the five newly installed monitoring wells (BH1/MW1 to BH5/MW5); and
- Laboratory analysis of groundwater and selected soil samples for relevant constituents as determined from the site history review and field observations during the investigation program.

Review of available historical records indicate that a paint manufacturing factory had been operating onsite (Lot 1 DP 56914) from the 1920s until the mid-1960s, and Lot 1 DP 56914 has been subsequently been used for various industrial and commercials uses. A plan attached in documentation from Council indicated that there were three UST burial areas containing multiple USTs on the site (Pits, refer to **Figures 2** and **3**). It was further reported in EIA (2015) that during the site inspection, undertaken as part of the assessment, the presence of infrastructure associated with USTs (i.e. fill point and vent pipes) were apparent at Pit 1.

The soil investigation found that the site lithology comprised fill materials (typically less than 1m in thickness) underlain by residual soils (silty clay/clays) and weathered shales. The fill comprised of various constituents, suggesting several periods of filling in the past. Trace level of brick inclusions were reported at a number of locations.

Hydrocarbon odours were noted in soil bore locations as shown in **Table 4.1** below and **Figure 8D**. Soil samples were screened with a photo-ionisation detector (PID). Soil PID readings above 5ppm are presented in **Table 4.1**.

Table 4.1: Odours (EIA 2015)

Soil Bore Location	Depth (mbgs)	Odour	PID reading (ppm)	Lithology
BH1/MW1	0.3-1.3	Hydrocarbon	4.2-176	Natural - clay
BH2/MW2	0.14-0.5	Hydrocarbon	0.1	Fill
	0.5-1.9	Hydrocarbon	0.2-1.1	Natural - clay
BH3/MW3	0.15-0.4	Hydrocarbon	12	Fill
	0.4-2	Hydrocarbon	0.8-3.6	Natural - clay
BH4/MW4	0.05-0.3	Hydrocarbon	11	Fill
	0.3-3	Hydrocarbon	14-180	Natural – clay/shale
BH5/MW5	0.0-0.3	Hydrocarbon	80	Fill
	0.3-2.3	Hydrocarbon	52-138	Natural - clay
BH11	0.15-0.6	Hydrocarbon	0.5	Fill
BH14	0.1-0.5	Hydrocarbon	0.8	Fill
	0.5-1.2	Hydrocarbon	0.8	Natural - clay
BH15	0.2-0.4	Hydrocarbon	0.5	Fill
BH16	0.2-0.5	Hydrocarbon	1.5	Fill

Soil Bore Location	Depth (mbgs)	Odour	PID reading (ppm)	Lithology
	0.5-1.1	Hydrocarbon	0.5	Natural - clay
BH17	0.4-0.9	Chemical	8.1	Fill
	0.9-1.3	N/A	6	Natural - clay
BH18	0.25-0.6	Hydrocarbon	0.5	Fill
BH19	0.15-0.6	Hydrocarbon	0.5	Fill
	0.6-1.2	Hydrocarbon	0.5	Natural - clay
BH20	1.5	N/A	16	Natural – rock
BH21	0.15-0.6	N/A	100	Fill
	0.6-1.2	N/A	12	Natural - clay

A total of thirty-six (twenty-two fill and fourteen natural) soil samples were submitted for heavy metal, total recoverable hydrocarbons (TRH), PAH, organochlorine pesticides (OCPs), polychlorinated biphenyls (PCB), organophosphorus pesticides (OPP), phenol and VOC analysis. Soil analytical results reported the following exceedances above the adopted NEPC (2013) Residential with Access to Soil (HIL-A/HSL-A) and ecological criteria:

- Twelve of thirty-six samples submitted for zinc analysis exceeded the ecological criterion of 190mg/kg, with zinc concentrations ranging from 210 to 2,500mg/kg;
- Two samples, BH14(0.3-0.5) and BH21(0.2-0.4), exceeded the copper ecological criterion of 90mg/kg with a concertation of 260 and 98mg/kg, respectively;
- Five samples, BH5(0.2-0.3), BH14(0.3-0.5), BH17(0.6-0.8), BH21(0.2-0.4) and BH22(0.2-0.4), reported lead concentrations above the HIL-A criterion of 300 mg/kg with lead concentrations of 320, 2,400, 500, 360 and 340mg/kg, respectively. Sample location BH14(0.3-0.5) also exceeded the adopted ecological criterion of 1,260mg/kg;
- Three locations, BH3(0.2-0.4), BH4(0.5-0.95), and BH16(0.7-0.9) exceeded the TRH F1 (0- 1.0m) HSL-A criteria of 45 mg/kg for fill and 50 mg/kg for clay, with concentrations of 71, 72 and 71mg/kg, respectively;
- Eight of thirty-six samples exceeded the adopted TRH F2 ecological criterion of 120mg/kg, with TRH F2 concentrations ranging from 130 to 1,100mg/kg;
- Four samples, BH4(0.5-0.95), BH16(0.4-0.5), BH16(0.7-0.9) and BH19(0.2-0.4), exceeded the TRH F2 HSL-A criteria of 110mg/kg for fill and 280 mg/kg for clay with a concentration of 300, 320, 420 and 1,100mg/kg, respectively;
- Sample locations BH16(0.4-0.5) and BH19(0.2-0.4) reported TRH C_{16}-C_{34} concentrations of 3,500mg/kg and 8,400mg/kg, respectively, exceeding the ecological and management limit criteria of 300 and 2,500mg/kg, respectively;
- Naphthalene at sample locations BH18(0.3-0.5) and BH19(0.2-0.4), exceeding the adopted HSL-A (0-1.0m) criterion of 3mg/kg with concentrations of 15 and 17mg/kg, respectively;
- Eight of thirty-six samples exceeded the adopted benzo(a)pyrene ecological criterion of 0.7mg/kg with concentrations ranging from 0.8 to 120mg/kg;
- Sample locations BH7(0.2-0.3), BH16(0.4-0.5), BH18(0.3-0.5), BH19(0.2-0.4) and BH19(0.8- 1.0) exceeded the carcinogenic PAHs (as BaP TEQ) HIL-A criterion of 3mg/kg with concentrations of 6.6, 64, 3.6, 160 and 8.1mg/kg, respectively;
- Sample BH2(0.14-0.4) reported asbestos in soils. A damaged asbestos pipe was also noted in the car park within the south-western site extent; and
- Chlorobenzene (exceeding the interim NEPC (2013) assessment guidelines) was also noted at BH17 (north-eastern portion of the site).

Exceedances of ecological based criteria for soils were considered not to pose an unacceptable risk to receptors as the site was covered by concrete hardstand, bitumen and gravel.

A total of ten samples were submitted for suspension peroxide oxidation combined acidity and sulfur (SPOCAS) analysis. Although some samples were reported to have peroxide oxidisable sulphur over 0.03% and total sulfidic acidity over 18 mol H+/tonne, it was reported it was unlikely that ASS/PASS were present at the site. Exceedance of ASSMAC (1998) criteria were attributed to residual soils originating from Ashfield Shales rather than soils exhibiting characteristic of ASS/PASS.

Monitoring wells MW1 to MW5 reported standing water level measurements between 10.81 (MW3) and 13.0m AHD (MW5), with groundwater flow on the site inferred to be in a south-westerly to southerly direction.

A total of five groundwater samples were submitted for heavy metals, TRH, BTEX, PAHs, ammonia, nitrogen, sulfate, chloride and VOCs. Groundwater analytical results from the investigation reported the following exceedances above the adopted groundwater criteria:

- Copper exceeded the adopted NEPC (2013) Marine Water criterion of 1.3µg/L at sample locations MW1 to MW4, with concentrations ranging from 2 to 4µg/L;
- Nickel exceeded the adopted NEPC (2013) Marine Water criterion of 7µg/L at sample locations MW1 to MW5, with concentrations ranging from 11 to 39µg/L;
- Zinc exceeded the adopted NEPC (2013) Marine Water criterion of 15µg/L at sample locations MW1 to MW5, with concentrations ranging from 38 to 100µg/L;
- Benzene at sample location MW4 with a concentration of 710µg/L, exceeding the adopted NEPC (2013) Marine Water and HSL-A criteria of 500µg/L;
- TRH F1 and TRH F2 fractions at sample locations MW1, MW3 and MW4 were reported above the laboratory limit of reporting (LOR);
- Naphthalene exceeded the adopted NEPC (2013) Marine Water criterion of 50µg/L at sample location MW4, with concentrations of 6 0µg/L; and
- Elevated VOC concentrations (exceeding the interim NEPC (2013) assessment guidelines) at monitoring wells MW1, MW4 and MW5, including:
    - Vinyl chloride (57µg/L) exceeding the adopted criterion of 0.3µg/L at sample location MW1;
    - 1,1-dichloroethene (34µg/L) exceeding the adopted criterion of 30µg/L at sample location MW5;
    - Chloroform (THM) (1 804 µg/L) exceeding the adopted criterion of 3µg/L at sample location MW1;
    - 1,2-dichloroethane (3 600µg/L) exceeding the adopted criterion of 3µg/L at sample location MW1;
    - Isopropylbenzene (63µg/L) exceeding the adopted criterion of 8.4µg/L at sample location MW4;
    - 1,3,5-trimethylbenzene (140µg/L) exceeding the adopted criterion of 25µg/L at sample location MW4; and
    - 1,2,4- trimethylbenzene (590µg/L) exceeding the adopted criterion of 24µg/L at sample location MW4.

Based on these results, EIA (2015) reported that contamination identified during the investigation was likely associated with past filling and from previous site operations (i.e. storage and

manufacture of paints and associated products). It was also reported that soil and groundwater impacts identified in both the fill and residual soils would require remediation prior to redevelopment of the site. EIA (2015) further identified the following data gaps under a HIL-A land use scenario:

- Further assessment of ground conditions underlying existing building within Lot 1 DP 556914;
- No assessment has been undertaken within residential allotments;
- Delineation of lead impacts at sample location BH14;
- The presence of hydrocarbon impacts in subsurface soils and groundwater was identified. The impacts were partially attributed to the presence of UST Pits (refer to **Figure 2**). However, it remained inconclusive that whether the impacts found at locations upgradient of the UST Pits have resulted from the same source. EIA (2015) noted that hydrocarbon impacts upgradient may be from another source (potentially historical paint, furniture manufacturing and fabrication activities);
- Delineation of TRH impacts at sample location BH21;
- The exact number, location and condition of USTs is unclear as well as their former contents. A ground penetrating radar (GPR) survey was recommended along with obtaining anecdotal records and completion of further intrusive investigations;
- Subsurface soils and groundwater below/within identified UST pits were not assessed and their environmental status is unknown;
- Delineation of carcinogenic PAHs (benzo(a)pyrene TEQ) at sample locations BH7, BH16 and BH19;
- Potential for offsite migration of site-related chemicals in groundwater;
- Confirmation of the primary sources of TRH and VOC impacts to groundwater; and
- EIA (2015) noted the F1 TRH concentration at sample location MW1 exceeded the water solubility limit and phase separated hydrocarbon (PSH)/light non-aqueous phase liquid (LNAPL) may occur in groundwater as a result. Although PSH/LNAPL was not identified, a slight sheen was noted at sample location MW4 suggesting the potential for PSH/LNAPL. EIA (2015) recommended that further assessment including sampling for PSH and speciation of TRH compounds and vapour intrusion assessment to confirm the presence of any PSH/LNAPL.

EIA (2015) concluded that the site was suitable to be rezoned and redeveloped to allow mixed residential and commercial land-use, subject to the recommendations provided in the report and management of contamination issues in accordance with the State Environmental Planning Policy 55 (SEPP 55) – Remediation of Land and the Marrickville Council Contaminated Land Policy.

5.3 Data Gap Assessment (JBS&G 2016[16])

JBS&G was engaged to undertake a data gap investigation (DGI) of Lot 1 in DP 556914. JBS&G were initially required to conduct additional limited investigation works for due diligence purposes for potential development of Lot 1 in DP 556914 for mixed land uses. However, the works evolved to address key data gaps identified in an earlier revision of EIA (2015) and further define identified impacts on site and assess for potential off-site migration.

[16] *Data Gap Assessment 75 Mary Street, St Peters, NSW.* JBS&G Australia Pty Ltd dated 15 September 2016 reference 51501/103491 Revision A (JBS&G 2016)

The scope of work completed comprised:

- Review of an earlier version of EIA (2015) to identify AECs and COPCs;
- A GPR survey in areas where potential pits/USTs were identified during the desktop assessment;
- Implementation of a site investigation program including drilling and soil sampling of eleven bore locations (SB1 to SB6, SBH7 to SBH10 and MW14) (up to a total depth of 7m bgs), with nine borehole locations converted into groundwater monitoring wells (SB1/MW6, SB2/MW7, SB3/MW8, SB5/MW9, SBH7/MW10, SBH8/MW11, SBH9/MW12, SBH10/MW13 and MW14);
- Sampling of five existing and nine newly installed groundwater monitoring wells (MW1 to MW14)
- Collection of liquid samples from two pits (sample ID Pit 1 and Pit 2);
- Collection of sub-slab vapour samples at twenty locations (SV1 to SV13, SV13A, SV13B, SV13C and SV14 to SV18);
- Collection of indoor air samples at one location (two rounds); and
- Laboratory analysis of soil, groundwater, liquid and vapour samples for relevant constituents as determined from the site history review, CSM and field observations during the investigation program.

The soil investigation identified the presence of fill materials (on average 0.5m-1.0m in thickness) underlain by residual soils (silty clay/clays) and weathered shales. The fill comprised various constituents, suggesting several periods of filling in the past.

Soil observations made during the investigation are summarised in **Table 4.2** below**.**

Table 4.2: Soil Investigation Observations (JBS&G 2016)

Lithologic Type	Depth	Lithologic Description	Inclusions
Surface (concrete)	0.0-0.5	Concrete	None
Fill (Gravelly clay/gravelly sand/silty clay/sandy clay)	0.4-1.8	Grey/brown/black, heterogeneous, medium plasticity	Ash, gravels and glass
Silty clay	0.4-2.9	Brown to grey (red mottles)/red (grey mottles)/ orange to brown to red, homogeneous, medium to high plasticity	None
Weathered shale*	1.5-9	Grey to brown	None

*Not observed at soil locations SB8/MW11, SB9/MW12 and SB10/MW13 (within proximity of the north-western building footprints). Silty clays were present to final investigation depth.

Slight to moderate hydrocarbon odours were noted in soil bore locations SB1/MW6 (from 0.3 to 1.1m bgs), SB2/MW7 (from 0.1 to 3.0m bgs), SB5/MW9 (from 0.25 to 0.6m bgs) and SB4 (0.5 bgs). Black soil staining was also observed at SB2/MW7 (1.0m bgs), SB5/MW9 (0.5m bgs) and SB4 (0.5m bgs), refer to **Figure 8D**. No asbestos containing material (ACM) was observed within fill during the investigation. Each soil sample was screened with a PID. Soil PID readings above 5 ppm are presented in **Table 4.3** and shown on **Figure 8D**.

Table 4.3: Soil PID Readings >5 ppm (JBS&G 2016)

Soil Bore Location	Depth (mbgs)	PID reading (ppm)
SB1	4.9-5.0	7.0
	5.9-6.0	5.7
SB2	0.1-0.2	10.4
	0.9-1.0	204
	1.9-2.0	50

Soil Bore Location	Depth (mbgs)	PID reading (ppm)
	2.9-3.0	30
	3.9-4.0	12.3
	4.9-5.0	13.8
	5.9-6.0	10.2
SB3	0.3-0.4	22.6
SB6	0.4-0.5	8
SBH7	1.0-1.1	9

During the JBS&G investigation, it was noted that subsurface fill and shallow clays were relatively dry until an inferred water bearing layer was encountered at approximately 4m bgs. This is particularly noted in soil investigation locations SBH8/MW11, SBH9/MW12 and SBH10/MW13 and MW14. Saturated soils were also encountered in very weathered shale material observed in SB1/MW6 and SB7/MW10 from 5.5m bgs. It was noted that the similarity in groundwater elevation at MW7 (deeper screen) and MW8 (shallow screen) suggests that the water bearing zone is likely within residual silty clay layer.

A GPR survey was undertaken across three areas and surrounds (Pit 1 to Pit 3, as shown on **Figure 2**). The following summarises JBS&G's observations during the survey conducted by Alpha:

- Pit 1 - Location indicated by multiple former fill points and visual confirmation of a pit via removal of fill point covers. The pit appeared to be a single concrete pit and did not appear to contain individual USTs during the site inspection. Liquid was observed to be present within the pit and was sampled (PIT 1). It was reported there is potentially two former USTs present to the north-west of the area based on fill points and GPR survey. However, the presence or status of the USTs could not be confirmed at the time of the investigation.
- Pit 2 - A former UST was identified based on fill points and GPR survey. Distillate petroleum hydrocarbons odours were observed following removal of the fill point cover. The current status of the UST and pit is uncertain. A pit was identified to the north of this UST, but may be related to site stormwater infrastructure. Liquid was observed to be present within this separate pit and was sampled (PIT 2).
- Pit 3 - EIA (2015) indicated the presence of a pit following encounter of a 4m void during advancement of soil bore BH13. JBS&G could not locate this pit nor identify the location of BH13 during the site inspection and GPR survey in May 2015.

Two grab samples were taken from the water in Pit 1 and Pit 2. All constituents were below the laboratory LOR, with the exception of TPH C_{15}-C_{28} (200µg/L), TPH C_{10}-C_{36} (total) (200µg/L), TRH >C_{16}- C_{34} (200µg/L), and arsenic (1µg/L) in Pit 1, and copper (6µg/L) and nickel (3µg/L) in Pit 2.

A total of sixteen (eleven fill and five natural) soil samples were submitted for heavy metal, TRH, BTEX, VOC and PAHs analysis while six fill samples were analysed for PCBs and phenols. Soil analytical results reported the following exceedances above the adopted NEPC (2013) HIL-D/HSL-D and ecological criteria:

- Lead at sample location SB3/MW8 with a concentration of 1 700mg/kg, exceeding the adopted HIL-D criterion of 1 500mg/kg.

Groundwater was generally grey to brown or colourless with moderate turbidity. A slight sheen was observed in MW1, while odours were present in MW1, MW4, MW7, and MW11. PSH/LNAPL was not encountered.

Standing groundwater levels were between 0.72 m bgs/12.7m AHD (MW8) and 3.35m bgs/8.6m AHD (MW13) based on gauging conducted on 20 July 2015. The inferred groundwater flow direction was to the west and south-west based on survey data of the current monitoring well network (excluding MW14).

The measured parameters for the water samples were as follows:

- pH range of 4.21 to 7.26;
- Redox potential of -53 to 479.8mV (vs Ag/AgCl);
- Dissolved oxygen (DO) range of 0.16 to 4.10 mg/L;
- Temperature range of 19.5 to 21.5°C; and
- Electrical Conductivity range of 479.8 to 5,588 µS/cm.

Field parameters indicate that the groundwater is fresh to brackish and relatively low in oxygen. The pH was slightly acidic in all wells (with the exception of MW14) and uncorrected redox potential was generally positive with the exception of MW4.

A total of fourteen groundwater samples were submitted for analysis for heavy metals, TRH, BTEX, PAHs and VOCs. Eight samples were submitted for phenols. Groundwater analytical results from the investigation reported the following exceedances above the adopted groundwater criteria:

- Benzene exceeded the adopted NEPC (2013) Marine Water criterion of 550µg/L and Recreational Water criterion of 10µg/L at sample locations MW4 (1 100µg/L) and MW7 (1 400µg/L);
- Ethylbenzene exceeded the adopted NEPC (2013) Marine Water criterion of 5µg/L at sample locations MW4 (430 µg/L) and MW7 (560µg/L);
- Xylenes (m&p) exceeded the adopted NEPC (2013) Marine Water criterion of 75µg/L at sample locations MW4 (340µg/L) and MW7 (1 400µg/L);
- Xylene (0) exceeded the adopted NEPC (2013) Marine Water criterion of 350µg/L at sample location MW7 (1 300µg/L);
- TRH F1 exceeded the adopted NEPC (2013) Marine Water criterion of 20µg/L at sample locations MW1 (4 100µg/L), MW4 (2 300µg/L), MW6 (3 600µg/L), MW7 (50 000µg/L), MW10 (11 000µg/L) and MW14 (1 800µg/L);
- TRH F2 exceeded the adopted NEPC (2013) Marine Water criterion of 50µg/L at sample locations MW1 (90µg/L), MW3 (1 300µg/L), MW4 (3 500µg/L) and MW6 (6 200µg/L);
- Naphthalene exceeded the adopted NEPC (2013) Marine Water criterion of 50µg/L at sample locations MW4 (140µg/L) and MW7 (100µg/L);
- Phenanthrene exceeded the adopted NEPC (2013) Marine Water criterion of 0.6µg/L at sample locationMW7 (2.9µg/L);
- Cadmium exceeded the adopted NEPC (2013) Marine Water criterion of 0.7µg/L at sample location MW14 (1µg/L);
- Copper exceeded the adopted NEPC (2013) Marine Water criterion of 1.3µg/L at sample locations MW1 (2µg/L), MW2 (3µg/L), MW5 (4µg/L), MW7 (3µg/L), MW9 (2µg/L), MW13 (3µg/L) and MW14 (53µg/L);
- Lead exceeded the adopted NEPC (2013) Marine Water criterion of 4.4µg/L at sample location MW14 (36µg/L);
- Nickel exceeded the adopted NEPC (2013) Marine Water criterion of 7µg/L at sample locations MW1 (43 µg/L), MW2 (10µg/L), MW5 (16µg/L), MW6 (13µg/L), MW11 (7µg/L) and MW13 (15µg/L);
- Twelve of sixteen samples submitted for zinc analysis exceeded the Marine Water criterion of 15µg/L, with zinc concentrations ranging from 20 to 400µg/L;

- 1,2-dichloroethane exceeded the adopted NEPC (2013) Marine Water criteria of 1 900µg/L and Recreational criteria of 30µg/L at sample locations MW1 (3 900µg/L), MW6 (3 100µg/L), MW9 (21 000µg/L) and MW14 (9 600µg/L);
- 1,1-dichloroethene was reported above the laboratory LOR at sample locations MW1 (11µg/L), MW4 (63µg/L) and MW5 (220µg/L);
- Vinyl chloride exceeded the adopted Recreational criterion of 3µg/L at sample locations MW1 (26µg/L), MW5 (5µg/L) and MW6 (6µg/L); and
- Chlorobenzene exceeded the adopted Marine Water (55µg/L) and/or Recreational (3 000µg/L) criteria at sample locations MW1 (150µg/L), MW4 (340µg/L), MW6 (770µg/L), MW7 (24 000µg/L) and MW14 (160µg/L).

A summary of key groundwater analytes is presented in **Table 4.4** below.

Table 4.4: Range of Key COPC Concentrations in Groundwater (µg/L) (JBS&G 2016)

Analyte	Min. Concentration (µg/L)	Max. Concentration (µg/L)	Mean Concentration	Location of Max. Concentration
Benzene	<1	1 400	211	MW7
Ethylbenzene	<1	560	87	MW7
Xylene (total)	1	2 900	376	MW7
Naphthalene	<0.05	140	20	MW4
Copper (filtered)	<1	53	5.3	MW14
Nickel (filtered)	<1	43	9.2	MW1
Zinc (filtered)	<5	400	86	MW14
1,2-dichloroethane	<1	21 000	2 524	MW10
Dichloromethane	<1	8	16	MW1
1,1-dichloroethene	<1	220	34	MW5
Vinyl chloride	<1	26	17	MW1
Chlorobenzene	<1	24 000	3 965.6	MW7

A total of twenty sub-slab soil vapour location were advanced across Lot 1 DP 556914. The measured parameters for the sub-slab samples were as follows:

- Oxygen levels were found to range from 12.0% to 20.8%;
- PID concentrations ranged from 0ppm to 184 ppm; and
- LEL (expressed in terms of VOCs) ranged from 0% to 86%.

Soil vapour samples were submitted for VOC analysis (and limited TRH analysis). Soil vapour analytical results reported the following exceedances above the adopted NEPC (2013) Interim Soil Vapour HIL- D/HSL- D and US EPA RSL:

- TCE at sample locations SV13 (7mg/m^3), SV13-A (32mg/m^3) and SV13-B (7.87mg/m^3), exceeding the adopted Interim Soil Vapour HIL-D criterion of 0.08mg/m^3.

A summary of key soil vapour analytes is presented in **Table 4.5** below.

Table 4.5: Range of Key COPC Concentrations in Soil Vapour (mg/m3) (JBS&G 2016)

COPC	PCE	TCE	TRH C6-C10	BTEX	Chlorobenzene
Max. concentration	0.14 (SV13-A)	32 (SV13-A)	9.83 (SV13)	3.334 (SV18)	0.367 (SV8)
Min. concentration	<0.08333	<0.08333	<1.667	<1.667	<0.08333

Based on the results, JBS&G (2016) reported:

- Lot 1 DP 55914 has historically been used for industrial purposes, in particular, Lot 1 DP 55914 was used for paint and varnish manufacturing (Taubmans) from the 1920s until the mid-1960s, and subsequently used for various industrial/commercial purposes.

- A previous site investigation identified both soil and groundwater impacts with various contaminants including metals, PAHs, TRH and VOCs inferred to be associated with filling and historical site activities.
- The site inspection identified that the majority of Lot 1 DP 55914 is currently sealed and covered by a mixture of large brick and metal warehouse structures, with an unpaved area used for car parking in the south-eastern portion of the site.
- Results of the GPR survey confirmed the presence of a UST in the central portion of the site. In addition, it was identified there was potentially two former USTs present to the north-west of Pit 1 (as shown on **Figure 2**) based on fill points and GPR survey. Grab water samples from pooled water in Pits 1 and 2 were analysed for a range of constituents with reported concentrations generally low or below the LOR. It is noted that relatively low concentrations of TRH>C_{16}-C_{34} (200µg/L) were reported in Pit 2.
- Soil sampling was conducted via the advancement of push tubes at eleven locations targeting AECs. Depth of fill materials across Lot 1 DP 55914 ranged from 0.5 to 1.2m bgs, and were predominantly silty, gravelly or sandy clays underlain by natural silty clay and weathered shale. Concentrations of COPCs in soil samples selected for analysis were below health based investigation and screening levels for commercial and industrial land-use with the exception of lead in shallow fill at SB03. On the basis that there is limited human exposure to underlying soils due to the presence of hardstand, it was considered that the Lot 1 DP 55914 soils do not pose an unacceptable risk to current on-site receptors.
- Groundwater monitoring and sampling was conducted on fourteen wells with the general groundwater flow direction confirmed to the south-west consistent with previous investigations. Petroleum hydrocarbons/chlorinated hydrocarbons groundwater impacts were identified within the central site extent in proximity to former paint manufactory activities and/or in proximity to UST/former sub-surface infrastructure.
- Twenty sub-slab vapour sampling locations were advanced targeting the areas of highest identified soil and groundwater VOC impacts. TCE at sample locations SV13 (7mg/m^3), SV13- A (32mg/m^3) and SV13-B (7.87 mg/m^3) exceeded the adopted Interim Soil Vapour HIL- D criterion of 0.08mg/m^3.
- Concentrations of key contaminants are less than or similar to the LOR downgradient of the zone identified with the most significant impacts (i.e. exceeding 10mg/L) of chlorinated organic compounds at MW4, MW7 and MW10. JBS&G (2016) reported given the likely old age of the primary source (likely to be pre-1960s), this indicates there is limited migration of contaminants in groundwater at the site. It was considered this is likely to be due to the presence of clays and shales, which are inferred to have low permeability based on literature and field observations, and natural attenuation mechanisms.
- The low permeability clays underlying fill materials likely act to retard vertical vapour movement, however, lateral migration of vapours in the vadose zone, in particular in fill materials, may potentially occur.
- Risks to residential receptors to the north-west of the site related to the TCE in sub-slab vapour identified at SV-13 were considered low due to the following:
    - The suspected source of the elevated TCE concentrations detected was considered to most likely represent isolated contamination in shallow soils and/or the sewer line running along the north-western boundary of the site;
    - Due to the physical chemical properties of TCE, if a significant TCE source was present in soils beneath the single level and/or multi-level building in this portion of the site, it would be reasonable to expect that detectable concentrations of TCE would be

identified in hydraulically downgradient wells (i.e. MW12, MW13), however, this was not the case (i.e. TCE below reporting limit of 1 µg/L in these wells); and

- If shallow soils onsite are the source of the elevated TCE concentrations detected in soil vapour, the offsite sewer is likely to act as a preferential pathway for vapour migration (i.e. act as a relatively high permeability barrier limiting vapour migration towards residences).

- If groundwater onsite is the source of the elevated TCE concentrations detected in soil vapour (unlikely), the offsite residences are hydraulically cross gradient of the site (i.e. unlikely to be affected by site originated groundwater contamination, noting that no TCE contamination has been identified in groundwater).
- The indoor air sampling location targeted the area of highest sub-slab vapour impact (SV13). Concentrations of TCE in indoor air ranged from below the laboratory LOR to 0.003mg/m^3 over two rounds of monitoring.
- On the basis of the findings of the investigation and in consideration of the current commercial use of Lot 1 DP 55914, the following actions were recommended:
  - Additional assessment of identified site impacts (particularly in relation to TCE in sub-slab vapour at location SV13) as part of a human health risk assessment (HHRA) to be prepared for the current commercial users; and
  - Implementation of an Environmental Management Plan (EMP) to control potential direct exposures to site soils and groundwater.

5.4 Human Health Risk Assessment (JBS&G 2016b[17])

JBS&G were engaged to prepare a Human Health Risk Assessment (HHRA) for Lot 1 DP 55914 for ongoing commercial use of the site to address soil, groundwater and soil vapour impacts.

On the basis of the available information and the assumptions adopted, JBS&G (2016b) concluded that:

- On the basis of the soil and groundwater data, direct contact exposure risks to current commercial workers (i.e. incidental ingestion, dermal contact) require ongoing management, however, risks can be managed to acceptable levels through the implementation of an EMP which predominantly focuses upon existing risk control measures (i.e. no groundwater use for any use other than monitoring, maintenance of existing barriers between soil and site users);
- When considering the available soil, groundwater and soil vapour data against adopted vapour intrusion based tier 1 criteria, vapour intrusion risks to current commercial workers at the site only require detailed assessment for Building 1;
- On the basis of the soil vapour data, indoor air data, vapour intrusion modelling and inhalation risk calculations, vapour intrusion risks to current commercial users of Building 1 are acceptable based upon current conditions.
- Subject to the appropriate implementation of an EMP it was considered that Lot 1 DP 55914 is suitable for commercial use.
- JBS&G (2016b) recommended an EMP should be prepared which focuses upon maintaining incomplete source-pathway-receptor linkages using safe work procedures and administrative controls to provide a framework for managing direct contact risks posed by

[17] *Human Health Risk Assessment – Commercial Workers, 75 Mary Street, St Peters, NSW.* JBS&G Australia Pty Ltd dated 22 September 2016 reference 51501/104733 Revision 0 (JBS&G 2016b)

the identified contamination (e.g. maintaining the existing permanent barrier across the site, precluding groundwater use for any purpose other than monitoring). It was recommended that the EMP should also include protocols for managing vapour inhalation risks during below ground and/or ground disturbing activities as well as ongoing indoor air monitoring for Building 1.

5.5 Interim Environmental Management Plan (JBS&G 2016c[18])

JBS&G was engaged to prepared an Interim EMP for Lot 1 DP 556914 due to identified soil, groundwater and soil vapour impacts.

The EMP provides management requirements to protect human health and the environment during normal aboveground access/maintenance activities as well as subsurface activities involving disturbance of soils during the ongoing commercial use of Lot 1 DP 556914.

To control risks associated with identified COPC, the Interim EMP requires the following procedures to be implemented to ensure the ongoing land use suitability:

- Groundwater should not be used for any purposes other than monitoring by a suitably qualified and experienced environmental consultant.
- The existing hardstand across the Lot 1 DP 55914 prevents direct contact (i.e. dermal, ingestion) and inhalation (i.e. particulate) exposure to the identified contamination. The physical integrity of the hardstand is required to be maintained by the site owner.
- Should intrusive works be required, suitably qualified and experienced environmental consultant should be engaged to advise on management and methodology of works to be undertaken (e.g. advice for soil handling/disposal, identification of appropriate Personnel Protection Equipment) from an environmental perspective.
- On the basis of the HHRA (JBS&G 2016b), ongoing indoor air monitoring is required for the single level section of Building 1.

JBS&G (2016c) concluded that Lot 1 DP 556914 was suitable for ongoing commercial land use subject to implementation of the Interim EMP. It was noted that the document represents an interim EMP only, with a comprehensive EMP required to be prepared in the future following development of the site.

[18] *Interim Environmental Management Plan – 75 Mary Street, St Peters, NSW*. JBS&G Australia Pty Ltd dated 23 September 2016 reference 51501/105374 (JBS&G 2016c)

6. Fill Retention

JBS&G has been advised by the client that future characterisation activities as part of data gap investigation (**Appendix A**) are required to assess the leaching potential of contaminants and assess the risk to human health and ecological receptors under the following fill retention scenarios:

- Retention of fill materials above the water table by means of physical separation (where appropriate); and
- Retention of fill materials below the water table (where appropriate). This may include retention of fill materials within areas of low aquifer transmissivity (i.e. surrounded by clay/shale).

The nature and extent of fill retention will only be resolved following receipt of additional sampling and analysis laboratory results and preparation of a HHERA to be prepared for the site. The results will be presented in a Remedial Works Plan (RWP) for Site Auditor endorsement prior to the works being implemented.

Primary contaminant sources (impacted fill/soils adjacent USTs/chemical storage and/or historical paint manufacturing activities) will be remediated by off-site disposal. The balance of fill/soils within the Site B: Precinct 75 Mixed Use Redevelopment with exceedance of ecological/health criteria will be subject to a fill retention suitability assessment as detailed in **Appendix A**.

The additional fill characterisation activities can only occur following demolition of existing site structures, providing access to areas previously inaccessible.

7. Data Gaps

Sufficient data has been collected to characterise the site and detail the remedial works/framework required to make the site suitable for proposed land uses, however, further environmental data is required to refine/confirm the extent of remedial works and support the preparation of a HHERA.

A number of data gaps have been identified which are proposed to be addressed through a systematic and targeted program of supplementary investigations as detailed in **Appendix A**. The additional works can only occur following demolition of existing site structures providing access to areas previously inaccessible.

The data gaps relevant to the remediation of the site and support the proposed fill retention strategy are as follows:

Site B: Precinct 75 Mixed Use Redevelopment

- Basement Vapour and Seepage Control Requirements - further soil vapour and groundwater characterisation is required in order to define the lateral extent of chlorinated hydrocarbon impacts identified near the western extent of the basement. Existing soil vapour and groundwater monitoring wells are located along the former proposed basement western alignment (Site B: Precinct 75 Mixed Use Redevelopment/Site A: Precinct 75 Commercial boundary), and it is uncertain whether the identified impacts extend east to the current proposed basement alignment (refer to **Figure 5B**).
- Site Wide Groundwater Quality - given the identification of additional chlorinated hydrocarbon impacts between EIA (2015) and JBS&G (2016), further assessment of groundwater is warranted.
- Residential Allotments - no sampling and analysis has been completed within Lot 1 DP 745667 (50 Edith Street), Lot 1 DP 745014 (52 Edith Street), Lot 1 DP 87558/Lot A DP 331215 (43 Roberts Street) and Part Lot 180958 (67 Mary Street). Assessment of the contamination status of these areas is required.
- Assessment Beneath Buildings - the extent of historical environmental investigations has been restricted by the occurrence of buildings/structures at the site. Further assessment is required beneath existing site structures.
- Fill Retention - further investigation is required to assess the leaching potential of contaminants and the risk to human health and ecological receptors where fill is proposed to be retained (refer to **Section 6**).
- Waste Classification - additional leachate assessment by TCLP testing for waste classification purposes is required.

<u>Site A: Precinct 75 Commercial</u>

- Site Wide Groundwater Quality - given the variability in chlorinated hydrocarbon between EIA (2015) and JBS&G (2016), further assessment of groundwater is required.
- Ambient Air Monitoring - Elevated sub-slab soil vapour TCE concentrations have been reported underlying the Building 1. However, ambient air quality results from within the building collected as part previous investigations were all below the adopted assessment criteria. As such, no current risk from sub-slab vapour conditions has been reported, however, additional assessment of sub-slab vapour conditions underlying Building 1 may be warranted to support ongoing management if the exposure scenario changes under the adaptive reuse or change to the EMP is necessary. In addition, ambient air monitoring within Building 1 is required to be undertaken to support the HHERA to be prepared for the site.

- Soil Vapour - the nature of the key contaminants in soil and groundwater (chlorinated hydrocarbons) at the site means that soil vapour is a potential contamination issue to be addressed for ongoing commercial use. Although targeted soil vapour investigations have been conducted in accessible areas of the site (primarily roadways), additional assessment of sub-slab vapour conditions underlying existing commercial buildings will be required to support the HHERA and remedial works plan (RWP). Further, confirmation of previous detections of volatile TRH and TCE in a sub-slab vapour sample near the western extent of the site is also required.

Following implementation of the DGI sampling, analysis and quality plan (SAQP) (refer to **Appendix A**) and documentation of the assessment finding in a revised contamination assessment report, a HHERA will be prepared for the site along with a RWP revising/confirming the extent of remedial works and confirming the suitability of fill retention strategy presented in **Section 6**.

8. Conceptual Site Model

Based on the available site history information and known site contamination status, the various CSM elements are discussed below. In addition, a schematic interpretation of the CSM in relation to the proposed development is presented as **Figure 9**.

8.1 Overview

NEPC (2013) identifies a CSM as a representation of site related information regarding contamination sources, receptors and exposure pathways between those sources and receptors. The development of a CSM is an essential part of all site assessment and remediation reports.

NEPC (2013) identified the essential elements of a CSM as including:

- Known and potential sources of contamination and contaminants of concern including the mechanism(s) of contamination;
- Potentially affected media (soil, sediment, groundwater, vapours etc.);
- Human and ecological receptors;
- Potential and complete exposure pathways; and
- Any potential preferential pathways for vapour migration (if potential for vapours identified).

8.2 Potentially Contaminated Media and Area of Environmental Concern

Potentially contaminated media comprise:

- Fill materials;
- Underlying natural soils;
- Subsurface vapour; and
- Groundwater

8.2.1 Soils – Site B: Precinct 75 Mixed Use Redevelopment

The soil investigations show the site lithology comprises heterogenous fill materials (on average between 0.5 to 0.7m in thickness) with trace levels of anthropogenic inclusions (gravels, glass and ash). The fill comprised various constituents, suggesting several periods of filling in the past (albeit limited in extent). The extent of historical environmental investigations has been restricted by the occurrence of buildings/structures at the site.

Available characterisation data has identified that samples of fill have, in some instances, concentrations of carcinogenic PAH compounds (including benzo(a)pyrene TEQ), TRH, heavy metals (principally zinc with limited copper and lead impacts) and asbestos in exceedance of ecological-based assessment criteria, and at relatively few locations, adopted health-based criteria as relevant to the proposed future land uses. Fill/soil materials are generally characterised by low leachability. Further leachability assessment of fill conditions is required should fill materials be proposed to be retained on site.

Analysis of natural soils indicated contaminated material is generally limited to fill overlying the natural soils. Several soil samples reported elevated TRH, PAH and heavy metals within the inferred top 0.5 to 0.9m of the natural soil profile. Potential remains for the historical sampling methodology to have resulted in minor cross-contamination of samples of underlying natural profile or for natural soils to have become impacted as a result of vertical migration of contaminants (albeit limited in extent).

The majority of soil (both fill and natural) exceedances are located within the central site extent, in proximity to historical paint manufacturing activities and/or petroleum/chemical storage and handling. Historical petroleum/chemical storage infrastructure is still present on site (**Figure 2**).

Elevated PID concentrations (i.e. over 5 ppm), odorous or stained soils were generally in proximity to historical paint manufacturing activities and/or in proximity or down gradient of petroleum/chemical sub-surface infrastructure (refer to **Figure 8D**).

A summary of existing analytical data is provided in **Appendix A**. Lithological cross sections are depicted in **Figures 6A** to **6B** to assist with the interpretation of site conditions. Soil sample exceedances with respect to the land use criteria presented **Section 10** are shown on **Figure 8A**. Historical soil bore logs are included in **Appendix A**.

8.2.2 Soil - Site A: Precinct 75 Commercial

The lithological profile within this area is similar to that within the Site B: Precinct 75 Mixed Use Redevelopment, comprising heterogenous fill materials (on average between 0.5 to 0.7m in thickness) with trace levels of anthropogenic inclusions (gravels, glass and ash). The fill comprised various constituents, suggesting several periods of filling in the past (albeit limited in extent).

Available characterisation data identified that fill/natural soils are suitable for the proposed commercial land use with the exception of soils at sample location BH16, which reported TRH/PAH exceeding the ecological and/or human health criteria.

Elevated PID concentrations (i.e. over 5 ppm), odorous or stained soils were generally in proximity to historical paint manufacturing activities and/or in proximity or down gradient of petroleum/chemical sub-surface infrastructure (refer to **Figure 8D**).

Similar to the Site B: Precinct 75 Mixed Use Redevelopment, the extent of historical environmental investigations has been restricted by the occurrence of buildings/structures at the site.

A summary of existing analytical data is provided in **Appendix A**. Lithological cross sections are depicted in **Figures 6A** to **6B** to assist with the interpretation of site conditions. Soil sample exceedance with respect to the land use criteria presented **Section 10** are shown on **Figure 8A**. Historical soil bore logs are included in **Appendix A**.

Based on the results of JBS&G (2016b) fill/soils beneath the Site A: Precinct 75 Commercial precinct do not represent an unacceptable risk to existing commercial workers provided existing site capping arrangements are retained/managed in accordance with the procedures in JBS&G (2016c).

8.2.3 Groundwater

JBS&G note that the site and areas hydrogeologically down gradient are located within Zone 2 of the Botany Sand Aquifer Embargo Area. 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 including 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 DPI – Office of Water and the NSW OEH.

Site groundwater has been identified to be impacted by petroleum hydrocarbons, chlorinated hydrocarbons and heavy metals, albeit limited in extent. Impacts were identified at the following locations:

- Elevated levels of heavy metals in groundwater were reported in all wells across the site. Concentrations are considered consistent with urban background levels and not to represent an unacceptable risk requiring remediation/management;

- Vinyl chloride in the northern and south-eastern site extents in proximity to locations MW1 and MW5 representing a potential unacceptable risk to future site users;
- PAHs, BTEX and chlorobenzene impact predominantly in the central portion of the site around locations MW4, MW6 and MW7 representing a potential unacceptable risk to future site users; and
- 1,2-dichloroethane impact predominantly in the north-central portion of the site around locations MW1, MW6, MW10 and MW14 representing a potential unacceptable risk to future site users.

No PSH/LNAPL has been identified underlying the site.

Further groundwater characterisation is required in order to define the lateral extent of chlorinated/petroleum hydrocarbon impacts identified near the western extent of the proposed basement. Existing groundwater monitoring wells are located along the former proposed basement western alignment (Site B: Precinct 75 Mixed Use Redevelopment/Site A: Precinct 75 Commercial boundary), and it is uncertain whether the identified impacts extend east to the current proposed basement alignment (refer to **Figure 5B**).

Concentrations of key contaminants are less than or similar to the LOR downgradient of the zone identified with the most significant impacts (i.e. exceeding 10 mg/L) of chlorinated organic compounds at MW4, MW7 and MW10. Given the likely old age of the primary source (likely to be pre-1960s) the plume is relatively small indicating that there is limited migration of contaminants in groundwater at the site. It is considered this is likely to be due to the presence of clays and shales, which are inferred to have low permeability based on literature and field observations, and natural attenuation mechanisms.

The low permeability clays underlying fill materials likely act to retard vertical vapour movement, however, lateral migration of vapours in the vadose zone, in particular in fill materials, may potentially occur.

Based on the results of JBS&G (2016b), groundwater beneath the Site A: Precinct 75 Commercial area does not represent an unacceptable risk to existing commercial workers provided groundwater is not used for any kind other than groundwater monitoring and ongoing implementation of procedures in JBS&G (2016c).

Based on the EPA assessment (**Appendix A**), groundwater migrating off-site does not represent an unacceptable risk requiring regulation.

8.2.4 Soil Vapour

Concentrations of VOCs in most sub-slab vapour samples collected from the site were below the laboratory LOR at locations targeted to the greatest identified soil and groundwater VOC impacts. TCE impact was identified in an isolated area around SV13, SV13-A and SV13-B exceeding the screening criteria for commercial and industrial land-use, applicable to this portion of the site.

Risks to residential receptors to the north-west of the site related to the TCE in sub-slab vapour identified at SV-13 were considered low due to the following:

- The suspected source of the elevated TCE concentrations detected was considered to most likely represent isolated contamination in shallow soils and/or the sewer line running along the north-western boundary of the site;
- Due to the physical chemical properties of TCE, if a significant TCE source was present in soils beneath the single level and/or multi-level building in this portion of the site, it would be reasonable to expect that detectable concentrations of TCE would be identified in

hydraulically downgradient wells (i.e. MW12, MW13), however, this was not the case (i.e. TCE below reporting limit of 1 µg/L in these wells); and

- If shallow soils onsite are the source of the elevated TCE concentrations detected in soil vapour, the offsite sewer is likely to act as a preferential pathway for vapour migration (i.e. act as a relatively high permeability barrier limiting vapour migration towards residences).

If groundwater onsite is the source of the elevated TCE concentrations detected in soil vapour (unlikely), the offsite residences are hydraulically cross gradient of the site (i.e. unlikely to be affected by site originated groundwater contamination, noting that no TCE contamination has been identified in groundwater).

The indoor air sampling location targeted the area of highest sub-slab vapour impact (SV13). Concentrations of TCE in indoor air ranged from below the laboratory LOR to 0.003mg/m^3 over two rounds of monitoring.

Further soil vapour characterisation is required in order to define the lateral extent of chlorinated hydrocarbon impacts identified near the western extent of the basement. Existing soil vapour locations are located along the former proposed basement western alignment (Site B: Precinct 75 Mixed Use Redevelopment/Site A: Precinct 75 Commercial precinct boundary), and it is uncertain whether the identified impacts extend east to the current proposed basement alignment (refer to **Figure 5B**).

Based on the results of JBS&G (2016b), soil vapour beneath the Site A: Precinct 75 Commercial area does not represent an unacceptable risk to existing commercial workers provided existing site capping arrangements are retained/managed in accordance with the procedures in JBS&G (2016c).

8.3 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 a combination of:

- 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 review and previous investigation are generally in either a solid form (e.g. heavy metals, asbestos, etc.) and liquid form (e.g. fuel, solvents, etc.), however, dependent upon concentrations, there is the potential for TRH/VOC/PAH impacts to occur in a vapour form.

As the site is primarily paved with concrete/asphaltic concrete or roadbase aggregate, 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 low given the extent of impermeable pavements at the site.

Given the low permeability nature of the underlying soils, migration of contamination via groundwater movement is considered to be a potential migration pathway albeit limited as discussed in **Section 5.3**. Potential remains for groundwater seepage into the proposed basement.

The vapour generation potential associated with volatile and semi-volatile COPC (TRH, VOCs, PAHs) are identified as a potential migration pathway, particularly in areas where subsurface infrastructure, such as stormwater, sewer, underlie the site and migration potential into the future basement.

As discussed in **Section 5.3**, the low permeability clays underlying fill materials likely act to retard vertical vapour movement, however, lateral migration of vapours in the vadose zone may potentially occur.

Based on the results of JBS&G (2016b), soil vapour beneath the Site A: Precinct 75 Commercial area does not represent an unacceptable risk to existing commercial workers provided existing site capping arrangements are retained/managed in accordance with the procedures in JBS&G (2016c).

8.4 Potential Exposure Pathways

Based on the COPC identified in various media, as discussed above, and proposed site development activities, the exposure pathways for the site during and following development works include:

- Inhalation of potential COPC vapours migrating upwards from material of unknown origins or impacted fill/soils resulting from historical leaks/spills, industrial activities etc.; 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 or bulk excavation activities; and/or
- Potential contaminant uptake by vegetation within landscaped areas.

Elevated sub-slab soil vapour TCE concentrations have been reported underlying Building 1. However, ambient air quality results from within the building collected as part of previous investigations were all below the adopted assessment criteria. As such, no current risk from sub-slab vapour conditions has been reported, however, additional assessment of sub-slab vapour conditions underlying Building 1 may be warranted to support ongoing management if the exposure scenario changes under the adaptive reuse or change to the EMP is necessary.

Risks to residential receptors to the north-west of the site related to the TCE in sub-slab vapour identified at SV-13 are considered low due to the following:

- The suspected source of the elevated TCE concentrations detected is considered to most likely represent isolated contamination in shallow soils and/or the sewer line running along the north-western boundary of the site;
- Due to the physical chemical properties of TCE, if a significant TCE source was present in soils beneath the single level and/or multi-level building in this portion of the site, it would be reasonable to expect that detectable concentrations of TCE would be identified in hydraulically downgradient wells (i.e. MW12, MW13), however, this was not the case (i.e. TCE below reporting limit of 1µg/L in these wells); and
- If shallow soils onsite are the source of the elevated TCE concentrations detected in soil vapour, the offsite sewer is likely to act as a preferential pathway for vapour migration (i.e. act as a relatively high permeability barrier limiting vapour migration towards residences).

Oral and dermal contact of regular site users to current in-situ soils on the site is anticipated will be restricted over the majority of the Site B: Precinct 75 Mixed Use Redevelopment by the basement envelope of future buildings and/or hardstands associated with the built form. Future exposure to retained fill materials below the basement envelope (under the fill retention strategy outlined in **Section 6**) will not be possible without obtaining a Development Application (DA) for the demolition of the built form.

Given the absence of available detailed design information for the portion of the Site B: Precinct 75 Mixed Use Redevelopment beyond the basement excavation and ground floor building line, it has been conservatively assumed that this portion of the site will comprise landscaped areas such that

there is the potential for Site B: Precinct 75 Mixed Use Redevelopment users to have dermal, inhalation and/or oral contact to surface soils.

Whilst temporary dewatering will be required to achieve construction requirements, it is not anticipated that any ongoing groundwater extraction (with the notable exception of seepage in the basement discussed below) will occur within site in the future following completion of construction works. The site is located within the Botany Aquifer Groundwater Management Zone 2 which restricts groundwater removal and disturbance. Excavation workers in deep excavations/trenches may potentially be exposed to infiltrating seepage water during building basement excavation/construction activities.

In the absence of detailed basement design plans and identified data gaps (**Section 7**), it has been assumed as a conservative measure that impacted groundwater to the west may enter the basement. Remedial works will be undertaken as outlined in this document to prevent impacted groundwater accumulation (and dermal/oral contact) within the basement via preventing physical access to potentially contaminated groundwater and construction of capture drains and a water treatment system. Basement ventilation measure will ensure removal of vapours entering the basement such that unacceptable levels do not accumulate.

8.5 Receptors

Potential receptors of environmental impact present within the site which will require to be addressed include:

- Future users of the non-paved areas of the site who may potentially be exposed to COPC through direct contact with impacted soils and/or inhalation of dusts/fibres/vapours associated with impacted soils; and/or
- Residents within the future multi-storey apartment building overlying the multi-level below ground ventilated basement carpark; and/or
- Commercial workers occupied within at grade and above ground floors of the multi-storey building overlying a ventilated basement carpark; and/or
- Commercial works occupied within the ventilated basement carpark (including cleaners, maintenance workers, carparking attendants, etc);
- Excavation/construction/maintenance workers conducting activities at or in the vicinity of the site who may potentially be exposed to COPC through direct contact with impacted soils/groundwater present within excavations and/or inhalation of dusts/fibres/vapours associated with impacted soils/groundwater; and/or
- The marine water ecosystem of Alexandra Canal located hydro-geologically downgradient of the site; and/or
- Flora species to be established on the landscaped/vegetated areas of the site including potential large tree plantings.

Based on the results of JBS&G (2016b), fill/soil, groundwater and soil vapour beneath the Site A: Precinct 75 Commercial areadoes not represent an unacceptable risk to existing commercial workers provided site capping arrangements are retained and procedures in JBS&G (2016c) are implemented including ensuring groundwater is not used for any kind other than groundwater monitoring. The existing EMP will be revised as appropriate following site development activities.

As discussed in **Section 5.4**, risks to residential receptors to the north-west of the site related to the TCE in sub-slab vapour identified at SV-13 were considered low due to the following:

- The suspected source of the elevated TCE concentrations detected was considered to most likely represent isolated contamination in shallow soils and/or the sewer line running along the north-western boundary of the site;
- Due to the physical chemical properties of TCE, if a significant TCE source was present in soils beneath the single level and/or multi-level building in this portion of the site, it would be reasonable to expect that detectable concentrations of TCE would be identified in hydraulically downgradient wells (i.e. MW12, MW13), however, this was not the case (i.e. TCE below reporting limit of 1 µg/L in these wells); and
- If shallow soils onsite are the source of the elevated TCE concentrations detected in soil vapour, the offsite sewer is likely to act as a preferential pathway for vapour migration (i.e. act as a relatively high permeability barrier limiting vapour migration towards residences).

8.6 Preferential Pathways

A range of preferential pathways currently exist at the site associated with the existing fill material and existing/former services trenches at the site, including sewer lines, stormwater pits and telecommunications conduits. Generally higher permeability backfill, or the reduced compaction requirements overlying these services result in the services trenches becoming preferential pathways for contaminant migration and as such it is anticipated that contaminants in liquid and/or vapour form may be associated with these areas.

Preferential pathways may also be created during future development works as a result of installation of new services, the basement and lift shafts connecting the lower basement levels to upper sections of the building that may result in the migration of vapours to upper levels of the multi-storey building, etc.

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.

9. Remedial Action Plan

9.1 Remedial Goal

The goal for the remediation and/or management of environmental impact is to:

- Remove unacceptable risks to human populations living at/working on/visiting the site by fill/soil, soil vapour and groundwater contamination; or
- Maintain requirements in the EMP (JBS&G 2016c) or appropriate revised management requirements to ensure ongoing suitability of areas of adaptive reuse; and
- Remove or manage unacceptable ecological risks to flora/fauna posed by fill/soil and groundwater contamination.

All remediation works are required to be undertaken in a manner consistent with principles of ESD.

9.2 Extent of Remediation

The following presents the extent of remediation/management required for the Site B: Precinct 75 Mixed Use Redevelopment and the Site A: Precinct 75 Commercial precinct with respect to their proposed land uses.

In addition, to support the requirements for preparation of HHERA, refining the remedial extents, and support the proposed fill retention strategy (refer to **Section 6**), supplementary data is required to be obtained to address identified data gaps in **Section 7**.

9.2.1 Site B: Precinct 75 Mixed Use Redevelopment

Soils

The Site B: Precinct 75 Mixed Use Redevelopment is underlain by fill/soil impacted (in areas) with concentrations of carcinogenic PAH compounds (including benzo(a)pyrene TEQ), TRH, heavy metals (principally zinc with limited copper and lead impacts) and asbestos in exceedance of ecological-based assessment criteria, and at relatively few locations, adopted health-based criteria as relevant to the proposed future land uses.

The majority of soil (both fill and natural) exceedances are located within the central site extent, in proximity to historical paint manufacturing activities and/or petroleum/chemical storage and handling. Historical petroleum/chemical storage infrastructure is still present on site (**Figure 10**).

The adopted remedial strategy will be excavation and off-site disposal of material identified as not suitable to be retained on site under the fill retention strategy outlined in **Section 6**.

Where fill/soil exceed the adopted ecological/human health criteria, but are identified as suitable (following completion of the HHERA) to be retained on site under the fill retention strategy outlined in **Section 6**, for these site portions to be considered suitable for their proposed future end uses, the minimum requirements comprise one or more of the following:

- A minimum thickness of 500 mm of suitable backfill material, comprising imported VENM or material sourced from the site that has been validated as suitable for beneficial reuse within the site as discussed in **Section 10**; or
- Permanent concrete, asphaltic concrete or landscape paving preventing access to potentially impacted soils; and
- Installation of a marker layer (high visibility orange geofabric) overlying the upper extent of the impacted material such that the material is delineated from the capping layer above. Refer to **Section 9.6.7** for the minimum survey requirements. Where it can be demonstrated that the permanent pavement cannot be penetrated (such as the basement engineered

concrete slab) or cannot be placed due to access restrictions (i.e. below Building 8), application of a marker layer is not required (subject to Site Auditor acceptance).

In addition, the following areas require remediation/management:

- Removal of underground petroleum/chemical storage systems, as shown on **Figure 10**;
- Within the Site B: Precinct 75 Mixed Use Redevelopment, removal of fill/natural soils to the west of the basement wall alignment inferred to be contributing to identified petroleum/chlorinated hydrocarbon groundwater impacts (refer to **Figure 10**). Fill/natural soils will be removed to the extent practicable with consideration of boundary conditions/structural stability issues.

The retention of fill materials under scenarios in **Section 6** will be supported by the HHERA to be prepared for the site and the extent of suitable fill/soils to be retained prescribed in the RWP to be prepared for the site.

Where fill material is retained, and is not proposed to be subject to the fill retention strategy outlined in **Section 6**, the material will be characterised as appropriate and the extents documented in the RWP to be prepared for the site.

Groundwater

In consideration of elevated chlorinated/petroleum hydrocarbon groundwater impacts, there are no specifically proposed remediation works aimed at addressing this particular issue. However, since the intended remedial actions proposed for addressing the impacted fill/soil at the site (i.e. excavation and off-site disposal of material inferred to be contributing to petroleum/chlorinated hydrocarbon groundwater impacts) will effectively result in the removal of most of Site B: Precinct 75 Mixed Use Redevelopment potential on-site sources of these contaminants in groundwater, it is considered that source removal works for chlorinated/petroleum hydrocarbon contamination will effectively be taking place at the site.

With respect to the development, chlorinated/petroleum hydrocarbon groundwater impacts have been identified to the west of the proposed basement alignment, in proximity to historical pant manufacturing activities (refer to **Figures 3** and **8B**). Potential remains for chlorinated/petroleum hydrocarbon (among other contaminates) groundwater ingress into the basement.

To ensure groundwater ingress along the western basement extent does not result in unacceptable risks to human health via oral/dermal or inhalation of vapours, groundwater capture, treatment and venting via a plenum along the western basement extent is required. Reference should be made to **Section 9.6.5** for a detailed description of the groundwater capture, treatment and venting remedial strategy.

The proposed remedial strategy will be supported by the HHERA to be prepared for the site.

9.2.2 Site A: Precinct 75 Commercial

As development activities within this portion largely comprises refurbishment/alterations to building interiors, with the majority of hardstands/foundations proposed to be retained, identified soil, soil vapour and groundwater impacts are proposed to be managed via implementation of the existing EMP (JBS&G 2016c) or appropriate revised management requirements to ensure ongoing suitability of this portion of the site for ongoing commercial use.

Existing cover/capping arrangements as documented in JBS&G (2016b) and the EMP (JBS&G 2016c) are required to be maintained or reinstated following improvements and/or extension and augmentation of physical infrastructure/utilities.

Newly established flora will be within constructed garden beds (i.e. above a permeant concrete slab with environmentally suitable soils rather than existing site soils) and/or within material demonstrated to be environmentally suitable (refer to **Sections 9.6.7** or **10.6.1**).

9.3 Assessment of Remedial Options

The *Contaminated Sites Guidelines for the NSW Auditor Scheme* (DEC 2006[19]) lists the following order of preference for soil remediation and management:

- On-site treatment of the soil so that the contaminant is either destroyed or the associated hazard is reduced to an acceptable level;
- Off-site treatment of excavated soil so that the contaminant is either destroyed or the associated hazard is reduced to an acceptable level, after which the soil is returned to the site;
- Removal of contaminated soil to an approved site or facility, followed where necessary by replacement with clean fill; and
- Consolidation and isolation of the soil on-site by containment within a properly designed barrier.

In addition, it is also a requirement that remediation should not proceed in the event that it is likely to cause a greater adverse effect than leaving the site undisturbed. And, where there are large quantities of soil with low levels of contamination, alternative strategies are required to be considered or developed (DEC 2006).

Remedial options have been assessed for the site as detailed in **Table 9.1** following.

[19] Contaminated Sites – Guidelines for the NSW Site Auditor Scheme (2nd Edition). NSW Department of Environment and Conservation 2006 (DEC 2006)

Table 9.1: Remediation Options Assessment Matrix – Site B: Precinct 75 Mixed Use Redevelopment

Remedial Option	Applicability	Assessment
1. On-site treatment so that the contaminants are either destroyed or the associated hazards are reduced to an acceptable level.	Metals Metals are unable to be destroyed. However, there are a number of microencapsulation treatment technologies which can reduce the mobility of the identified inorganic contaminants of concern (e.g. cement stabilisation).	Metals Not a suitable option Metals are unable to be destroyed, so this is not an option which is able to be considered. Microencapsulation is not considered necessary given the absence of identified groundwater impacts requiring remediation.
	PAHs Polycyclic aromatic hydrocarbons present in site soils are typically restricted to heavier non-volatile constituents. These can be remediated by thermal processes. However, this requires substantial investment in plant and equipment and substantial energy use. Similarly, for heavy metals, there are a number of microencapsulation treatment technologies which can reduce the mobility of the identified organic contaminants of concern (e.g., cement stabilisation).	PAHs Not a suitable option Remediation options are available for PAH contaminated fill contaminants, generally restricted to thermal treatment processes which are energy intensive. These options are not considered consistent with the ESD objectives for the site. Microencapsulation is not considered necessary given the absence of identified groundwater impacts requiring remediation.
	Hydrocarbons (petroleum and chlorinated) Given that soil contaminants associated with petroleum/chemical storage and areas of historical manufacturing/storage consist of hydrocarbon constituents, there is a potential that they may be able to be remediated on site by a bioremediation style remediation method. Bioremediation occurs where contaminants are chemically broken-down by the metabolic processes of micro-organisms into less toxic or non-toxic forms. Recent NSW EPA guidance requires bioremediation methods to demonstrate that pollutant emissions are not discharged to the atmosphere. On this basis, the lateral extent of the bioremediation activity requires to be restricted to ensure that air emissions from remediation materials are able to be collected.	Hydrocarbons (petroleum and chlorinated) Potential option Given the clayey nature of soils, volume of material, restricted space and time it may take to remediate fill/soils to a level that they do not represent an unacceptable risk and/or contribute to groundwater impacts, this method any not be practicable but is feasible.
	Asbestos There is no known technology to remove asbestos fibres from soils. Asbestos present in non-friable forms can be remediated by screening to remove oversize materials. However, the co-occurrence of a range of construction and demolition materials with the asbestos containing material reduces the potential effectiveness of screening processes. In addition, where friable asbestos impacts have been identified, screening of impacted material increases the risk of exposure to site workers and migration of fibres within the works area.	Asbestos Not a viable option There is no treatment method available for asbestos impacts. On this basis, on site treatment of impacted fill material is considered not to be a viable option.
2. Off-site treatment so that the contaminants are either destroyed or the associated	Metals Metals are unable to be destroyed. However, there are a number of microencapsulation treatment technologies which can reduce the mobility	Metals/ Hydrocarbons (petroleum and chlorinated)/PAHs Not a suitable option.

Remedial Option	Applicability	Assessment
hazards are reduced to an acceptable level, after which the soil is returned to the site.	of the identified inorganic contaminants of concern (e.g. cement stabilisation).	Energy/resource use associated with the transport and return of materials is not considered consistent with ESD objectives for the project.
	PAHs PAHs present in site soils are typically restricted to heavier non-volatile constituents. These can be remediated by thermal processes. However, this requires substantial investment in plant and equipment and substantial energy use. Similarly, for heavy metals, there are a number of microencapsulation treatment technologies which can reduce the mobility of the identified organic contaminants of concern (e.g., cement stabilisation).	
	Hydrocarbons (petroleum and chlorinated) As above (Option 1), however, additional time, energy and costs are incurred to take soils off site and return them to the site, in addition to there being no currently licensed facilities in close proximity of the site to undertake soil treatment.	
	Asbestos There is no known technology to remove asbestos fibres from soils. Asbestos present in non-friable forms can be remediated by screening to remove oversize materials. However, the co-occurrence of a range of construction and demolition materials with the asbestos containing material reduces the potential effectiveness of screening processes. In addition, where friable asbestos impacts have been identified, screening of impacted material increases the risk of exposure to site workers and migration of fibres within the works area.	Asbestos Not a suitable option
3. Excavation and off-site removal of the impacted material.	Fill Materials (TRH, PAHs, heavy metals and asbestos) There are currently suitably licensed waste facilities in the Sydney Metropolitan region capable of accepting the identified contaminants within fill materials. These are generally located a significant distance from the site.	Fill/Soil (PAHs, heavy metals and asbestos) A potentially applicable option but inferior to on-site placement (Option 4). The environmental impact of the transport of materials, waste generation and resource use in sourcing materials to re-instate the Stage 1 Developable Area to development levels is considered inconsistent with the ESD requirements for the project. Whilst this method is viable from a technical and practical view point, as a result of resource consumption and waste generation volume considerations, this is not the most preferred remedial option available. However, where materials are identified as not being environmentally suitable under option 4, or surplus to construction requirements then this is the preferred option. Hydrocarbons (petroleum and chlorinated) The likely option given space, timing etc. otherwise Option 1

Remedial Option	Applicability	Assessment
4. On-site in situ management of the soil by physical separation, and ongoing management.	<u>Fill/Soil (PAHs, Hydrocarbons, heavy metals and asbestos)</u> Fill materials, based on existing analytical data and to be supported by the HHERA for the site, have largely been found to be largely free of constituents: • That will pose a potential groundwater risk by the demonstrated absence of significant groundwater impact attributable to the Stage 1 Developable Area/assessment area; and • That will pose a potential inhalation risk as demonstrated by the assessment of vapours. On this basis, the impacted fill materials are suitable for retention on site in areas where human/ecological exposures can be restricted. Where materials are identified as not being suitable for containment (hydrocarbon impacts), Option 3 is the preferred remedial strategy.	<u>Fill /Soil (PAHs, heavy metals, asbestos)</u> This is the preferred option for the management of impacted fill/soil. The retention of the materials will reduce the waste generation and resource requirements of the remediation of the site, as consistent with the ESD objectives. The site will be subject to significant areas of building and pavements which will provide physical separation between site users and retained fill materials. This option is of highest ranking with respect to the ESD principles as a result of the low waste volumes and energy use. However, consideration of the practical implications of an ongoing site management plan is required prior to implementation.

9.4 Proposed Remedial Approach

As shown in **Table 9.1**, with consideration to DEC (2006) hierarchy for remediation, the principles of ESD, procedures for managing risks to the environment and human health under the proposed development scenario are shown in **Table 9.2** and discussed in the following sections.

Remedial extents are shown on **Figure 10** where appropriate.

Soils moved within the site will require that a material tracking system is implemented during works (as described in **Section 9.6.10**). Fill volumes for retention are discussed in **Table 9.3**. Fill/soil volumes requiring off-site disposal as a result of remediation are shown on **Figure 10**.

Following the removal of fill/soils identified as not suitable to be retained on site under the fill retention strategy in **Section 6** (based on the outcomes of the HHERA) and fill/soils inferred to potentially be contributing to identified chlorinated/petroleum hydrocarbon groundwater impacts to the west of the proposed basement, based on fill/soil physical properties, analytical results, and to be supported by the HHERA to be prepared for the site, contaminates generally fall within Groups 2 and 10, as listed in Table 1 (ANZECC, 1999[20]). For these contaminant groups, inhalation of vapours is not a primary exposure. Therefore, implementation of a 'cap/cover' remedial strategy as indicated in ANZECC (1999), in conjunction with appropriate control measures, is appropriate with respect to management of the health risk.

Furthermore, based on fill/soil physical properties, analytical results, and to be supported by the findings of the HHERA, water exclusion as listed in Table 2 (ANZECC, 1999) is not considered necessary. Notwithstanding, as another level of conservatism, as discussed above and herein, where fill material is proposed to be placed below the water table, fill material will be placed below an engineer concrete slab associated with the overlying (basement) surrounded by low transmissive units, reducing groundwater hydrogeology and in turn the contaminant leachate generation potential.

The HHERA to be prepared for the site will support the proposed fill retention strategy to assist JVMC with achieving the principals of ESD for the development. Should the findings of the HHERA not support the fill retention strategy for retention of fill/soil below the basement then Option B (Soil Management Activities – Site B: Precinct 75 Mixed Use Redevelopment) in **Table 9.2** will be implemented or an alternatively suitable remedial strategy development in consultation with the Site Auditor and documented in the RWP to be prepared for the site.

[20] *Guidelines for the Assessment of On-site Containment of Contaminated Soils*. Australian and New Zealand Environment and Conservation Council dated September 1999 (ANZECC 1999)

Table 9.2: Procedures for Managing Risks and Remedial Extents

Area	Proposed Development	Proposed Civil Works	Proposed Ongoing Management Measures
Site B: Precinct 75 Mixed Use Redevelopment (excluding land beneath Building 8)	Three multi-storey residential buildings (Building A to Building C, refer to **Figure 4A**) with a single multi-level integrated car parking basement. Ground floor retail is proposed in portions of Buildings A, B and C. The basement (not tanked) is off-set from the Site B: Precinct 75 Mixed Use Redevelopment boundaries (in areas) with surface treatments external to the basement comprising minor landscaped areas (inclusive of the north-western extent of Central Park) and/or pavements. A Pocket Park is proposed in the south-eastern Site B: Precinct 75 Mixed Use Redevelopment extent.	**Soil Management Activities – Site B: Precinct 75 Mixed Use Redevelopment** Option A (preferred option subject to endorsement of the HHERA findings and revision of the remedial extents to be presented in a Site Auditor endorsed RWP, otherwise option B) • Removal of petroleum/chemical infrastructure; • Excavation and off-site disposal of material identified as not suitable to be retained on site under the fill retention strategy outlined in **Section 6**; • Excavation and off-site disposal of chlorinated/petroleum hydrocarbon impacted fill/soils inferred to be a potential source of identified groundwater impacts to the west of the basement alignment to the extent practicable (refer to **Section 9.2.1**); • Excavation of balance of fill/soils across the Site B: Precinct 75 Mixed Use Redevelopment identified as suitable to be retained on site under the fill retention strategy outlined in **Section 6** based on the finding of the HHERA and stockpile for onsite reuse; • Excavation of natural material below the basement envelope to target depth (i.e. over excavated natural soil/rock, off-site as VENM (if appropriate), herein referred to as the borrow pit) based upon onsite retention of fill material (refer to **Section 2.1** and **6**); • Placement of stockpiled fill material within the borrow pit within the confines of low transmissive units (i.e. clay/shale) to reduce the contaminant leachate generation potential; and • Establishment of a basement with an engineered slab over retained fill such that penetration is not possible. Option B (where Option A is not practicable, as a contingency) • Removal of petroleum/chemical infrastructure. • Excavation and off-site disposal of material identified as not suitable to be retained on site under the fill retention strategy outlined in **Section 6**.	**Soil Management** Development and implementation of an EMP where required to address residual contamination

Area	Proposed Development	Proposed Civil Works	Proposed Ongoing Management Measures
		• Excavation and off-site disposal of chlorinated/petroleum hydrocarbon impacted fill/soils inferred to be a potential source of identified groundwater impacts to the west of the basement alignment to the extent practicable (refer to **Section 9.2.1**); • Removal of existing fill material to a depth of 0.5 for grass/shrubs and/or 1.5 m for trees or to a reduced level to accommodate future pavements; • Placement of marker layer above retained fill material; • Placement of at least 0.5m of chemically suitable fill material above marker layer for grass/garden areas; • Placement of at least 1.5m of chemically suitable fill material above marker layer for tree areas; and/or • Establishment of sub-grade layer (environmentally suitable soils) and pavement above marker layer.	
		Basement Vapour and Seepage Control Requirements – Site B: Precinct 75 Mixed Use Redevelopment Option A (preferred option subject to endorsement of the HHERA findings and revision of the remedial extents as presented in a Site Auditor endorsed RWP). To ensure groundwater ingress along the western basement extent does not result in unacceptable risks to human health via oral/dermal or inhalation of vapours, groundwater capture, treatment and venting via a plenum along the north eastern, north western and western basement extent is required. The extent of the proposed plenum is shown on **Figure 10**. Reference should be made to **Section 9.6.4** for discourse on the plenum, drainage and water treatment plant requirements and associated risk assessment to support the remedial strategy. Option B (where Option A is not practicable, as a contingency) The basement is tanked to prevent groundwater ingress. A tanked basement would still likely require a groundwater treatment system for volatile contaminants in groundwater collected from beneath the bottom carpark slab (i.e. below the basement). To prevent this a cutoff system that extends	**Basement Vapour and Seepage Control Requirements** Options A - development and implementation of an EMP Option B - no ongoing management as no future unacceptable exposure scenario

Area	Proposed Development	Proposed Civil Works	Proposed Ongoing Management Measures
		below the bottom of the basement (and the proposed fill retention strategy) by several metres (say 2.0 m) would be required to minimise/prevent ingress of contaminated water into the groundwater collection system beneath the lowest slab. This cutoff system would need to extend along at least 25% of the Edith Street/Mary Street boundaries to be effective and be supported by the HHERA to be prepared for the site.	
Site B: Precinct 75 Mixed Use Redevelopment (land beneath Building 8)	It is understood residential apartments are proposed to be built above the existing commercial studios in Building 8 (i.e. additions to the built form to accommodate residential apartments).	**Beneath Building 8 - Site B: Precinct 75 Mixed Use Redevelopment** As development activities within this portion the site largely comprises refurbishment/alterations to building interiors on lower levels and additions to upper levels to accommodate residential land use, identified impacts are proposed to be managed via implementation of the existing EMP (JBS&G 2016c) or appropriate revised management requirements to ensure ongoing suitability of this portion of the site for mixed land uses.	Development and implementation of an EMP
Commercial Precinct	Development will largely comprise refurbishment/alterations to building interiors, with the majority of hardstands/foundations proposed to be retained. Some minor landscaping and pavement modifications are proposed external to building footprints along with the addition of minor landscaped areas.	**Site A: Precinct 75 Commercial Management Requirements** As development activities within this portion the site largely comprises refurbishment/alterations to building interiors, with the majority of hardstands/foundations proposed to be retained, identified soil, soil vapour and groundwater impacts are proposed to be managed via implementation of the existing EMP (JBS&G 2016c) or appropriate revised management requirements to ensure ongoing suitability of this portion of the site for ongoing commercial use. Newly established flora will be within either constructed garden beds (i.e. above a permeant concrete slab) and/or within material demonstrated to be environmentally suitable as follows: • Removal of existing fill material to a depth of 0.5 for grass/shrubs and/or 1.5 m for trees; • Placement of marker layer above retained fill material; • Placement of at least 0.5m of chemically suitable fill material above marker layer for grass/garden areas; and/or • Placement of at least 1.5m of chemically suitable fill material above marker layer for tree areas.	Development and implementation of an EMP

9.5 Regulatory and Planning Requirements

The following planning requirements for the proposed remedial works are presented.

Environment Planning and Assessment Act 1979/SEPP 55

The remediation works are classified as Category 1 Remediation Works as per the meaning provided in SEPP 55 and will require development consent under the *Environmental Planning and Assessment Act 1997*.

The nature of remediation works is relatively straightforward and it is considered most appropriate that development applications for remediation works are included with DA documentation for the associated earthworks as ancillary to other development.

Environment Planning and Assessment Regulation 2000 – Schedule 3 Designated Development

The proposed remediation works do not constitute designated development.

It is not anticipated that the proposed remediation works will incorporate any on-site treatment of soil. However, in the event that soil is required to be pre-treated prior to off-site disposal, an assessment of potential triggers for the works to be designated development as presented in Schedule 3 – Clause 15 will be required to be completed.

Protection of the Environment Operations Act 1997

All potential discharges from the site during remediation works will require to be maintained below applicable assessment criteria/threshold guidelines during the remediation works. This would apply to potential emissions in air, water and discharges to groundwater. Levels of discharges are typically assessed at a site boundary.

A HHERA will be prepared for the site to support the fill retention strategy and ensure that the beneficial re-use of materials does not cause pollution of groundwater and/or waters by reference to any applicable criteria as may be used to assess pollution under the *POEO Act* (including s120).

The proposed remediation/validation activities are not required to be licensed under the *Protection of the Environment Operation Act (1997)*. The site is less than 3ha in area, does not store greater than 30,000m^3 of contaminated fill and hence does not trigger the licensing requirements.

Water Management Act 2000

Should dewatering be required, a dewatering and potentially a re-injection approval will be required from the NSW Department of Primary Industry - Water (DPI-Water) for any dewatering proposed with the site remediation works. The approval will require to be obtained prior to the undertaking of any groundwater dewatering and treatment. At this stage, short term dewatering is anticipated as the development plans includes a subsurface basement.

Protection of the Environment Operations (Waste) Regulation 2014

The regulations make requirements relating to non-licensed waste activities and waste transporting. The proposed works will not require to be licensed. Section 48 of the Reg. requires that wastes are stored in an environmentally safe manner. It also stipulates that vehicles used to transport waste must be covered when loaded. This regulation also details additional tracking requirements for vehicles carrying Special (Asbestos) waste.

Provision is provided in the Regulation and EPA (2014[21]) guidelines for the NSW EPA to approve the immobilisation of contaminants in waste (if required).

[21] Waste Classification Guidelines – Part 1: Classifying Waste. NSW EPA 2014 (EPA 2014)

It is noted that no waste will be received at the site and only VENM, excavated natural material (ENM) or materials covered by a NSW EPA exemption will be imported to the site.

Protection of the Environment Operations (Underground Storage Systems UPSS) Regulation 2014

The removal of USTs will be undertaken in accordance with WorkCover NSW requirements and a validation report will be provided in accordance with the provisions of the *Protection of the Environment Operations (UPSS) Regulation 2014*. The validation process in this RAP meets the requirements of the regulation.

Waste Classification Guidelines (EPA 2014)

All wastes generated and proposed to be disposed off-site shall be assessed, classified and managed in accordance with this guideline. Where wastes require immobilisation prior to off-site disposal (to reduce waste classifications) an immobilisation approval shall be sought in accordance with Part 2 of this guideline. Immobilisations are only anticipated to be required with unexpected finds.

NSW Aquifer Interference Policy (NSW Office of Water 2012)

Groundwater underlying the site will potentially be classified as an aquifer as per the policy. The policy does not apply to the site development as the extent of works proposed to be undertaken within the saturated portion of the site will not contaminate groundwater (as assessed by comparison to applicable standards and guidelines) and will not cause an unacceptable loss of storage or cause structural damage to the aquifer.

The HHERA will be used to support the fill retention strategy.

Marrickville (2011) 'Development Control Plan'

The Council development control plan (DCP) provides a number of environmental and site management provisions required to be employed during remediation works. These have been incorporated into this RAP as minimum standards for the environmental management of remediation works.

Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997

Completion of the works presented in this RAP will not result in a 'Duty to Report' as defined in the guidelines. Consistent with the scope of works, no works will be permitted within the validation of the site that will potentially cause levels of site constituents to be present at points of exposure and/or the site boundary that will cause any NSW EPA published or endorsed criteria to be exceeded.

As discussed in **Section 5.3**, risks to residential receptors to the north-west of the site related to the TCE in sub-slab vapour identified at SV-13 were considered to represent an unacceptable risk requiring regulation by the EPA

Work Health and Safety Act 2011 No 10 and Work Health and Safety Regulation 2011

The information and data provided in this RAP should be considered by the Principal/Remediation Contractor in preparation of their health and safety plans for the remedial works.

9.6 Remedial Scope of Works

It is envisaged that remedial and validation works will be potentially conducted as a staged process as required for the site. Within each proposed stage, remediation works will comprise, where appropriate the following actions.

9.6.1 Site Establishment

For each stage of remediation works the boundary will be defined (via survey) and secured as appropriate to ensure that all safety and environmental controls are implemented, including necessary contractor briefings and inductions for the remediation workforce. A summary of the controls is provided in **Section 12**.

9.6.2 Removal of Petroleum/Chemical Infrastructure

All existing site petroleum/chemical infrastructure (refer to **Figure 10**) is required to be removed, inclusive of the following anticipated infrastructure:

- USTs;
- Remote fill points;
- Vent points and associated venting lines;
- Bunding (i.e. concrete bunding);
- Fuel dispensers (bowsers);
- Fuel pipework; and
- Tank anchors.

Bedding sand associated with these structures will also be removed and stockpiled as necessary for characterisation pending off-site disposal. Remedial excavation validation samples will be subsequently collected by JBS&G field staff for field screening and laboratory analysis in accordance with the methodology and densities outlined in **Section 10**.

Stockpiling shall be undertaken to restrict potential environmental emissions in accordance with the requirements of the Remediation Environmental Management Plan (REMP) as discussed in **Section 12**. Hydrocarbon impacted soils, including the bedding sand, as may be identified in conjunction with the infrastructure removal work is required to be remediated by off-site disposal to a facility lawfully able to accept the material.

Validation of the removal works and associated remediation of impacted material shall be undertaken in accordance with *UPSS Technical Note: Site Validation Reporting* (DECCW 2010), *Guidelines for Assessing Service Station Sites, 1994, NSW EPA* (NSW EPA 1994) and the requirements of NEPC (2013). In addition, detailed notes and documentation (including photographs and description of tank contents) will be made during removal of the petroleum infrastructure.

It is envisaged that removal of the petroleum/chemical infrastructure will occur subsequent to demolition works and prior to the commencement of bulk earthworks in the vicinity of the infrastructure.

Groundwater assessment requirements of NSW EPA (1994) do not require application where the area is free of hydrocarbon impacted soils.

The location and extents of inferred impact are shown on **Figure 10**.

Should USTs (or similar) be identified within the Site A: Precinct 75 Commercial area, a strategy of environmental management via in-situ decommissioning will be required in accordance with NSW EPA made or endorsed guidelines.

9.6.3 Impacted Soils Not Suitable for Retention – Site B: Precinct 75 Mixed Use Redevelopment

Fill/soil identified as not suitable for retention under the fill retention strategy in **Section 6** based on the findings of the HHERA are required to be excavated and separated from the balance of the site fill/natural soils.

Fill/soil not suitable for retention will be identified visually, from olfactory detection, and through the use of a PID, and will be chased out under the direction/supervision of one of JBS&G's qualified and experienced scientists/engineers. Excavated fill/soil will be temporarily stockpiled. Stockpiling shall be undertaken to restrict potential environmental emissions in accordance with the requirements of REMP as discussed in **Section 12**.

Remedial excavation validation samples will be subsequently collected by JBS&G field staff for field screening and laboratory analysis in accordance with the methodology and densities outlined in **Section 10**.

Fill/soils will be remediated via removal from the site to a facility lawfully able to accept the material.

9.6.4 Excavation of Petroleum Hydrocarbon and Chlorinated Hydrocarbon Impacted Soils – Site B: Precinct 75 Mixed Use Redevelopment

Fill/soils between the Site A: Precinct 75 Commercial area and the proposed basement alignment within Site B: Precinct 75 Mixed Use Redevelopment are inferred to be a potential source of identified groundwater chlorinated/petroleum hydrocarbon impacts. As such, fill/soils within this portion of the site are required to be excavated and separated from the balance of the site fill/natural soils.

Fill/natural soils will be removed to the extent practicable with consideration of boundary conditions/structural stability issues. The locations and extents are shown on **Figure 10**.

Impacted material will be identified visually, from olfactory detection, and through the use of a PID, and will be chased out under the direction/supervision of one of JBS&G's qualified and experienced scientists/engineers. Excavated fill materials will be temporarily stockpiled. Stockpiling shall be undertaken to restrict potential environmental emissions in accordance with the requirements of REMP as discussed in **Section 12**.

Remedial excavation validation samples will be subsequently collected by JBS&G field staff for field screening and laboratory analysis in accordance with the methodology and densities outlined in **Section 10**.

Hydrocarbon impacted material will be remediated via removal from the site to a facility lawfully able to accept the material.

9.6.5 Basement Vapour and Seepage Control Requirements – Site B: Precinct 75 Mixed Use Redevelopment

A pile wall is proposed to be installed at the lateral extents of the basement to retain surrounding soils/rock. As the basement design plans have yet to be confirmed/finalised, as a conservative measure, for the purpose of remedial planning and preparation of a HHERA, it has been assumed that the basement is not tanked and potential remains for groundwater ingress. As such, potential remains for groundwater impacted with chlorinated/petroleum hydrocarbons to enter the basement.

To ensure potential groundwater ingress from the western basement wall face does not result in unacceptable risks to human health via oral/dermal or inhalation of vapours, groundwater capture, treatment and venting via a plenum along the north eastern, north western and western basement wall extent is required. The extent of the proposed plenum is shown on **Figure 10**.

The plenum will comprise a continuous 100mm (as a minimum) void with no obstructions to air flow. The plenum will be either passively vented, with the vents placed at suitable regular locations (i.e. not next to residential windows/doors or air intakes) or mechanically ventilated.

The HHERA to be prepared for the site will set air exchange rates to demonstrate that any passive air transfer to the balance of the basement and in turn advective migration of vapours associated with lift shafts to upper levels of residential and commercial floors will not be at levels which represent an unacceptable health risk to future site users.

In addition, subfloor basement drains within the lateral extent of the plenum will also be designed to drain to an independent and isolated collection sump within the lowest basement level. This will address the collection of potentially impacted groundwater intrusion. Drains within this area will also be isolated from and independent of the drains beneath the balance of the basement floor.

Both the plenum and the basement subfloor drain/sumps will be connected to an extraction system connected to a groundwater treatment plant to facilitate treatment of collected water prior to off-site discharge to stormwater. Treatment of groundwater will be via standard/common commercially available methods.

A secondary objective of the plenum is to prevent oral/dermal contact to potentially contaminated groundwater.

The construction methodology of the plenum, drains and water treatment plant will be detailed in the HHERA/RWP to be prepared for the site following receipt of finalised design plans from JVMC.

9.6.6 Borrow Pit Construction Details and Fill Retention

Following removal of petroleum/chemical infrastructure, fill/soil identified as not suitable under the fill retention strategy in **Section 6** and fill/soil potentially contributing to chlorinated/petroleum hydrocarbon groundwater impacts to the west of the basement alignment, fill identified as suitable for retention below the water table is intended to be beneficially reused/placed within the borrow pit to assist JVMC with the principals of ESD.

This reuse will include the placement of fill/soil below the basement envelope in areas of the site that are inaccessible and identified as not representing an unacceptable human health or ecological risk through the process of risk assessment.

Design plans (**Appendix A**) show a single excavation (multi-level basement) will be completed across the majority of the Site B: Precinct 75 Mixed Use Redevelopment with bulk excavation levels of approximately RL 11.8 to 8.4 m AHD for the first basement level and 8.75 to 7.2 m AHD for the second level basement (where present). The extent of the basement and basement depths/levels are shown on **Figure 4A**. The basement will terminate in bedrock (shale), as shown on **Figure 4B**.

To facilitate the proposed fill retention strategy (**Section 6**), natural soils (clay) and in turn bedrock (shale) are proposed to be over excavated beneath the basement envelope to an RL of approximately 6.2m AHD, as shown on **Figure 4B**. VENM is proposed to be either beneficially reused on site within landscaped areas/as engineered fill to establish site levels, or taken to a facility lawfully able to accept the material.

Following establishment of excavation levels, soils/fill suitable to be retained in the borrow pit (as demonstrated through the process of risk assessment) are proposed to be emplaced beneath the basement envelope within the excavation void surrounded by low transmissive units (i.e. low permeability clay/shale) reducing groundwater flow and the potential for contaminant leachate generation potential.

Only materials identified as not representing an unacceptable ecological/human health risk will be retained below the basement envelope within the confines of low transmissive units.

Table 9.3 presents volumes of fill to be retained within the borrow pit beneath the basement within the confines of the low transmissive units and soil volumes requiring excavation to accommodate the development and fill retention strategy.

Based on fill/soil physical properties, analytical results, and subject to the findings of the HHERA, water exclusion as listed in Table 2 (ANZECC, 1999) is not considered necessary.

The as-built of the borrow pit is required to be defined by survey as completed by a registered surveyor sufficient to identify:

- The as-built reduced levels of the borrow pit and associated batters/walls of surrounding low transmissive units;
- The lateral extent and upper depth height of retained fill materials; and
- The lateral extent and type of cover (e.g. engineered concrete slab to the basement) within the remediation area/stage.

Adoption of a physical separation remedial strategy within these portions of the site will require development and implementation of a long-term EMP which will be discoverable and legally enforceable.

Table 9.3: Approximate Fill and Excavation Volumes for the Fill Retention Strategy[22]

	Area	Average Depth of Fill	Total Volume of Fill[23]	Average Ground Surface Level	Average Basement Subgrade Level	Total Volume of Fill/Soil to Achieve Construction Grade	Volume of VENM to Achieve Construction Grade	Average Borrow Pit Subgrade	Storage Capacity of Borrow Pit	Soil Thickness	Over Excavation of VENM to Achieve Burrow Pit RL
	(m^2)	(m bgs)	(m^3)	(m AHD)	(m AHD)	(m^3)	(m^3)	(m AHD)	(m^3)	(m)	(m^3)
Site B: Precinct 75 Mixed Use Redevelopment	10 000	0.7[24]	7 000	14	-	-	-	-	-	-	-
Basement Footprint	6 800	0.7[25]	4 760	-	8	40 800	36 040	-	-	-	-
Borrow Pit Footprint	4 100	-	-	-	-	-	-	6.25	7 175	0.95-2.5	7 175
To Be Placed in Borrow Pit	-	-	7 000	-	-	-	-	-	-	-	-

[22] These number are estimates only and the appointed Principal Contractor should verify these numbers and assumptions and in turn volumes presented in **Table 9.3**. These volumes are subject to the limitations presented in **Section 14**

[23] These numbers include fill volumes that require off-site disposal due to petroleum/chlorinated hydrocarbons (refer to **Sections 9.6.2** to **9.6.4** above). The volume from **Figure 10** should be subtracted from this.

[24] It is noted that the average depth of fill based on existing data ranges between 0.5 to 0.7m bgs. A soil thickness of 1m is stated in **Appendix A** to ensure the sampling densities are meet and in turn fill is characterised appropriately to support the fill retention strategy. Given the encountered variability in fill depth and the identification of data gaps, as a conservative measure, a fill thickness of 0.7m has been adopted in this RAP. Following the data gap assessment, the fill volumes will be revised and presented in the RWP to be prepared for the site.

9.6.7 Cap/Cover Remedial Strategy

Where fill material is identified as representing a potential unacceptable ecological/human health risk but suitable to be retained on site, fill is proposed to be excavated, stockpiled and beneficially reused onsite.

This reuse will include the placement of fill materials below the basement envelope in areas of the site that are inaccessible and identified as not representing an unacceptable human health or ecological risk through the process of risk assessment as discussed in **Section 9.6.6**.

Alternatively, where this is not possible due to boundary conditions/structural stability issues or the risk assessment identifies that the material is not suitable for placement below the basement (but suitable above the water table), implementation of a physical separation remedial strategy is proposed. This includes:

- Removal of existing fill material to a depth of 0.5m for grass/shrubs and/or 1.5m for trees and/or reduced levels to accommodate future pavements;
- Placement of marker layer (orange geofabric) above retained fill material;
- Placement of at least 0.5m of chemically suitable fill material above marker layer for grass/garden areas (refer to **Section 10)**;
- Placement of at least 1.5m of chemically suitable fill material above marker layer for tree areas (refer to **Section 10)**; and/or
- Establishment of sub-grade layer (environmentally suitable soils, refer to **Section 10**) and pavement above marker layer.

Installation of physical separation arrangements shall be defined by survey as completed by a registered surveyor and/or building as-built drawings sufficient to identify:

- The lateral extent and upper depth height of known environmentally impacted materials (i.e. residual fill materials underlying the cover) within each remediation area/stage;
- The lateral extent and type of cover (e.g. building or permanent pavement) within the remediation area/stage; and
- Confirmation, by photos or otherwise, of the installation of the 'marker layer' underlying the cover (as required).

Adoption of a physical separation remedial strategy within these portions of the site will require development and implementation of a long-term EMP which will be discoverable and legally enforceable.

Given the specific development plans as understood at the time of preparation of the RAP, the following capping and cover procedures are to be implemented:

- Cover of fill materials by buildings – installation of a marker layer overlying potentially contaminated material to denote the extent of retained fill. The concrete floor slab shall act as a physical barrier;
- Cover of fill materials by permanent paved areas beyond building footprints – installation of a marker layer overlying potentially contaminated material followed by sub-grade material validated as environmentally suitable materials for human/ecological exposure (where required) and then the permanent pavement (i.e. concrete, asphalt, pavers, etc.);
- Capping of fill materials in landscaped areas – installation of the marker layer at a minimum depth of 0.5m below final finished site levels in areas of shallow planting (for grasses and

shrubs), or a minimum of 1.5m below final finished site levels in areas of tree planting, with environmentally suitable materials placed above to the final levels; and

- Within underground services trenches – in the event underground services trenches are to be installed, the service infrastructure will require to be installed above a marker layer within suitable materials for potential human and/or ecological exposure.

9.6.8 Importation and Off-site Disposal of Fill Materials

Reference should be made to **Section 10** for sampling densities and analytes and compliance with relevant EPA made or endorsed guidelines.

9.6.9 Asbestos Management

Based on the available site characterisation data, an isolated area of asbestos impacted fill has been identified (BH2 0.14-0.4). As such, fill within this portion of the site is required to be considered as potentially impacted with asbestos fibres, and has been provisionally classified as asbestos contaminated soil until deemed otherwise.

Asbestos contaminated soil necessitating management for potential asbestos exposure is defined in *How to Manage and Control Asbestos in the Workplace Code of Practice*, 2016, Safe Work Australia/NSW WorkCover 2016 (SWA 2016/NSW WorkCover 2016) as:

- Soil that contains visible asbestos as determined by a competent person; or
- Soil that contains asbestos fibres at quantities exceeding trace levels (considered to be the analytical detection limit in lieu of alternate guidance) as reported by analysis undertaken in accordance with AS4964:2004 *Method for the qualitative identification of asbestos in bulk samples*.

Environmental, health and safety management requirements for the handling of these materials will be based on the requirements provided for asbestos-related works in SWA 2016/NSW WorkCover 2016. This will include preparation of an asbestos register and associated asbestos removal control/management plan as outlined in SWA 2016/NSW WorkCover 2016.

Where sampling and analysis of specific fill materials is completed in conjunction with inspection by a competent person, and the results indicate the material does not fall within the “asbestos contaminated soil” definition, the requirements for management of “asbestos contaminated soils” will not be required to be implemented. The extent of asbestos contaminated soils may be further delineated within a work stage by a similar assessment (i.e. identification of asbestos contamination hotspots).

For the purposes of remediation works within the site, a competent person shall be considered to be a person who holds a tertiary degree in an environmental or occupational hygiene discipline, holds a Class A Asbestos Assessor License and/or has completed a WorkSafe approved Asbestos Removal Supervisor course and has experience in contaminated site assessment/remediation.

9.6.10 Movement of Material

Movement of materials will be required at the site and shall be moved as per a material tracking plan as documented following. The tracking system is designed to track the quantity and quality of materials from their arrival on site or their derivation point, through temporary storage to placement.

The system comprises the following elements;

- Definition of Roles and Responsibilities;
- Material quality information;
- Material movement tracking;

- Material emplacement;
- Documentation required;
- Dealing with non-conformance; and
- Dealing with expected and unexpected finds

9.6.10.1 Roles and Responsibility

The Principal Contractor will be responsible for the following:

- Implementation and overall management of onsite procedures and protocols defined in the RAP document.
- Responsible for ensuring all subcontractors and consultants employed in reuse material classification generation, movement and placement are adequately briefed in the requirements of the RAP.
- Will take ultimate responsibility for the movement and placement of materials intended for reuse.
- Will ensure clear lines of communication are maintained between all relevant responsible parties.
- Will be responsible for liaison with suppliers in sourcing of materials from offsite, whether imported VENM or material under a NSW EPA exemption.
- Responsible for ensuring the RAP is operated effectively in conjunction with other relevant documents and in line with the overarching Health, Safety and Environmental Plan, Asbestos Management Plan to be developed for the site.

JBS&G will be responsible for the following:

- Liaise with the Principal Contractor with regards to the importation of materials which does not meet the definition of VENM to ensure materials meet the project requirements and to prevent unsuitable materials being inadvertently brought onto the site, such that the site cannot be validated as suitable for proposed permissible uses.
- Undertake inspections when material importation works are being undertaken to confirm materials sampled are consistent with those being imported.
- Review materials tracking documents submitted by the Principal Contractor and investigate/resolve any discrepancies.
- Cross check inspection findings with materials tracking sheets.
- Provide directives (decisions) relating to a proposed and/or placed fill materials suitability.

9.6.10.2 Material Tracking

The movement of classified materials within the site will be controlled by an appropriately managed Materials Tracking System, as discussed below.

In order to minimize double handling on the site, improve cost effectiveness and reduce environmental impacts, every effort should be made to facilitate the movement of excavated or imported material directly to the area of placement.

It is, however, recognized that this objective may not always be practical and hence the following range of potential material movements is anticipated:

- Stockpile to Placement;

- Import to Emplacement;
- Import to Stockpile;
- Stockpile to Stockpile; and
- Offsite disposal.

9.6.10.3 Materials Characterisation Form

All material movements within the site will be controlled using Materials Classification Forms (MCF) and Material Tracking Sheets (MTS).

Each MCF outlines procedures for confirming material quality, quantity and summarising existing analytical data. The MCF will be completed by the Principal Contractor and/or the Civil Works Contractor and will include the following:

- A unique MCF document name/number;
- A summary of VENM/ENM (other) reports prepared JBS&G;
- Materials description; and
- Material reuse suitability summary.

Each MCF will be completed and signed off by the Principal Contractor/Civil Works Contractor based on material characterisation reports prepared by JBS&G. Once completed, the MCF will be incorporation into the Principal Contractors materials tracking system prior to placement within the site.

An example of the MCF is presented in **Appendix B**.

9.6.10.4 Materials Tracking Sheet

The MTS is a two-part document which requires information to be collected at the material source location and at one of the three potential destination sites. An example of the MTS is presented in **Appendix B**.

All MTSs will be uniquely referenced and stored as a record of material movements.

This first part (Part A) of the document will record the following data:

i. Time and Date
ii. Truck registration or plant identification;
iii. Load quality; and
iv. MCF reference name/number. The MCF will provide details on items such as a source location reference, visual/olfactory observations, materials classification/reuse zone suitability summary.

The document will also be used for materials required for onsite placement or temporary stored prior to placement and will be completed at the point of unloading. The sheet will record the following details:

- Items i, ii, iii, as above;
- Visual and olfactory observations; and
- Zone of emplacement.

The final portion of the sheet (Part B) will be completed for materials which cannot be used within the site and are scheduled for off-site disposal in accordance with EPA (2014).

Items I, ii, iii and iv above will be recorded initially. The name of the haulage company responsible for transferring the material to the tip site and the details of the receiving site must also be recorded. Prior to leaving the site, the material should have undergone a waste classification in accordance with EPA (2014) and confirmation of this should be acknowledged on the sheet.

Finally, a note should be made of the consignment note number or receipt identification obtained.

The MTS will be reviewed and signed off as completed by the Principal Contractor and or Civil Works Contractor.

9.6.10.5 Material Placement

Zones (grid references) of material placement will be accurately surveyed. This will allow the interrogation of the data set to ensure reuse material loads have been correctly deposited and a record kept of cumulative loads deposited in any particular zone.

10. Validation Plan

10.1 Overview

Validation data is required to be collected to verify the effectiveness of the remedial works and document the final site conditions as being suitable for the proposed future use(s).

The following sections establish the data quality objectives (DQOs) to be adopted during validation of the site remediation works.

10.2 State the Problem

The site, which has historically been used for commercial/industrial land uses is proposed to be redeveloped for mixed uses (refer to **Section 2**). Past assessment activities, as summarised in **Section 5** have identified that, prior to redevelopment, remediation of contamination is required.

A number of data gaps have been identified which are proposed to be addressed through a systematic and targeted program of supplementary investigations as detailed in **Appendix A**. The additional works can only occur following demolition of existing site structures providing access to areas previously inaccessible.

During remediation activities, sufficient validation of the site activities is required to demonstrate that the identified environmental and health based risks to future site user(s) have been adequately managed to render the site suitable for the proposed land use/development.

10.2.1 Identify the Decision

The decisions which are required to be made for validation of the site are:

- Have all petroleum/chemical infrastructure been successfully removed from the site?
- Has all fill/soil not suitable for retention on site under the fill retention strategy (refer to **Section 6**) been successfully removed from the site?
- Has all petroleum/chlorinated impacted fill/soil to the west of the proposed basement alignment within the Site B: Precinct 75 Mixed Use Redevelopment inferred to be a potential source of identified groundwater chlorinated/petroleum hydrocarbon impacts been successfully removed from the site to the extent practicable?
- Have basement vapour and seepage controls including the plenum, drainage and water treatment plant been installed and documented in a way that can be used to demonstrate that there are no unacceptable risks to human health via oral/dermal or inhalation of vapours, and that groundwater can be made suitable for disposal to stormwater?

  Specifically, construction of the basement vapour and seepage controls are required to demonstrate that:

  - The plenum comprises a continuous 100 mm (as a minimum and supported/amended based on the findings of the HHERA) void with no obstructions to air flow and is either passively vented, with the vents placed at suitable regular locations (i.e. not next to residential windows/doors or air intakes) or mechanically ventilated.
  - Air exchange rates, based on the findings of the HHERA, demonstrating that any passive air transfer to the balance of the basement and in turn advective migration of vapours associated with lift shafts to upper levels of residential and commercial floors are not at levels which represent an unacceptable health risk to future site users.
  - Subfloor basement drains within the lateral extent of the plenum have been designed to drain to an independent and isolated collection sump within the lowest basement level

and that drains within this area have been isolated from and independent of drains beneath the balance of the basement floor.

    - The basement subfloor drain/sump has been connected to an extraction system connected to a groundwater treatment plant to facilitate treatment of collected water to a level suitable for disposal to stormwater prior to off-site discharge[25].
    - The plenum has been designed to prevent oral/dermal contact of site users to potentially contaminated water.
- Are accessible soils environmentally suitable?
- Have physical separation arrangement layers (where required) been installed appropriately and in accordance with the RAP requirements including the retention of fill surrounded by low transmissive units below the basement?
- Are imported soils (where required) environmentally suitable for their proposed use?
- Have capping arrangements for buildings/areas of adaptive reuse been maintained/reinstated in accordance with (JBS&G 2016c)?
- Has ambient air monitoring been undertaken as per the requirements of JBS&G (2016b and 2016c)?

10.2.2 Identify Inputs to the Decision?

Inputs to the decisions are:

- A systematic and targeted program of supplementary investigations as detailed in **Appendix A**.
- The findings of the HHERA to be prepared for the site.
- Detailed development plans to be provided by JVMC appropriate to identify;
    - Consistency of the proposed development with the assumptions of the HHERA including confirmation by the project engineer (or similar) that the design and construct of the plenum, water treatment plant and engineered slab of the basement preventing access to retained fill has been appropriately installed/constructed;
    - Areas of accessible soils; and
    - Areas of plantings.
- Field observations in relation to inspection of all excavation bases, walls and stockpiles for odours, sheen, discolouration, and other indicators of potential contamination.
- Field observation as to the maintenance of existing capping arrangements.
- Soil validation analysis data collected from stockpiles and the base and walls of remedial excavations.
- Waste classification and/or material characterisation data obtained during assessment of fill materials/soils.
- Materials tracking records.
- Ambient air analytical results.
- Importation assessment criteria.

[25] or sewer if appropriate

- Disposal dockets and relevant documents in relation to appropriate disposal of material to be removed from site as part of the remediation works (landfill dockets, beneficial reuse/recycling dockets).
- Survey as-built data of the borrow pit excavation and location within the context of the site/basement.
- Survey data as to the extent and thickness of physical separation arrangements and extent of retained impacted material.
- Data quality indicators as assessed by quality assurance/quality control (QA/QC).

Specifically, sufficient data needs to be collected from each of the identified potentially impacted media (e.g. fill material and natural soils) across the site for associated COPC (**Section 8**).

10.2.3 Define the Study Boundaries

The site is located at 50 and 52 Edith Street, 67 and 73[26] Mary Street and 43 Robert Street, St Peters, NSW, is legally identified as Lot 1 Deposited Plan (DP) 745657, Lot 1 DP 745014, Part Lot 1 DP 180958, Lot 1 DP 556914, Lot A DP 331215 and Lot 1 DP 87885 and occupies an area of approximately 1.5 hectares (ha), as shown on **Figures 1** and **2**.

The surrounding land uses have been identified as follows:

- North-east - The site is bound to the north-east by Edith Street, across which are low density residential allotments. To the north, the site is bound by Edith Street and in turn Unwins Bridge Road, across which are serval industrial allotments;
- South-east - The site is bound to the south-east by low density residential allotments;
- South-west - The site is bound to the south-west by Mary Street across which are low density residential allotments and several commercial allotments; and
- North-west - The site is bound to the north-west by residential allotments and in turn Unwins Bridge Road, across which is an Inner West Council depot.

The vertical extent of the works will be the maximum depth where fill will be retained (approximately 6.2m AHD).

Validation works will be completed within development timelines to be informed by JVMC.

10.2.4 Develop a Decision Rule

Decision rules are provided following for each of the decisions:

- Have all petroleum/chemical infrastructure been successfully removed from site?
    - If all petroleum/chemical infrastructure has been removed from the Site B: Precinct 75 Mixed Use Redevelopment (or decommissioned in-situ in the Site A: Precinct 75 Commercial area where removal is not possible) in accordance with EPA made or endorsed guidelines and the material removed from site to a facility lawfully able to accept the waste, then the decision will be Yes. Otherwise the decision will be No and additional assessment and/or remediation will be required to demonstrate the objectives of the RAP/HHERA have been achieved.
- Has all fill/soil not suitable for retention on site under the fill retention strategy (refer to **Section 6**) been successfully removed from the site?

[26] Also known as 75 Mary Street

- If assessment of field observations and analytical results with site validation criteria indicates remedial works have effectively result in the removal of material not suitable to be retained then the decision will be Yes. Otherwise the decision will be No and additional assessment and/or remediation will be required to demonstrate the objectives of the RAP/HHERA have been achieved.

- Has fill/soil between the Site A: Precinct 75 Commercial area and the proposed basement alignment (to the extent practicable) within the Site B: Precinct 75 Mixed Use Redevelopment, identified as potentially being a source of the identified petroleum/chlorinated hydrocarbon groundwater impacts been successfully removed from site?
  - If assessment of field observations and analytical results with site validation criteria indicates remedial works have effectively result in the removal of most of the Site B: Precinct 75 Mixed Use Redevelopment potential on-site sources of these contaminants to groundwater, it is considered that source removal works for chlorinated/petroleum hydrocarbon contamination have occurred then the decision will be Yes. Otherwise the decision will be No and additional assessment and/or remediation will be required to demonstrate the objectives of the RAP/HHERA have been achieved.

- Have basement vapour and seepage controls including the plenum, drainage and water treatment plant been installed and documented in a way that can be used to demonstrate that there are no unacceptable risks to human health via oral/dermal or inhalation of vapours, and that groundwater can be made suitable for disposal to stormwater?
  - To validate the appropriate construction of the plenum and seepage drain collection system, the following works will be undertaken/documented:
    - Construction certification is required for the plenum to document installation in accordance with the HHERA and RWP to be prepared for the site including:

      * The plenum comprises a continuous 100mm void (or as amended based on the finding of the HHERA) with no obstructions to air flow and is either passively vented, with the vents placed at suitable regular locations (i.e. not next to residential windows/doors or air intakes) or mechanically ventilated.

      * Air exchange rates, based on the findings of the HHERA, demonstrate that any passive air transfer to the balance of the basement and in turn advective migration of vapours associated with lift shafts to upper levels of residential and commercial floors are not at levels which represent an unacceptable health risk to future site users.

      * Documentation that the plenum has been designed to prevent oral/dermal contact of site users to potentially contaminated water.

    - The drainage system at the base of the plenum and associated sump will be inspected and surveyed to ensure a consistent fall occurs along the length of the drain to the collection sump; and
    - Inspection will be completed documenting that the drainage system has been appropriately isolated from collection pits form the balance of the basement and connections completed to transfer the water to the treatment system.
  - To validate the effectiveness of the water treatment system in treating water to a level suitable for discharge to stormwater, the following works will be undertaken and documented:

- Initial outlet water quality analysis results for a period appropriate to demonstrate the successful operation of the water treatment plant with respect to reduction of contaminant concentrations prior to off-site discharge to stormwater (as to be outlined in the EMP); and
- Preparation of as-built drawings documenting the treatment plant schematics.

  - If basement vapour and seepage controls have been installed and documented in a way that can be used to demonstrate that there are no unacceptable risks to human health via oral/dermal or inhalation of vapours and in accordance with this RAP and the assumptions in the HHERA then the decision will be Yes. Otherwise the decision will be No and additional assessment and/or remediation will be required to demonstrate the objectives of the RAP/HHERA have been achieved.

- Are accessible soils environmentally suitable for the proposed land use?
  - If the upper 3.0m of soils satisfies the site validation criteria (human health and ecological) or the upper 3.0 m of soils is comprised of VENM (which cannot be recontamination as a result of contaminant migration from the Site A: Precinct 75 Commercial area), then the decision will be Yes. Otherwise the decision will be No and additional remedial works are required.
- Have physical separation arrangement layers (where required) been installed appropriately and in accordance with the RAP requirements including the retention of fill below the basement as surrounded by low transmissive units?
  - The marker and physical separation arrangements must be installed across the extent of the remedial area. The marker layer must be installed to the RAP requirements, as well as the manufacturer's installation requirements. The vertical and lateral extents of the marker layer should be surveyed (**Sections 9.6.6** and **9.6.7**), along with consistent and comprehensive photographic evidence.
  - Where soil based material is to be used for physical separation, placed above the marker layer and readily accessible to human users, this material is required to be validated as meeting the health and ecological validation requirements for the site in addition to aesthetic requirements.
  - All imported materials to be used as the physical separation arrangement must be environmentally suitable, as defined below.
  - Physical Separation arrangement are discussed in **Sections 9.6.6** and **9.6.7**.
  - Retained fill materials in the borrow pit are required to be placed beneath an engineered slab of the overlying basement and surrounded by low transmissive units (clay/shale).
  - If the marker layer and physical separation arrangements have been installed with the requirements of the RAP and assumption in the HHERA then the answer will be Yes. Otherwise the decision will be No and additional assessment and/or remediation is required to demonstrate the objectives of the RAP and HHERA have been achieved.
- Are imported soils (where required) suitable for their proposed use?
  - If imported soils are comprised of VENM or ENM and they are used in accordance with the relevant exemptions, and analyte levels within the soils meet all the adopted validation criteria (**Section 10.5**) for accessible soils on the site then the decision will be Yes. Otherwise the decision will be No.

- Have capping arrangements for buildings/areas of adaptive reuse been maintained in accordance with (JBS&G 2016c)?
    - Existing cover/capping arrangements as documented in JBS&G (2016b) and the EMP (JBS&G 2016c) are required to be maintained or reinstated following improvements and/or extension and augmentation of physical infrastructure/utilities.
    - New landscaped areas. Where new landscaped areas are proposed, these are required to be installed in accordance with **Section 9.6.7**.
    - If capping arrangements have been maintained/or reinstated in accordance with the JBS&G (2016c) and the HHERA to be prepared for the site, then the answer will be Yes, otherwise No and additional assessment and/or remediation is required to demonstrate the objectives of the RAP and HHERA have been achieved.
- Does ambient air within Building 1 represent an unacceptable risk to site users?
    - The results of ambient air monitoring will be compared to JBS&G (2016b) and the HHERA to be prepared for the site. If COPC are all below the adopted criteria, the answer will be No, otherwise Yes and additional assessment and/or remediation is required to demonstrate the objectives of the RAP and HHERA have been achieved.

10.2.5 Specify 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 the NSW EPA, NEPC (2013), ANZECC (2000[27]), DEC (2007[28]), appropriate indicators of data quality (DQIs used to assess QA/QC) and standard JBS&G procedures for field sampling and handling.

To assess the usability of the data prior to making decisions, the data will be assessed against pre-determined DQIs for completeness, comparability, representativeness, precision and accuracy.

The pre-determined Data Quality Indicators (DQIs) established for the project are discussed below in relation to precision, accuracy, representativeness, comparability, completeness and sensitivity (PARCCS parameters), and are shown in **Table 10.1**.

- **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

[27] *Australian and New Zealand Guidelines for Fresh and Marine Waste Quality, Volume 1.* Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand, October 2000 (ANZECC 2000)

[28] Contaminated Sites: Guidelines for the Assessment and Management of Groundwater Contamination. NSW Department of Environment and Conservation 2007 (DEC 2007)

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 laboratory methods, including the limits of reporting, in producing reliable data in relation to the adopted criteria.

If any of the DQIs are not met, further assessment of the data set will be required in order to determine whether the non-conformance has significant effects on the usefulness of the data. Corrective action to correct an adverse impact on the reliability of the dataset may include, but is not limited to, the request of further information from samplers and/or analytical laboratories, downgrading of the quality of the data or alternatively, re-collection of the data.

Table 10.1: Summary of Quality Assurance/Quality Control Program

Data Quality Objectives	Frequency	Data Quality Indicator
Precision		
Blind duplicates (intra laboratory)[4]	1 / 20 samples	<50% RPD[2], asbestos in agreement
Blind duplicates (inter laboratory)[4]	1 / 20 samples	<50% RPD[2], asbestos in agreement
Laboratory duplicates	1 / 20 samples	<50% RPD[2], asbestos in agreement
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		-[3]
Samples extracted and analysed within holding times.	-	Soil: organics (14 days), inorganics (6 months) Groundwater: metals (6 months, other than mercury - 28 days), sVOCs (>C_{10} - 7 days), volatiles (<C_{10} - 14 days) Soil vapour: sorbent tubes VOCs/TRH (28 days)
Trip spike (soil and ground water only)[4]	1 per sampling event	70-130% recovery
Storage blank (soil and groundwater only)[4]	1 per sampling event	<LOR
Rinsate blank (soil and groundwater only)[4]	1 per sampling data where reusable equipment is used	<LOR
Method blank (soil vapour only)[1]	1 per lab batch	<LOR
Equipment blank (soil vapour only) [1]	1 per lab batch	<LOR
Laboratory blanks	1 per lab batch	<LOR
Comparability		
Standard operating procedures for sample collection & handling	All Samples	All samples[3]
Standard analytical methods used for all analyses	All Samples	All samples[3]
Consistent field conditions, sampling staff and laboratory analysis	All Samples	All samples[3]
Limits of reporting appropriate and consistent	All Samples	All samples[3]
Completeness		
Sample description and COCs completed and appropriate	All Samples	All samples[3]
Appropriate documentation	All Samples	All samples[3]

Data Quality Objectives	Frequency	Data Quality Indicator
Satisfactory frequency and result for QC samples	All QA/QC samples	-[3]
Data from critical samples is considered valid	-	Critical samples valid[3]
Sensitivity		
Analytical methods and limits of recovery appropriate for media and adopted site assessment criteria	All Samples	All samples

[1] Inclusion of DQI for soil vapour

[2] 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.

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

[4] Not required for VENM/ENM importation samples

10.2.6 Optimise the Design for Obtaining Data

The validation sampling design is summarised for each specific type of validation works as follows.

10.2.6.1 Validation of Petroleum/Chemical Infrastructure Removal

Inspection of excavations following removal of petroleum/chemical infrastructure will require to be completed to confirm the absence of residual impact which may exceed the adopted validation criteria.

Where residual impacts which may exceed the adopted fill retention strategy criteria/or land use criteria without ongoing management remain (via visual inspection, olfactory detection and/or through the use of a PID assessment), these materials will be further chased out prior to the validation.

Subsequent to the removal of the petroleum/chemical infrastructure and associated backfill, validation requirements, consistent with NSW EPA (1994) shall include:

- Sample locations from the walls of excavations formed by the removal of USTs/backfill sands at the frequency of one sample per 5m of excavation wall, with a minimum of one per wall;
- Sample locations from the base of excavations formed by the removal of USTs at the frequency of one sample per 25m^2, with a minimum of one per former UST location;
- Discrete sample locations under other petroleum infrastructure (i.e. remote fill points, fuel dispensers). In the event that significant impacted soil volumes are removed from these areas, the adopted sampling frequency for excavation bases and walls following UST removal will be adopted; and
- Sample locations at a linear spacing of 5m underlying pipelines.

Soil samples shall be analysed for TRH, PAHs, phenols, lead and VOCs.

10.2.6.2 Impacted Soil Not Suitable for Retention

Inspection of excavations following removal of material identified as not suitable to be retained on site under the fill retention strategy in **Section 6** will require to be completed to confirm the absence of residual impact which may exceed the fill retention strategy criteria.

Where residual impacts which may exceed the adopted fill retention strategy criteria/or land use criteria without ongoing management remain (via visual inspection, olfactory detection and/or through the use of a PID assessment), these materials will be further chased out prior to the validation.

Subsequent to the removal of the impacted fill/soils, validation samples will be collected at the following density:

- Sample locations from the walls of excavations formed by the removal of impacted material at the frequency of one sample per 5m of excavation wall, with a minimum of one per wall; and
- Sample locations from the base of excavations formed by the removal of impacted material at the frequency of one sample per 25m$^{2.}$

Soil samples shall be analysed for heavy metals, TRH, PAHs and VOCs.

10.2.6.3 Petroleum/Chlorinated Hydrocarbon Impacted Material

Excavation activities will be extended to the extent practicable with consideration of boundary conditions and structural stability issues.

Inspection of excavations following removal of material identified as potentially contributing to identified petroleum/chlorinated hydrocarbon groundwater impacts will require to be completed to demonstrate that source removal works for chlorinated/petroleum hydrocarbon contamination will effectively be taking place at the site.

Where residual impacts which may exceed the adopted fill retention strategy criteria/or land use criteria without ongoing management remain (via visual inspection, olfactory detection and/or through the use of a PID assessment), these materials will be further chased out prior to the validation.

Subsequent to the removal of the impacted fill/soils, validation samples will be collected at the following density:

- Sample locations from the walls of excavations formed by the removal of impacted material at the frequency of one sample per 5m of excavation wall, with a minimum of one per wall; and
- Sample locations from the base of excavations formed by the removal of impacted material at the frequency of one sample per 25m$^{2.}$

Soil samples shall be analysed for TRH, PAHs and VOCs.

In addition, soil vapour samples (0.5m into the excavation wall/base) are proposed to be collected at the following density:

- Sample locations from the walls of excavations formed by the removal of impacted material at the frequency of one sample per 15m of excavation wall, with a minimum of one per wall; and
- Sample locations from the base of excavations formed by the removal of impacted material at the frequency of one sample per 100m$^{2.}$

Soil vapour samples shall be analysed for TRH and VOCs.

10.2.6.4 Areas of Accessible Soils (not subject to ongoing management)

Where fill material is retained, and is not proposed to be subject to management, existing site characterisation data will be used to demonstrate the land use suitability.

Alternatively, fill exceeding the adopted human health/ecological criteria which are not proposed to be subject to ongoing management require removal exposing underlying natural soil (approximately 0.7m bgs) or excavated to a depth of 3m where fill remains. Where natural soils are encountered prior to 3m in depth, soil samples shall be analysed in-situ for TRH, VOC, PAH, heavy metals and asbestos at a density of one sample per 100m^2 to confirm the overlying impacts have been removed.

Where fill remains at a depth greater than 3m, no additional sampling and analysis is required, with fill conditions considered to have been adequately characterised. However, where impacted fill is

retained at depth this is required to be documented/defined by survey as completed by a registered surveyor sufficient to identify the lateral extent and upper depth height of known environmentally impacted materials (i.e. residual fill materials retained at 3m depth).

In addition, the HHERA to be prepared for the site will be required to demonstrate that residual contamination, notably beneath the Site A: Precinct 75 Commercial area, does not represent an unacceptable risk to site portions in which a EMP is not proposed to apply.

10.2.6.5 Fill Retention with the Borrow Pit

The as-built of the borrow pit is required to be defined by survey as completed by a registered surveyor sufficient to identify:

- The as-built reduced levels of the borrow pit and associated batters/walls of surrounding low transmissive units;
- The lateral extent and upper depth height of retained fill materials; and
- The lateral extent and type of cover (e.g. engineered concrete slab to the basement) within the remediation area/stage.

In addition, construction certification is required to confirm the design life of the engineered concrete slab removing the source/pathway/receptor linkages between residual contaminated fill material and onsite receptors.

10.2.6.6 Installation of the Physical Barrier

Installation of physical separation arrangements (where fill removal is not possible/practicable or the HHERA identifies the requirement for management) shall be defined by survey as completed by a registered surveyor and/or building as-built drawings sufficient to identify:

- The lateral extent and upper depth height of known environmentally impacted materials (i.e. residual fill materials underlying the cover) within each remediation area/stage;
- The lateral extent and type of cover (e.g. permanent pavement, soil thickness) within the remediation area/stage; and
- Confirmation, by photos or otherwise, of the installation of the marker layer underlying the cover (as required).

Physical separation arrangement requirements (i.e. thickness etc.) are detailed in **Section 9.6.7**.

It is anticipated the following soil types will be used to provide physical separation.

<u>Growing Media</u>

Soils to be imported to the site and used as growing media shall be sampled at a rate of at least one sample per 100m^3 with a minimum of three samples per source/end location. Samples shall be analysed for TRH, PAHs, heavy metals, (including As, Cd, Cr, Cu, Pb, Hg, Ni and Zn), OCPs, PCBs, asbestos and soil pH. The materials shall be further inspected for any aesthetic indicators of contamination.

Site sourced VENM shall be analysed for heavy metals, TRH, VOCs, PAHs. In addition, assessment of the potential presence of aesthetic issues, including staining, discolouration and/or odorous soil conditions will be completed.

Visual inspection is required.

VENM

VENM shall be as defined under the *Protection of the Environment Operations (POEO) Act 1997* and characterised by at least five samples per source site and one per 1 000m^3 being collected if more than 10 000 m^3. Visual inspection is required.

ENM

Sampling and analysis is required to be undertaken as per the exemption.

Visual inspection is required.

Recycled Products

Sampling of materials as per an EPA exemption is required to be undertaken by the facility in accordance with the exemption. In addition, where materials are proposed for beneficial reuse under a NSW EPA exemption (i.e. imported to the site), fill material will need to be further assessed by JBS&G for land use suitability. Sampling densities and analysis for COPC will be dependent on the volume, material type, source and subject to Site Auditor endorsement.

10.2.6.7 Materials Classification

Materials sampled for waste classification in accordance with EPA (2014) shall be sampled at an appropriate rate to characterise the materials. The stockpiles will be sampled in accordance with NEPC (2013). If the stockpile is greater than 200m^3 the sampling rate shall be determined by the Field Scientist on the basis of the volume of materials and any potential heterogeneity occurring within the materials.

Sampling of materials as per the ENM exemption (or similar) requires to be undertaken in accordance with the exemption.

Sampling of site materials as per a VENM classification will require the collection of at least 10 samples with one per 1 000m^3 being collected if more than 10 000 m^3 has been removed.

Sampling of materials as per an EPA exemption is required to be undertaken by the facility in accordance with the exemption. In addition, where materials are proposed for beneficial reuse under a NSW EPA exemption (i.e. imported to the site), fill material will need to be further assessed by JBS&G for land use suitability. Sampling densities and analysis for COPC will be dependent on the volume, material type, source and subject to Site Auditor endorsement.

10.2.6.8 Basement Vapour and Seepage Controls

As discussed in **Section 10.2.4**, to validate the appropriate construction of plenum and seepage drain collection system the following works will be undertaken/documented:

- Construction certification is required for the plenum to document installation in accordance with the HHERA and RWP to be prepared for the site including:
    - The plenum comprises a continuous 100mm void (or as amended based on the finding of the HHERA) with no obstructions to air flow and is either passively vented, with the vents placed at suitable regular locations (i.e. not next to residential windows/doors or air intakes) or mechanically ventilated.
    - Air exchange rates, based on the findings of the HHERA, demonstrate that any passive air transfer to the balance of the basement and in turn advective migration of vapours associated with lift shafts to upper levels of residential and commercial floors are not at levels which represent an unacceptable health risk to future site users.
    - Documentation that the plenum has been designed to prevent oral/dermal contact of site users to potentially contaminated water.

- The drainage system at the base of the plenum and associated sump will be inspected and surveyed to ensure a consistent fall occurs along the length of the drain to the collection sump; and
- Inspection will be completed documenting that the drainage system has been appropriately isolated from collection pits form the balance of the basement and connections completed to transfer the water to the treatment system.

To validate the effectiveness of the water treatment system in treating water to a level suitable for discharge to stormwater, the following works will be undertaken and documented:

- Initial outlet water quality analysis results for a period appropriate to demonstrate the successful operation of the water treatment plant with respect to reduction of contaminant concentrations prior to off-site discharge to stormwater; and
- Preparation of as-built drawings documenting the treatment plant schematics.

The construction methodology of the plenum, drains and water treatment plant will be detailed in the HHERA/RWP to be prepared for the site following receipt of finalised design plans from JVMC.

10.2.6.9 Areas Adaptive Reuse

As development activities within this portion the site largely comprises refurbishment/alterations to building interiors, with the majority of hardstands/foundations proposed to be retained, identified soil, soil vapour and groundwater impacts are proposed to be managed via implementation of the existing EMP (JBS&G 2016c) or appropriate revised management requirements to ensure ongoing suitability of this portion of the site for ongoing commercial use.

Existing cover/capping arrangements as documented in JBS&G (2016b) and the EMP (JBS&G 2016c) are required to be maintained or reinstated following improvements and/or extension and augmentation of physical infrastructure/utilities.

Sufficient photographic evidence is required to demonstrate the assumptions in in JBS&G (2016b) and the EMP (JBS&G 2016c) or appropriate revised management requirements as a result of the HHERA to be prepared for the site.

Newly established areas of flora are required to be either within constructed garden beds (i.e. above a concrete pavement with imported environmentally suitable soils rather than existing site soils, refer to **Section 10.2.6.7**) or as per **Section 10.2.6.4**/**Section 10.2.6.6**.

10.3 Soil Sampling Methodology

The soil sampling method shall be determined by the Field Scientist as consistent with the observations of the site sub-surface and appropriate to generate representative samples. The soil sampling method shall be consistent with the data quality indicators in **Section 10.2.5**.

Where sample locations are placed by boreholes, undisturbed samples, as collected by push tube or SPT sampler, are preferred where able to be effectively implemented. Otherwise samples may be recovered from solid flight augers or via use of an excavator/hand tools. Re-usable equipment shall require to be decontaminated between sampling locations.

10.3.1 Soil Sample Containers

During the collection of soil samples, features such as seepage, discolouration, staining, odours and other indications of contamination shall be noted on field reporting sheets/field logs.

Collected soil samples shall be immediately transferred to sample containers of appropriate composition (glass jars) fitted with Teflon sealed lids. 500 mL samples shall be additionally collected and placed in new zip lock bags where asbestos analysis is required. Sample labels shall record sample identification number and date and time of sampling. Sample containers shall be transferred

to a chilled ice box for sample preservation prior to and during shipment to the testing laboratory. A chain-of-custody form shall be completed and forwarded with the samples to the testing laboratory, containing the following information:

- Sample identification;
- Signature of sampler;
- Date of collection;
- Type of sample;
- Number and type of container;
- Inclusive dates of possession; and
- Signature of receiver.

10.3.2 PID Screening

Soil samples will be screened during field works using a PID to assess the potential presence of VOCs including petroleum/chlorinated hydrocarbons. Samples obtained for PID screening will be placed in a sealed plastic bag for approximately 5 minutes to equilibrate, prior to a PID being attached to the bag. Readings will then be monitored for a period of approximately 30 seconds or until values stabilise and the stabilise/highest reading will be recorded on the field sample forms. The PID will be calibrated prior to the commencement of field works and then check readings will be completed on a daily basis during the field program using suitable calibration gas. If required, the PID will be re-calibrated during the field program in accordance with manufacturer's instructions.

10.4 Soil Laboratory Analysis

NATA accredited laboratories shall be used for all analysis of samples. Appropriate methods and LORs are required for comparison to relevant criteria. Laboratory methods and LORs are presented in **Table 10.2** below.

Table 10.2: Soil Laboratory Analysis Methods (all units in mg/kg unless stated)

Analyte	Limit of Reporting	Laboratory Method
Metals		
Arsenic	4.0	ICP-AES (USEPA 200.7)
Cadmium	1.0	ICP-AES (USEPA 200.7)
Chromium (total)	1.0	ICP-AES (USEPA 200.7)
Chromium (VI)	1.0	Alkali leach colorimetric (APHA3500-Cr/USEAP3060A)
Copper	1.0	ICP-AES (USEPA 200.7)
Lead	1.0	ICP-AES (USEPA 200.7)
Nickel	1.0	ICP-AES (USEPA 200.7)
Zinc	1.0	ICP-AES (USEPA 200.7)
Mercury (inorganic)	0.1	Cold Vapour ASS (USEPA 7471A)
TRH		
$C_6 – C_9$ Fraction	25	Purge Trap-GCMS (USEPA8260)
$C_{10} – C_{36}$ Fraction	250	Purge Trap-GCFID (USEPA8000)
BTEX		
Benzene	1.0	Purge Trap-GCMS (USEPA8260)
Toluene	1.0	Purge Trap-GCMS (USEPA8260)
Ethylbenzene	1.0	Purge Trap-GCMS (USEPA8260)
Total Xylenes	3.0	Purge Trap-GCMS (USEPA8260)
PAHs		
Benzo(a)pyrene	0.05	GCMS (USEPA8270)
Total PAHs	1.55	GCMS (USEPA8270)
PCBs		
PCBs (total)	0.7	GCECD (USEPA8140,8080)
OCPs		
Aldrin + Dieldrin	0.2	GCECD (USEPA8140,8080)
Chlordane	0.1	GCECD (USEPA8140,8080)
DDT + DDD + DDE	0.3	GCECD (USEPA8140,8080)
Endosulfan	0.3	GCECD (USEPA8140,8080)
Endrin	0.1	GCECD (USEPA8140,8080)
Methoxychlor	0.1	GCECD (USEPA8140,8080)
Heptachlor	0.1	GCECD (USEPA8140,8080)
Phenols		
Total Phenols	5	Distillation-Colorimetric (APHA 5530)
VOCs		
PCE	1.0	Purge Trap-GCMS (USEPA8260)
TCE	1.0	Purge Trap-GCMS (USEPA8260)
Cis 1,2 DCE	1.0	Purge Trap-GCMS (USEPA8260)
Trans 1,2 DCE	1.0	Purge Trap-GCMS (USEPA8260)
VC	1.0	Purge Trap-GCMS (USEPA8260)
Other		
Asbestos	Presence/ 0.1 g/kg	PLM / Dispersion Staining as per AS4964:2004
Soil pH	0.1	5:1 leach

10.5 Soil Vapour Sampling Methodology

The vapour assessment activities will comprise advancement of soil vapour points 0.5m into the excavation face/base. The proposed methodology has been developed with consideration of the guidance on vapour sampling methods outlined in CRCCARE (2013[29]).

The soil vapour locations will be completed as follows:

- Advancement of locations 0.5m into the excavation face/base via the use of a 10mm diameter drill;

[29] *Technical Report No.23 Petroleum Hydrocarbon Vapour Intrusion Assessment*. Australia Guidance, July 2013, CRC for Contamination Assessment and Remediation of the Environment (CRCCARE 2013)

- 6mm teflon tubing with a stainless-steel tip will be installed within the hole to the depth of the hole (0.5m) and sealed in place with air drying clay before the sampling works are to commence. Sand will be placed within the hole covering the stainless-steel sampling tip with the remainder of the hole sealed with air drying clay.
- The sample locations will be left to equilibrate for a period of at least 30 minutes prior to the commencement of purging and sampling.
- A landfill gas meter will be used to purge each probe. Gas readings will be monitored until oxygen and PID readings have stabilised.
- Following this a leak detection evaluation will be completed via placement of an isopropyl alcohol soaked rag over the top of the backfilled borehole to assess the potential occurrence of leaks whilst the gas detector was purging the sample point. Elevated PID readings on the gas detector would indicate a leaking probe. Any leaking probes would be required to be re-installed and re-checked prior to sampling using the same method.
- A personal sampling pump will be calibrated to a flow rate of 200ml/min (+/- 10 %) for use in sampling drawing 60L to allow for an appropriate LOR sufficiently lower than the adopted assessment criteria such that appropriate conclusion may be drawn. A SKC carbon sorbent tube will be connected to the soil vapour probe once it has been purged via use of a multi-port valve. The sampling pump will then be connected to the carbon tube outlet and turned on.
- The sampling pump will be set to run for five hours (approximately 60L soil vapour sample volume). The purged condition of the probe will be maintained by use of the multi-port valve.
- At the completion of the sampling period, the pump will be switched off and the carbon tube removed from the vapour probe. The sampling pump flow rate will be checked and the identified sampling rate recorded and caps will be returned to the carbon tubes.
- Duplicate samples will be collected at the required frequency via use of the same vapour probes after a period of at least 24 hours has passed following collection of the primary sample, using identical equipment including the calibrated pump.
- The carbon tubes will be forwarded to the NATA accredited laboratory for analysis using the 8260 method. The laboratory will be instructed to evaluate the potential presence of 2-propanol (i.e. Isopropyl alcohol) as may be present due to a leak in the vapour well during the sampling event. It is noted that where a significant leak does occur, the tube would be expected to be saturated with 2-propanol and analysis for COPC would be the subject of significantly elevated detection limits.
- Upon completion of the sampling it is proposed that the tubing will be removed and the sampling location will be sealed with a cement grout.

An ambient air sample will be collected as per the methodology in JBS&G (2016c) to assess whether sub-slab soil vapour TCE concentrations underlying Building 1 represent an unacceptable risk to current/future commercial users.

10.6 Validation Criteria

10.6.1 Accessible Soils/Exposed Natural Soils (with no ongoing management)

Based on the proposed development details and in accordance with the decision process for assessment of urban redevelopment sites (DEC 2006), concentrations of contaminants in media shall be compared against the adopted criteria as presented in **Tables 10.3** to **10.8**, sourced from the following:

Areas within Minimal Access to Soils (Built Area - **Tables 10.3** and **10.4**)

- Health based Investigation Levels (HILs) for residential with minimal access to soils land use NEPC (2013) - HIL-B;
- Health Screening Levels (HSLs) for petroleum hydrocarbons considering potential for vapour intrusion, fine grained soil for low-high density residential (HSL A & B) land use at 0.0-1.0 m depth (NEPC 2013);
- As a conservative measure, generic and site specific ecological investigation levels (EILs) derived through the added contaminant limits for residential with minimal access to soils;
- Management Limits for TRH, fine grained soils for residential land use – NEPC (2013);
- Ecological Screening Levels (ESLs) for TRH fractions, BTEX and benzo(a)pyrene in fine grained soil for residential land use (NEPC 2013); and
- Where there are no NSW EPA endorsed thresholds the laboratory LOR has been adopted as an initial screening value for the purposes of this validation assessment.

Table 10.3 HIL-B Health Based Soil Investigation Criteria and Hydrocarbon Management Limits (all units in mg/kg)

	Laboratory Method	Health Investigation/Screening Levels	Management Limits[5]
		HIL-B	Urban Residential, Parkland and Public Open Space
Metals			
Arsenic	ICP-AES (USEPA 200.7)	500	-
Cadmium	ICP-AES (USEPA 200.7)	150	-
Chromium	ICP-AES (USEPA 200.7)	500[1]	-
Chromium (VI)	Alkali leach colorimetric (APHA3500-Cr/USEAP3060A)	500	-
Copper	ICP-AES (USEPA 200.7)	30 000	-
Nickel	ICP-AES (USEPA 200.7)	1 200	-
Lead	ICP-AES (USEPA 200.7)	1 200	-
Zinc	ICP-AES (USEPA 200.7)	60 000	-
Mercury (inorganic)	Cold Vapour ASS (USEPA 7471A)	120[2]	-
PAHs			
Carcinogenic PAHs (as B(a)P TEQ)[3]	GCMS (USEPA8270)	4	-
Total PAHs[4]	GCMS (USEPA8270)	400	-
BTEX			
Benzene	Purge Trap-GCMS (USEPA8260)	0.7[6]	-
Toluene	Purge Trap-GCMS (USEPA8260)	480[6]	-
Ethylbenzene	Purge Trap-GCMS (USEPA8260)	NL[6]	-
Total Xylenes	Purge Trap-GCMS (USEPA8260)	110[6]	-
Naphthalene	Purge Trap-GCMS (USEPA8260)	5	-
TRH			
F1 C_6-C_{10}	TPH Purge Trap-GCMS (USEPA8260)	50[6,7]	800[5]
F2 >C_{10}-C_{16}	TPH Purge Trap-GCMS (USEPA8260)	280[6]	1 000[5]
F3 >C_{16}-C_{34}	Purge Trap-GCFID (USEPA8000)	-	3 500
F4 >C_{34}-C_{40}	Purge Trap-GCFID (USEPA8000)	-	10 000
OCPs			
DDT + DDD + DDE	GCECD (USEPA8140,8080)	600	-
Aldrin + Dieldrin	GCECD (USEPA8140,8080)	10	-
Chlordane	GCECD (USEPA8140,8080)	90	-
Endosulfan	GCECD (USEPA8140,8080)	400	-
Endrin	GCECD (USEPA8140,8080)	20	-
Heptachlor	GCECD (USEPA8140,8080)	10	-
HCB	GCECD (USEPA8140,8080)	15	-
Methoxychlor	GCECD (USEPA8140,8080)	500	-
HERBICIDES/PESTICIDES			
2,4,5-T	GCECD (USEPA8140,8080)	900	-

	Laboratory Method	Health Investigation/Screening Levels	Management Limits[5]
		HIL-B	Urban Residential, Parkland and Public Open Space
2,4-D	GCECD (USEPA8140,8080)	1 600	-
MCPA	GCECD (USEPA8140,8080)	900	-
MCPB	GCECD (USEPA8140,8080)	900	-
Mecoprop	GCECD (USEPA8140,8080)	900	-
Picloram	GCECD (USEPA8140,8080)	6 600	-
Atrazine	GCECD (USEPA8140,8080)	470	-
Chlorpyrifos	GCECD (USEPA8140,8080)	340	-
Bifenthrin	GCECD (USEPA8140,8080)	840	-
PCBs			
Total PCBs	GCECD (USEPA8140,8080)	1	-
Phenols			
Phenol	GCECD (USEPA8140,8080)	45 000	-
VOCs			
PCE	Purge Trap-GCMS (USEPA8260)	1[8]	-
TCE	Purge Trap-GCMS (USEPA8260)	1[8]	-
Cis 1,2 DCE	Purge Trap-GCMS (USEPA8260)	1[8]	-
Trans 1,2 DCE	Purge Trap-GCMS (USEPA8260)	1[8]	-
VC	Purge Trap-GCMS (USEPA8260)	1[8]	-
OTHER			
Asbestos (surface soils)	PLM / Dispersion Staining	No visible asbestos	-
Asbestos (top 0.5 m)	PLM / Dispersion Staining	No asbestos capable of being detected via the investigation, which comprises both visual identification and sample analysis by a NATA accredited laboratory	-
Asbestos (below 0.5 m)	PLM / Dispersion Staining	No asbestos capable of being detected via the investigation, which comprises both visual identification and sample analysis by a NATA accredited laboratory	-

Notes:

[1.] Guideline values presented are for Chromium (VI) in absence of total Chromium values. Where total Chromium results are elevated, samples will be analysed for Chromium (VI).

[2.] Guideline values are for inorganic mercury. Where elevated mercury concentrations are encountered and/or site information suggests the potential presence of elemental mercury and/or methyl mercury, consideration of applicability would be needed.

[3.] Carcinogenic PAHs calculated as per Benzo(a)pyrene Toxicity Equivalent Factor requirements presented in NEPC (2013)

[4.] Total PAHs calculated as per requirements presented in NEPC (2013).

[5.] Management Limits are based on fine grained soil, with F1 and F2 concentrations inclusive of naphthalene and BTEX compounds.

[6.]Soil Health Screening Levels for Vapour Intrusion: Clay Soils. Values presented are those for 0 to <1 m bgl as the most conservative level. Reference should be made to results tables for further detail of levels at greater depths. NL: Non-limiting.
[7.]Values for F1 C6-C9 are obtained by subtracting BTEX (Sum) from laboratory result for C6-C9 TRH.
[8]. No EPA endorsed criteria, The LOR is proposed as a screening level in the absence of endorsed site-specific criteria.

Table 10.4 HIL-B Ecological Screening Levels and Soil Quality Guideline Values (all units in mg/kg)

	Laboratory Method	ESLs Urban Residential and public open space	SQGs (Aged) Urban Residential and public open space
Metals			
Arsenic	ICP-AES (USEPA 200.7)	-	100
Cadmium	ICP-AES (USEPA 200.7)	-	-
Chromium	ICP-AES (USEPA 200.7)	-	250
Chromium (VI)	Alkali leach colorimetric (APHA3500-Cr/USEAP3060A)	-	-
Copper	ICP-AES (USEPA 200.7)	-	190
Nickel	ICP-AES (USEPA 200.7)	-	170
Lead	ICP-AES (USEPA 200.7)	-	1 100
Zinc	ICP-AES (USEPA 200.7)	-	400
Mercury (inorganic)	Cold Vapour ASS (USEPA 7471A)	-	-
PAHs			
Benzo(a)pyrene	GCMS (USEPA8270)	0.7	-
Naphthalene	GCMS (USEPA8270)	-	170
BTEX			
Benzene	Purge Trap-GCMS (USEPA8260)	65	-
Toluene	Purge Trap-GCMS (USEPA8260)	105	-
Ethylbenzene	Purge Trap-GCMS (USEPA8260)	125	-
Total Xylenes	Purge Trap-GCMS (USEPA8260)	45	-
TRH			
F1 C_6-C_{10}	TPH Purge Trap-GCMS (USEPA8260)	180[1]	-
F2 >C_{10}-C_{16}	TPH Purge Trap-GCMS (USEPA8260)	120[2]	-
F3 >C_{16}-C_{34}	Purge Trap-GCFID (USEPA8000)	1 300	-
F4 >C_{34}-C_{40}	Purge Trap-GCFID (USEPA8000)	5 600	-
OCPs			
DDT	GCECD (USEPA8140,8080)	-	180

Notes:
[1.]Values for F1 C6-C9 are obtained by subtracting BTEX (Sum) from laboratory result for C6-C9 TRH.
[2.]Values for F2 >C10-C16 are obtained by subtracting naphthalene from laboratory result for >C10-C16 TRH.

Recreational Areas (Park within South Eastern Site Extent) (**Tables 10.5** and **10.6**)

- Health based Investigation Levels (HILs) for recreational land use NEPC (2013) - HIL-C;
- Health Screening Levels (HSLs) for petroleum hydrocarbons considering potential for vapour intrusion, fine grained soil for recreational/open space land use (HSL C) land use at 0.0-1.0 m depth (NEPC 2013);
- As a conservative measure, generic and site specific ecological investigation levels (EILs) derived through the added contaminant limits for recreational land uses;
- Management Limits for TRH, fine grained soils for residential/park/open space land uses – NEPC (2013);
- Ecological Screening Levels (ESLs) for TRH fractions, BTEX and benzo(a)pyrene in fine grained soil for residential/recreational land uses (NEPC 2013); and
- Where there are no NSW EPA endorsed thresholds the laboratory LOR has been adopted as an initial screening value for the purposes of this validation assessment.

Table 10.5 HIL-C Health Based Soil Investigation Criteria and Hydrocarbon Management Limits (all units in mg/kg)

	Laboratory Method	Health Investigation/Screening Levels	Management Limits[5]
		HIL-C	Urban Residential, Parkland and Public Open Space
Metals			
Arsenic	ICP-AES (USEPA 200.7)	300	-
Cadmium	ICP-AES (USEPA 200.7)	90	-
Chromium	ICP-AES (USEPA 200.7)	300[1]	-
Chromium (VI)	Alkali leach colorimetric (APHA3500-Cr/USEAP3060A)	300	-
Copper	ICP-AES (USEPA 200.7)	17 000	-
Nickel	ICP-AES (USEPA 200.7)	1 200	-
Lead	ICP-AES (USEPA 200.7)	600	-
Zinc	ICP-AES (USEPA 200.7)	30 000	-
Mercury (inorganic)	Cold Vapour ASS (USEPA 7471A)	80[2]	-
PAHs			
Carcinogenic PAHs (as B(a)P TEQ)[3]	GCMS (USEPA8270)	3	-
Total PAHs[4]	GCMS (USEPA8270)	300	-
BTEX			
Benzene	Purge Trap-GCMS (USEPA8260)	NL[6]	-
Toluene	Purge Trap-GCMS (USEPA8260)	NL[6]	-
Ethylbenzene	Purge Trap-GCMS (USEPA8260)	NL[6]	-
Total Xylenes	Purge Trap-GCMS (USEPA8260)	NL[6]	-
Naphthalene	Purge Trap-GCMS (USEPA8260)	NL[6]	-
TRH			
F1 C_6-C_{10}	TPH Purge Trap-GCMS (USEPA8260)	NL[6,7]	800[5]
F2 >C_{10}-C_{16}	TPH Purge Trap-GCMS (USEPA8260)	NL[6]	1 000[5]
F3 >C_{16}-C_{34}	Purge Trap-GCFID (USEPA8000)	-	3 500
F4 >C_{34}-C_{40}	Purge Trap-GCFID (USEPA8000)	-	10 000
OCPs			
DDT + DDD + DDE	GCECD (USEPA8140,8080)	400	-
Aldrin + Dieldrin	GCECD (USEPA8140,8080)	10	-
Chlordane	GCECD (USEPA8140,8080)	70	-
Endosulfan	GCECD (USEPA8140,8080)	340	-
Endrin	GCECD (USEPA8140,8080)	20	-
Heptachlor	GCECD (USEPA8140,8080)	10	-
HCB	GCECD (USEPA8140,8080)	15	-
Methoxychlor	GCECD (USEPA8140,8080)	400	-
HERBICIDES/PESTICIDES			
2,4,5-T	GCECD (USEPA8140,8080)	800	-

	Laboratory Method	Health Investigation/Screening Levels	Management Limits[5]
		HIL-C	Urban Residential, Parkland and Public Open Space
2,4-D	GCECD (USEPA8140,8080)	1 300	-
MCPA	GCECD (USEPA8140,8080)	800	-
MCPB	GCECD (USEPA8140,8080)	800	-
Mecoprop	GCECD (USEPA8140,8080)	800	-
Picloram	GCECD (USEPA8140,8080)	5 700	-
Atrazine	GCECD (USEPA8140,8080)	400	-
Chlorpyrifos	GCECD (USEPA8140,8080)	250	-
Bifenthrin	GCECD (USEPA8140,8080)	730	-
PCBs			
Total PCBs	GCECD (USEPA8140,8080)	1	-
Phenols			
Phenol	GCECD (USEPA8140,8080)	40 000	-
VOCs			
PCE	Purge Trap-GCMS (USEPA8260)	1[8]	-
TCE	Purge Trap-GCMS (USEPA8260)	1[8]	-
Cis 1,2 DCE	Purge Trap-GCMS (USEPA8260)	1[8]	-
Trans 1,2 DCE	Purge Trap-GCMS (USEPA8260)	1[8]	-
VC	Purge Trap-GCMS (USEPA8260)	1[8]	-
OTHER			
Asbestos (surface soils)	PLM / Dispersion Staining	No visible asbestos	-
Asbestos (top 0.5 m)	PLM / Dispersion Staining	No asbestos capable of being detected via the investigation, which comprises both visual identification and sample analysis by a NATA accredited laboratory	-
Asbestos (below 0.5 m)	PLM / Dispersion Staining	No asbestos capable of being detected via the investigation, which comprises both visual identification and sample analysis by a NATA accredited laboratory	-

Notes:

[1.] Guideline values presented are for Chromium (VI) in absence of total Chromium values. Where total Chromium results are elevated, samples will be analysed for Chromium (VI).

[2.] Guideline values are for inorganic mercury. Where elevated mercury concentrations are encountered and/or site information suggests the potential presence of elemental mercury and/or methyl mercury, consideration of applicability would be needed.

[3.] Carcinogenic PAHs calculated as per Benzo(a)pyrene Toxicity Equivalent Factor requirements presented in NEPC (2013)

[4.] Total PAHs calculated as per requirements presented in NEPC (2013).

[5.] Management Limits are based on fine grained soil, with F1 and F2 concentrations inclusive of naphthalene and BTEX compounds.

[6.]Soil Health Screening Levels for Vapour Intrusion: Clay Soils. Values presented are those for 0 to <1 m bgl as the most conservative level. Reference should be made to results tables for further detail of levels at greater depths. NL: Non-limiting.
[7.]Values for F1 C6-C9 are obtained by subtracting BTEX (Sum) from laboratory result for C6-C9 TRH.
[8]. No EPA endorsed criteria, The LOR is proposed as a screening level in the absence of endorsed site-specific criteria.

Table 10.6 HIL-C Ecological Screening Levels and Soil Quality Guideline Values (all units in mg/kg)

	Laboratory Method	ESLs Urban Residential and public open space	SQGs (Aged) Urban Residential and public open space
Metals			
Arsenic	ICP-AES (USEPA 200.7)	-	100
Cadmium	ICP-AES (USEPA 200.7)	-	-
Chromium	ICP-AES (USEPA 200.7)	-	250
Chromium (VI)	Alkali leach colorimetric (APHA3500-Cr/USEAP3060A)	-	-
Copper	ICP-AES (USEPA 200.7)	-	190
Nickel	ICP-AES (USEPA 200.7)	-	170
Lead	ICP-AES (USEPA 200.7)	-	1 100
Zinc	ICP-AES (USEPA 200.7)	-	400
Mercury (inorganic)	Cold Vapour ASS (USEPA 7471A)	-	-
PAHs			
Benzo(a)pyrene	GCMS (USEPA8270)	0.7	-
Naphthalene	GCMS (USEPA8270)	-	170
BTEX			
Benzene	Purge Trap-GCMS (USEPA8260)	65	-
Toluene	Purge Trap-GCMS (USEPA8260)	105	-
Ethylbenzene	Purge Trap-GCMS (USEPA8260)	125	-
Total Xylenes	Purge Trap-GCMS (USEPA8260)	45	-
TRH			
F1 C_6-C_{10}	TPH Purge Trap-GCMS (USEPA8260)	180[1]	-
F2 >C_{10}-C_{16}	TPH Purge Trap-GCMS (USEPA8260)	120[2]	-
F3 >C_{16}-C_{34}	Purge Trap-GCFID (USEPA8000)	1 300	-
F4 >C_{34}-C_{40}	Purge Trap-GCFID (USEPA8000)	5 600	-
OCPs			
DDT	GCECD (USEPA8140,8080)	-	180

Notes:
[1.]Values for F1 C6-C9 are obtained by subtracting BTEX (Sum) from laboratory result for C6-C9 TRH.
[2.]Values for F2 >C10-C16 are obtained by subtracting naphthalene from laboratory result for >C10-C16 TRH.

Areas of Adaptive Reuse (**Tables 10.7** and **10.8**)

- Health based Investigation Levels (HILs) for commercial land use NEPC (2013) - HIL-D;
- Health Screening Levels (HSLs) for petroleum hydrocarbons considering potential for vapour intrusion, fine grained soil for commercial land use (HSL D) land use at 0.0-1.0 m depth (NEPC 2013);
- As a conservative measure, generic and site specific ecological investigation levels (EILs) derived through the added contaminant limits for commercial land uses;
- Management Limits for TRH, fine grained soils for commercial land uses – NEPC (2013);
- Ecological Screening Levels (ESLs) for TRH fractions, BTEX and benzo(a)pyrene in fine grained soil for commercial land uses (NEPC 2013); and
- Where there are no NSW EPA endorsed thresholds the laboratory LOR has been adopted as an initial screening value for the purposes of this validation assessment.

Table 10.7 HIL-D Health Based Soil Investigation Criteria and Hydrocarbon Management Limits (all units in mg/kg)

	Laboratory Method	Health Investigation/Screening Levels	Management Limits[5]
		HIL-D	Commercial/Industrial
Metals			
Arsenic	ICP-AES (USEPA 200.7)	3 000	-
Cadmium	ICP-AES (USEPA 200.7)	900	-
Chromium	ICP-AES (USEPA 200.7)	3 600[1]	-
Chromium (VI)	Alkali leach colorimetric (APHA3500-Cr/USEAP3060A)	3 600	-
Copper	ICP-AES (USEPA 200.7)	240 000	-
Nickel	ICP-AES (USEPA 200.7)	6 000	-
Lead	ICP-AES (USEPA 200.7)	1 500	-
Zinc	ICP-AES (USEPA 200.7)	400 000	-
Mercury (inorganic)	Cold Vapour ASS (USEPA 7471A)	730[2]	-
PAHs			
Carcinogenic PAHs (as B(a)P TEQ)[3]	GCMS (USEPA8270)	40	-
Total PAHs[4]	GCMS (USEPA8270)	4 000	-
BTEX			
Benzene	Purge Trap-GCMS (USEPA8260)	4[6]	-
Toluene	Purge Trap-GCMS (USEPA8260)	NL[6]	-
Ethylbenzene	Purge Trap-GCMS (USEPA8260)	NL[6]	-
Total Xylenes	Purge Trap-GCMS (USEPA8260)	NL[6]	-
Naphthalene	Purge Trap-GCMS (USEPA8260)	NL	-
TRH			
F1 C_6-C_{10}	TPH Purge Trap-GCMS (USEPA8260)	310[6,7]	800[5]
F2 >C_{10}-C_{16}	TPH Purge Trap-GCMS (USEPA8260)	NL[6]	1 000[5]
F3 >C_{16}-C_{34}	Purge Trap-GCFID (USEPA8000)	-	5 000
F4 >C_{34}-C_{40}	Purge Trap-GCFID (USEPA8000)	-	10 000
OCPs			
DDT + DDD + DDE	GCECD (USEPA8140,8080)	3 600	-
Aldrin + Dieldrin	GCECD (USEPA8140,8080)	45	-
Chlordane	GCECD (USEPA8140,8080)	530	-
Endosulfan	GCECD (USEPA8140,8080)	2 000	-
Endrin	GCECD (USEPA8140,8080)	100	-
Heptachlor	GCECD (USEPA8140,8080)	50	-
HCB	GCECD (USEPA8140,8080)	80	-
Methoxychlor	GCECD (USEPA8140,8080)	2 500	-
HERBICIDES/PESTICIDES			
2,4,5-T	GCECD (USEPA8140,8080)	5 000	-

	Laboratory Method	Health Investigation/Screening Levels	Management Limits[5]
		HIL-D	Commercial/Industrial
2,4-D	GCECD (USEPA8140,8080)	9 000	-
MCPA	GCECD (USEPA8140,8080)	5 000	-
MCPB	GCECD (USEPA8140,8080)	5 000	-
Mecoprop	GCECD (USEPA8140,8080)	5 000	-
Picloram	GCECD (USEPA8140,8080)	35 000	-
Atrazine	GCECD (USEPA8140,8080)	470	-
Chlorpyrifos	GCECD (USEPA8140,8080)	340	-
Bifenthrin	GCECD (USEPA8140,8080)	840	-
PCBs			
Total PCBs	GCECD (USEPA8140,8080)	7	-
Phenols			
Phenol	GCECD (USEPA8140,8080)	240 000	-
VOCs			
PCE	Purge Trap-GCMS (USEPA8260)	1[8]	-
TCE	Purge Trap-GCMS (USEPA8260)	1[8]	-
Cis 1,2 DCE	Purge Trap-GCMS (USEPA8260)	1[8]	-
Trans 1,2 DCE	Purge Trap-GCMS (USEPA8260)	1[8]	-
VC	Purge Trap-GCMS (USEPA8260)	1[8]	-
OTHER			
Asbestos (surface soils)	PLM / Dispersion Staining	No visible asbestos	-
Asbestos (top 0.5 m)	PLM / Dispersion Staining	No asbestos capable of being detected via the investigation, which comprises both visual identification and sample analysis by a NATA accredited laboratory	-
Asbestos (below 0.5 m)	PLM / Dispersion Staining	No asbestos capable of being detected via the investigation, which comprises both visual identification and sample analysis by a NATA accredited laboratory	-

Notes:

[1.] Guideline values presented are for Chromium (VI) in absence of total Chromium values. Where total Chromium results are elevated, samples will be analysed for Chromium (VI).

[2.] Guideline values are for inorganic mercury. Where elevated mercury concentrations are encountered and/or site information suggests the potential presence of elemental mercury and/or methyl mercury, consideration of applicability would be needed.

[3.] Carcinogenic PAHs calculated as per Benzo(a)pyrene Toxicity Equivalent Factor requirements presented in NEPC (2013)

[4.] Total PAHs calculated as per requirements presented in NEPC (2013).

[5.] Management Limits are based on fine grained soil, with F1 and F2 concentrations inclusive of naphthalene and BTEX compounds.

[6.] Soil Health Screening Levels for Vapour Intrusion: Clay Soils. Values presented are those for 0 to <1 m bgl as the most conservative level. Reference should be made to results tables for further detail of levels at greater depths. NL: Non-limiting.

[7]. Values for F1 C6-C9 are obtained by subtracting BTEX (Sum) from laboratory result for C6-C9 TRH.
[8]. No EPA endorsed criteria, The LOR is proposed as a screening level in the absence of endorsed site-specific criteria.

Table 10.8 HIL-D Ecological Screening Levels and Soil Quality Guideline Values (all units in mg/kg)

	Laboratory Method	ESLs Commercial/Industrial	SQGs (Aged) Commercial/Industrial
Metals			
Arsenic	ICP-AES (USEPA 200.7)	-	160
Cadmium	ICP-AES (USEPA 200.7)	-	-
Chromium	ICP-AES (USEPA 200.7)	-	420
Chromium (VI)	Alkali leach colorimetric (APHA3500-Cr/USEAP3060A)	-	-
Copper	ICP-AES (USEPA 200.7)	-	280
Nickel	ICP-AES (USEPA 200.7)	-	290
Lead	ICP-AES (USEPA 200.7)	-	1 800
Zinc	ICP-AES (USEPA 200.7)	-	620
Mercury (inorganic)	Cold Vapour ASS (USEPA 7471A)	-	-
PAHs			
Benzo(a)pyrene	GCMS (USEPA8270)	1.4	-
Naphthalene	GCMS (USEPA8270)	-	370
BTEX			
Benzene	Purge Trap-GCMS (USEPA8260)	95	-
Toluene	Purge Trap-GCMS (USEPA8260)	135	-
Ethylbenzene	Purge Trap-GCMS (USEPA8260)	185	-
Total Xylenes	Purge Trap-GCMS (USEPA8260)	95	-
TRH			
F1 C_6-C_{10}	TPH Purge Trap-GCMS (USEPA8260)	215[1]	-
F2 >C_{10}-C_{16}	TPH Purge Trap-GCMS (USEPA8260)	170[2]	-
F3 >C_{16}-C_{34}	Purge Trap-GCFID (USEPA8000)	2 500	-
F4 >C_{34}-C_{40}	Purge Trap-GCFID (USEPA8000)	6 600	-
OCPs			
640	GCECD (USEPA8140,8080)	-	180

10.6.1.1 Application of Soil Assessment Criteria

For soils to be considered as meeting the health/ecological based assessment criteria (i.e., not posing an unacceptable risk), the following criteria will be adopted:

Either:

- All contaminant concentrations were less than the adopted site assessment criteria,

Or:

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

In addition to the numerical criteria, the following visual observations will also supplemented the assessment process:

- No visible asbestos containing material in addition to laboratory analysis results; and
- Consideration was given to odorous or discoloured soils (caused by contamination).

10.6.2 Material Characterisation for Off-site Disposal

Where contaminated fill/soil is not suitable for onsite management or is surplus to construction requirements, materials are proposed to be remediated by off-site removal and disposal. Materials shall be classified in accordance with EPA (2014) *Waste Classification Guidelines* or an appropriate exemption as created under the *Protection of the Environment Operations (Waste) Regulation 2014*.

Material will require to be removed to a facility lawfully able to receive it.

10.6.3 Imported Materials

In accordance with current EPA policy, only material that does not represent an environmental or health risk at the receiving site may be considered for resource recovery. Imported materials will only be accepted to the site if they meet the restrictions placed on these materials and meet the definition of:

- Virgin Excavated Natural Material (VENM) as defined in the *Protection of the Environment Operations Act* (1997) Schedule 1;
- Excavated Natural Material (ENM) as defined in EPA (2014); or
- Recycle materials as per an EPA exemption.

All material imported onto the site are required to be accompanied by appropriate documentation that has been verified by the appointed site contamination (environmental) consultant.

Sampling of materials as per an EPA exemption (recycled products) is required to be undertaken by the facility in accordance with the exemption. In addition, where materials are proposed for beneficial reuse under a NSW EPA exemption (i.e. imported to the site), fill material will need to be further assessed by JBS&G for land use suitability. Sampling densities and analysis for COPC will be dependent on the volume, material type, source and subject to Site Auditor endorsement

10.6.4 Validation of Soil Placement Areas (Capped Soil)

Soils which are to be moved to another area of the site will be subject to the following data recording process for future reference purposes, and detailed in the MTP:

- A location plan of the placed materials with co-ordinates based on an agreed grid system (e.g., GPS or relative to the lot boundaries);
- The levels in m AHD of the base of the placement location(s) prior to the material placement;
- The levels in m AHD of the placement locations once all materials have been placed;
- The levels in m AHD of any defining layers; and
- Subsequently the total placed volume of materials.

10.6.5 Soil Vapour

The following soil vapour criteria will be adopted for the site based on the land use scenario:

- HSLs for petroleum hydrocarbons, fine grained as provided in the NEPM (2013); and
- Interim soil vapour HILs as provided in the NEPM (2013) for chlorinated hydrocarbons.

A copy of the validation criteria is **Appendix C**.

10.7 Reporting

At the completion of site remediation works, a validation report will be prepared in general accordance with DEC (2006) and OEH (2011) *Guidelines for Consultants Reporting on Contaminated Site*, documenting the works as completed.

This report will contain information including:

- Details of the remediation works conducted;
- The results and findings of the data gap investigation and HHERA;
- Information demonstrating that the objectives of this RAP and the findings of the HHERA have been achieved, in particular the validation sample results and assessment of the data against both the pre-defined DQO and the remediation acceptance (validation) criteria;
- Information demonstrating compliance with appropriate regulations and guidelines;
- Any variations to the strategy undertaken during the implementation of the remedial works;
- Results of all environmental monitoring undertaken during the course of the remedial works;
- Details of any environmental incidents occurring during the course of the remedial works and the actions undertaken in response to these incidents;
- Verification of regulatory compliance;
- Details on waste classification, tracking and off-site disposal including landfill dockets;
- Clear statement of the suitability of the site (or part of the site) that is the subject of the validation report, for the proposed use(s); and
- Other information as appropriate, including details of EMPs (if required) that will apply to the part of the site that is the subject of the validation report.

The report will serve to document the remediation works for future reference.

10.8 Environmental Management Plan

Where required, the EMP shall contain the following elements:

- A statement of the objectives of the EMP – i.e., to ensure continued suitability of the site after it has been remediated;
- Identification of residual environmental contamination issues at the site that require ongoing management/monitoring to meet the EMP objectives, including the type of contamination and location within the site (including survey plans);
- Documentation of environmental management measures which have been implemented to address the identified environmental issues at/within the site;
- Description of management controls to limit the exposure of the site users to known areas of contamination to acceptable levels;
- Description of responsibilities for implementing various elements of the provisions contained in the EMP;
- Timeframes for implementing the various control/monitoring, etc. elements outlined in the EMP;
- Environmental monitoring and reporting requirements (if required) for the future management of environmental impact underlying/within the site including:
    - Appropriate monitoring locations and depth within and down-gradient of any residual contamination;
    - Relevant assessment criteria to be used in evaluating monitoring results;
    - Frequency of monitoring and reporting;
    - Process for reviewing monitoring data and how decisions will be made regarding the ongoing management strategy;
    - The length of time for which monitoring is expected to continue;
    - The regulatory authorities involved and the management inputs required from each;
    - The integration of environmental management and monitoring measures for soil and groundwater;
    - Health and safety requirements for particular activities;
    - A program of review and audits;
    - The provisions in the EMP are feasible (i.e., able to be implemented) and able to be legally enforceable (i.e., a mechanism exists, such as development consent conditions, to give the plan a basis in law); and
    - The relevant consent authority is satisfied that the inclusion of a development consent condition relating to the implementation of the EMP is acceptable;
- Corrective action procedures to be implemented where EMP assessment criteria are breached.

The EMP will be provided to the appointed Site Auditor for review and approval prior to preparation of the Site Audit Statement (SAS) and Site Audit Report (SAR).

11. Contingency Plan

A review of the proposed contamination-related aspects of the works associated with development of the site has been undertaken and has identified a number of potential risks, outlined in the following sections that required the development of contingencies to ensure that the objectives of this RAP are met.

The Contingency Plan is required to be part of the REMP, as described in **Section 12**, below, and part of the Work Health and Safety Plan (WHSP), as described in **Section 12**.

11.1 Unexpected Finds

The possibility exists for hazards that have not been identified to date to be present within fill materials or underlying pavements/building on the site. The nature of hazards which may be present and which may be discovered at the site are generally detectable through visual or olfactory means, for example:

- The presence of significant aggregates of friable asbestos materials (visible) as opposed to minor occurrences of fragments or fibre bundles in soil; and/or
- Excessive quantities of Construction/Demolition Waste (visible); and/or
- Hydrocarbon impacted materials (visible/odorous); and/or
- Drums, waste pits, former pipework or USTs (visible); and/or
- Oily Ash and/or oily slag contaminated soils/fill materials (visible/odorous); and/or
- Tarry like impacted soil/fill material (visible/odorous); and/or
- Potential chlorinated hydrocarbon impact (sweet odour soils).

As a precautionary measure to ensure the protection of the workforce and surrounding community, should any of the abovementioned substances (or any other unexpected potentially hazardous substance) be identified, the procedure summarised in **Flow Chart 11.1** is to be followed.

An enlarged version of the Unexpected Finds Protocol, suitable for use on the site, should be posted in the Site Office and referred to during the site-specific induction by the Principal Contractor.

The sampling strategy for each “unexpected find” shall be designed by a suitably qualified environmental consultant. The strategy will, however, be aimed at determining the nature of the substance – that is, is it hazardous and, if so, is it at concentrations which pose an unacceptable risk to human health or the environment.

The sampling frequency of the identified substance/materials shall meet the minimum requirements outlined in EPA (1995) in addition to those outlined in **Section 10**.

11.1.1 Change in Development Plans

In the event that the development plans are changed from those available at the time of preparation of this RAP, particularly where significant amendment of the extent of permanent paving at the site, changes in the basement design/layout, and/or absence of groundwater extraction is altered, consideration of the suitability of the proposed remedial strategy will be required. Any changes to the development plans must be considered with respect to the assumptions of the HHERA to be prepared for the site and where the assumptions are no longer satisfied additional risk assessment must be undertaken.

11.1.2 Identification of Additional Underground Storage Tank

There is the potential that one or more additional USTs may be encountered during demolition of the pavements or subsequent earthworks. In the event of such an occurrence, the Unexpected Finds Protocol (**Flow Chart 11.1**) will be implemented and remedial actions defined with consideration to the requirements for known USTs as documented in **Section 9**.

11.1.3 Identification of Oily or Tarry Materials

In the event that oily/tarry materials are encountered, the provisions outlined in the Unexpected Finds Protocol will be implemented, comprising inspection, testing and appropriate action as advised by the Field Scientist (**Section 11.1**).

Any suspected oily/tarry materials must be segregated from other excavated materials and placed in a designated area with appropriate odour and sediment controls until such time as appropriate assessment is completed and a methodology is confirmed for their appropriate management. In the event that the oily/tarry materials do not meet the Site Acceptance Criteria, then they shall be stored in a secure area for later treatment or classified and removed from the site for treatment and/or disposal at an appropriately licensed facility.

11.1.4 Identification of Chlorinated Hydrocarbon Impact

In the event that chlorinated hydrocarbon impacted materials are encountered (potentially as a result of the identification of sweet odours in soils), the provisions outlined in the Unexpected Finds Protocol will be implemented, comprising inspection, testing and appropriate action as advised by the Field Scientist (**Section 11.1**).

Any suspected chlorinated hydrocarbon impacted materials must be segregated from other excavated materials and placed in a designated area with appropriate odour and sediment controls until such time as appropriate assessment is completed and a methodology is confirmed for their appropriate management. In the event that the materials do not meet the Site Acceptance Criteria, then they shall be stored in a secure area for later treatment or classified and removed from the site for treatment and/or disposal at an appropriately licensed facility.

11.1.5 Material Storage Breach

In the event that any materials storage containment controls are breached and stockpiled materials classified as asbestos contaminated soil or otherwise have escaped (or have the potential to escape), then the management controls shall be rectified and investigations undertaken to review the adequacy of the controls and any improvements implemented. The REMP (**Section 12**) shall include a documented process for identifying and responding to such incidents.

11.1.6 Emissions Complaints

Due to the nature of the activities and type of contaminants identified within the site, there is a potential for complaints to be received from members of the public and/or occupants of surrounding properties relating to environmental emissions including:

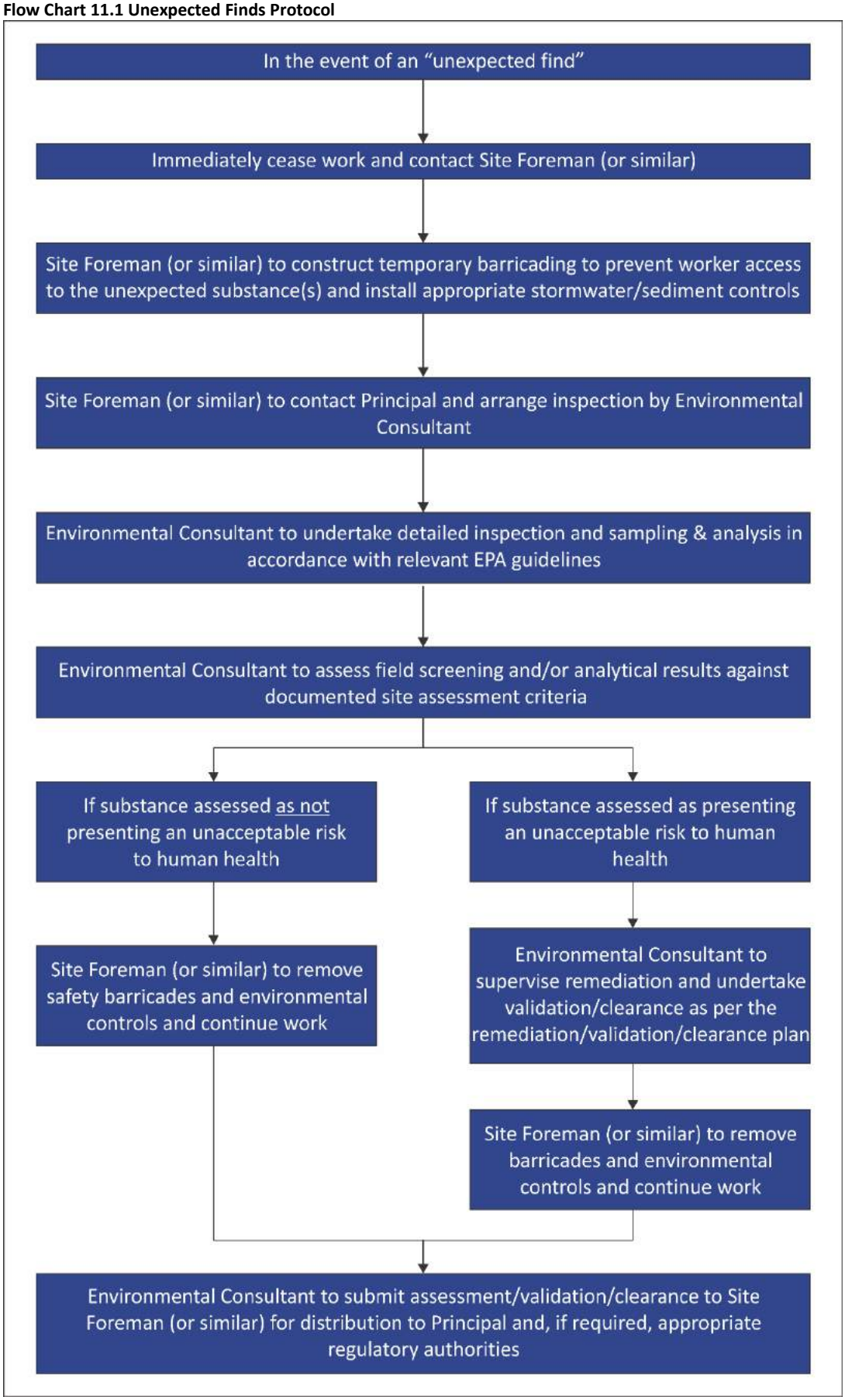
- Odour emissions arising from handling of malodorous soil;
- Noise and vibration arising from excavation, piling and other works;
- Dust emissions arising from excavation, material handling and placement; and
- Visibly impacted water quality in surface water discharge from the site.

Monitoring of all environmental emissions shall be undertaken during the works as detailed in the REMP (discussed in **Section 12**) and appropriate actions taken to further control emissions following receipt of a complaint. The REMP shall contain provision for contingency actions where excessive

emissions occur, however it is anticipated that one or more of the following actions will be considered:

- Increased application of odour screening/masking chemicals on odorous materials;
- Disturbance of soils during meteorologically favourable periods only; and/or
- Covering of impacted soils.

Flow Chart 11.1 Unexpected Finds Protocol



12. Other Remediation Documents

12.1 Environmental Management

12.1.1 Preparation of a Remediation Environmental Management Plan

Prior to commencement of remediation works, a REMP shall be prepared by the Principal Contractor or the Principal Contractors Remediation Contractor, which documents the environmental monitoring and management measures required to be implemented during the remediation and construction related activities associated with the construction of the site.

The REMP shall address each of the nominated items in **Section 12.1.2** and shall include the Contingency Plan, referred to in **Section 11**, above. Additional environmental management requirements may be required as part of development consent.

12.1.2 Required Elements/Procedures

An assessment of the proposed activities and the associated elements required to be incorporated into the REMP is provided in **Table 12.1**. The REMP is required to address each of the required elements and procedures in full detail and to include detailed monitoring processes and procedures, corrective actions and reporting requirements.

Table 11.1 Required Elements of the REMP

Element	Specific Minimum Requirements to be included in REMP
1. Dust and Airborne Hazard Control	Dust and asbestos air monitoring. Provisions for dust control based on monitoring results.
2. Flora and Fauna	As appropriate.
3. Heritage/Archaeological	In accordance with relevant heritage/archaeological studies.
4. Visual Impacts	Visual monitoring at site boundary Specific colour requirements for various controls/measures, including PPE (e.g., navy coveralls)
5. Emergency Response	As appropriate. Procedures required for spill incident response including material storage breach.
6. Noise Control	Hours of operation, consistent with the consent conditions.
7. Traffic	Controls on vehicle movements on public roads. Controls on transport of tar impacted materials.
8. Protection of Adjoining Structures	As appropriate.
9. Odour Control	Management of all potential odour generating activities (i.e., excavation of petroleum hydrocarbon contaminated soils and treatment) with appropriate odour controls incorporating safeguards and monitoring. Daily monitoring of odour levels at site boundary during handling of malodorous materials. Procedures for addressing elevated odour monitoring results, including, but not limited to: reduction in earthworks activities within odorous material areas during adverse meteorological conditions; application of odour masking solutions at the odour source or between identified source(s) and receptor(s); review of biopile operation and covering identified potential odour sources by hydromulching or with less odorous materials.
10. Handling of Contaminated Soil and Groundwater	Soil and water management (stockpiling, site access, excavation pump out, reinstatement).
11. Soil Storage/Placement Areas	Soil and water management (stockpiling, site access, excavation pump out, reinstatement). Bunding. Heavy vehicle/personnel decontamination. Interim storage requirements for materials requiring later treatment. Site drainage requirements, incorporating clean/dirty areas and modifications to existing surface water and drainage controls beneath retained pavements.

Element	Specific Minimum Requirements to be included in REMP
	Monitoring as required.
12. Sediment Control	Bunding. Collection/treatment/handling impacted sediments.
13. Operation of Site Office	As appropriate.
14. Decontamination of Heavy Equipment	As appropriate.
15. Environmental Monitoring	Monitoring of dusts, noise, odour and fibres. Monitoring as required for vibration and water releases. Inspection checklists and field forms. Monitoring within the Locomotive Workshop is required as per the requirements of the EMP and HHRA.
16. Environmental Criteria	Soil and water criteria as presented in this RAP
17. Material Classification	As detailed in this RAP. Materials tracking, including QA/QC inspection and sampling.
18. Community Relations Plan	Specific communication protocols, incorporating nomination of specific contact persons & details and requirements for communications/response register.
19. Incident Reporting	As appropriate, including standard form/checklist.
20. Security and Signage	Secure site perimeter. Site boundary signage.
21. EMP Review	As appropriate.
22. Training	As appropriate.
23. Contact Details	Company/personnel details, including names/phone numbers for: - Principal Contractor - Site Auditor - Remediation Consultant - Remediation Contractor - OH&S Compliance - Environmental Compliance
24. Stockpiling	All materials stockpiled onsite will be managed by the Remedial Contractor. Unique numbers will be provided for each stockpile, the source of the stockpile, its estimated volume, material characterisation and its location onsite (via GPS) will also be recorded consistent with the Material Tracking Plan provided as **Section 9.6.10**. The following procedures will be implemented by the Remedial Contractor: No stockpiles of soil or other materials shall be placed on footpaths or nature strips unless prior Council approval has been obtained; All stockpiles of soil or other materials shall be placed away from drainage lines gutters or stormwater pits or inlets; All stockpiles of soil or other materials likely to generate dust or odours shall be covered; All stockpiles of chemically contaminated soil shall be stored in a secure area and be covered if remaining more than 24 hours; and All stockpiles of asbestos contaminated soils shall be kept damp and covered to minimise potential fibre release, and if left for more than 24 hours, be stored in a secure area.

12.1.3 Certification

Prior to commencement of remediation works, the Remediation Contractor is required to have the REMP endorsed as acceptable by the Environmental Consultant or Site Auditor appointed to validate the works.

A copy of the REMP and the endorsement to the satisfaction of Environmental Consultant or Site Auditor are required to be provided by the Principal Contractor/Remedial Contractor prior to commencement of remediation works.

12.1.4 Hours of Site Operation/Duration of Works

Remediation works shall be completed in accordance with the permissible hours of work and noise as nominated in of the Development Consent.

The appointed remediation contractor will be required to include a proposed schedule of remediation works within the REMP submitted for endorsement as discussed above.

12.2 Health and Safety

12.2.1 Work Health and Safety Management Plan

A WHSP shall be prepared by the Remediation Contractor prior to commencement of remediation works. The Plan shall contain procedures and requirements that are to be implemented as a minimum during the works, in addition to the Contingency Plan, referred to in **Section 11**.

The objectives of the WHSP are:

- To apply standard procedures that minimises risks resulting from the works;
- To ensure all employees are provided with appropriate training, equipment and support to consistently perform their duties in a safe manner; and
- To have procedures to protect other site workers and the general public.

These objectives will be achieved by:

- Assignment of responsibilities;
- An evaluation of hazards;
- Establishment of personal protection standards, mandatory safety practices and procedures;
- Monitoring of potential hazards and implementation of corrective measures; and
- Provision for contingencies that may arise while operations are being conducted at the site.

12.2.2 Additional Site-Specific Elements/Procedures

In addition to the normal construction-related matters, the WHSP shall address the following site-specific specific hazards associated with the works relating to the management of contaminated soil and groundwater:

- Under/aboveground services, specifically former petroleum infrastructure;
- Use of plant and machinery within confined spaces (i.e. tank pit excavations);
- Contact to asbestos contaminated soils, including friable asbestos;
- Contact with contaminated soil (heavy metals, TRH, VOC and PAHs), groundwater and vapours, including requirements for specific Personal Protective Equipment (PPE); and
- Heat/cold stress.

12.2.3 Asbestos

During the remedial works, perimeter asbestos in air monitoring will be conducted at each applicable remedial works area boundary when soil with asbestos are being disturbed. Air monitoring will be conducted on a daily basis at relevant locations whilst disturbance of asbestos contaminated areas takes place.

Air monitoring will be conducted during any ground disturbance activities within the site to verify that implementation of appropriate control measures have been successful at managing the risk of air borne fibre generation. Air monitoring will be undertaken in accordance with the requirements of the National Occupational Health and Safety Commission (NOHSC) Asbestos Code of Practice and Guidance Notes, in particular the *Guidance note for the estimation of airborne asbestos dust* [NOHSC 3002:2005].

12.2.4 Additional Consideration of Chemical Contaminants

In addition to general assessment of the potential for exposure to chemical contaminants the WHSP should also include specific consideration of additional contaminants such as lead and PAHs distributed throughout fill materials.

As a precautionary measure, the WHSP should include the requirement for the plan to be revised in the event of an unexpected find of contaminated material during remediation and/or construction.

When working with contaminated materials in general, care needs to be taken to ensure that the contamination is not introduced to the worker via ingestion, inhalation or absorption. The WHSP must detail the PPE and decontamination requirements to be followed to control the risks posed by potential exposure to chemical contaminants at the site.

13. Conclusions and Recommendations

13.1 Conclusions

Overall, it is considered that the proposed actions outlined in this RAP conform to the requirements of the *Contaminated Sites Guidelines for the NSW Site Auditor Scheme (2nd Edition)* (DEC 2006) because they are: technically feasible; environmentally justifiable; and consistent with relevant laws policies and guidelines endorsed by NSW EPA.

Subject to the successful implementation of the measures described in this RAP and the recommendations below, it is concluded that the site can be made suitable for the intended uses and that the risks posed by contamination can be managed in such a way as to be adequately protective of human health and the environment.

It is anticipated that staged remediation and progressive validation signoffs will be required, with Site Audit Statements/Reports required prior to be issue of progressive occupation certificates, with construction of the built form in some instances servicing as the remedial strategy (i.e. pavements in landscaped areas, the basement internal fit out will serve as part of the remedial strategy and/or construction of the built form serving as a physical barrier to retained fill).

13.2 Recommendations

It is recommended that the processes outlined in this RAP be implemented and that the following documentation be developed and implemented to ensure the risks and impacts during remediation works are controlled in an appropriate manner:

- Preparation of a HHERA to support the remedial/fill retention strategy;
- Development of RWP refining the nature and extent of remedial works based on the results supplementary investigations (**Appendix A**) and the finding of the HHERA;
- A REMP, to document the monitoring and management measures required to control the environmental impacts of the works and ensure the validation protocols are being addressed; and
- A WHSP to document the procedures to be followed to manage the risks posed to the health of the remediation workforce.

Upon completion of the works, or within various specific areas, validation report(s) are required to be submitted by the Remediation Consultant to the Site Auditor for certification that the site, or relevant portion(s) are suitable for the proposed uses.

14. 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: 53113

Client: JVMC Pty Ltd

Version: R02 Rev 0	Date: 24-Aug-2017
Drawn By: RF	Checked By: NC

Scale 1:5,000

0 50 100

metres

Coor. Sys. GDA 1994 MGA Zone 56

St Peters, NSW

SITE LOCATION

FIGURE 1:

File Name: 53113_01
Reference: https://maps.six.nsw.gov.au/

ID	Easting	Northing
1	331029.730	6245994.818
2	331105.119	6246061.311
3	331211.533	6245940.664
4	331171.521	6245905.373
5	331177.407	6245898.696
6	331167.333	6245889.815
7	331138.843	6245922.134
8	331148.916	6245931.018
9	331134.317	6245947.580
10	331088.531	6245907.265
11	331058.807	6245941.144
12	331054.299	6245966.959

Legend:

- Approximate Site Boundary
- Cadastre - Lot & DP Boundaries
- Pits (Former Potential Petroleum/Chemical Storage)
- Area of GPR Survey

Current Layout - Building Footprint

- 67 Mary Street
- 73 Mary Street
- 50 Edith Street
- 52 Edith Street
- 43 Roberts Street

JBS&G

Job No: 53113

Client: JVMC Pty Ltd

Version: R02 Rev 0 | Date: 24-Aug-2017

Drawn By: RF | Checked By: NC

Scale 1:1,000

0 10 20
metres

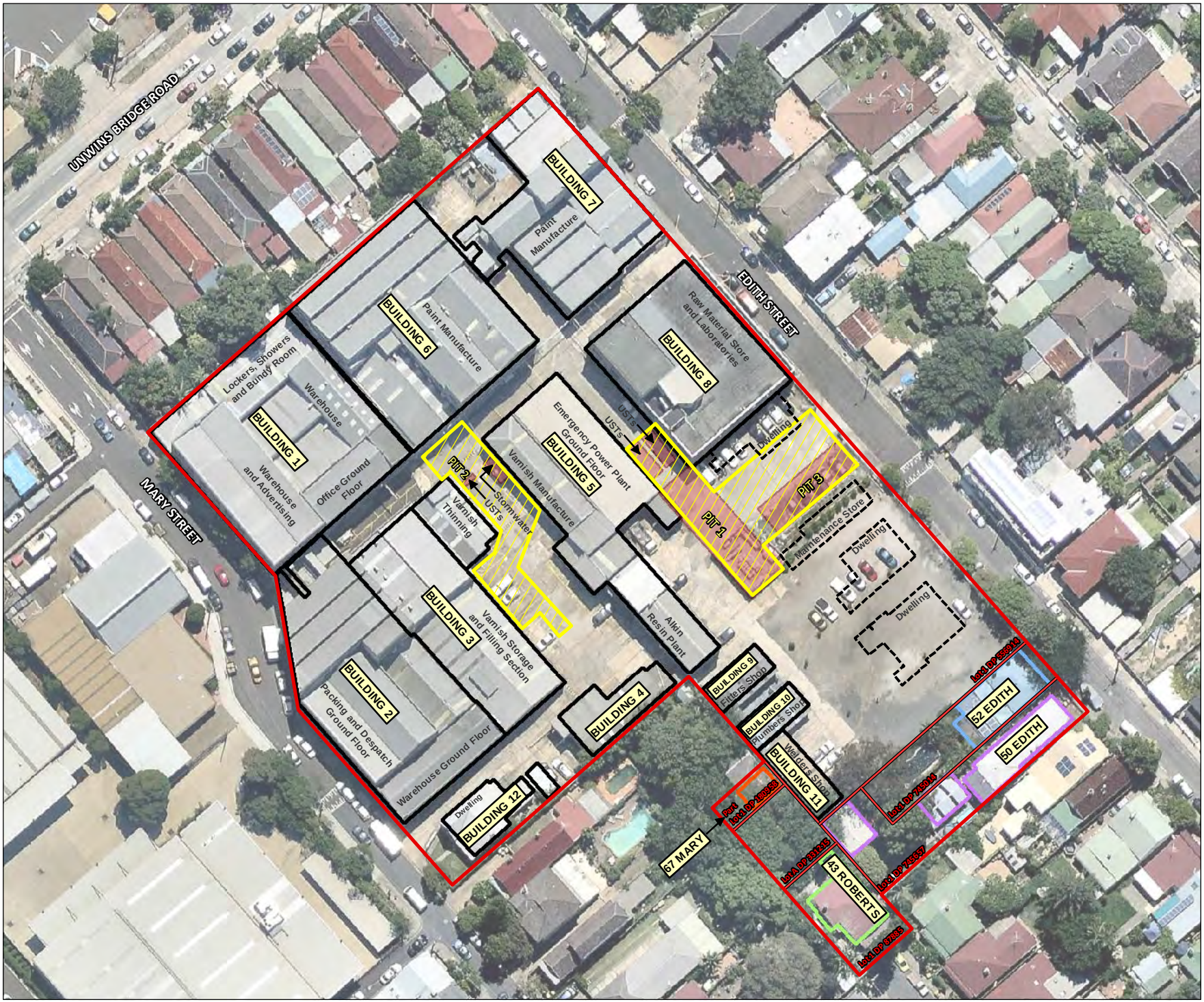
Coor. Sys. GDA 1994 MGA Zone 56

St Peters, NSW

CURRENT SITE LAYOUT AND FEATURES

FIGURE 2:

File Name: 53113_02
Reference: https://maps.six.nsw.gov.au/



Legend:

- Approximate Site Boundary
- Cadastre - Lot & DP Boundaries
- Pits (Former Potential Petroleum/Chemical Storage)
- Area of GPR Survey

Current Layout - Building Footprint

- 67 Mary Street
- 73 Mary Street
- 50 Edith Street
- 52 Edith Street
- 43 Roberts Street
- Former Buildings

JBS&G

Job No: 53113

Client: JVMC Pty Ltd

Version: R02 Rev 0	Date: 24-Aug-2017
Drawn By: RF	Checked By: NC

Scale 1:1,000

0 10 20
metres

Coor. Sys. GDA 1994 MGA Zone 56

St Peters, NSW

HISTORICAL SITE LAYOUT AND FEATURES

FIGURE 3:

File Name: 53113_03
Reference: https://maps.six.nsw.gov.au/

Legend:

- Approximate Site Boundary
- Site A: Precinct 75 Commercial
- Site B: Precinct 75 Mixed Use Redevelopment

Integrated Basement Extent

- Basement - B1 (FFL 8.400-11.850 mAHD)
- Basement - B2 (FFL 7.200-8.750 mAHD)
- Potential Borrow Pit Area
- Transect Location (see Figure 4B,6A & 6B)

JBS&G

Job No: 53113

Client: JVMC Pty Ltd

Version: R02 Rev 0	Date: 24-Aug-2017
Drawn By: RF	Checked By: NC

Scale 1:1,000

0 10 20

metres

Coor. Sys. GDA 1994 MGA Zone 56

St Peters, NSW

PROPOSED SITE LAYOUT

FIGURE 4A:

File Name: 53113_04A
Reference: https://maps.six.nsw.gov.au/

Legend:

- CONCRETE/FILL
- ENVIRONMENTALLY SUITABLE FILL
- Silty CLAY/CLAY
- MUDSTONE/SHALE
- Inferred Groundwater Elevation

JBS&G

Job No: 53113

Client: JVMC Pty Ltd

Version: R02 Rev 0	Date: 24-Aug-2017
Drawn By: RF	Checked By: NC

Scale: Vertical Exageration 3:1

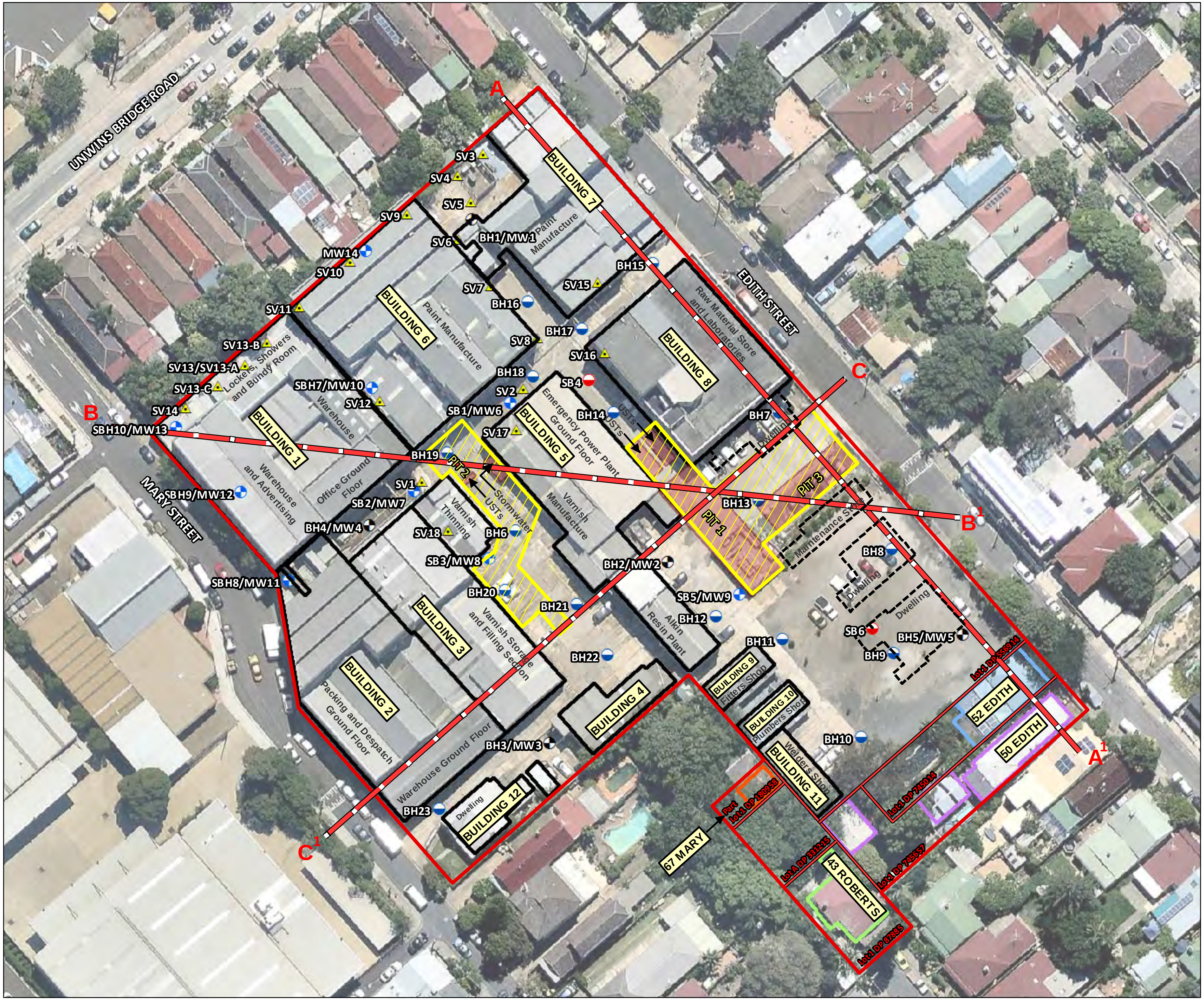
0 10 20
metres

Coord. Sys. GDA 1994 MGA Zone 56

St Peters, NSW

CROSS SECTION A-A[1] AND C-C[1]
(Location of transect on Figure 4A)

FIGURE 4B:



Legend:

- Approximate Site Boundary
- Cadastre - Lot & DP Boundaries
- Pits (Former Potential Petroleum/Chemical Storage)
- Area of GPR Survey

Current Layout - Building Footprint

- 67 Mary Street
- 73 Mary Street
- 50 Edith Street
- 52 Edith Street
- 43 Roberts Street
- Former Buildings

Historical Sample Locations

- Monitoring Well Location - EIA 2014/2015
- Monitoring Well Location - JBS&G 2016
- Soil Sample Location - EIA 2014/2015
- Soil Sample Location - JBS&G 2016
- Sub-Slab Vapour Location - JBS&G 2016
- Transect Location (see Figure 4B,6A & 6B)

JBS&G

Job No: 53113

Client: JVMC Pty Ltd

Version: R02 Rev 0	Date: 24-Aug-2017
Drawn By: RF	Checked By: NC

Scale 1:1,000

0 10 20
metres

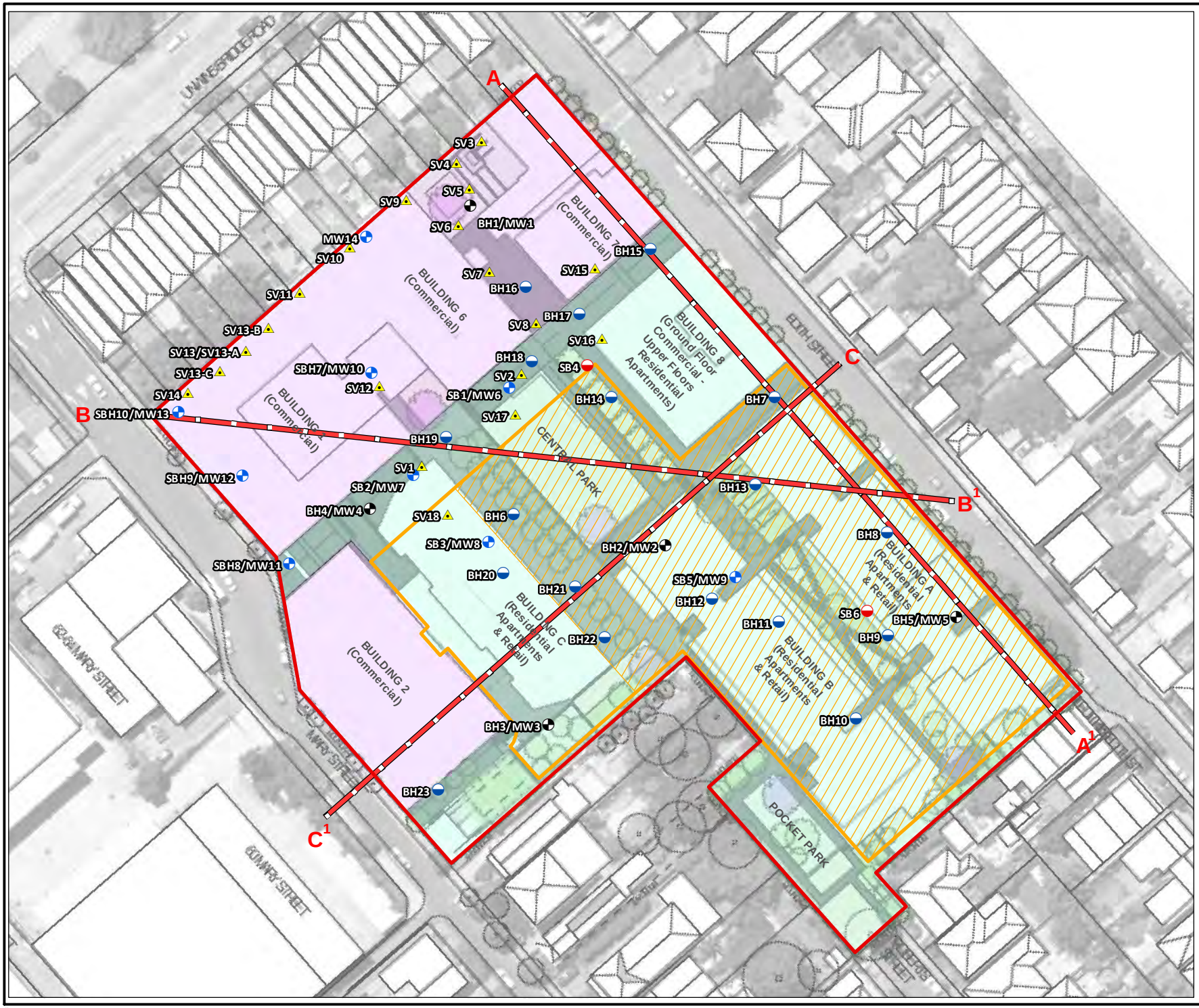
Coor. Sys. GDA 1994 MGA Zone 56

St Peters, NSW

HISTORICAL SITE LAYOUT AND HISTORICAL SAMPLE LOCATIONS

FIGURE 5A:

File Name: 53113_05A
Reference: https://maps.six.nsw.gov.au/



Legend:

- Approximate Site Boundary
- Site A: Precinct 75 Commercial
- Site B: Precinct 75 Mixed Use Redevelopment

Integrated Basement Extent

- Basement - B1 (FFL 8.400-11.850 mAHD)
- Basement - B2 (FFL 7.200-8.750 mAHD)
- Transect Location (see Figure 4B,6A & 6B)

Historical Sample Locations

- Monitoring Well Location - EIA 2014/2015
- Monitoring Well Location - JBS&G 2016
- Soil Sample Location - EIA 2014/2015
- Soil Sample Location - JBS&G 2016
- Sub-Slab Vapour Location - JBS&G 2016

JBS&G

Job No: 53113

Client: JVMC Pty Ltd

Version: R02 Rev 0	Date: 24-Aug-2017
Drawn By: RF	Checked By: NC

Scale 1:1,000

0 10 20
metres

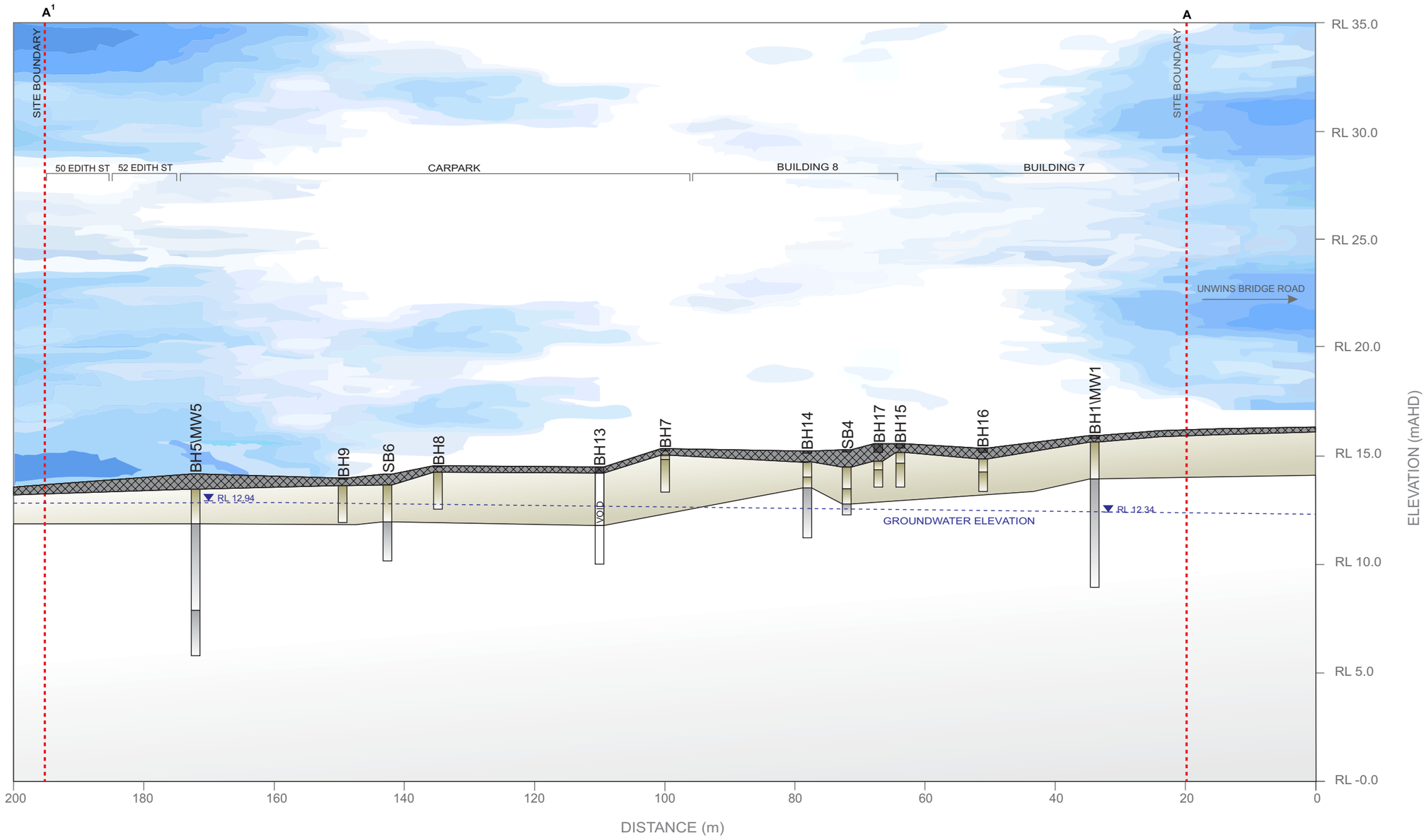
Coor. Sys. GDA 1994 MGA Zone 56

St Peters, NSW

PROPOSED SITE LAYOUT AND HISTORICAL SAMPLE LOCATIONS

FIGURE 5B:

File Name: 53113_05B
Reference: https://maps.six.nsw.gov.au/



Legend:

- CONCRETE/FILL
- Silty CLAY/CLAY
- MUDSTONE/SHALE
- Inferred Groundwater Elevation

JBS&G

Job No: 53113	
Client: JVMC Pty Ltd	
Version: R02 Rev 0	Date: 24-Aug-2017
Drawn By: RF	Checked By: NC

Scale: Vertical Exageration 3:1

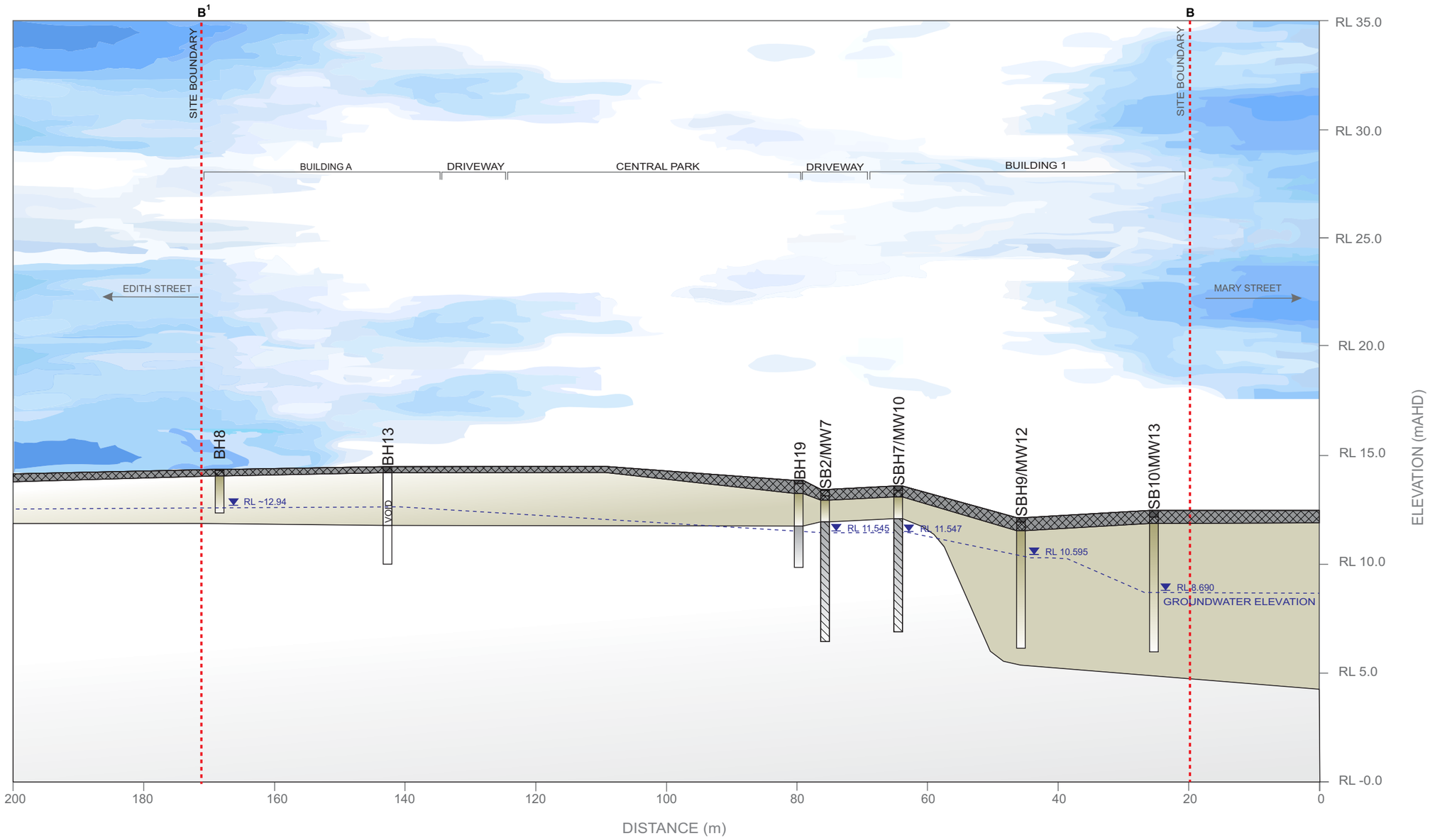
0 10 20
metres

Coord. Sys. GDA 1994 MGA Zone 56

St Peters, NSW

CROSS SECTION A-A1
(Location of transect on Figure 5A & 5B)

FIGURE 6A:



Legend:

- CONCRETE/FILL
- Silty CLAY/CLAY
- MUDSTONE/SHALE
- Inferred Groundwater Elevation

JBS&G

Job No: 53113	
Client: JVMC Pty Ltd	
Version: R02 Rev 0	Date: 24-Aug-2017
Drawn By: RF	Checked By: NC

Scale: Vertical Exageration 3:1

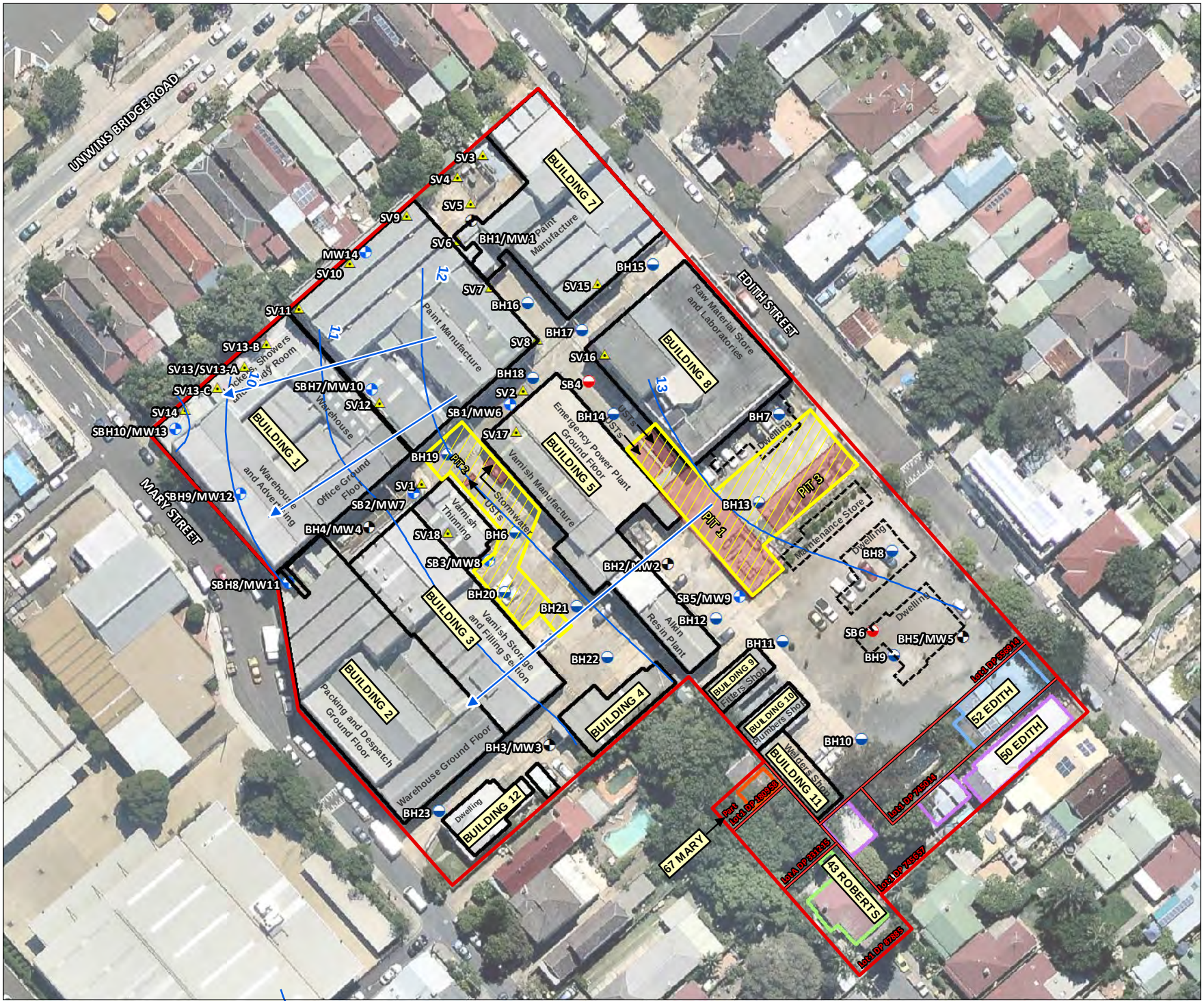
0 10 20
metres

Coord. Sys. GDA 1994 MGA Zone 56

St Peters, NSW

CROSS SECTION B-B^{1}
(Location of transect on Figure 5A & 5B)

FIGURE 6B:



Legend:

- Approximate Property Boundary
- Cadastre - Lot & DP Boundaries
- Pits (Former Potential Petroleum/Chemical Storage)
- Area of GPR Survey

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- Former Buildings

Historical Sample Locations

- Monitoring Well Location - EIA 2014/2015
- Monitoring Well Location - JBS&G 2016
- Soil Sample Location - EIA 2014/2015
- Soil Sample Location - JBS&G 2016
- Sub-Slab Vapour Location - JBS&G 2015/2016
- Inferred Groundwater Contour(m AHD) - July 20, 2015

JBS&G

Job No: 53113

Client: JVMC Pty Ltd

Version: R02 Rev 0	Date: 24-Aug-2017
Drawn By: RF	Checked By: NC

Scale 1:1,000

0 10 20
metres

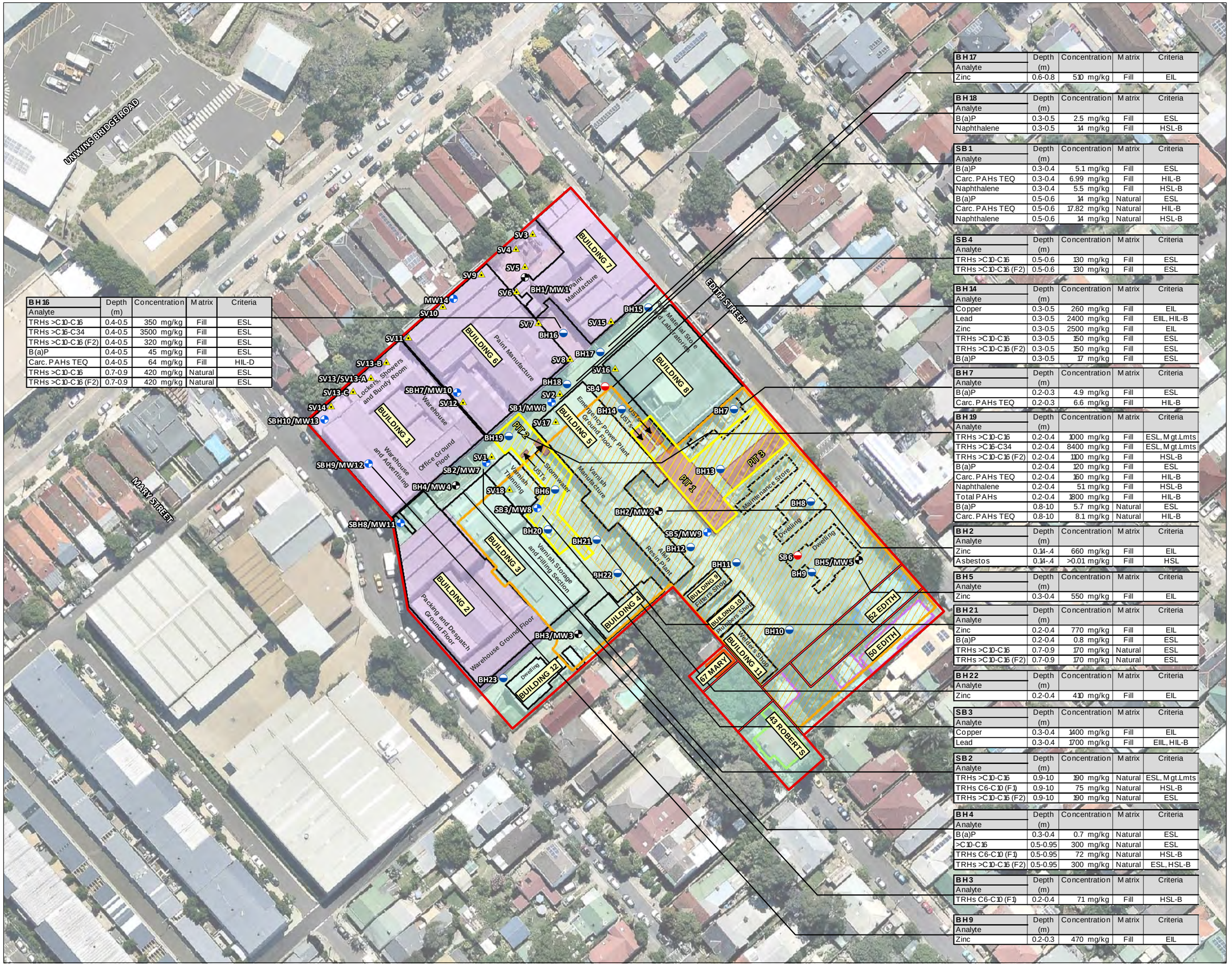
Coor. Sys. GDA 1994 MGA Zone 56

St Peters, NSW

INFERRED GROUNDWATER FLOW DIRECTION

FIGURE 7:

File Name: 53113_07
Reference: https://maps.six.nsw.gov.au/



BH16	Depth (m)	Concentration	Matrix	Criteria
Analyte				
TRHs >C10-C16	0.4-0.5	350 mg/kg	Fill	ESL
TRHs >C16-C34	0.4-0.5	3500 mg/kg	Fill	ESL
TRHs >C10-C16 (F2)	0.4-0.5	320 mg/kg	Fill	ESL
B(a)P	0.4-0.5	45 mg/kg	Fill	ESL
Carc. PAHs TEQ	0.4-0.5	64 mg/kg	Fill	HIL-D
TRHs >C10-C16	0.7-0.9	420 mg/kg	Natural	ESL
TRHs >C10-C16 (F2)	0.7-0.9	420 mg/kg	Natural	ESL

BH17	Depth (m)	Concentration	Matrix	Criteria
Analyte				
Zinc	0.6-0.8	510 mg/kg	Fill	EIL

BH18	Depth (m)	Concentration	Matrix	Criteria
Analyte				
B(a)P	0.3-0.5	2.5 mg/kg	Fill	ESL
Naphthalene	0.3-0.5	14 mg/kg	Fill	HSL-B

SB1	Depth (m)	Concentration	Matrix	Criteria
Analyte				
B(a)P	0.3-0.4	5.1 mg/kg	Fill	ESL
Carc. PAHs TEQ	0.3-0.4	6.99 mg/kg	Fill	HIL-B
Naphthalene	0.3-0.4	5.5 mg/kg	Fill	HSL-B
B(a)P	0.5-0.6	14 mg/kg	Natural	ESL
Carc. PAHs TEQ	0.5-0.6	17.82 mg/kg	Natural	HIL-B
Naphthalene	0.5-0.6	14 mg/kg	Natural	HSL-B

SB4	Depth (m)	Concentration	Matrix	Criteria
Analyte				
TRHs >C10-C16	0.5-0.6	130 mg/kg	Fill	ESL
TRHs >C10-C16 (F2)	0.5-0.6	130 mg/kg	Fill	ESL

BH14	Depth (m)	Concentration	Matrix	Criteria
Analyte				
Copper	0.3-0.5	260 mg/kg	Fill	EIL
Lead	0.3-0.5	2400 mg/kg	Fill	EIL, HIL-B
Zinc	0.3-0.5	2500 mg/kg	Fill	EIL
TRHs >C10-C16	0.3-0.5	150 mg/kg	Fill	ESL
TRHs >C10-C16 (F2)	0.3-0.5	150 mg/kg	Fill	ESL
B(a)P	0.3-0.5	17 mg/kg	Fill	ESL

BH7	Depth (m)	Concentration	Matrix	Criteria
Analyte				
B(a)P	0.2-0.3	4.9 mg/kg	Fill	ESL
Carc. PAHs TEQ	0.2-0.3	6.6 mg/kg	Fill	HIL-B

BH19	Depth (m)	Concentration	Matrix	Criteria
Analyte				
TRHs >C10-C16	0.2-0.4	1000 mg/kg	Fill	ESL, Mgt.Lmts
TRHs >C16-C34	0.2-0.4	8400 mg/kg	Fill	ESL, Mgt.Lmts
TRHs >C10-C16 (F2)	0.2-0.4	1100 mg/kg	Fill	HSL-B
B(a)P	0.2-0.4	120 mg/kg	Fill	ESL
Carc. PAHs TEQ	0.2-0.4	160 mg/kg	Fill	HIL-B
Naphthalene	0.2-0.4	51 mg/kg	Fill	HSL-B
Total PAHs	0.2-0.4	1800 mg/kg	Fill	HIL-B
B(a)P	0.8-10	5.7 mg/kg	Natural	ESL
Carc. PAHs TEQ	0.8-10	8.1 mg/kg	Natural	HIL-B

BH2	Depth (m)	Concentration	Matrix	Criteria
Analyte				
Zinc	0.14-.4	660 mg/kg	Fill	EIL
Asbestos	0.14-.4	>0.01 mg/kg	Fill	HSL

BH5	Depth (m)	Concentration	Matrix	Criteria
Analyte				
Zinc	0.3-0.4	550 mg/kg	Fill	EIL

BH21	Depth (m)	Concentration	Matrix	Criteria
Analyte				
Zinc	0.2-0.4	770 mg/kg	Fill	EIL
B(a)P	0.2-0.4	0.8 mg/kg	Fill	ESL
TRHs >C10-C16	0.7-0.9	170 mg/kg	Natural	ESL
TRHs >C10-C16 (F2)	0.7-0.9	170 mg/kg	Natural	ESL

BH22	Depth (m)	Concentration	Matrix	Criteria
Analyte				
Zinc	0.2-0.4	410 mg/kg	Fill	EIL

SB3	Depth (m)	Concentration	Matrix	Criteria
Analyte				
Copper	0.3-0.4	1400 mg/kg	Fill	EIL
Lead	0.3-0.4	1700 mg/kg	Fill	EIL, HIL-B

SB2	Depth (m)	Concentration	Matrix	Criteria
Analyte				
TRHs >C10-C16	0.9-10	190 mg/kg	Natural	ESL, Mgt.Lmts
TRHs C6-C10 (F1)	0.9-10	75 mg/kg	Natural	HSL-B
TRHs >C10-C16 (F2)	0.9-10	190 mg/kg	Natural	ESL

BH4	Depth (m)	Concentration	Matrix	Criteria
Analyte				
B(a)P	0.3-0.4	0.7 mg/kg	Natural	ESL
>C10-C16	0.5-0.95	300 mg/kg	Natural	ESL
TRHs C6-C10 (F1)	0.5-0.95	72 mg/kg	Natural	HSL-B
TRHs >C10-C16 (F2)	0.5-0.95	300 mg/kg	Natural	ESL, HSL-B

BH3	Depth (m)	Concentration	Matrix	Criteria
Analyte				
TRHs C6-C10 (F1)	0.2-0.4	71 mg/kg	Fill	HSL-B

BH9	Depth (m)	Concentration	Matrix	Criteria
Analyte				
Zinc	0.2-0.3	470 mg/kg	Fill	EIL

Legend:

- Approximate Property Boundary
- Cadastre - Lot & DP Boundaries
- Pits (Former Potential Petroleum/Chemical Storage)
- Area of GPR Survey
- Basement - B1 (FFL 8.400-11.850 mAHD)
- Basement - B2 (FFL 7.200-8.750 mAHD)
- Site A: Precinct 75 Commercial
- Site B: Precinct 75 Mixed Use Redevelopment

Current Layout - Building Footprint

- 67 Mary Street
- 73 Mary Street
- 50 Edith Street
- 52 Edith Street
- 43 Roberts Street
- Former Buildings

Historical Sample Locations

- Monitoring Well Location - EIA 2014/2015
- Monitoring Well Location - JBS&G 2016
- Soil Sample Location - EIA 2014/2015
- Soil Sample Location - JBS&G 2016
- Sub-Slab Vapour Location - JBS&G 2016

JBS&G

Job No: 53113

Client: JVMC Pty Ltd

Version: R01 Rev 0 | Date: 24-Aug-2017

Drawn By: RF | Checked By: NC

Scale:1:1,000

0 10 20
metres

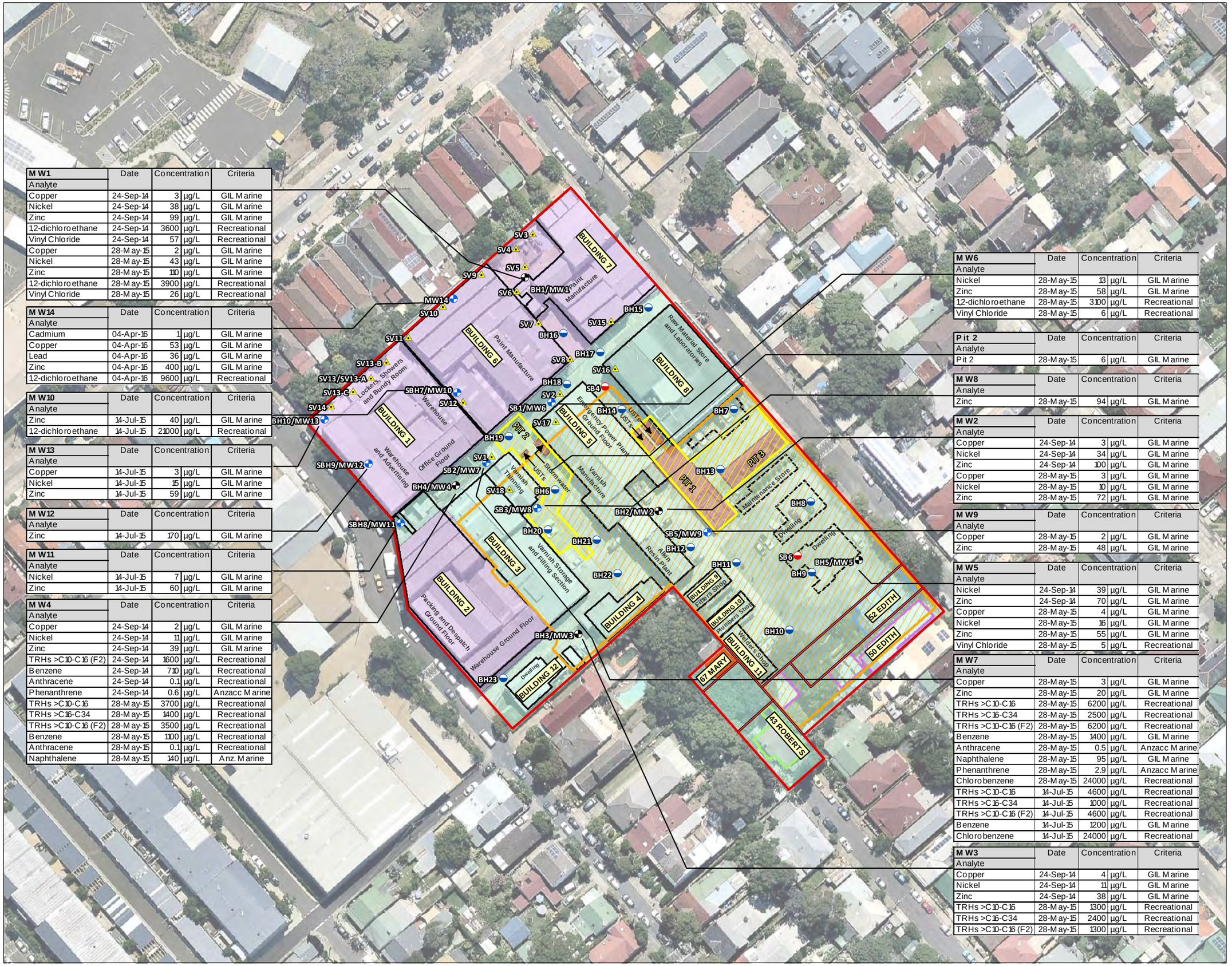
Coord. Sys. GDA 1994 MGA Zone 56

St Peters, NSW

HISTORICAL SOIL EXCEEDANCES

FIGURE 8A:

Document Path: 5311308A
Reference: https://maps.six.nsw.gov.au/



M W1	Date	Concentration		Criteria
Analyte				
Copper	24-Sep-14	3	µg/L	GIL Marine
Nickel	24-Sep-14	38	µg/L	GIL Marine
Zinc	24-Sep-14	99	µg/L	GIL Marine
1,2-dichloroethane	24-Sep-14	3600	µg/L	Recreational
Vinyl Chloride	24-Sep-14	57	µg/L	Recreational
Copper	28-May-15	2	µg/L	GIL Marine
Nickel	28-May-15	43	µg/L	GIL Marine
Zinc	28-May-15	110	µg/L	GIL Marine
1,2-dichloroethane	28-May-15	3900	µg/L	Recreational
Vinyl Chloride	28-May-15	26	µg/L	Recreational

M W14	Date	Concentration		Criteria
Analyte				
Cadmium	04-Apr-16	1	µg/L	GIL Marine
Copper	04-Apr-16	53	µg/L	GIL Marine
Lead	04-Apr-16	36	µg/L	GIL Marine
Zinc	04-Apr-16	400	µg/L	GIL Marine
1,2-dichloroethane	04-Apr-16	9600	µg/L	Recreational

M W10	Date	Concentration		Criteria
Analyte				
Zinc	14-Jul-15	40	µg/L	GIL Marine
1,2-dichloroethane	14-Jul-15	21000	µg/L	Recreational

M W13	Date	Concentration		Criteria
Analyte				
Copper	14-Jul-15	3	µg/L	GIL Marine
Nickel	14-Jul-15	15	µg/L	GIL Marine
Zinc	14-Jul-15	59	µg/L	GIL Marine

M W12	Date	Concentration		Criteria
Analyte				
Zinc	14-Jul-15	170	µg/L	GIL Marine

M W11	Date	Concentration		Criteria
Analyte				
Nickel	14-Jul-15	7	µg/L	GIL Marine
Zinc	14-Jul-15	60	µg/L	GIL Marine

M W4	Date	Concentration		Criteria
Analyte				
Copper	24-Sep-14	2	µg/L	GIL Marine
Nickel	24-Sep-14	11	µg/L	GIL Marine
Zinc	24-Sep-14	39	µg/L	GIL Marine
TRHs >C10-C16 (F2)	24-Sep-14	1600	µg/L	Recreational
Benzene	24-Sep-14	710	µg/L	Recreational
Anthracene	24-Sep-14	0.1	µg/L	Recreational
Phenanthrene	24-Sep-14	0.6	µg/L	Anzacc Marine
TRHs >C10-C16	28-May-15	3700	µg/L	Recreational
TRHs >C16-C34	28-May-15	1400	µg/L	Recreational
TRHs >C10-C16 (F2)	28-May-15	3500	µg/L	Recreational
Benzene	28-May-15	1100	µg/L	Recreational
Anthracene	28-May-15	0.1	µg/L	Recreational
Naphthalene	28-May-15	140	µg/L	Anz. Marine

M W6	Date	Concentration		Criteria
Analyte				
Nickel	28-May-15	13	µg/L	GIL Marine
Zinc	28-May-15	58	µg/L	GIL Marine
1,2-dichloroethane	28-May-15	3100	µg/L	Recreational
Vinyl Chloride	28-May-15	6	µg/L	Recreational

Pit 2	Date	Concentration		Criteria
Analyte				
Pit 2	28-May-15	6	µg/L	GIL Marine

M W8	Date	Concentration		Criteria
Analyte				
Zinc	28-May-15	94	µg/L	GIL Marine

M W2	Date	Concentration		Criteria
Analyte				
Copper	24-Sep-14	3	µg/L	GIL Marine
Nickel	24-Sep-14	34	µg/L	GIL Marine
Zinc	24-Sep-14	100	µg/L	GIL Marine
Copper	28-May-15	3	µg/L	GIL Marine
Nickel	28-May-15	10	µg/L	GIL Marine
Zinc	28-May-15	72	µg/L	GIL Marine

M W9	Date	Concentration		Criteria
Analyte				
Copper	28-May-15	2	µg/L	GIL Marine
Zinc	28-May-15	48	µg/L	GIL Marine

M W5	Date	Concentration		Criteria
Analyte				
Nickel	24-Sep-14	39	µg/L	GIL Marine
Zinc	24-Sep-14	70	µg/L	GIL Marine
Copper	28-May-15	4	µg/L	GIL Marine
Nickel	28-May-15	16	µg/L	GIL Marine
Zinc	28-May-15	55	µg/L	GIL Marine
Vinyl Chloride	28-May-15	5	µg/L	Recreational

M W7	Date	Concentration		Criteria
Analyte				
Copper	28-May-15	3	µg/L	GIL Marine
Zinc	28-May-15	20	µg/L	GIL Marine
TRHs >C10-C16	28-May-15	6200	µg/L	Recreational
TRHs >C16-C34	28-May-15	2500	µg/L	Recreational
TRHs >C10-C16 (F2)	28-May-15	6200	µg/L	Recreational
Benzene	28-May-15	1400	µg/L	GIL Marine
Anthracene	28-May-15	0.5	µg/L	Anzacc Marine
Naphthalene	28-May-15	95	µg/L	GIL Marine
Phenanthrene	28-May-15	2.9	µg/L	Anzacc Marine
Chlorobenzene	28-May-15	24000	µg/L	Recreational
TRHs >C10-C16	14-Jul-15	4600	µg/L	Recreational
TRHs >C16-C34	14-Jul-15	1000	µg/L	Recreational
TRHs >C10-C16 (F2)	14-Jul-15	4600	µg/L	Recreational
Benzene	14-Jul-15	1200	µg/L	GIL Marine
Chlorobenzene	14-Jul-15	24000	µg/L	Recreational

M W3	Date	Concentration		Criteria
Analyte				
Copper	24-Sep-14	4	µg/L	GIL Marine
Nickel	24-Sep-14	11	µg/L	GIL Marine
Zinc	24-Sep-14	38	µg/L	GIL Marine
TRHs >C10-C16	28-May-15	1300	µg/L	Recreational
TRHs >C16-C34	28-May-15	2400	µg/L	Recreational
TRHs >C10-C16 (F2)	28-May-15	1300	µg/L	Recreational

Legend:

- Approximate Property Boundary
- Cadastre - Lot & DP Boundaries
- Pits (Former Potential Petroleum/Chemical Storage)
- Area of GPR Survey
- Site A: Precinct 75 Commercial
- Site B: Precinct 75 Mixed Use Redevelopment
- Basement - B1 (FFL 8.400-11.850 mAHD)
- Basement - B2 (FFL 7.200-8.750 mAHD)

Current Layout - Building Footprint

- 67 Mary Street
- 73 Mary Street
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- Former Buildings

Historical Sample Locations

- Monitoring Well Location - EIA 2014/2015
- Monitoring Well Location - JBS&G 2016
- Soil Sample Location - EIA 2014/2015
- Soil Sample Location - JBS&G 2016
- Sub-Slab Vapour Location - JBS&G 2016

JBS&G

Job No: 53113

Client: JVMC Pty Ltd

Version: R02 Rev 0 | Date: 24-Aug-2017

Drawn By: RF | Checked By: NC

Scale: 1:1,000

0 10 20
metres

Coord. Sys. GDA 1994 MGA Zone 56

St Peters, NSW

HISTORICAL GROUNDWATER EXCEEDANCES

FIGURE 8B:

Document Path: 53113_08B
Reference: https://maps.six.nsw.gov.au/

SV13-B (Summa)	Date	Concentration		Criteria
Analyte				
Trichloroethene	24-Mar-16	7.8	mg/m³	HIL-B & HIL-D

SV13 (Front)	Date	Concentration		Criteria
Analyte				
Trichloroethene	06-Aug-15	7	mg/m³	HIL-B & HIL-D

SV13-A (Summa Lab Dup.)	Date	Concentration		Criteria
Analyte				
Trichloroethene	24-Mar-16	6.5	mg/m³	HIL-B & HIL-D

SV13-A (Summa)	Date	Concentration		Criteria
Analyte				
Trichloroethene	24-Mar-16	32	mg/m³	HIL-B & HIL-D

Legend:

- Approximate Property Boundary
- Cadastre - Lot & DP Boundaries
- Pits (Former Potential Petroleum/Chemical Storage)
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- Site A: Precinct 75 Commercial
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- Basement - B1 (FFL 8.400-11.850 mAHD)
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Historical Sample Locations

- Monitoring Well Location - EIA 2014/2015
- Monitoring Well Location - JBS&G 2016
- Soil Sample Location - EIA 2014/2015
- Soil Sample Location - JBS&G 2016
- Sub-Slab Vapour Location - JBS&G 2015/2016

JBS&G

Job No: 53113	
Client: JVMC Pty Ltd	
Version: R02 Rev 0	Date: 24-Aug-2017
Drawn By: RF	Checked By: NC
Scale:1:1,000	

0 10 20
metres

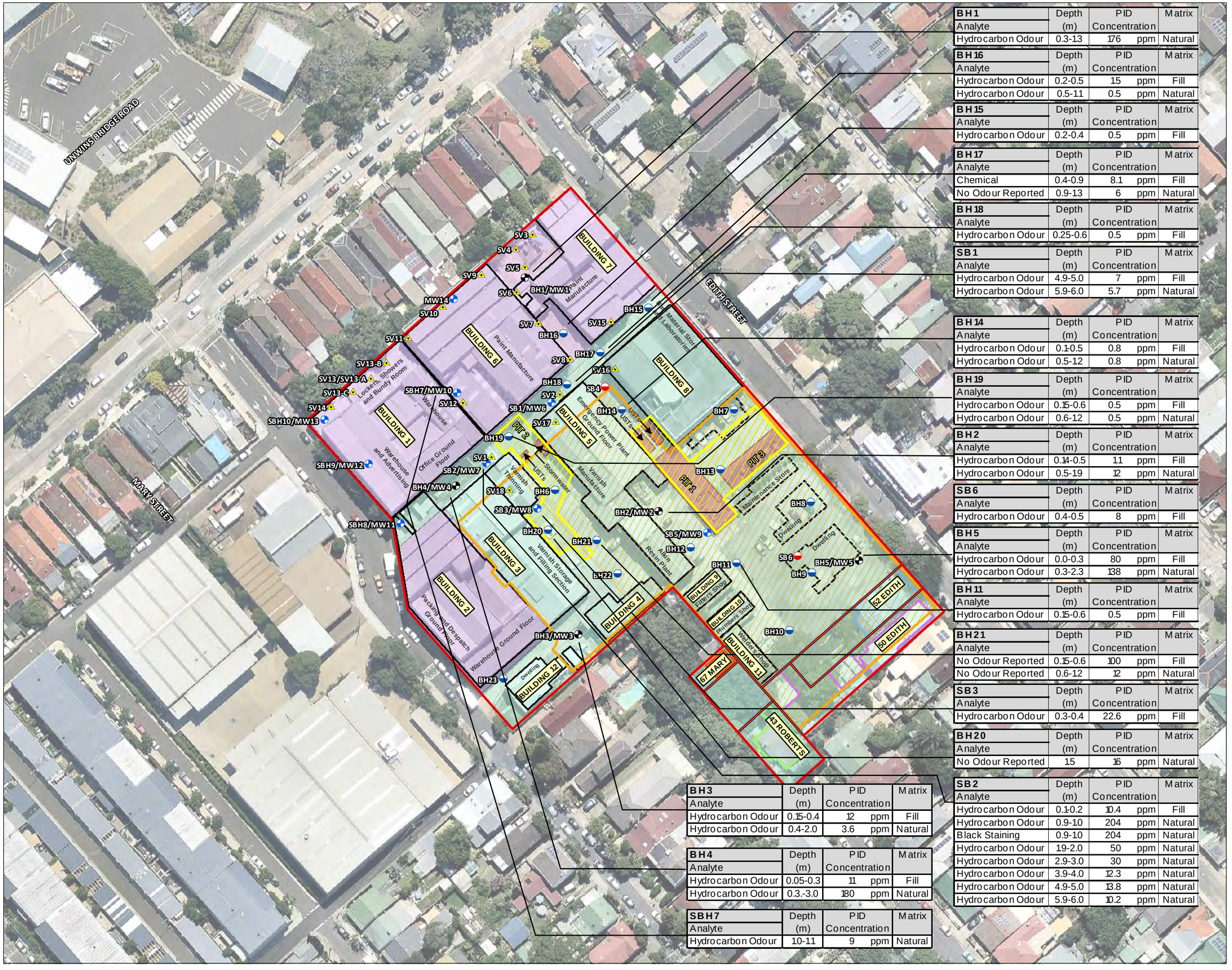
Coord. Sys. GDA 1994 MGA Zone 56

St Peters, NSW

HISTORICAL SOL VAPOUR EXCEEDANCES

FIGURE 8C:

Document Path: 53113_08C
Reference: https://maps.six.nsw.gov.au/



BH1	Depth	PID	Matrix
Analyte	(m)	Concentration	
Hydrocarbon Odour	0.3-1.3	176 ppm	Natural

BH16	Depth	PID	Matrix
Analyte	(m)	Concentration	
Hydrocarbon Odour	0.2-0.5	15 ppm	Fill
Hydrocarbon Odour	0.5-1.1	0.5 ppm	Natural

BH15	Depth	PID	Matrix
Analyte	(m)	Concentration	
Hydrocarbon Odour	0.2-0.4	0.5 ppm	Fill

BH17	Depth	PID	Matrix
Analyte	(m)	Concentration	
Chemical	0.4-0.9	8.1 ppm	Fill
No Odour Reported	0.9-1.3	6 ppm	Natural

BH18	Depth	PID	Matrix
Analyte	(m)	Concentration	
Hydrocarbon Odour	0.25-0.6	0.5 ppm	Fill

SB1	Depth	PID	Matrix
Analyte	(m)	Concentration	
Hydrocarbon Odour	4.9-5.0	7 ppm	Fill
Hydrocarbon Odour	5.9-6.0	5.7 ppm	Natural

BH14	Depth	PID	Matrix
Analyte	(m)	Concentration	
Hydrocarbon Odour	0.1-0.5	0.8 ppm	Fill
Hydrocarbon Odour	0.5-1.2	0.8 ppm	Natural

BH19	Depth	PID	Matrix
Analyte	(m)	Concentration	
Hydrocarbon Odour	0.15-0.6	0.5 ppm	Fill
Hydrocarbon Odour	0.6-1.2	0.5 ppm	Natural

BH2	Depth	PID	Matrix
Analyte	(m)	Concentration	
Hydrocarbon Odour	0.14-0.5	11 ppm	Fill
Hydrocarbon Odour	0.5-1.9	12 ppm	Natural

SB6	Depth	PID	Matrix
Analyte	(m)	Concentration	
Hydrocarbon Odour	0.4-0.5	8 ppm	Fill

BH5	Depth	PID	Matrix
Analyte	(m)	Concentration	
Hydrocarbon Odour	0.0-0.3	80 ppm	Fill
Hydrocarbon Odour	0.3-2.3	138 ppm	Natural

BH11	Depth	PID	Matrix
Analyte	(m)	Concentration	
Hydrocarbon Odour	0.15-0.6	0.5 ppm	Fill

BH21	Depth	PID	Matrix
Analyte	(m)	Concentration	
No Odour Reported	0.15-0.6	100 ppm	Fill
No Odour Reported	0.6-1.2	12 ppm	Natural

SB3	Depth	PID	Matrix
Analyte	(m)	Concentration	
Hydrocarbon Odour	0.3-0.4	22.6 ppm	Fill

BH20	Depth	PID	Matrix
Analyte	(m)	Concentration	
No Odour Reported	1.5	16 ppm	Natural

SB2	Depth	PID	Matrix
Analyte	(m)	Concentration	
Hydrocarbon Odour	0.1-0.2	10.4 ppm	Fill
Hydrocarbon Odour	0.9-1.0	204 ppm	Natural
Black Staining	0.9-1.0	204 ppm	Natural
Hydrocarbon Odour	1.9-2.0	50 ppm	Natural
Hydrocarbon Odour	2.9-3.0	30 ppm	Natural
Hydrocarbon Odour	3.9-4.0	12.3 ppm	Natural
Hydrocarbon Odour	4.9-5.0	13.8 ppm	Natural
Hydrocarbon Odour	5.9-6.0	10.2 ppm	Natural

BH3	Depth	PID	Matrix
Analyte	(m)	Concentration	
Hydrocarbon Odour	0.15-0.4	12 ppm	Fill
Hydrocarbon Odour	0.4-2.0	3.6 ppm	Natural

BH4	Depth	PID	Matrix
Analyte	(m)	Concentration	
Hydrocarbon Odour	0.05-0.3	11 ppm	Fill
Hydrocarbon Odour	0.3.-3.0	180 ppm	Natural

SBH7	Depth	PID	Matrix
Analyte	(m)	Concentration	
Hydrocarbon Odour	10-11	9 ppm	Natural

Legend:

- Approximate Property Boundary
- Cadastre - Lot & DP Boundaries
- Pits (Former Potential Petroleum/Chemical Storage)
- Area of GPR Survey
- Site A: Precinct 75 Commercial
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- Basement - B1 (FFL 8.400-11.850 mAHD)
- Basement - B2 (FFL 7.200-8.750 mAHD)

Current Layout - Building Footprint

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- Former Buildings

Historical Sample Locations

- Monitoring Well Location - EIA 2014/2015
- Monitoring Well Location - JBS&G 2016
- Soil Sample Location - EIA 2014/2015
- Soil Sample Location - JBS&G 2016
- Sub-Slab Vapour Location - JBS&G 2016

JBS&G

Job No: 53113

Client: JVMC Pty Ltd

Version: R01 Rev 0 | Date: 24-Aug-2017

Drawn By: RF | Checked By: NC

Scale:1:1,000

0 10 20
metres

Coord. Sys. GDA 1994 MGA Zone 56

St Peters, NSW

HISTORICAL AESTHETIC IMPACTS

FIGURE 8D:

Document Path: 53113_08D
Reference: https://maps.six.nsw.gov.au/

Legend:

- Approximate Site Boundary
- Cadastre - Lot & DP Boundaries
- Pits (Former Potential Petroleum/Chemical Storage)
- Area of GPR Survey
- Site A: Precinct 75 Commercial
- Site B: Precinct 75 Mixed Use Redevelopment
- Basement - B1 (FFL 8.400-11.850 mAHD)
- Basement - B2 (FFL 7.200-8.750 mAHD)

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Historical Sample Locations

- Monitoring Well Location - EIA 2014/2015
- Monitoring Well Location - JBS&G 2016
- Soil Sample Location - EIA 2014/2015
- Soil Sample Location - JBS&G 2016
- Sub-Slab Vapour Location - JBS&G 2016

Areas of Environmental Concern

- AEC 1
- AEC 2
- AEC 4

Proposed Sample Locations

- Borehole Location
- Groundwater Monitoring Well Location
- Sub-Slab Soil Vapour Location
- Soil Vapour Well Location

JBS&G

Job No: 53113	
Client: JVMC Pty Ltd	
Version: R02 Rev 0	Date: 24-Aug-2017
Drawn By: RF	Checked By: NC

Scale: 1:750

0 10 20
metres

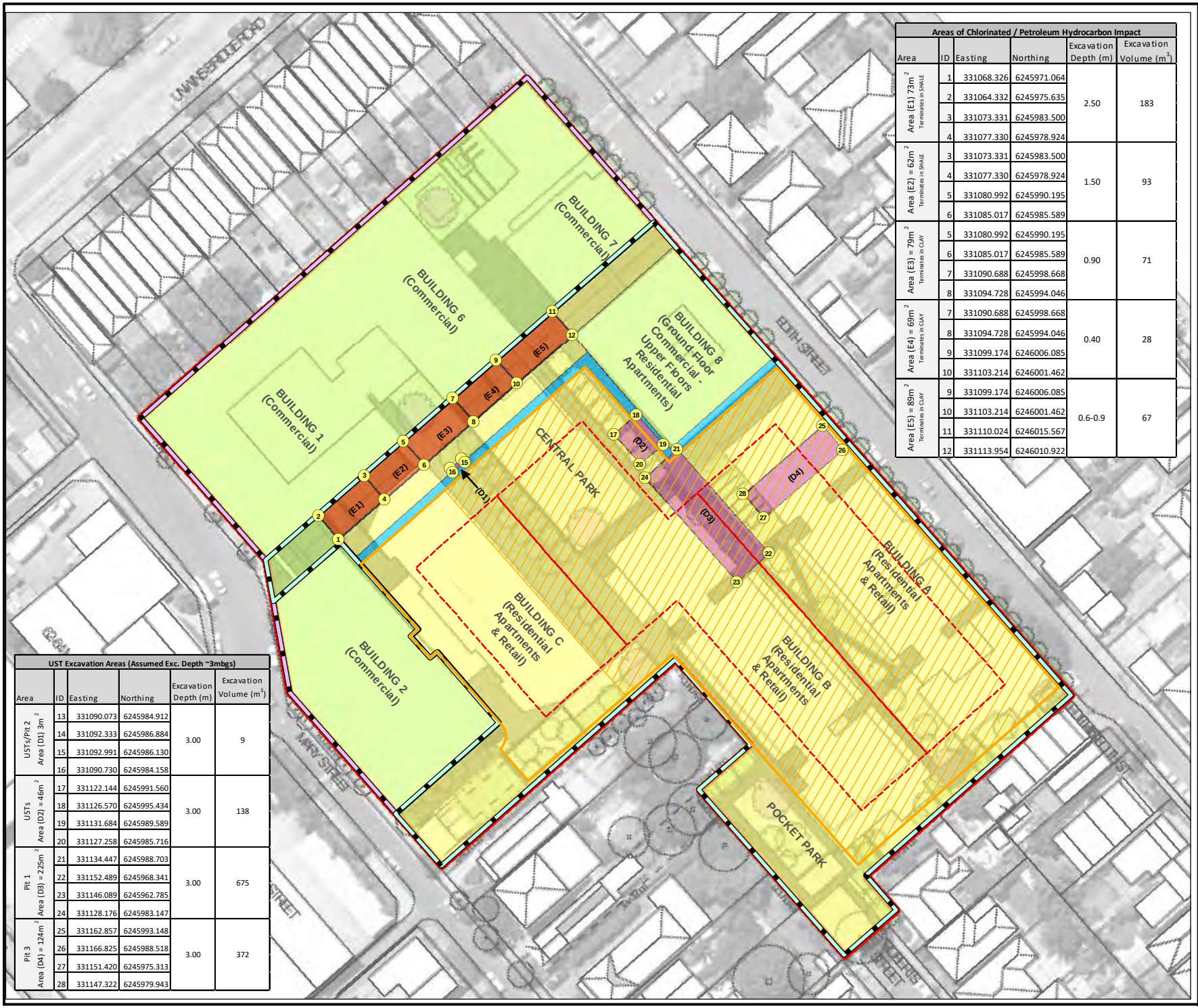
Coord. Sys. GDA 1994 MGA Zone 56

St Peters, NSW

AEC AND DATA GAP SAMPLING LOCATIONS

FIGURE 9:

Document Path: 53113_09
Reference: https://maps.six.nsw.gov.au/



Areas of Chlorinated / Petroleum Hydrocarbon Impact

Area	ID	Easting	Northing	Excavation Depth (m)	Excavation Volume (m^3)
Area (E1) 73m^2 Terminates in SHALE	1	331068.326	6245971.064	2.50	183
	2	331064.332	6245975.635		
	3	331073.331	6245983.500		
	4	331077.330	6245978.924		
Area (E2) = 62m^2 Terminates in SHALE	3	331073.331	6245983.500	1.50	93
	4	331077.330	6245978.924		
	5	331080.992	6245990.195		
	6	331085.017	6245985.589		
Area (E3) = 79m^2 Terminates in CLAY	5	331080.992	6245990.195	0.90	71
	6	331085.017	6245985.589		
	7	331090.688	6245998.668		
	8	331094.728	6245994.046		
Area (E4) = 69m^2 Terminates in CLAY	7	331090.688	6245998.668	0.40	28
	8	331094.728	6245994.046		
	9	331099.174	6246006.085		
	10	331103.214	6246001.462		
Area (E5) = 89m^2 Terminates in CLAY	9	331099.174	6246006.085	0.6-0.9	67
	10	331103.214	6246001.462		
	11	331110.024	6246015.567		
	12	331113.954	6246010.922		

UST Excavation Areas (Assumed Exc. Depth ~3mbgs)

Area	ID	Easting	Northing	Excavation Depth (m)	Excavation Volume (m^3)
USTs/Pit 2 Area (D1) 3m^2	13	331090.073	6245984.912	3.00	9
	14	331092.333	6245986.884		
	15	331092.991	6245986.130		
	16	331090.730	6245984.158		
USTs Area (D2) = 46m^2	17	331122.144	6245991.560	3.00	138
	18	331126.570	6245995.434		
	19	331131.684	6245989.589		
	20	331127.258	6245985.716		
Pit 1 Area (D3) = 225m^2	21	331134.447	6245988.703	3.00	675
	22	331152.489	6245968.341		
	23	331146.089	6245962.785		
	24	331128.176	6245983.147		
Pit 3 Area (D4) = 124m^2	25	331162.857	6245993.148	3.00	372
	26	331166.825	6245988.518		
	27	331151.420	6245975.313		
	28	331147.322	6245979.943		

Legend:

- Approximate Site Boundary
- Site A: Precinct 75 Commercial
- Site B: Precinct 75 Mixed Use Redevelopment

Integrated Basement Extent

- Basement - B1 (FFL 8.400-11.850 mAHD)
- Basement - B2 (FFL 7.200-8.750 mAHD)
- Potential Borrow Pit Area

Remediation Extents

- Area A - Extent of plenum
- Area B - Fill subject to further characterisation for landuse suitability and/or for rentention on site
- Area C - Fill/Soil to managed via implimentation of JBS&G 2016b/2016c as revised
- Area D - UST remedial Excavation
- Area E - Chlorinated/Petroleum hydrocarbons remediation extent

JBS&G

Job No: 53113

Client: JVMC Pty Ltd

Version: R02 Rev 0 | Date: 24-Aug-2017

Drawn By: RF | Checked By: NC

Scale 1:1,000

0 10 20
metres

Coor. Sys. GDA 1994 MGA Zone 56

St Peters, NSW

REMEDIAL EXTENTS

FIGURE 10:

File Name: 53113_10
Reference: https://maps.six.nsw.gov.au/

Appendix A Data Gap SAQP (incl. background info, architectural plans and analytical summary tables)

JVMC Pty Ltd

Site A: Precinct 75 Commercial (Buildings 1, 2, 6 & 7) and Site B: Precinct 75 Mixed Use Redevelopment (Buildings A, B, C & 8) Data Gap Sampling Analysis and Quality Plan

50 and 52 Edith Street, 67 and 73 Mary Street and 43 Robert Street, St Peters, NSW, 2044

25 August 2017
53113/110605 Revision 0

JBS&G Australia Pty Ltd

JVMC Pty Ltd

Site A: Precinct 75 Commercial (Buildings 1, 2, 6 & 7) and Site B: Precinct 75 Mixed Use Redevelopment (Buildings A, B, C & 8) Data Gap Sampling Analysis and Quality Plan

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JBS&G Australia Pty Ltd

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Abbreviations

Term	Definition
ACM	Asbestos Containing Material
AGMG	Australian Groundwater Modelling Guidelines
AHD	Australian Height Datum
AMP	Asbestos Management Plan
ASRIS	Australian Soil Resource Information System
ASS	Acid Sulfate Soils
ASSMP	Acid Sulfate Soil Management Plan
AST	Aboveground Storage Tank
bgs	Below Ground Surface
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes
CEC	Cation Exchange Capacity
COC	Chain of Custody
COPC	Contaminants of Potential Concern
Council	The Inner West Council
CSM	Conceptual Site Model
DA	Development application
DGI	Data Gap Investigation
DO	Dissolved Oxygen
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
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
F&T	Fate and Transport
GIL	Groundwater Investigation Levels
GME	Groundwater Monitoring Event
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
K_{oc}	Organic Carbon Partition Coefficient
LCS	Laboratory Control Sample
LEP	Local Environmental Plan
LNAPL	Light Non-Aqueous Phase Liquid
LOR	Limit of Reporting
CH_4	Methane
MNA	Monitored Natural Attenuation
NAPL	Non-Aqueous Phase Liquid
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

Term	Definition
PCB	Polychlorinated Biphenyls
PCR	Primary Contact Recreation
pH	Potential of Hydrogen
PID	Photo-ionisation Detector
ppm	Parts Per Million
PSH	Phase-separated Hydrocarbon
QA/QC	Quality Assurance / Quality Control
RAP	Remedial Action Plan
RL	Relative Level
RPD	Relative Percent Difference
RSW	Restricted Solid Waste
SWL	Standing Water Level
RWPs	Remedial Works Plan
SAS	Site Audit Statement
SAQP	Sampling, Analysis and Quality Plan
SP	Strata Plan
SPOCAS	Suspension Peroxide Oxidation Combined Acidity and Sulfur
SO4	Sulfate
TCE	Trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
TPH	Total Petroleum Hydrocarbons
TRH	Total Recoverable Hydrocarbons
UCL	Upper Confidence Limit
UPSS	Underground Petroleum Storage System
UST	Underground Storage Tank
VOC	Volatile Organic Compounds

Executive Summary

JBS&G Australia Pty Ltd (JBS&G) has been engaged by JVMC Pty Ltd (JVMC, the client) for the provision of environmental services associated with the remediation/validation and development of Site A: Precinct 75 Commercial (Buildings 1, 2, 6 & 7) and Site B: Precinct 75 Mixed Use Redevelopment (Buildings A, B, C & 8), herein referred to as the site.

The site is located at 50 and 52 Edith Street, 67 and 73 Mary Street and 43 Robert Street, St Peters, NSW, is legally identified as Lot 1 Deposited Plan (DP) 745657, Lot 1 DP 745014, Part Lot 1 DP 180958, Lot 1 DP 556914, Lot A DP 331215 and Lot 1 DP 87885 and occupies and area of approximately 1.5 hectares (ha), as shown on **Figures 1** and **2**.

The site has been subject to a number of previous investigations which have identified historical industrial land uses from the 1920s until the mid-1960s, followed more recently by light commercial/industrial land uses.

Soil impact has been identified as follows:

- Associated with historical petroleum/chemical storage, handling and manufacturing;
- Hot-spots of volatile to non-volatile petroleum/chlorinated hydrocarbons;
- Polycyclic aromatic hydrocarbons (PAH) and/or heavy metals, associated with fill materials historically used across the site or resultant from historical site storage/manufacturing activities; and
- Isolated asbestos impact in fill.

Historical petroleum/chemical infrastructure is still present on site (**Figure 2**).

Groundwater has been identified to be affected with petroleum/chlorinated hydrocarbons, and heavy metals, albeit limited in extent. In addition, trichloroethene (TCE) soil vapour impacts were identified in an isolated area exceeding the screening criteria for commercial and industrial land-use applicable to this portion of the site (beneath north-western extent of Building1, refer to **Figure 2**). The extent of historical environmental investigations has been restricted by the occurrence of buildings/structures at the site.

Review of architectural plans (**Appendix A**) indicates that the site is proposed to be developed as a mixed-use precinct including residential apartments (with a single multi-level integrated car parking basement in areas), adaptive reuse of some existing buildings for commercial land uses, and public domains (landscaping/parks and paved extents.

Sufficient data has been collected to characterise the site and detail the remedial works required to make the site suitable for proposed land uses, however, further environmental data is required to refine the extent of remedial works. To this end, the objective of the assessment is to collect additional data to inform the environmental assessment process, allow preparation of a human health and ecological risk assessment (HHERA) and refine the remedial planning such that a remedial works plan (RWP) can be developed for the site following demolition of existing site structures and access to areas previously inaccessible.

The scope of work to prepare this SAQP comprised:

- Review of existing documentation, including geotechnical reports and previous environmental assessments;
- A detailed inspection of the site and immediate surrounds;
- Development and documentation of a conceptual site model (CSM) based on the available information; and

- Preparation of an SAQP prior to commencement of field works.

The scope of work proposed in this DGI SAQP comprises:

- Advancement of systematic and targeted soil bores across accessible areas of the site;
- Use of a global positioning unit (GPS) to record sample locations for reference in the remedial planning/works;
- Comprehensive soil sampling for contaminants of potential concern (COPCs) from boreholes installed across the site;
- Analysis of selected soil samples at a National Association of Testing Authority (NATA) accredited laboratory for a range of COPC including, but not limited to, total recoverable hydrocarbons (TRH), benzene, toluene, ethylbenzene and xylene (BTEX) compounds, PAHs, heavy metals, total organic carbon (TOC), volatile organic compounds (VOCs), polychlorinated biphenyls (PCBs) and asbestos;
- Additional analysis by toxicity characteristic leaching procedure (TCLP) for heavy metals and PAHs to allow for waste characterisation in accordance with EPA (2014[1]) Waste Classification Guidelines;
- Assess potential contaminant leaching from soils via a program of Australian standard leaching procedure (ASLP) analysis (for volatiles) and column testing (for non-volatiles) in general accordance with the *Standard Test Method for Leaching Solid Material in a Column Apparatus* (European Method *NEN 7373, NEN 7383 and CMA/2/II/A.9.1*) to assist in the remedial planning and fill retention strategy;
- Advancement of targeted soil vapour probes beneath existing commercial buildings to be retained for adaptive commercial uses and in proximity to the proposed western basement envelope alignment to assess the potential for soil vapour migration into the future basement;
- Analysis of soil vapour samples at a NATA accredited laboratory for a range of COPC (volatile TRH and VOCs);
- Conversion of selected boreholes into groundwater monitoring wells in proximity to the western edge of the proposed basement to assess the potential for chlorinated hydrocarbon groundwater impact to migrate into the future basement;
- Gauging, purging and sampling of existing and newly installed groundwater monitoring wells;
- A field assessment of hydraulic conductivity at five nominated locations;
- Analysis of groundwater samples at a laboratory NATA accredited for a range of COPC including, but not limited to, heavy metals, TRH, BTEX, VOCs and PAHs; and
- Preparation of a Data Gap Investigation Report in general accordance with relevant EPA Guidelines.

[1] *Waste Classification Guidelines: Part 1 – Classifying Waste.* NSW EPA 2014 (EPA 2014)

1. Introduction

1.1 Introduction and Background

JBS&G Australia Pty Ltd (JBS&G) has been engaged by JVMC Pty Ltd (JVMC, the client) for the provision of environmental services associated with the remediation/validation and development of Site A: Precinct 75 Commercial (Buildings 1, 2, 6 & 7) and Site B: Precinct 75 Mixed Use Redevelopment (Buildings A, B, C & 8), herein referred to as the site.

The site is located at 50 and 52 Edith Street, 67 and 73 Mary Street and 43 Robert Street, St Peters, NSW, is legally identified as Lot 1 Deposited Plan (DP) 745657, Lot 1 DP 745014, Part Lot 1 DP 180958, Lot 1 DP 556914, Lot A DP 331215 and Lot 1 DP 87885 and occupies an area of approximately 1.5 hectares (ha), as shown on **Figures 1** and **2**.

The site has been subject to a number of previous investigations which have identified historical industrial land uses from the 1920s until the mid-1960s, followed more recently by light commercial/industrial land uses (vehicle mechanic workshop, beer brewery, coffee roaster, furniture manufacturing, offices, workshops and design studios). Site activities were reported to have historically comprised the manufacturing of paints, varnish manufacturing and drum washing associated with a Taubmans paint factory (**Figure 3**). The balance of the site has been used for residential land uses since the 1930s.

Soil impact has been identified as follows:

- Associated with historical petroleum/chemical storage, handling and manufacturing;
- Hot-spots of volatile to non-volatile petroleum/chlorinated hydrocarbons;
- Polycyclic aromatic hydrocarbons (PAH) and/or heavy metals, associated with fill materials historically used across the site or resultant from historical site storage/manufacturing activities; and
- Isolated asbestos impact in fill.

Historical petroleum/chemical infrastructure is still present on site (**Figure 2**).

Groundwater has been identified to be affected with petroleum/chlorinated hydrocarbons, and heavy metals, albeit limited in extent. In addition, trichloroethene (TCE) soil vapour impacts were identified in an isolated area exceeding the screening criteria for commercial and industrial land-use applicable to this portion of the site (beneath north-western extent of Building1, refer to **Figure 2**). The extent of historical environmental investigations has been restricted by the occurrence of buildings/structures at the site.

Review of architectural plans (**Appendix A**) indicates that the site is proposed to be developed as a mixed-use precinct including residential apartments (with a single multi-level integrated car parking basement in areas), adaptive reuse of some existing buildings for commercial land uses, and public domains (landscaping/parks and paved extents), as shown on **Figure 4**.

To support the requirements for preparation of a human health and ecological risk assessment (HHERA) and remedial works plan (RWP) refining the remedial extent supplementary data is required to be obtained to address identified data gaps (refer to **Section 7**).

This document provides a data gap investigation (DGI) sampling, analysis and quality plan (SAQP) for review and approval by the appointed NSW Environment Protection Authority (EPA) Site Auditor.

This DGI SAQP has been developed in accordance with guidelines made or approved by the NSW EPA and relevant Australian Standards.

1.2 Objective

Sufficient data has been collected to characterise the site and detail the remedial works required to make the site suitable for proposed land uses, however, further environmental data is required to refine the extent of remedial works. To this end, the objective of the DGI is to collect additional data to inform the environmental assessment process, allow preparation of a HHERA and refine the remedial planning such that a RWP can be developed for the site.

1.3 Scope of Work

The scope of work to prepare this SAQP comprised:

- Review of existing documentation, including geotechnical reports and previous environmental assessments;
- A detailed inspection of the site and immediate surrounds;
- Development and documentation of a conceptual site model (CSM) based on the available information; and
- Preparation of an SAQP prior to commencement of field works.

The scope of work proposed in this DGI SAQP comprises:

- Advancement of systematic and targeted soil bores across accessible areas of the site;
- Use of a global positioning unit (GPS) to record sample locations for reference in the remedial planning/works;
- Comprehensive soil sampling for contaminants of potential concern (COPCs) from boreholes installed across the site;
- Analysis of selected soil samples at a National Association of Testing Authority (NATA) accredited laboratory for a range of COPC including, but not limited to, total recoverable hydrocarbons (TRH), benzene, toluene, ethylbenzene and xylene (BTEX) compounds, PAHs, heavy metals, total organic carbon (TOC), volatile organic compounds (VOCs), polychlorinated biphenyls (PCBs) and asbestos;
- Additional analysis by toxicity characteristic leaching procedure (TCLP) for heavy metals and PAHs to allow for waste characterisation in accordance with EPA (2014[2]) Waste Classification Guidelines;
- Assess potential contaminant leaching from soils via a program of Australian standard leaching procedure (ASLP) analysis (for volatiles) and column testing (for non-volatiles) in general accordance with the *Standard Test Method for Leaching Solid Material in a Column Apparatus* (European Method *NEN 7373, NEN 7383 and CMA/2/II/A.9.1*) to assist in the remedial planning and fill retention strategy (refer to **Section 5**);
- Advancement of targeted soil vapour probes beneath existing commercial buildings to be retained for adaptive commercial uses and in proximity to the proposed western basement envelope alignment to assess the potential for soil vapour migration into the future basement;
- Analysis of soil vapour samples at a NATA accredited laboratory for a range of COPC (volatile TRH and VOCs);

[2] *Waste Classification Guidelines: Part 1 – Classifying Waste.* NSW EPA 2014 (EPA 2014)

- Conversion of selected boreholes into groundwater monitoring wells in proximity to the western edge of the proposed basement to assess the potential for chlorinated hydrocarbon groundwater impact to migrate into the future basement;
- Gauging, purging and sampling of existing and newly installed groundwater monitoring wells;
- A field assessment of hydraulic conductivity at five nominated locations;
- Analysis of groundwater samples at a laboratory NATA accredited for a range of COPC including, but not limited to, heavy metals, TRH, BTEX, VOCs and PAHs; and
- Preparation of a Data Gap Investigation Report in general accordance with relevant EPA Guidelines.

2. Site Condition & Surrounding Environment

2.1 Site Identification

The site is situated approximately 6.1 kilometres (km) south-west of the Sydney central business district (CBD), within the local government area of the Inner West Council (Council). The site is a vibrant creative precinct comprising twelve-character buildings (refer to **Figure 3**) remaining from past industrial land use activities and four residential allotments over 1.5ha.

The site is bound by Edith Street to the north-east, low density residential allotments to the south- east, Mary Street to the south-west and low density residential allotments to the north-west.

The location of the site and surrounds is shown in **Figure 1.** The current layout is shown in **Figure 2**. The historical site layout and proposed site development layout is shown on **Figures 3** and **4**, respectively. Site details are summarised in **Table 2.1** and discussed in detail in the following section.

Table 2.1: Summary of Site Details

Site Legal Identifier (as shown on **Figure 2**)	Lot 1 DP 745657 Lot 1 DP 745014 Part Lot 1 DP 180958 Lot 1 DP 556914 Lot A DP 331215 Lot 1 DP 87885
Site Address	Lot 1 DP 745657 – 50 Edith Street, St Peters, NSW, 2044 Lot 1 DP 745014 – 52 Edith Street, St Peters, NSW, 2044 Part Lot 1 DP 180958 – 67 Mary Street, St Peters, NSW, 2044 Lot 1 DP 556914 – 73[3] Mary Street, St Peters, NSW, 2044 Lot A DP 331215 – 43 Roberts Street, St Peters, NSW, 2044 Lot 1 DP 87885 – 43 Roberts Street, St Peters, NSW, 2044
Site Area	Approximately 1.5ha
Site B: Precinct 75 Mixed Use Redevelopment (Buildings A, B, C & 8)	Approximately 1ha (refer to **Figure 4** and **Section 2.3**)
Site A: Precinct 75 Commercial (Buildings 1, 2, 6 & 7	Approximately 0.5ha (refer to **Figure 4** and **Section 2.3**)
Approximate Relative Level (RL) m Australian Height Datum (AHD)	16.3 m AHD – north site extent 9.8 m AHD south-western site extent
Local Government Authority	Inner West Council
County/Parish	Petersham/Cumberland County
Site Geographic Coordinates (MGA 56)	Refer to **Figure 2**
Current Zoning (Marrickville Local Environmental Plan (LEP) 2011, last updated 5 August 2016)	Lot 1 DP 745657 – R2 Low Density Residential Lot 1 DP 745014 – R2 Low Density Residential Part Lot 1 DP 180958 – R2 Low Density Residential Lot 1 DP 556914 – IN2 Light Industrial Lot A DP 331215 – R2 Low Density Residential Lot 1 DP 87885 – R2 Low Density Residential
Proposed Zoning	It is understood a rezoning application has been submitted for the site. The planning proposal request seeks to rezone the site land to B4 Mixed Use with a small area of RE1 Public Recreation (Part Lot 1 DP 180958, Lot A DP 331215 and Lot 1 DP 87885)
Current Land Owner(s)	JVM Holding Pty Ltd Chalak Holding Pty Ltd
Developer	JVMC Pty Ltd
Previous Land Uses	Industrial and Residential (manufacturing of paints, varnish manufacturing and drum washing associated with a Taubmans paint factory, refer to **Figure 3** and areas of residential land use within the southern site extents)

[3] Also known as 75 Mary Street, St Peters, NSW

Current Land Uses	Light Commercial/Industrial and Residential Land Uses (vehicle mechanic workshop, beer brewery, coffee roaster, furniture manufacturing, offices, workshops, design/dance studios and residential and uses within the southern site extents)
Proposed Land Uses	Mixed-use Precinct (residential apartments (with areas of ground floor retail) with basement parking in areas, adaptive reuse of existing commercial buildings for commercial land uses, and public domains (landscaping, parks and paved extents). It is understood that Building 8 for adaptive commercial reuse will also include apartments above the existing commercial suits)

2.2 Site Condition

The majority of the site (Lot 1 DP 556914) has historically been used for industrial purposes, in particular, a large portion of the site was previously used for paint and varnish manufacturing (Taubmans) from the 1920s until the mid-1960s. Lot 1 DP 556914 has subsequently been used for various light industrial/commercial purposes. The balance of the site (Lot 1 DP 74567, Lot 1 DP 745014, Part Lot 1 DP 180958, Lot A DP 331215 and Lot 1 DP 87885) has historically, and is currently used for residential land uses.

The majority of Lot 1 DP 556914 is currently covered by a mix of large brick (one to three storeys in height) and metal warehouse structures and pavement (concrete or asphalt). An unpaved area covered by roadbase aggregate is used for car parking as present at the south-eastern site extent. Current commercial/industrial site activities identified during the JBS&G site inspection within Lot 1 DP 556914 included, but were not limited to, a vehicle maintenance and mechanics workshop (south-east portion of the site), beer brewery, coffee roaster, cellar door, furniture manufacturer, offices, workshops and design studios over seventy tenancies ranging from 50 square meters (sqm) to 740 sqm.

Access at the time of inspection to Lot 1 DP 556914 was via a driveway off Mary Street, and two separate driveways on Edith Street (adjacent to the site carpark, and corridor north-east of the site). Lot 1 DP 556914 slopes gently to the south-west.

Historical records reported in EIA (2015[4]) indicate that several underground storage tanks (USTs) were potentially present within Lot 1 DP 556914. Historical records suggest multiple USTs within three separate areas (Pits 1 to Pit 3, refer to **Figures 2** and **3**). During the site inspection numerous fill points were apparent within these areas. It is noted that site inspections have been limited to accessible areas outside buildings with the exception of buildings along the north-western site boundary. As discussed herein, one UST was identified by JBS&G in proximity to Pit 2 (refer to **Figure 2**) and potential remains for two USTs to the north-west of Pit 1 (refer to **Figure 2**).

Landscaped areas (grass and trees) surround the residences within the southern site extent. A pool is present in the rear yard of Lot 1 DP 745014. As discussed herein, 67 Mary Street, 43 Roberts Street and 50 and 52 Edith Street appear to have been used for residential land uses since the 1930s.

[4] *Detailed Site Investigation Report 67 &75 Mary Street, 43 Roberts Street, 50 and 52 Edith Street, St Peters, NSW*. Environmental Investigations Australia Pty Ltd dated 18 September 2015 reference E22317 AA_Rev 3 (EIA 2015)

2.3 Proposed Development

Review of architectural plans (**Appendix A**) indicates that the site is proposed to be developed as a mixed-use precinct including residential apartments (with a single multi-level integrated car parking basement in areas), adaptive reuse of a number of existing buildings for commercial land uses, and public domains (landscaping/parks and paved extents), as shown on **Figure 4**.

Two development applications (DAs) are proposed to be lodged for the redevelopment of the site:

- Site A: Precinct 75 Commercial (Buildings 1, 2, 6 & 7); and
- Site B: Precinct 75 Mixed Use Redevelopment (Buildings A, B, C & 8).

The extent of these two development areas are shown on **Figure 4**.

Site B: Precinct 75 Mixed Use Redevelopment

Architectural plans (**Appendix A**) show three multi-storey residential buildings (Building A to Building C, refer to **Figure 4**) with a single multi-level integrated car parking basement (occupying an area of approximately 6,825m2) underlying the majority of the Site B: Precinct 75 Mixed Use area. Ground floor retail is proposed in portions of Buildings A, B and C. It is understood residential apartments are proposed to be built above the existing commercial studios in Building 8 (i.e. additions to the built form to accommodate residential apartments).

Bulk excavation associated with the basement is anticipated to progress to a RL of 11.8m AHD to 8.4m AHD for the first basement level and 8.75m AHD to 7.2m AHD for the second level basement (where present). The extent of the basement and basement depths/levels are shown on **Figure 4**. The basement will terminate in clay/bedrock.

The basement is off-set from the Site B: Precinct 75 Mixed Use area boundaries (in areas) with surface treatments external to the basement comprising minor landscaped areas (inclusive of the north-western extent of Central Park) and/or pavements (including the foundations of the built form), as shown on **Figure 4**.

A Pocket Park is proposed in the south-eastern Site B: Precinct 75 Mixed Use area extent (Part Lot 1 DP 180958, Lot A DP 331215 and Lot 1 DP 87885), as shown on **Figure 4** and will occupy an area of approximately 600 m^2. It is understood that following development the Pocket Park will be dedicated to Council.

The following land use criteria have been adopted for the Site B: Precinct 75 Mixed Use area based on the proposed future uses:

- Built Areas – NEPC (2013[5]) Health Investigation Level (HIL)/Health Screening Level (HSL) Residential with Minimal Access to Soils (HIL/HSL- B); and
- Park Lands - NEPC (2013) HILs/HSLs Public Open Space (recreational) (HIL- C).

Consideration will also be given to generic and site-specific ecological investigations levels (EILs)/ecological screening levels (ESLs).

In some cases, a commercial industrial land use scenario may be applicable in areas where basement car parking underlies residential developments or where residential apartments are located above commercial uses (Building 8). Following implementation of this DGI SAQP, further details/amendments to land use criteria will be included in the RWP to be prepared for the site.

[5] *National Environment Protection (Assessment of Site Contamination) Measure 1999 (as amended).* National Environment Protection Council (NEPC 2013)

Construction of the Site B: Precinct 75 Mixed Use area will require demolition of Buildings 3 to Building 5, Buildings 9 to Building 12 and residential dwellings at 43 Roberts Street, 50 and 52 Edith Street and 67 Mary Street, as shown on **Figure 3**.

Site A: Precinct 75 Commercial

As shown in **Appendix A** (architectural plans) Building 1, Building 2, Building 6 and Building 7 are proposed for adaptive reuse for commercial land use.

Development will largely comprise refurbishment/alterations to building interiors, with the majority of hardstands/foundations proposed to be retained. Some minor landscaping and pavement modifications are proposed along with the addition of minor landscaped areas.

The following land use criteria have been adopted for the Site A: Precinct 75 Commercial area based on the proposed future uses:

- Commercial Precinct – NEPC (2013) HILs/HSLs: Commercial/Industrial Land Uses (HIL- D); and
- Consideration will also be given to generic and site-specific EILs/ESLs.

2.4 Surrounding Land Uses

The surrounding land uses have been identified as follows:

- North-east - The site is bound to the north-east by Edith Street, across which are low density residential allotments. To the north, the site is bound by Edith Street and in turn Unwins Bridge Road, across which are serval industrial allotments;
- South-east - The site is bound to the south-east by low density residential allotments;
- South-west - The site is bound to the south-west by Mary Street across which are low density residential allotments and several commercial allotments; and
- North-west - The site is bound to the north-west by residential allotments and in turn Unwins Bridge Road, across which is an Inner West Council depot.

The closest environmental receptor is Alexandria Canal located approximately 800m south, south-west of the site.

2.5 Topography

A review of the 1:25,000 Botany Bay Topographic Map 9130-3-S (LPI 2013[6]) indicates that the site lies at an elevation of approximately 10m AHD. The regional topography consists of gently undulating rises with local relief to 30m, slopes are usually <5% with broad rounded crests with gentle incised slopes.

The site slopes gently towards the south-west with the highest level being approximately 15.6m AHD at MW01 (**Figures 5A** and **5B**) in the north and 11.1m AHD in the south-west (MW11, **Figures 5A** and **5B**) fronting Mary Street. A slight ridge line with a north-east/south-west axis through MW06/MW04 is present. The car cark in the south-east is relatively level.

In the vicinity of the site, regional ground levels fall gently toward the south/south-west, generally toward Alexandra Canal, located approximately 800m to the south, south-west of the site.

The site appears to have been subject to minor cut and fill activities to facilitate construction of the historical/current built form and/or to accommodate sub-surface infrastructure. Potential remains for fill materials of unknown origin to have been imported, or use of site waste material resultant from historical manufacturing activities to create former/existing site levels.

[6] *1:25 000 Botany Bay Topographic Map 9130-3-S Sheet 9130 (third edition*). Department of Land and Property Information 2013 (DPI 2013)

2.6 Geology & Soils

According to the 1:100,000 Geological Series Sydney Geological Survey of NSW Sheet 9130 (1983[7]), the site is underlain by Ashfield Shales of the Wianamatta Group which consists of black to dark-grey shale and laminite. Ashfield Shale generally weathers into silty clays of medium to high plasticity. A dyke is present in the vicinity of the site to the south.

A review of the regional soil map (DLWC 2002[8]) indicated that the site is underlain by the Blacktown Landscape Group. Soils are characterised as generally shallow to moderately deep (<1m) red and brown podzolic soils on upper slopes; deep (150-300cm) yellow podzolic soils and soloths on lower slopes.

A summary of the encountered site lithology during previous investigations (**Section 4**) is presented in **Table 2.2** below and graphically represented as **Figures 6A** and **6B**.

Table 2.2: Summary of Lithology within Lot 1 DP 556914

Lithologic Type	Depth (m bgs)	Lithologic Description
Concrete	0.0-0.5	Concrete
Fill	0.4-1.8	Gravelly clay/gravelly sand, grey to brown, heterogeneous, damp, medium to high plasticity, including ash, brick fragments and glass
Clay/Silty Clay	0.4-2.9	Silty clay, brown to red, stiff, homogeneous, damp, medium to high plasticity
Weathered Shale	1.5-9	Shale, grey to brown

In summary, based on recent site investigation works, shallow fill material (incl. of pavements), typically between 0.1m to 1.8m below ground surface (bgs), is inferred to be present across the site, comprising of gravelly clays, silty gravels and sands with minor anthropogenic materials (brick, ash, glass). Fill material was observed to be underlain by silty clays/clay from 0.4m to 2.9m bgs, followed by shale to the maximum depth of investigation (9m bgs).

There is limited site geological information beneath the footprints of existing buildings and no geological information for residential allotments.

2.7 Acid Sulfate Soils

Review of the *Acid Sulfate Soil Risk Map for Botany Bay*[9] indicates that the site is located within an area classed as "No Known Occurrence" of acid sulfate soils (ASS).

Review of the Marrickville LEP 2011 ASS Map – Sheet ASS-04, the site falls within a category classified as Class 5 ASS. Council consent is required for development works within 500m of adjacent Class 1, 2, 3 or 4 land that is below 5m AHD, and the works are likely to lower the water table to below 1m AHD on adjacent Class 1, 2, 3 or 4 land. Two Class 2 ASS zones were found within 500m of the site, one located across the Illawarra Railway approximately 250m north-west of the site, the other located approximately 350m south of the site beyond the Princes Highway.

The nearest occurrence of identified/confirmed ASS comprises the sediments of the Alexandra Canal, located approximately 800m to the south, south east of the site.

During previous investigations (**Section 4**), natural soils were assessed for the potential of ASS/potential acid sulfate soils (PASS) properties. Although some samples were reported to have peroxide oxidisable sulphur over 0.03% and total sulfidic acidity over 18 mol H+/tonne, it was reported it was unlikely that ASS/PASS were present at the site.

With consideration to the geological and soil characteristics of the site management of development activities is not required to address the potential for impact on ASS.

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7 *1:100 000 Sydney Geological Map Sheet 9130 Edition 1.* Department of Mineral Resources, Published 1983 (DMR 1983)

8 *1:100 000 Sydney Soil Landscape Series Sheet 9130 (2nd Edition).* Department of Land and Water Conservation 2002 (DLWC 2002)

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

2.8 Hydrology

Existing pavements/structures are present across approximately 90% of the site. As such, rainfall runoff is anticipated to be controlled by the current storm water network, draining towards Mary Street and Roberts Road site boundaries and then into the regional stormwater system. It is understood that regional stormwater flow occurs via below ground infrastructure to Alexandra Canal.

Alexandra Canal is a constructed waterway approximately 4.5km in length. The canal begins in Alexandra and discharges into the Cooks River and receives stormwater from the industrial and residential areas of Waterloo, Alexandria, Redfern and Moore Park. The water quality in Alexandra Canal is recognised as poor due to its industrial and urban catchment.

Overall, infiltration of precipitation at the site is expected to be low due to significant hardscape and buildings present, however, limited infiltration into the subsurface is likely to occur in unsealed areas (i.e. car park in the south-east portion of the site and landscaped areas surrounding residential dwellings), and where deteriorating conditions (i.e. cracks) on the concrete hardstand are present.

2.9 Hydrogeology

Groundwater is inferred to be present underlying the site in intermittent zones within residual clays, and more broadly within underlying shales. This is supported by observations during the previous investigations (**Section 4**) that noted shallow fill and clays were relatively dry until an inferred semi-confined water bearing unit was encountered at approximately 4m to 5m bgs.

Groundwater recharge is inferred to be related to local rainfall infiltration, though there is also potential for input from surface water features (e.g. water supply system, drains).

Shallow groundwater flow at the site is inferred to be generally towards the south-west/west. At the eastern extent of the site, groundwater flow potentially has a more southerly direction, and at the western property extent groundwater flow has a more westerly component, following the pattern of surface topography. Deeper groundwater in the site area is inferred to flow towards local surface water features (i.e. Alexandra Canal). The presence of a dyke indicated on geological maps to the south of the site may also influence local groundwater flow. Groundwater flow direction is shown on **Figure 7**.

Groundwater flow is expected to predominantly occur within fractures and joints within weathered shales. Flow within shallower residual clays is expected to be limited based on observations in previous investigations (**Section 4**) and the expected[10] low transmissivity of this unit.

July 2015 groundwater gauging data from onsite monitoring wells indicated the standing water level ranged from approximately 0.7 to 3.4m bgs (8.69 to 12.94m AHD).

Consistent with the historical extensive use of groundwater in the Botany 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[11]) indicates that the site is located within Zone 2 of the Botany Sand Aquifer Embargo Area. The DNR 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) – Office of Water and the NSW Office of Environment and Heritage (OEH).

[10] Based on range of hydraulic conductivities in *Groundwater* by Freeze and Cherry (1979)

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

2.10 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]).

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.

[12] http://www.bom.gov.au/climate/averages/tables/cw_066037.shtml. Commonwealth of Australia, 2011 Bureau of Meteorology, Product IDCJCM0028 prepared at 05 July 2017 and accessed by JBS&G on 05 July 2017

3. Site History

3.1 Historical Titles

A search of the historical certificates of title was previously undertaken by Environmental Investigations Australia Pty Ltd (EIA) and summarised in EIA (2015). Review of the Land Title Office information, as obtained by EIA is summarised in **Tables 3.1** and **3.2** and indicated the following key points in site ownership history.

Table 3.1: Summary Site Ownership – 73 Mary Street, St Peters

Years	Owners	Land Use
Part Lot 1 DP 556914 – 73 Mary Street (former Allotment 1)		
1911-1923	George McAllister (Builder)	-
1923-1965	Taubmans Limited, now Taubmans Industries Limited	Paint manufacturing
1965-2013	Genimpex Pty Ltd	Light commercial/industrial
Leases	Numerous leases were found affecting this land from 1966 Sydney County Council Substation No. 723 together with rights, now expired (1970)	
Easements	Right of Way (K500099) associated with a lease now expired (1965-1973)	
Part Lot 1 DP 556914 – 73 Mary Street (former Allotment 2)		
1912-1965	Taubmans Limited, now Taubmans Industries Limited	Paint manufacturing
1965-2017	Genimpex Pty Ltd	Light commercial/industrial
Leases	Various leases were found affecting this land from 1970	
Part Lot 1 DP 556914 – 73 Mary Street (former Allotment 3)		
1896-1921	Charles Benjamin Comber (cook)	-
1921-1965	Taubmans Limited, now Taubmans Industries Limited	Paint manufacturing
1965-2013	Genimpex Pty Ltd	Light commercial/industrial
Leases	Various leases were found affecting this land from 1970	
Part Lot 1 DP 556914 – 73 Mary Street (former Allotment 4)		
1911-1923	John Miller (brick layer)	-
1923-1923	Victor James Pringle (commercial traveller)	-
1923-1965	Taubmans Limited, now Taubmans Industries Limited	Paint manufacturing
1965-2013	Genimpex Pty Ltd	Light commercial/industrial
Leases	Various leases were found affecting this land from 1966	
Part Lot 1 DP 556914 – 73 Mary Street (former Allotment 5)		
1899-1922	William Fredick Dawes (brick maker)	-
1922-1928	Edward Townsend (carrier)	-
1928-1965	Taubmans Limited, now Taubmans Industries Limited	Paint manufacturing
1965-2013	Genimpex Pty Ltd	Light commercial/industrial
Easement	Right of Way (K500099) associated with a lease now expired (1965-1973)	
Part Lot 1 DP 556914 – 73 Mary Street (former Allotment 6)		
1911-1930	Henry Alfred Gale Jobbins (gentleman) Fredick Lynne Rolin (solicitor)	-
1930-1938	Fredick Lynne Rolin (solicitor)	-
1938-1945	Fredick Lynne Rolin (solicitor) Francis Archer Lynne Rolin (no occupation)	-
1945-1965	Taubmans Limited, now Taubmans Industries Limited	Paint manufacturing
1965-2013	Genimpex Pty Ltd	Light commercial/industrial
Part Lot 1 DP 556914 – 73 Mary Street (former Allotment 7A and 7B)		
1891-1973	Richard Ralp (butcher) (Part 7B)	-
1937-1942	Frank William Cable (solicitor) (Part 7B)	-
1942-1965	Taubmans Limited, now Taubmans Industries Limited (Part 7B)	Paint manufacturing
1910-1946	Isaac Edwin Spackman (ironmonger) (Part 7A) Annie Adelaide Spackman (married woman)	-
1946-1965	Taubmans Limited, now Taubmans Industries Limited (Part 7A)	Paint manufacturing
1965-2013	Genimpex Pty Ltd (whole of 7A and 7B)	Light commercial/industrial
Leases	Henry James Bennett (plasterer) (Part 7A) (1946-1948)	
Part Lot 1 DP 556914 – 73 Mary Street (former Allotment 8)		
1946-1965	Taubmans Limited, now Taubmans Industries Limited	Paint manufacturing formally part of a road reserve
1965-2013	Genimpex Pty Ltd (whole of 7A and 7B)	Light commercial/industrial

Years	Owners	Land Use
Leases	Atlantic Lithographic Plates Pty Ltd (1971)	
Current Lot 1 DP 556914 – 73 Mary Street		
2013-2017	JVM Holding Pty Ltd Chalak Holding Pty Ltd	Light commercial/industrial
Leases	Various leases were found affecting this land from 2013	

Lot 1 DP 556914 was found to consist of eight allotments previously. A consolidation of these allotments took place in 1973.

In summary, at the beginning of the 20th century, apart from Allotments 2 and 8, most land parcels were privately owned. Allotment 2 was registered under Taubmans Limited, known to be a paint manufacturer, which started acquiring other allotments from the early 1920s. By the late 1920s, allotments numbered 1 to 5 had been transferred to Taubmans Limited. During the 1940s Taubmans Limited underwent another expansion and acquired allotments 6, 7A, 7B and 8.

Taubmans ownership over the current Lot 1 DP 556914 was transferred to Genimpex Pty Ltd in 1965. In 2013, JVM Holding Pty Ltd and Chalak Holdings Pty Ltd acquired the lot jointly.

Table 3.2: Summary Site Ownership – 43 Roberts Street, 50 and 52 Edith Street, and 67 Mary Street, St Peters

Years	Owners	Land Use
Lot A DP 331215 – 43 Roberts Street		
1887-1924	Emma Annabel (married woman) (and her deceased estate)	Residential
1924-1935	Edith Isabel Annabel (spinster) Alice Adeleaise Harcourt (married woman)	Residential
1935-1951	Leslie Norman Annabel (carter)	Residential
1951-1965	Taubmans Limited, now Taubmans Industries Limited	Residential
1965-2013	Genimpex Pty Ltd	Residential
2013-2017	JVM Holding Pty Ltd Chalak Holding Pty Ltd	Residential
Lot 1 DP 87885 – 43 Roberts Street		
1887-1920	Emma Annabel (married woman) (and her deceased estate)	Residential
1920-1928	Thomas William Annabel (freeholder)	Residential
1928-1951	Leslie Norman Annabel (carter)	Residential
1951-1965	Taubmans Limited, now Taubmans Industries Limited	Residential
1965-2013	Genimpex Pty Ltd	Residential
2013-2017	JVM Holding Pty Ltd Chalak Holding Pty Ltd	Residential
Easement	Right of Way (1499) (1928)	
Lot 1 DP 745657 – 50 Edith Street		
1909-1953	Amelia Grace Favell (married woman then widow)	Residential
1953-1959	Sydney James Wedderburn (salesman)	Residential
1959-1987	Yvonne Valerie Lyden (married woman)	Residential
1987-1990	Brian McLenaghan (clerk) Deborah Patricia McLenaghan (married woman)	Residential
1990-1996	Emma Margaret O'Malley (secretary)	Residential
1996-2015	Michael Francs Kelly Marcela Cecila Pacheco	Residential
Lot 1 DP 745014 – 52 Edith Street		
1909-1953	Amelia Grace Favell (married woman then widow)	Residential
1953-1987	Sydney James Wedderburn (salesman)	Residential
1987-1999	George Yacoub (taxi driver)	Residential
1999-2015	Borche Ivanovski now Borce Ivanovski	Residential
Part Lot 1 DP 180958 – 67 Mary Street		
1916-1918	Gertrude Strongman (spinster)	Residential
1918-1920	James Auburn Edwards (general merchant)	Residential
1920-1928	Angnes Frances Edwards (married woman)	Residential
1928-1945	Willaim Collins (carrier)	Residential
1945-1945	Emma Collins (widow)	Residential
1945-1973	Gordan Anthony Scott (council employee)	Residential
1973-1973	William Kenneth Scott (taxi driver)	Residential

Years	Owners	Land Use
1973-1978	Peter Yanakoulias (panel beater) Debby Yanakoulias (married woman)	Residential
1978-1979	Paul Grant (panel beater) Colleen Mary Grant (married woman)	Residential
1979-2014	Noel John Power (electrical mechanic) Ruby Adeline Power (married woman)	Residential
2014-2017	JVM Holding Pty Ltd Chalak Holding Pty Ltd	Residential

The search results identified that the land parcels were owned by various individual from the 20th century up until 2014/2015, except for 43 Roberts Street (both lots) which was registered to different individuals until 1951 when Taubmans Industries Limited acquired the lots and in turn Genimpex in 1965 and the joint venture of JVM Holding Pty Ltd and Chalak Holdings Pty Ltd in 2013.

Copies of the historical certificates of title are included in **Appendix B**.

3.2 Aerial Photographs

Historical aerial photographs dated 1930, 1943, 1951, 1961, 1978, 1986, 1994, 2005, 2010 and 2014 were obtained from the Land and Property Information Division of the Department of Finances and Services by EIA. The aerial photograph review by EIA (2015) identified the following features in relation to the history of the site a summarised in **Table 3.3** below.

Table 3.3: Summary of Aerial Photograph Observations

Year	Site Observations	Potential land Uses	Surrounding Land Uses
1930	**73 Mary Street**: Majority of the lot was occupied by multiple low rise, medium density industrial structures, except for the north-eastern/eastern corner where residential structures were apparent **Other Allotments**: The other allotments appeared to have been used for residential purposes with residential style structures and landscaping (yard areas) apparent.	**73 Mary Street**: Primary industrial with the notable exception of the north-eastern lot extent which appeared to have been used for residential purposes **Other Allotments**: Residential	**North**: Low density residential properties. Industrial properties further afield including quarrying activities and the Illawarra Railway line **East**: Low density residential properties. Areas of industry were apparent beyond the Princes Highway **South**: Low density residential and an industrial property. A holding pond was also apparent to the south of the site **West**: Low density residential allotments and in turn Unwins Bridge Road, across which were industrial properties
1943	**73 Mary Street**: Structures/land uses in this portion of the site appeared similar to the previous aerial photograph **Other Allotments**: The site appeared similar to the previous aerial photograph with the notable of a few additions and alterations to the built form	**73 Mary Street**: Primary industrial with the notable exception of the north-eastern lot extent which appeared to have been used for residential purposes **Other Allotments**: Residential	**North**: Low density residential properties. Industrial properties further afield including quarrying activities and the Illawarra Railway line **East**: Low density residential properties. Areas of industry were apparent beyond the Princes Highway. Two large excavations were apparent (quarries) **South**: Low density residential and an industrial property. A holding pond was also apparent to the south-west of the site **West**: Low density residential allotments and in turn Unwins Bridge Road, across which were industrial properties. A industrial property was located to the south-west, presumably part of the Taubmans paint manufacturing facility
1951	**73 Mary Street**: Two new industrial structures were apparent in the eastern lot extent. One of the residential style structures was no longer apparent with this portion of the site now paved (driveway). Additions and alterations to the built form of the other residence was apparent. **Other Allotments**: Structures/land uses in this portion of the site appeared similar to the previous aerial photograph	**73 Mary Street**: Industrial **Other Allotments**: Residential	**North**: Low density residential properties. Industrial properties further afield **East**: Low density residential properties. Areas of industry were apparent beyond the Princes Highway **South**: Low density residential and an industrial property. The industrial property appeared to have been altered/damaged. The former holding pond appeared to have been backfilled

Year	Site Observations	Potential land Uses	Surrounding Land Uses
			West: Low density residential allotments and in turn Unwins Bridge Road, across which were industrial properties. A large holding pond was apparent
1961	**73 Mary Street**: The residential style structure remaining in the eastern lot extent was no longer apparent, with this area used for vehicle parking **Other Allotments**: Structures/land uses in this portion of the site appeared similar to the previous aerial photograph	**73 Mary Street**: Industrial **Other Allotments**: Residential	**Surrounding Land Uses:** Structures/land uses appeared similar to the previous aerial photograph
1978	**73 Mary Street**: The lot appeared similar to the previous aerial photograph **Other Allotments**: The allotment appeared similar to the previous aerial photograph with the notable exception of a rectangular building in the rear yard of Lot 4 DP 87885 (43 Roberts Street)	**73 Mary Street**: Industrial **Other Allotments**: Residential	**Surrounding Land Uses:** Structures/land uses appeared similar to the previous aerial photograph. The large holding pond to the north of Unwins Bridge Road was no longer apparent
1986	**73 Mary Street**: Structures/land uses in this portion of the site appeared similar to the previous aerial photograph **Other Allotments**: Structures/land uses in this portion of the site appeared similar to the previous aerial photograph	**73 Mary Street**: Industrial **Other Allotments**: Residential	**Surrounding Land Uses:** Structures/land uses appeared similar to the previous aerial photograph
1994	**73 Mary Street**: Structures/land uses in this portion of the site appeared similar to the previous aerial photograph **Other Allotments**: Structures/land uses in this portion of the site appeared similar to the previous aerial photograph with the notable exception of the presence of a pool within Lot 1 DP 745014 (52 Edith Street)	**73 Mary Street**: Industrial **Other Allotments**: Residential	**Surrounding Land Uses:** Structures/land uses appeared similar to the previous aerial photograph
2005	**73 Mary Street**: Structures/land uses in this portion of the site appeared similar to the previous aerial photograph **Other Allotments**: Structures/land uses in this portion of the site appeared similar to the previous aerial photograph	**73 Mary Street**: Industrial **Other Allotments**: Residential	**Surrounding Land Uses:** Structures/land uses appeared similar to the previous aerial photograph
2010	**73 Mary Street**: Structures/land uses in this portion of the site appeared similar to the previous aerial photograph **Other Allotments**: Structures/land uses in this portion of the site appeared similar to the previous aerial photograph	**73 Mary Street**: Industrial **Other Allotments**: Residential	**Surrounding Land Uses:** Structures/land uses appeared similar to the previous aerial photograph
2014	**73 Mary Street**: Structures/land uses in this portion of the site appeared similar to the previous aerial photograph **Other Allotments**: Structures/land uses in this portion of the site appeared similar to the previous aerial photograph	**73 Mary Street**: Industrial **Other Allotments**: Residential	**Surrounding Land Uses:** Structures/land uses appeared similar to the previous aerial photograph
Reference should be made to **Section 2.2** for discussion on the current site configuration			

Based on review of the aerial photographs, the majority of the site has been used for industrial purposes. The north-eastern site extent was used of residential land use until the 1960s, following which it was used as a car park. 43 Roberts Street, 67 Mary Street and 50 and 52 Edith Street appears to have been used for residential land uses since the 1930s.

Historical land uses in surrounding areas was primarily residential with areas of industrial land uses.

3.3 Council Records

3.3.1 Council Development Application/Building Application Records

EIA undertook a review of Council's development application/building application records pertaining to the site and surrounds. The review by EIA (2015) identified the following features in relation to the history of the site, a summarised in **Table 3.4** below.

Table 3.4: Summary of Council Records

Years	DA/BA Number	Item
1950	BA 204/50	Applicant: Taubmans Pty Ltd Proposed: Additions to factory and new stores. Other Information: A schematic sketch of existing buildings situated adjacent to the proposed development suggested the presence of chemical and chlorine sections in the factory The application was approved
1950	BA 235/50	Applicant: Taubmans Pty Ltd Proposed: New drum cleaning shed The application was approved
1951	BA 239/51	Applicant: Taubmans Pty Ltd Proposed: Addition and alterations to existing buildings Other Information: Three areas (Pits) of underground storage tanks (USTs) were identified, the inferred location of the Pits are shown on **Figure 3** The application was approved
1954	BA 116/54	Applicant: Taubmans Pty Ltd Proposed: Storage of good The application was approved
1967	BA 397/67	Applicant: George Colemen (construction) Pty Ltd Proposed: Installation of a sub-station within Building 5 The application was approved

Council records indicate the site was used for the manufacturing of paint, varnish manufacturing and drum washing by Taubmans Pty Ltd. Manufacturing activities by Taubmans Pty Ltd also appear to have occurred across Mary Street, in which lacquer, nitrocotton manufacturing and storage were carried out. A fire occurred in the 1950s. It is unclear if the fire was isolated to building located across Mary Street or resulted in damage to the subject site.

Several buildings across Mary Street were noted to be of asbestos fibre cement sheeting construction.

Following divestment of the site by Taubmans Pty Ltd, records show Genimpex Pty Ltd acquired the site and leased the site to various tenants for a number of land use activities including: motor manufacturing and repairs, furniture manufacturing, wood working, yarn/cloth manufacturing and storage, paper lamination, styrene moulding for food models, sign writing and motor vehicle detailing, storage of metal spray equipment, forklift repair and servicing, manufacturing of fibre glass products, wielding and wrought iron production, neon sign manufacturing and jewellery and casting manufacturing.

Copies of Council's records as presented in EIA (2015) are included in **Appendix C**.

3.3.2 Section 149 Planning Certificate Search

A planning certificate dated June 2017 was obtained from Council by JBS&G for Lot 1 DP 556914 (**Appendix D**). The planning certificate included the following information regarding the site.

- The land is zoned IN2 – Light Industrial under the Marrickville LEP 2011;
- The land is identified as being subject to ASS under clause 6.2 of Marrickville Local Environmental Plan 2011. Development on land that is subject to ASS risk requires development consent and the preparation of an acid sulfate soil management plan (ASSMP)

subject to a preliminary assessment of the proposed works prepared in accordance with the Acid Sulfate Soil Manual (ASSMAC 1998[13]). Development consent is not required where the works involve the disturbance of less than 1 tonne of soil or are not likely to lower the water table.

- The land is not affected by a policy adopted by any other public authority and notified to the Council for the express purpose of its adoption by that authority being referred to on a planning certificate issued by Council, that restricts the development of the land because of the likelihood of land slip, bushfire, flooding, tidal inundation, subsidence or any other risk.

With respect to matters arising under the *CLM Act (1997)*:

- The land to which this certificate relates is not significantly contaminated within the meaning of the *CLM Act* (*1997*);
- The land to which this certificate relates is not subject to a management order within the meaning of the *CLM Act* (*1997*);
- The land to which this certificate relates is not the subject of an approved voluntary management proposal within the meaning of the *CLM Act* (*1997*);
- The land to which this certificate relates is not subject to an ongoing maintenance order within the meaning of the *CLM Act* (*1997*); and
- The land to which this certificate relates is not the subject of a site audit statement within the meaning of the *CLM Act* (*1997*).

3.4 WorkCover Search

EIA reported a search for the storage of dangerous good at the site (Lot 1 DP 556914) was submitted to WorkCover. The correspondence received indicated that records pertaining to historical storage of dangerous goods on site were not identified on the Stored Chemical Information Database (SCID) or the microfiche records held by WorkCover. WorkCover records are included in **Appendix E**.

As discussed above, historical records reported in EIA (2015) indicate that several USTs were potentially present within Lot 1 DP 556914. Historical records suggest multiple USTs within three areas (Pits 1 to 3, refer to **Figures 2** and **3**). During the site inspection numerous fill points in these areas were apparent.

One UST was identified by JBS&G in proximity to Pit 2 (refer to **Figure 2**) and potential remains for two USTs to the north-west of Pit 1 (refer to **Figure 2**) as discussed in **Section 4.3** below.

3.5 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 for properties directly adjacent the site. It is noted a number of properties hydrogeologically downgradient of the site have been issued clean-up or prohibition notices.

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.

Review of the EPA's list of NSW Contaminated Sites Notified to OEH (**Appendix F**) identified that the site had been notified under Section 60 of the *CLM Act 1997*, however, the EPA has completed an

[13] *Acid Sulfate Soil Manual*. New South Wales Acid Sulfate Soil Management Advisory Committee August 1998 (ASSMAC 1998)

assessment of the contamination and decided that regulation under the *CLM Act 1997* was not required. It is noted that a number of site hydrogeologically down gradient of the site have also been notified under Section 60 of the *CLM Act 1997*.

Results of the search are presented in **Appendix F**. A copy of the EPA's determination is also presented in **Appendix F.**

3.6 Australian and NSW Heritage Register

A search of the Australian Heritage Trust database and the NSW Heritage Inventory was undertaken and records are included in **Appendix G**. The search did not identify the presence of any items of national or state significance in the immediate vicinity of the site.

3.7 Integrity Assessment and Summary of Site History

The majority of the site was historically used for industrial land uses from the 1920s until the mid-1960s, followed more recently by light commercial/industrial land uses (vehicle mechanic workshop, beer brewery, coffee roaster, furniture manufacturing, offices, workshops and design studios). Site activities were reported to have historically comprised the manufacturing of paints, varnish manufacturing and drum washing associated with a Taubmans paint factory (**Figure 3**). The balance of the site has been used for residential land uses since the 1930s.

Based on the range of sources and the general consistency of the historical information, it is considered that the historical assessment has an acceptable level of accuracy with respect to the potentially contaminating activities historically occurring at the site.

4. Previous Investigations

The following sections provide a summary of the information and site characterisation data presented within available assessment reports. These reports include both historical and information relating to investigations conducted at that time.

Comments in relation to COPC are provided in the following text in relation to assessment criteria adopted at the time of report preparation. Exceedances of assessment criteria presented in **Section 10** with respect to proposed land uses are shown in accompanying summary results tables (**Appendix H**) and **Figures 8A** to **8C**.

This is considered appropriate to identify contaminants requiring further consideration in relation to proposed development of the site and preparation of a HHERA/RWP.

4.1 Preliminary Geotechnical Investigation (EI 2014[14])

EIA was engaged to undertake a Preliminary Geotechnical Investigation (PGI) in conjunction with a detailed site investigation (DSI, EIA 2015), summarised below, to provide preliminary geotechnical advice and recommendations in support of a Council planning application, and the preparation of initial concept designs for a proposed residential development at the site.

The scope of works for EIA (2014) comprised the following:

- Subsurface investigation comprising of drilling, sampling and field testing at six borehole locations (BH1/MW1 to BH5/MW5 and BH6, refer to **Figures 5A** and **5B**) up to 9 m bgs across a portion of the site (Lot 1 DP 556914) to assess the soil profile for geotechnical purposes;
- Laboratory analysis of selected samples collected from the subsurface investigation to assess for engineering properties (i.e. soil moisture content, Atterberg Limits, soil and groundwater aggressivitiy – e.g. pH, chloride and sulfate content and electrical conductivity); and
- Review and interpretation of results and field testing/observations from the site investigation to provide site management recommendations on excavation support requirements, excavation methodologies, building and retaining wall structure foundations, construction constraints, and potential groundwater management requirements.

The general subsurface soil profile observed during the EI (2014) geotechnical investigation included the following:

- Fill (up to 0.7m bgs) - comprising of asphalt or concrete hardstand up to 190mm in thickness, overlying sandy clay, clayey silt, clay, silty gravel, gravelly clay and gravelly sand with minor anthropogenic fragments;
- Silty clay and weathered shale (up to 2.7m bgs) - firm to very stiff, medium to high plasticity clay with sub-rounded ironstone gravel grading to extremely weathered and low strength shale;
- Mudstone and weathered shale (up to 4.7m bgs) - distinctly weathered, very low to low strength mudstone and shale; and
- Shale (up to total investigated depth) - slightly weathered to fresh, low to medium strength shale.

[14] *Preliminary Geotechnical Investigation Report – 75 Mary Street, St Peters, NSW.* Environmental Investigation Australia Pty Ltd dated 9 December 2014 reference E22317 GA (EIA 2014)

Based on the findings of the investigation, it was reported in EIA (2014) there was a low risk of geotechnical conditions preventing the proposed development, subject to the recommendations provided in EIA (2014) for the preliminary design and construction of the development.

4.2 Detailed Site Investigation (EIA 2015)

EIA was engaged to undertake a DSI of the site to assess the environmental conditions and the potential for onsite impacts associated with the identified current and historical land uses, and to establish whether ASS are present on the site.

The scope of works for EIA (2015) comprised the following:

- A review of available site history and background information to identify potential areas of environmental concern (AEC);
- A detailed inspection of the site and surrounds to establish potential AECs prior to investigation works;
- Implementation of a site investigation program including drilling and soil sampling of twenty-three borehole locations (inclusive of the aforementioned EIA (2014) geotechnical locations) across Lot 1 DP 556914 (up to a total depth of 9m bgs) with five borehole locations converted to monitoring wells (BH1/MW1 to BH5/MW5). Due to access constraints, the program adopted a targeted/judgemental sampling pattern;
- Groundwater sampling from the five newly installed monitoring wells (BH1/MW1 to BH5/MW5); and
- Laboratory analysis of groundwater and selected soil samples for relevant constituents as determined from the site history review and field observations during the investigation program.

Review of available historical records indicate that a paint manufacturing factory had been operating onsite (Lot 1 DP 56914) from the 1920s until the mid-1960s, and Lot 1 DP 56914 has been subsequently been used for various industrial and commercials uses. A plan attached in documentation from Council indicated that there were three UST burial areas containing multiple USTs on the site (Pits, refer to **Figures 2** and **3**). It was further reported in EIA (2015) that during the site inspection, undertaken as part of the assessment, the presence of infrastructure associated with USTs (i.e. fill point and vent pipes) were apparent at Pit 1.

The soil investigation found that the site lithology comprised fill materials (typically less than 1m in thickness) underlain by residual soils (silty clay/clays) and weathered shales. The fill comprised of various constituents, suggesting several periods of filling in the past. Trace level of brick inclusions were reported at a number of locations.

Hydrocarbon odours were noted in soil bore locations as shown in **Table 4.1** below. Soil samples were screened with a photo-ionisation detector (PID). Soil PID readings above 5ppm are presented in **Table 4.1**.

Table 4.1: Odours (EIA 2015)

Soil Bore Location	Depth (mbgs)	Odour	PID reading (ppm)	Lithology
BH1/MW1	0.3-1.3	Hydrocarbon	4.2-176	Natural - clay
BH2/MW2	0.14-0.5	Hydrocarbon	0.1	Fill
	0.5-1.9	Hydrocarbon	0.2-1.1	Natural - clay
BH3/MW3	0.15-0.4	Hydrocarbon	12	Fill
	0.4-2	Hydrocarbon	0.8-3.6	Natural - clay
BH4/MW4	0.05-0.3	Hydrocarbon	11	Fill
	0.3-3	Hydrocarbon	14-180	Natural – clay/shale
BH5/MW5	0.0-0.3	Hydrocarbon	80	Fill
	0.3-2.3	Hydrocarbon	52-138	Natural - clay
BH11	0.15-0.6	Hydrocarbon	0.5	Fill

Soil Bore Location	Depth (mbgs)	Odour	PID reading (ppm)	Lithology
BH14	0.1-0.5	Hydrocarbon	0.8	Fill
	0.5-1.2	Hydrocarbon	0.8	Natural - clay
BH15	0.2-0.4	Hydrocarbon	0.5	Fill
BH16	0.2-0.5	Hydrocarbon	1.5	Fill
	0.5-1.1	Hydrocarbon	0.5	Natural - clay
BH17	0.4-0.9	Chemical	8.1	Fill
	0.9-1.3	N/A	6	Natural - clay
BH18	0.25-0.6	Hydrocarbon	0.5	Fill
BH19	0.15-0.6	Hydrocarbon	0.5	Fill
	0.6-1.2	Hydrocarbon	0.5	Natural - clay
BH20	1.5	N/A	16	Natural – rock
BH21	0.15-0.6	N/A	100	Fill
	0.6-1.2	N/A	12	Natural - clay

A total of thirty-six (twenty-two fill and fourteen natural) soil samples were submitted for heavy metal, TRH, PAH, organochlorine pesticides (OCPs), PCB, organophosphorus pesticides (OPP), phenol and VOC analysis. Soil analytical results reported the following exceedances above the adopted NEPC (2013) Residential with Access to Soil (HIL-A/HSL-A) and ecological criteria:

- Twelve of thirty-six samples submitted for zinc analysis exceeded the ecological criterion of 190mg/kg, with zinc concentrations ranging from 210 to 2,500mg/kg;
- Two samples, BH14(0.3-0.5) and BH21(0.2-0.4), exceeded the copper ecological criterion of 90mg/kg with a concertation of 260 and 98mg/kg, respectively;
- Five samples, BH5(0.2-0.3), BH14(0.3-0.5), BH17(0.6-0.8), BH21(0.2-0.4) and BH22(0.2-0.4), reported lead concentrations above the HIL-A criterion of 300 mg/kg with lead concentrations of 320, 2,400, 500, 360 and 340mg/kg, respectively. Sample location BH14(0.3-0.5) also exceeded the adopted ecological criterion of 1,260mg/kg;
- Three locations, BH3(0.2-0.4), BH4(0.5-0.95), and BH16(0.7-0.9) exceeded the TRH F1 (0- 1.0m) HSL-A criteria of 45 mg/kg for fill and 50 mg/kg for clay, with concentrations of 71, 72 and 71mg/kg, respectively;
- Eight of thirty-six samples exceeded the adopted TRH F2 ecological criterion of 120mg/kg, with TRH F2 concentrations ranging from 130 to 1,100mg/kg;
- Four samples, BH4(0.5-0.95), BH16(0.4-0.5), BH16(0.7-0.9) and BH19(0.2-0.4), exceeded the TRH F2 HSL-A criteria of 110mg/kg for fill and 280 mg/kg for clay with a concentration of 300, 320, 420 and 1,100mg/kg, respectively;
- Sample locations BH16(0.4-0.5) and BH19(0.2-0.4) reported TRH C_{16}-C_{34} concentrations of 3,500mg/kg and 8,400mg/kg, respectively, exceeding the ecological and management limit criteria of 300 and 2,500mg/kg, respectively;
- Naphthalene at sample locations BH18(0.3-0.5) and BH19(0.2-0.4), exceeding the adopted HSL-A (0-1.0m) criterion of 3mg/kg with concentrations of 15 and 17mg/kg, respectively;
- Eight of thirty-six samples exceeded the adopted benzo(a)pyrene ecological criterion of 0.7mg/kg with concentrations ranging from 0.8 to 120mg/kg;
- Sample locations BH7(0.2-0.3), BH16(0.4-0.5), BH18(0.3-0.5), BH19(0.2-0.4) and BH19(0.8- 1.0) exceeded the carcinogenic PAHs (as BaP TEQ) HIL-A criterion of 3mg/kg with concentrations of 6.6, 64, 3.6, 160 and 8.1mg/kg, respectively;
- Sample BH2(0.14-0.4) reported asbestos in soils. A damaged asbestos pipe was also noted in the car park within the south-western site extent; and

- Chlorobenzene (exceeding the interim NEPC (2013) assessment guidelines) was also noted at BH17 (north-eastern portion of the site).

Exceedances of ecological based criteria for soils were considered not to pose an unacceptable risk to receptors as the site was covered by concrete hardstand, bitumen and gravel.

A total of ten samples were submitted for suspension peroxide oxidation combined acidity and sulfur (SPOCAS) analysis. Although some samples were reported to have peroxide oxidisable sulphur over 0.03% and total sulfidic acidity over 18 mol H+/tonne, it was reported it was unlikely that ASS/PASS were present at the site. Exceedance of ASSMAC (1998) criteria were attributed to residual soils originating from Ashfield Shales rather than soils exhibiting characteristic of ASS/PASS.

Monitoring wells MW1 to MW5 reported standing water level measurements between 10.81 (MW3) and 13.0m AHD (MW5), with groundwater flow on the site inferred to be in a south-westerly to southerly direction.

A total of five groundwater samples were submitted for heavy metals, TRH, BTEX, PAHs, ammonia, nitrogen, sulfate, chloride and VOCs. Groundwater analytical results from the investigation reported the following exceedances above the adopted groundwater criteria:

- Copper exceeded the adopted NEPC (2013) Marine Water criterion of 1.3µg/L at sample locations MW1 to MW4, with concentrations ranging from 2 to 4µg/L;
- Nickel exceeded the adopted NEPC (2013) Marine Water criterion of 7µg/L at sample locations MW1 to MW5, with concentrations ranging from 11 to 39µg/L;
- Zinc exceeded the adopted NEPC (2013) Marine Water criterion of 15µg/L at sample locations MW1 to MW5, with concentrations ranging from 38 to 100µg/L;
- Benzene at sample location MW4 with a concentration of 710µg/L, exceeding the adopted NEPC (2013) Marine Water and HSL-A criteria of 500µg/L;
- TRH F1 and TRH F2 fractions at sample locations MW1, MW3 and MW4 were reported above the laboratory limit of reporting (LOR);
- Naphthalene exceeded the adopted NEPC (2013) Marine Water criterion of 50µg/L at sample location MW4, with concentrations of 6 0µg/L; and
- Elevated VOC concentrations (exceeding the interim NEPC (2013) assessment guidelines) at monitoring wells MW1, MW4 and MW5, including:
    - Vinyl chloride (57µg/L) exceeding the adopted criterion of 0.3µg/L at sample location MW1;
    - 1,1-dichloroethene (34µg/L) exceeding the adopted criterion of 30µg/L at sample location MW5;
    - Chloroform (THM) (1 804 µg/L) exceeding the adopted criterion of 3µg/L at sample location MW1;
    - 1,2-dichloroethane (3 600µg/L) exceeding the adopted criterion of 3µg/L at sample location MW1;
    - Isopropylbenzene (63µg/L) exceeding the adopted criterion of 8.4µg/L at sample location MW4;
    - 1,3,5-trimethylbenzene (140µg/L) exceeding the adopted criterion of 25µg/L at sample location MW4; and
    - 1,2,4- trimethylbenzene (590µg/L) exceeding the adopted criterion of 24µg/L at sample location MW4.

Based on these results, EIA (2015) reported that contamination identified during the investigation was likely associated with past filling and from previous site operations (i.e. storage and manufacture of paints and associated products). It was also reported that soil and groundwater impacts identified in both the fill and residual soils would require remediation prior to redevelopment of the site. EIA (2015) further identified the following data gaps under a HIL-A land use scenario:

- Further assessment of ground conditions underlying existing building within Lot 1 DP 556914;
- No assessment has been undertaken within residential allotments;
- Delineation of lead impacts at sample location BH14;
- The presence of hydrocarbon impacts in subsurface soils and groundwater was identified. The impacts were partially attributed to the presence of UST Pits (refer to **Figure 2**). However, it remained inconclusive that whether the impacts found at locations upgradient of the UST Pits have resulted from the same source. EIA (2015) noted that hydrocarbon impacts upgradient may be from another source (potentially historical paint, furniture manufacturing and fabrication activities);
- Delineation of TRH impacts at sample location BH21;
- The exact number, location and condition of USTs is unclear as well as their former contents. A ground penetrating radar (GPR) survey was recommended along with obtaining anecdotal records and completion of further intrusive investigations;
- Subsurface soils and groundwater below/within identified UST pits were not assessed and their environmental status is unknown;
- Delineation of carcinogenic PAHs (BaP TEQ) at sample locations BH7, BH16 and BH19;
- Potential for offsite migration of site-related chemicals in groundwater;
- Confirmation of the primary sources of TRH and VOC impacts to groundwater; and
- EIA (2015) noted the F1 TRH concentration at sample location MW1 exceeded the water solubility limit and phase separated hydrocarbon (PSH)/light non-aqueous phase liquid (LNAPL) may occur in groundwater as a result. Although PSH/LNAPL was not identified, a slight sheen was noted at sample location MW4 suggesting the potential for PSH/LNAPL. EIA (2015) recommended that further assessment including sampling for PSH and speciation of TRH compounds and vapour intrusion assessment to confirm the presence of any PSH/LNAPL.

EIA (2015) concluded that the site was suitable to be rezoned and redeveloped to allow mixed residential and commercial land-use, subject to the recommendations provided in the report and management of contamination issues in accordance with the State Environmental Planning Policy 55 (SEPP 55) – Remediation of Land and the Marrickville Council Contaminated Land Policy.

4.3 Data Gap Assessment (JBS&G 2016[15])

JBS&G was engaged to undertake a DGI of Lot 1 in DP 556914. JBS&G were initially required to conduct additional limited investigation works for due diligence purposes for potential development of Lot 1 in DP 556914 for mixed land uses. However, the works evolved to address key data gaps identified in an earlier revision of EIA (2015) and further define identified impacts on site and assess for potential off-site migration.

The scope of work completed comprised:

- Review of an earlier version of EIA (2015) to identify AECs and COPCs;
- A GPR survey in areas where potential pits/USTs were identified during the desktop assessment;
- Implementation of a site investigation program including drilling and soil sampling of eleven bore locations (SB1 to SB6, SBH7 to SBH10 and MW14) (up to a total depth of 7m bgs), with nine borehole locations converted into groundwater monitoring wells (SB1/MW6, SB2/MW7, SB3/MW8, SB5/MW9, SBH7/MW10, SBH8/MW11, SBH9/MW12, SBH10/MW13 and MW14);
- Sampling of five existing and nine newly installed groundwater monitoring wells (MW1 to MW14)
- Collection of liquid samples from two pits (sample ID Pit 1 and Pit 2);
- Collection of sub-slab vapour samples at twenty locations (SV1 to SV13, SV13A, SV13B, SV13C and SV14 to SV18);
- Collection of indoor air samples at one location (two rounds); and
- Laboratory analysis of soil, groundwater, liquid and vapour samples for relevant constituents as determined from the site history review, CSM and field observations during the investigation program.

The soil investigation identified the presence of fill materials (on average 0.5m-1.0m in thickness) underlain by residual soils (silty clay/clays) and weathered shales. The fill comprised various constituents, suggesting several periods of filling in the past.

Soil observations made during the investigation are summarised in **Table 4.2** below**.**

Table 4.2: Soil Investigation Observations (JBS&G 2016)

Lithologic Type	Depth	Lithologic Description	Inclusions
Surface (concrete)	0.0-0.5	Concrete	None
Fill (Gravelly clay/gravelly sand/silty clay/sandy clay)	0.4-1.8	Grey/brown/black, heterogeneous, medium plasticity.	Ash, gravels and glass
Silty clay	0.4-2.9	Brown to grey (red mottles)/red (grey mottles)/ orange to brown to red, homogeneous, medium to high plasticity.	None
Weathered shale*	1.5-9	Grey to brown.	None

*Not observed at soil locations SB8/MW11, SB9/MW12 and SB10/MW13 (within proximity of the north-western building footprints). Silty clays were present to final investigation depth.

Slight to moderate hydrocarbon odours were noted in soil bore locations SB1/MW6 (from 0.3 to 1.1m bgs), SB2/MW7 (from 0.1 to 3.0m bgs), SB5/MW9 (from 0.25 to 0.6m bgs) and SB4 (0.5 bgs).

[15] *Data Gap Assessment 75 Mary Street, St Peters, NSW.* JBS&G Australia Pty Ltd dated 15 September 2016 reference 51501/103491 Revision A (JBS&G 2016)

Black soil staining was also observed at SB2/MW7 (1.0m bgs), SB5/MW9 (0.5m bgs) and SB4 (0.5m bgs). No ACM was observed within fill during the investigation. Each soil sample was screened with a PID. Soil PID readings above 5 ppm are presented in **Table 4.3**.

Table 4.3: Soil PID Readings >5 ppm (JBS&G 2016)

Soil Bore Location	Depth (mbgs)	PID reading (ppm)
SB1	4.9-5.0	7.0
	5.9-6.0	5.7
SB2	0.1-0.2	10.4
	0.9-1.0	204
	1.9-2.0	50
	2.9-3.0	30
	3.9-4.0	12.3
	4.9-5.0	13.8
	5.9-6.0	10.2
SB3	0.3-0.4	22.6
SB6	0.4-0.5	8
SBH7	1.0-1.1	9

During the JBS&G investigation, it was noted that subsurface fill and shallow clays were relatively dry until an inferred water bearing layer was encountered at approximately 4m bgs. This is particularly noted in soil investigation locations SBH8/MW11, SBH9/MW12 and SBH10/MW13 and MW14. Saturated soils were also encountered in very weathered shale material observed in SB1/MW6 and SB7/MW10 from 5.5m bgs. It was noted that the similarity in groundwater elevation at MW7 (deeper screen) and MW8 (shallow screen) suggests that the water bearing zone is likely within residual silty clay layer.

A GPR survey was undertaken across three areas and surrounds (Pit 1 to Pit 3, as shown on **Figure 2**). The following summarises JBS&G's observations during the survey conducted by Alpha:

- Pit 1 - Location indicated by multiple former fill points and visual confirmation of a pit via removal of fill point covers. The pit appeared to be a single concrete pit and did not appear to contain individual USTs during the site inspection. Liquid was observed to be present within the pit and was sampled (PIT 1). It was reported there is potentially two former USTs present to the north-west of the area based on fill points and GPR survey. However, the presence or status of the USTs could not be confirmed at the time of the investigation.
- Pit 2 - A former UST was identified based on fill points and GPR survey. Distillate petroleum hydrocarbons odours were observed following removal of the fill point cover. The current status of the UST and pit is uncertain. A pit was identified to the north of this UST, but may be related to site stormwater infrastructure. Liquid was observed to be present within this separate pit and was sampled (PIT 2).
- Pit 3 - EIA (2015) indicated the presence of a pit following encounter of a 4m void during advancement of soil bore BH13. JBS&G could not locate this pit nor identify the location of BH13 during the site inspection and GPR survey in May 2015.

Two grab samples were taken from the water in Pit 1 and Pit 2. All constituents were below the laboratory LOR, with the exception of TPH C_{15}-C_{28} (200µg/L), TPH C_{10}-C_{36} (total) (200µg/L), TRH >C_{16}- C_{34} (200µg/L), and arsenic (1µg/L) in Pit 1, and copper (6µg/L) and nickel (3µg/L) in Pit 2.

A total of sixteen (eleven fill and five natural) soil samples were submitted for heavy metal, TRH, BTEX, VOC and PAHs analysis while six fill samples were analysed for PCBs and phenols. Soil analytical results reported the following exceedances above the adopted NEPC (2013) HIL-D/HSL-D and ecological criteria:

- Lead at sample location SB3/MW8 with a concentration of 1 700mg/kg, exceeding the adopted HIL-D criterion of 1 500mg/kg.

Groundwater was generally grey to brown or colourless with moderate turbidity. A slight sheen was observed in MW1, while odours were present in MW1, MW4, MW7, and MW11. PSH/LNAPL was not encountered.

Standing groundwater levels were between 0.72 m bgs/12.7m AHD (MW8) and 3.35m bgs/8.6m AHD (MW13) based on gauging conducted on 20 July 2015. The inferred groundwater flow direction was to the west and south-west based on survey data of the current monitoring well network (excluding MW14).

The measured parameters for the water samples were as follows:

- pH range of 4.21 to 7.26;
- Redox potential of -53 to 479.8mV (vs Ag/AgCl);
- Dissolved oxygen (DO) range of 0.16 to 4.10 mg/L;
- Temperature range of 19.5 to 21.5°C; and
- Electrical Conductivity range of 479.8 to 5,588 µS/cm.

Field parameters indicate that the groundwater is fresh to brackish and relatively low in oxygen. The pH was slightly acidic in all wells (with the exception of MW14) and uncorrected redox potential was generally positive with the exception of MW4.

A total of fourteen groundwater samples were submitted for analysis for heavy metals, TRH, BTEX, PAHs and VOCs. Eight samples were submitted for phenols. Groundwater analytical results from the investigation reported the following exceedances above the adopted groundwater criteria:

- Benzene exceeded the adopted NEPC (2013) Marine Water criterion of 550µg/L and Recreational Water criterion of 10µg/L at sample locations MW4 (1 100µg/L) and MW7 (1 400µg/L);
- Ethylbenzene exceeded the adopted NEPC (2013) Marine Water criterion of 5µg/L at sample locations MW4 (430 µg/L) and MW7 (560µg/L);
- Xylenes (m&p) exceeded the adopted NEPC (2013) Marine Water criterion of 75µg/L at sample locations MW4 (340µg/L) and MW7 (1 400µg/L);
- Xylene (0) exceeded the adopted NEPC (2013) Marine Water criterion of 350µg/L at sample location MW7 (1 300µg/L);
- TRH F1 exceeded the adopted NEPC (2013) Marine Water criterion of 20µg/L at sample locations MW1 (4 100µg/L), MW4 (2 300µg/L), MW6 (3 600µg/L), MW7 (50 000µg/L), MW10 (11 000µg/L) and MW14 (1 800µg/L);
- TRH F2 exceeded the adopted NEPC (2013) Marine Water criterion of 50µg/L at sample locations MW1 (90µg/L), MW3 (1 300µg/L), MW4 (3 500µg/L) and MW6 (6 200µg/L);
- Naphthalene exceeded the adopted NEPC (2013) Marine Water criterion of 50µg/L at sample locations MW4 (140µg/L) and MW7 (100µg/L);
- Phenanthrene exceeded the adopted NEPC (2013) Marine Water criterion of 0.6µg/L at sample locationMW7 (2.9µg/L);
- Cadmium exceeded the adopted NEPC (2013) Marine Water criterion of 0.7µg/L at sample location MW14 (1µg/L);
- Copper exceeded the adopted NEPC (2013) Marine Water criterion of 1.3µg/L at sample locations MW1 (2µg/L), MW2 (3µg/L), MW5 (4µg/L), MW7 (3µg/L), MW9 (2µg/L), MW13 (3µg/L) and MW14 (53µg/L);

- Lead exceeded the adopted NEPC (2013) Marine Water criterion of 4.4µg/L at sample location MW14 (36µg/L);
- Nickel exceeded the adopted NEPC (2013) Marine Water criterion of 7µg/L at sample locations MW1 (43 µg/L), MW2 (10µg/L), MW5 (16µg/L), MW6 (13µg/L), MW11 (7µg/L) and MW13 (15µg/L);
- Twelve of sixteen samples submitted for zinc analysis exceeded the Marine Water criterion of 15µg/L, with zinc concentrations ranging from 20 to 400µg/L;
- 1,2-dichloroethane exceeded the adopted NEPC (2013) Marine Water criteria of 1 900µg/L and Recreational criteria of 30µg/L at sample locations MW1 (3 900µg/L), MW6 (3 100µg/L), MW9 (21 000µg/L) and MW14 (9 600µg/L);
- 1,1-dichloroethene was reported above the laboratory LOR at sample locations MW1 (11µg/L), MW4 (63µg/L) and MW5 (220µg/L);
- Vinyl chloride exceeded the adopted Recreational criterion of 3µg/L at sample locations MW1 (26µg/L), MW5 (5µg/L) and MW6 (6µg/L); and
- Chlorobenzene exceeded the adopted Marine Water (55µg/L) and/or Recreational (3 000µg/L) criteria at sample locations MW1 (150µg/L), MW4 (340µg/L), MW6 (770µg/L), MW7 (24 000µg/L) and MW14 (160µg/L).

A summary of key groundwater analytes is presented in **Table 4.4** below.

Table 4.4: Range of Key COPC Concentrations in Groundwater (µg/L) (JBS&G 2016)

Analyte	Min. Concentration (µg/L)	Max. Concentration (µg/L)	Mean Concentration	Location of Max. Concentration
Benzene	<1	1400	211	MW7
Ethylbenzene	<1	560	87	MW7
Xylene (total)	1	2900	376	MW7
Naphthalene	<0.05	140	20	MW4
Copper (filtered)	<1	53	5.3	MW14
Nickel (filtered)	<1	43	9.2	MW1
Zinc (filtered)	<5	400	86	MW14
1,2-dichloroethane	<1	21000	2524	MW10
Dichloromethane	<1	8	16	MW1
1,1-dichloroethene	<1	220	34	MW5
Vinyl chloride	<1	26	17	MW1
Chlorobenzene	<1	24000	3965.6	MW7

A total of twenty sub-slab soil vapour location were advanced across Lot 1 DP 556914. The measured parameters for the sub-slab samples were as follows:

- Oxygen levels were found to range from 12.0% to 20.8%;
- PID concentrations ranged from 0ppm to 184 ppm; and
- LEL (expressed in terms of VOCs) ranged from 0% to 86%.

Soil vapour samples were submitted for VOC analysis (and limited TRH analysis). Soil vapour analytical results reported the following exceedances above the adopted NEPC (2013) Interim Soil Vapour HIL- D/HSL- D and US EPA RSL:

- TCE at sample locations SV13 (7mg/m^3), SV13-A (32mg/m^3) and SV13-B (7.87mg/m^3), exceeding the adopted Interim Soil Vapour HIL-D criterion of 0.08mg/m^3.

A summary of key soil vapour analytes is presented in **Table 4.5** below.

Table 4.5: Range of Key COPC Concentrations in Soil Vapour (mg/m³) (JBS&G 2016)

COPC	PCE	TCE	TRH C_6-C_{10}	BTEX	Chlorobenzene
Max. concentration	0.14 (SV13-A)	32 (SV13-A)	9.83 (SV13)	3.334 (SV18)	0.367 (SV8)
Min. concentration	<0.08333	<0.08333	<1.667	<1.667	<0.08333

Based on the results, JBS&G (2016) reported:

- Lot 1 DP 55914 has historically been used for industrial purposes, in particular, Lot 1 DP 55914 was used for paint and varnish manufacturing (Taubmans) from the 1920s until the mid-1960s, and subsequently used for various industrial/commercial purposes.
- A previous site investigation identified both soil and groundwater impacts with various contaminants including metals, PAHs, TRH and VOCs inferred to be associated with filling and historical site activities.
- The site inspection identified that the majority of Lot 1 DP 55914 is currently sealed and covered by a mixture of large brick and metal warehouse structures, with an unpaved area used for car parking in the south-eastern portion of the site.
- Results of the GPR survey confirmed the presence of a UST in the central portion of the site. In addition, it was identified there was potentially two former USTs present to the north-west of Pit 1 (as shown on **Figure 2**) based on fill points and GPR survey. Grab water samples from pooled water in Pits 1 and 2 were analysed for a range of constituents with reported concentrations generally low or below the LOR. It is noted that relatively low concentrations of TRH>C_{16}-C_{34} (200µg/L) were reported in Pit 2.
- Soil sampling was conducted via the advancement of push tubes at eleven locations targeting AECs. Depth of fill materials across Lot 1 DP 55914 ranged from 0.5 to 1.2m bgs, and were predominantly silty, gravelly or sandy clays underlain by natural silty clay and weathered shale. Concentrations of COPCs in soil samples selected for analysis were below health based investigation and screening levels for commercial and industrial land-use with the exception of lead in shallow fill at SB03. On the basis that there is limited human exposure to underlying soils due to the presence of hardstand, it was considered that the Lot 1 DP 55914 soils do not pose an unacceptable risk to current on-site receptors.
- Groundwater monitoring and sampling was conducted on fourteen wells with the general groundwater flow direction confirmed to the south-west consistent with previous investigations. Petroleum hydrocarbons/chlorinated hydrocarbons groundwater impacts were identified within the central site extent in proximity to former paint manufactory activities and/or in proximity to UST/former sub-surface infrastructure.
- Twenty sub-slab vapour sampling locations were advanced targeting the areas of highest identified soil and groundwater VOC impacts. TCE at sample locations SV13 (7mg/m³), SV13- A (32mg/m³) and SV13-B (7.87 mg/m³) exceeded the adopted Interim Soil Vapour HIL- D criterion of 0.08mg/m³.
- Concentrations of key contaminants are less than or similar to the LOR downgradient of the zone identified with the most significant impacts (i.e. exceeding 10mg/L) of chlorinated organic compounds at MW4, MW7 and MW10. JBS&G (2016) reported given the likely old age of the primary source (likely to be pre-1960s), this indicates there is limited migration of contaminants in groundwater at the site. It was considered this is likely to be due to the presence of clays and shales, which are inferred to have low permeability based on literature and field observations, and natural attenuation mechanisms.
- The low permeability clays underlying fill materials likely act to retard vertical vapour movement, however, lateral migration of vapours in the vadose zone, in particular in fill materials, may potentially occur.

- Risks to residential receptors to the north-west of the site related to the TCE in sub-slab vapour identified at SV-13 were considered low due to the following:
    - The suspected source of the elevated TCE concentrations detected was considered to most likely represent isolated contamination in shallow soils and/or the sewer line running along the north-western boundary of the site;
    - Due to the physical chemical properties of TCE, if a significant TCE source was present in soils beneath the single level and/or multi-level building in this portion of the site, it would be reasonable to expect that detectable concentrations of TCE would be identified in hydraulically downgradient wells (i.e. MW12, MW13), however, this was not the case (i.e. TCE below reporting limit of 1 µg/L in these wells); and
    - If shallow soils onsite are the source of the elevated TCE concentrations detected in soil vapour, the offsite sewer is likely to act as a preferential pathway for vapour migration (i.e. act as a relatively high permeability barrier limiting vapour migration towards residences).
- If groundwater onsite is the source of the elevated TCE concentrations detected in soil vapour (unlikely), the offsite residences are hydraulically cross gradient of the site (i.e. unlikely to be affected by site originated groundwater contamination, noting that no TCE contamination has been identified in groundwater).
- The indoor air sampling location targeted the area of highest sub-slab vapour impact (SV13). Concentrations of TCE in indoor air ranged from below the laboratory LOR to 0.003mg/m^3 over two rounds of monitoring.
- On the basis of the findings of the investigation and in consideration of the current commercial use of Lot 1 DP 55914, the following actions were recommended:
    - Additional assessment of identified site impacts (particularly in relation to TCE in sub-slab vapour at location SV13) as part of a human health risk assessment (HHRA) to be prepared for the current commercial users; and
    - Implementation of an Environmental Management Plan (EMP) to control potential direct exposures to site soils and groundwater.

4.4 Human Health Risk Assessment (JBS&G 2016b[16])

JBS&G were engaged to prepare a Human Health Risk Assessment (HHRA) for Lot 1 DP 55914 for ongoing commercial use of the site to address soil, groundwater and soil vapour impacts.

On the basis of the available information and the assumptions adopted, JBS&G (2016b) concluded that:

- On the basis of the soil and groundwater data, direct contact exposure risks to current commercial workers (i.e. incidental ingestion, dermal contact) require ongoing management, however, risks can be managed to acceptable levels through the implementation of an EMP which predominantly focuses upon existing risk control measures (i.e. no groundwater use for any use other than monitoring, maintenance of existing barriers between soil and site users);
- When considering the available soil, groundwater and soil vapour data against adopted vapour intrusion based tier 1 criteria, vapour intrusion risks to current commercial workers at the site only require detailed assessment for Building 1;

[16] *Human Health Risk Assessment – Commercial Workers, 75 Mary Street, St Peters, NSW.* JBS&G Australia Pty Ltd dated 22 September 2016 reference 51501/104733 Revision 0 (JBS&G 2016b)

- On the basis of the soil vapour data, indoor air data, vapour intrusion modelling and inhalation risk calculations, vapour intrusion risks to current commercial users of Building 1 are acceptable based upon current conditions.
- Subject to the appropriate implementation of an EMP it was considered that Lot 1 DP 55914 is suitable for commercial use.
- JBS&G (2016b) recommended an EMP should be prepared which focuses upon maintaining incomplete source-pathway-receptor linkages using safe work procedures and administrative controls to provide a framework for managing direct contact risks posed by the identified contamination (e.g. maintaining the existing permanent barrier across the site, precluding groundwater use for any purpose other than monitoring). It was recommended that the EMP should also include protocols for managing vapour inhalation risks during below ground and/or ground disturbing activities as well as ongoing indoor air monitoring for Building 1.

4.5 Interim Environmental Management Plan (JBS&G 2016c[17])

JBS&G was engaged to prepared an Interim EMP for Lot 1 DP 556914 due to identified soil, groundwater and soil vapour impacts.

The EMP provides management requirements to protect human health and the environment during normal aboveground access/maintenance activities as well as subsurface activities involving disturbance of soils during the ongoing commercial use of Lot 1 DP 556914.

To control risks associated with identified COPC, the Interim EMP requires the following procedures to be implemented to ensure the ongoing land use suitability:

- Groundwater should not be used for any purposes other than monitoring by a suitably qualified and experienced environmental consultant.
- The existing hardstand across the Lot 1 DP 55914 prevents direct contact (i.e. dermal, ingestion) and inhalation (i.e. particulate) exposure to the identified contamination. The physical integrity of the hardstand is required to be maintained by the site owner.
- Should intrusive works be required, suitably qualified and experienced environmental consultant should be engaged to advise on management and methodology of works to be undertaken (e.g. advice for soil handling/disposal, identification of appropriate Personnel Protection Equipment) from an environmental perspective.
- On the basis of the HHRA (JBS&G 2016b), ongoing indoor air monitoring is required for the single level section of Building 1.

JBS&G (2016c) concluded that Lot 1 DP 556914 was suitable for ongoing commercial land use subject to implementation of the Interim EMP. It was noted that the document represents an interim EMP only, with a comprehensive EMP required to be prepared in the future following development of the site.

4.6 Evaluation of the Data Set

A review and evaluation of data usability has identified that for the most part, previous data collection activities have been completed and documented in a manner suitable to support the development of a CSM of site contamination potential.

[17] *Interim Environmental Management Plan – 75 Mary Street, St Peters, NSW*. JBS&G Australia Pty Ltd dated 23 September 2016 reference 51501/105374 (JBS&G 2016c)

5. Fill Retention

JBS&G has been advised by the client that future characterisation activities are required to assess the leaching potential of contaminants and assess the risk to human health and ecological receptors under the following fill retention scenarios:

- Retention of fill materials above the water table by means of physical separation (where appropriate); and
- Retention of fill materials below the water table (where appropriate). This may include modification of groundwater flow paths to limit the potential for contaminant migration and/or over excavation of clay/shale and reinstatement of the excavation with fill materials within areas of low aquifer transmissivity.

The nature and extent of fill retention and associated fill retention engineering will only be resolved following receipt of additional sampling and analysis laboratory results and preparation of a HHERA.

6. Contamination Status

The following section presents a discussion of the contamination status with respect to the adopted site assessment criteria in **Section 10** and the proposed development.

6.1 Soil Contamination Status

Site B: Precinct 75 Mixed Use Area

The soil investigation shows the site lithology comprises heterogenous fill materials (typically less than 1m in thickness) with trace levels of anthropogenic inclusions (gravels, glass and ash). The fill comprised various constituents, suggesting several periods of filling in the past (albeit limited in extent). The extent of historical environmental investigations has been restricted by the occurrence of buildings/structures at the site.

Available characterisation data has identified that samples of fill have, in some instances, concentrations of carcinogenic PAH compounds (including benzo(a)pyrene TEQ), TRH, heavy metals (principally zinc with limited copper and lead impacts) and asbestos in exceedance of ecological-based assessment criteria, and at relatively few locations, adopted health-based criteria as relevant to the proposed future land uses. Fill/soil materials are generally characterised by low leachability. Further leachability assessment of fill conditions is required should fill materials be proposed to be retained on site.

Analysis of natural soils indicated contaminated material is generally limited to the fill material overlying the natural soils. Several soil samples reported elevated TRH, PAH and heavy metals within the inferred top 0.5 to 0.9m of the natural soil profile. Potential remains for the historical sampling methodology to have resulted in minor cross-contamination of samples of underlying natural profile or for natural soils to have become impacted as a result of vertical migration of contaminants (albeit limited in extent).

The majority of soil (both fill and natural) exceedances are located within the central site extent, in proximity to historical paint manufacturing activities and/or petroleum/chemical storage and handling. Historical petroleum/chemical storage infrastructure is still present on site (**Figure 2**).

A summary of existing analytical data is provided in **Appendix H**. Lithological cross sections are depicted in **Figures 6A** to **6B** to assist with the interpretation of site conditions. Soil sample exceedances with respect to the land use criteria presented **Section 10** are shown on **Figure 8A**. Historical soil bore logs are included as **Appendix I**.

Site A: Precinct 75 Commercial area

The lithological profile within this area is similar to that within the Site B: Precinct 75 Mixed Use area, comprising heterogenous fill materials (typically less than 1.0m in thickness) with trace levels of anthropogenic inclusions (gravels, glass and ash). The fill comprised various constituents, suggesting several periods of filling in the past (albeit limited in extent).

Available characterisation data identified that fill/natural soils are suitable for the proposed commercial land use with the exception of soils at sample location BH16, which reported TRH/PAH exceeding the ecological and/or human health criteria.

Similar to the Site B: Precinct 75 Mixed Use area, the extent of historical environmental investigations has been restricted by the occurrence of buildings/structures at the site.

A summary of existing analytical data is provided in **Appendix H**. Lithological cross sections are depicted in **Figures 6A** to **6B** to assist with the interpretation of site conditions. Soil sample exceedance with respect to the land use criteria presented **Section 10** are shown on **Figure 8A**. Historical soil bore logs are included as **Appendix I**.

6.2 Groundwater Contamination Status

Groundwater has been identified to be impacted by petroleum hydrocarbons, chlorinated hydrocarbons and heavy metals, albeit limited in extent. Impacts were identified at the following locations:

- Elevated levels of heavy metals in groundwater were reported in all wells across the site. Concentrations are considered consistent with urban background levels.
- Vinyl chloride in the northern and south-eastern site extents in proximity to locations MW1 and MW5.
- PAH, BTEX and chlorobenzene impact predominantly in the central portion of the site around locations MW4, MW6 and MW7.
- 1,2-dichloroethane impact predominantly in the north-central portion of the site around locations MW1, MW6, MW10 and MW14.

No PSH/LNAPL has been identified underlying the site.

Further groundwater characterisation is required in order to define the lateral extent of chlorinated hydrocarbon impacts identified near the western extent of the proposed basement. Existing groundwater monitoring wells are located along the former proposed basement western alignment (Site B: Precinct 75 Mixed Use area/Site A: Precinct 75 Commercial area), and it is uncertain whether the identified impacts extend east to the current proposed basement alignment (refer to **Figure 5B**).

Concentrations of key contaminants are less than or similar to the LOR downgradient of the zone identified with the most significant impacts (i.e. exceeding 10 mg/L) of chlorinated organic compounds at MW4, MW7 and MW10. Given the likely old age of the primary source (likely to be pre-1960s) the plume is relatively small indicating that there is limited migration of contaminants in groundwater at the site. It is considered this is likely to be due to the presence of clays and shales, which are inferred to have low permeability based on literature and field observations, and natural attenuation mechanisms.

The low permeability clays underlying fill materials likely act to retard vertical vapour movement, however, lateral migration of vapours in the vadose zone, in particular in fill materials, may potentially occur.

6.3 Soil Vapour Contamination Status

Concentrations of VOCs in most sub-slab vapour samples collected from the site were below the laboratory LOR at locations targeted to the greatest identified soil and groundwater VOC impacts. TCE impact was identified in an isolated area around SV13, SV13-A and SV13-B exceeding the screening criteria for commercial and industrial land-use, applicable to this portion of the site.

Risks to residential receptors to the north-west of the site related to the TCE in sub-slab vapour identified at SV-13 were considered low due to the following:

- The suspected source of the elevated TCE concentrations detected was considered to most likely represent isolated contamination in shallow soils and/or the sewer line running along the north-western boundary of the site;
- Due to the physical chemical properties of TCE, if a significant TCE source was present in soils beneath the single level and/or multi-level building in this portion of the site, it would be reasonable to expect that detectable concentrations of TCE would be identified in hydraulically downgradient wells (i.e. MW12, MW13), however, this was not the case (i.e. TCE below reporting limit of 1 µg/L in these wells); and

- If shallow soils onsite are the source of the elevated TCE concentrations detected in soil vapour, the offsite sewer is likely to act as a preferential pathway for vapour migration (i.e. act as a relatively high permeability barrier limiting vapour migration towards residences).

If groundwater onsite is the source of the elevated TCE concentrations detected in soil vapour (unlikely), the offsite residences are hydraulically cross gradient of the site (i.e. unlikely to be affected by site originated groundwater contamination, noting that no TCE contamination has been identified in groundwater).

The indoor air sampling location targeted the area of highest sub-slab vapour impact (SV13). Concentrations of TCE in indoor air ranged from below the laboratory LOR to 0.003mg/m^3 over two rounds of monitoring.

Further soil vapour characterisation is required in order to define the lateral extent of chlorinated hydrocarbon impacts identified near the western extent of the basement. Existing soil vapour locations are located along the former proposed basement western alignment (Site B: Precinct 75 Mixed Use area/Site A: Precinct 75 Commercial area boundary), and it is uncertain whether the identified impacts extend east to the current proposed basement alignment (refer to **Figure 5B**).

7. Data Gaps

Based on the review of the site history and previous site investigation data, the following data gaps have been identified in relation to the site with respect to the proposed development.

Site B: Precinct 75 Mixed Use area

- Basement Vapour and Seepage Control Requirements (AEC-1) - further soil vapour and groundwater characterisation is required in order to define the lateral extent of chlorinated hydrocarbon impacts identified near the western extent of the basement. Existing soil vapour and groundwater monitoring wells are located along the former proposed basement western alignment (Site B: Precinct 75 Mixed Use area/ Site A: Precinct 75 Commercial area boundary), and it is uncertain whether the identified impacts extend east to the current proposed basement alignment (refer to **Figure 5B**).
- Site Wide Groundwater Quality (AEC-2) - given the identification of additional chlorinated hydrocarbon impacts between EIA (2015) and JBS&G (2016), further assessment of groundwater is warranted.
- Residential Allotments (AEC-3) - no sampling and analysis has been completed within Lot 1 DP 745667 (50 Edith Street), Lot 1 DP 745014 (52 Edith Street), Lot 1 DP 87558/Lot A DP 331215 (43 Roberts Street) and Part Lot 180958 (67 Mary Street). Assessment of the contamination status of these areas is required.
- Assessment Beneath Buildings (AEC-4) - the extent of historical environmental investigations has been restricted by the occurrence of buildings/structures at the site. Further assessment is required beneath existing site structures.
- Fill Retention (AEC-5) - further investigation is required to assess the leaching potential of contaminants and the risk to human health and ecological receptors where fill is proposed to be retained (refer to **Section 5**).
- Waste Classification (AEC-6) - additional leachate assessment by TCLP testing for waste classification purposes is required.

Site A: Precinct 75 Commercial area

- Site Wide Groundwater Quality (AEC-2) - given the variability in chlorinated hydrocarbon between EIA (2015) and JBS&G (2016), further assessment of groundwater is required.
- Ambient Air Monitoring (AEC-7) - Elevated sub-slab soil vapour TCE concentrations have been reported underlying the Building 1. However, ambient air quality results from within the building collected as part previous investigations were all below the adopted assessment criteria. As such, no current risk from sub-slab vapour conditions has been reported, however, additional assessment of sub-slab vapour conditions underlying Building 1 may be warranted to support ongoing management if the exposure scenario changes under the adaptive reuse or change to the EMP is necessary. In addition, ambient air monitoring within Building 1 is required to be undertaken to support the HHERA to be prepared for the site.
- Soil Vapour (AEC-8) - the nature of the key contaminants in soil and groundwater (chlorinated hydrocarbons) at the site means that soil vapour is a potential contamination issue to be addressed for ongoing commercial use. Although targeted soil vapour investigations have been conducted in accessible areas of the site (primarily roadways), additional assessment of sub-slab vapour conditions underlying existing commercial buildings will be required to support the HHERA and RWP. Further, confirmation of previous

detections of volatile TRH and TCE in a sub-slab vapour sample near the western extent of the site is also required.

8. Preliminary Conceptual Site Model

The information presented below together with the figures included with this SAQP aid in presenting a CSM for the site.

8.1 Potential Areas and Substances of Environmental Concern

Based on the available site history information, review of previous investigations, proposed development plan and JBS&G's understanding of site conditions, data gap AECs and associated COPC have been identified and are presented in **Table 8.1** and shown on **Figure 9** (where appropriate).

Table 8.1: Areas of Environmental Concern and Associated Contaminants of Potential Concern

Areas of Environmental Concern (AEC)	Contaminants of Potential Concern (COPCs)
AEC 1: Basement Vapour and Seepage Control Requirements Further soil vapour (sub-slab and at depth) and groundwater characterisation is required in order to define the lateral extent of chlorinated hydrocarbon impacts identified near the western extent of the basement	Soil Vapour TRH/BTEX VOC Groundwater TRH/BTEX VOC PAHs
AEC 2: Site Wide Groundwater Quality Given the identification of chlorinated hydrocarbon, further assessment of groundwater is required	Groundwater Heavy metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Zn) PAHs TRH/BTEX VOC pH TDS Ammonia nitrate
AEC 3: Residential Allotments Fill materials/natural soils within residential allotments (~1,600m^2)	Soil Heavy metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Zn) PAHs TRH VOC Asbestos
AEC 4: Assessment Beneath Buildings Fill materials beneath buildings to be demolished (~2,500m^2) • Building 3 – ~900m^2 • Building 4 – ~200m^2 • Building 5 – ~950m^2 • Building 9 – ~100m^2 • Building 10 – ~100m^2 • Building 11 – ~100m^2 • Building 12 – ~150m^2	Soil Heavy metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Zn) PAHs TRH VOC PCBs (near substations/transformers) Asbestos
AEC 5: Leachability Assessment General assessment of fill across the Site B: Precinct 75 Mixed Use area for leachability	Soil Column leachate - heavy metals, PAHs, TRH (semi to no volatile) ASLP - VOCs and volatile TRHs
AEC 6: Waste Classification Leachate assessment by TCLP testing for waste classification purposes is required	Soil TCLP heavy metals and PAHs
AEC 7: Ambient Air Assessment of ambient air quality within single level section of Building 1	Ambient Air VOC Volatile TRH
AEC 8: Soil Vapour Assessment of soil vapour within areas of elevated volatiles and below existing buildings to be retained for adaptive commercial reuse	Soil Vapour VOC Volatile TRH

8.2 Potentially Contaminated Media

Potentially contaminated media comprise:

- Fill materials;
- Underlying natural soils;
- Subsurface vapour; and
- Groundwater.

Table 8.2 below provides a breakdown of potentially contaminated media with identified AECs presented in **Table 8.1**.

Table 8.2: Potentially Contaminated Media

AEC	Potentially Contaminated Media	Comment
AEC 3 to AEC 6	Fill material	Potential remains for contamination in fill material resultant from historical manufacturing land uses, importation of fill materials of unknown origin or use of site waste materials to create former/existing site levels
	Natural soils	Natural soils underlie fill materials and may potentially be impacted by the downward migration of contaminants through fill, particularly in open areas where infiltration is possible or subsurface infrastructure is/was present. Natural soils may also be impacted by contaminated groundwater migration
	Groundwater	Contamination in groundwater has previously been reported. There is the potential for the leaching of contaminants vertically from fill into groundwater. In addition, hydrocarbon/ chlorinated hydrocarbon impacts have been reported in proximity to historical sub-surface infrastructure, soil impacts and/or in proximity to historical manufacturing activities
AEC 1 and AEC 2	Groundwater	Contamination in groundwater has previously been reported. There is the potential for the leaching of contaminants vertically from fill into groundwater. In addition, hydrocarbon/ chlorinated hydrocarbon impacts have been reported in proximity to historical sub-surface infrastructure, soil impacts and/or in proximity to historical manufacturing activities
AEC 1, AEC 7 and AEC 8	Soil Vapour	Given the occurrence of fill across the site and the potential volatile nature of some contaminants and contamination in groundwater has previously been reported, there is a potential for soil vapour to be a contaminated medium

8.3 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 a combination of:

- 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 review and previous investigation are generally in either a solid form (e.g. heavy metals, asbestos, etc.) and liquid form (e.g. fuel, lubricants, pesticides, etc.), however, dependent upon concentrations, there is the potential for TRH/VOC impacts to occur in a vapour form.

As the site is primarily paved with concrete/asphaltic concrete or roadbase aggregate, 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 low given the extent of impermeable pavements at the site.

Given the low permeability nature of the underlying soils, migration of contamination via groundwater movement is considered to be a potential migration pathway albeit limited as discussed in **Section 6.2**.

The vapour generation potential associated with volatile COPC (TRH, VOCs) are identified as a potential migration pathway, particularly in areas where subsurface infrastructure, such as stormwater, sewer, underlie the site and migration potential into the future basement.

As discussed in **Section 4.3** above, the low permeability clays underlying fill materials likely act to retard vertical vapour movement, however, lateral migration of vapours in the vadose zone may potentially occur.

8.4 Potential Exposure Pathways

Based on the COPC identified in various media, as discussed above, and proposed site development activities, the exposure pathways for the site during and following development works include:

- Inhalation of potential COPC vapours migrating upwards from material of unknown origin or impacted surface soils resulting from historical leaks/spills, industrial activities etc.; 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.

Elevated sub-slab soil vapour TCE concentrations have been reported underlying Building 1. However, ambient air quality results from within the building collected as part of previous investigations were all below the adopted assessment criteria. As such, no current risk from sub-slab vapour conditions has been reported, however, additional assessment of sub-slab vapour conditions underlying Building 1 may be warranted to support ongoing management if the exposure scenario changes under the adaptive reuse or change to the EMP is necessary.

Risks to residential receptors to the north-west of the site related to the TCE in sub-slab vapour identified at SV-13 are considered low due to the following:

- The suspected source of the elevated TCE concentrations detected is considered to most likely represent isolated contamination in shallow soils and/or the sewer line running along the north-western boundary of the site;
- Due to the physical chemical properties of TCE, if a significant TCE source was present in soils beneath the single level and/or multi-level building in this portion of the site, it would be reasonable to expect that detectable concentrations of TCE would be identified in hydraulically downgradient wells (i.e. MW12, MW13), however, this was not the case (i.e. TCE below reporting limit of 1 µg/L in these wells); and
- If shallow soils onsite are the source of the elevated TCE concentrations detected in soil vapour, the offsite sewer is likely to act as a preferential pathway for vapour migration (i.e. act as a relatively high permeability barrier limiting vapour migration towards residences).

8.5 Receptors

Potential human populations who may be exposed to site impacts in the future (if they are not remediated or appropriate management is not implemented prior to or during development) include:

- Potential future occupants of residential developments;
- Residential and commercial occupants in surrounding properties;
- Current and future worker/occupants of commercial;
- Current and future recreational users of public open spaces;
- Future construction and site maintenance workers; and
- Future and current sub-surface excavation and intrusive workers.

Potential on site ecological receptors include existing/future flora species established within current public open and future open spaces that may occur with the redevelopment of the site.

Offsite ecological receptors may potentially be impacted by groundwater, surface water and vapours discharged from the site. Surrounding public open spaces and water bodies (the marine ecosystem of Alexandra Canal) are also ecological receptors.

8.6 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 gases.

Man-made preferential pathways are present throughout the site, generally associated with fill materials, and at near surface depths over the remainder of the site. Fill materials are anticipated to have a high permeability.

Sub-surface services are also present, or will be present as part of site redevelopment, throughout the site. Preferential pathways can be created by the generally higher permeability backfill used to re-instate these trenches.

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.

9. Sampling Analysis and Quality Plan

9.1 Data Quality Objectives

Data quality objectives (DQOs) are statements that define the confidence required in conclusions drawn for data produced for a project, and which must be set to realistically define and measure the quality of data needed.

DQOs have been developed for this DGI, as discussed in the following sections.

9.1.1 State the Problem

The site is proposed to be redeveloped to accommodate a mixed-use development (refer to **Section 2.3**). Previous investigations conducted at the site indicate there are potential risks posed by soil, groundwater and vapour contamination at the site. Additional environmental data is required to inform the environmental assessment process including the preparation of a HHERA and development of RWP that includes a refined remedial scope.

The ensuing works will be used to assess whether risks posed by identified contamination are unacceptable with respect to the proposed future uses of the site and to refine the extent of remediation works required for inclusion in a RWP to be developed for the site.

9.1.2 Identify the Decision

The decisions below generally follow the DEC (2006[18]) decision making process for assessing urban redevelopment sites:

- Are there any unacceptable risks to likely onsite receptors from soil?
- Are there any issues relating to the local area background soil concentrations that exceed appropriate criteria?
- Are there any unacceptable risks to likely onsite receptors from groundwater underlying the site?
- Is fill material suitable for retention (refer to **Section 5**)?
- Are there any unacceptable risks to likely onsite receptors from vapours underlying the site?
- Are there any impacts of chemical mixtures?
- Are there any unacceptable aesthetic issues?
- Is there any evidence of or potential for migration of contaminants from the site?

9.1.3 Identify Inputs to the Decision

Inputs to the decisions are:

- The results of previous assessments relevant to the areas of investigation, including background historical information, site observations, laboratory results and report findings;
- New environmental data collected by sampling and analysis and site observations made during the current investigation;
- Assessment criteria to be achieved as based on the intended land uses, design details and project objectives, as defined by the site assessment criteria nominated in **Section 10**; 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

[18] *Guidelines for the NSW Site Auditor Scheme* (2nd Edition). NSW Department of Environment and Conservation, April 2006 (DEC 2006)

assurance/quality control (QA/QC) as per the data quality indicators (DQIs) established in **Section 9.1.6**.

9.1.4 Define the Study Boundaries

The study boundary comprises the extent of the site as shown on **Figure 2** and detailed in **Sections 2.1** and **2.2**.

The proposed vertical extent of the study will comprise:

- Soil - approximately 1m into natural soils. At selected locations sample locations, sample locations will be extended to depths of 6m to allow for the assessment of contaminant conditions (including soils in the vadose zone) and potential migration of contaminants into the future basement.
- Groundwater - sampling of existing and newly installed groundwater monitoring. New groundwater monitoring wells will be installed to depths of approximately 2m below the standing water table or a maximum of 6m bgs (whichever is shallower).
- Soil vapour - maximum depth of 2.m bgs.

9.1.5 Develop a Decision Rule

Laboratory analytical data will be assessed against EPA endorsed criteria as identified in **Section 10**. Alternate criteria will be applied with appropriate justification where there are no EPA endorsed criteria.

The decision rules adopted to answer the decisions identified in **Section 9.1.2** are summarised in **Table 9.1**.

Table 9.1: Summary of Decision Rules

Decision Required to be Made	Decision Rule
1. Are there any unacceptable risks to likely onsite receptors from soil?	Soil analytical data will be compared against EPA endorsed criteria. Statistical analyses of the data in accordance with relevant guidance documents will be undertaken, if appropriate, to facilitate the decisions. The following statistical criteria will be adopted with respect to soils: Either: the reported concentrations are all below the site criteria; Or: the average[19] site concentration for each analyte must be below the adopted site criterion; no single analyte concentration exceeds 250% of the adopted site criterion; and the standard deviation of the results must be less than 50% of the site criteria. And: the 95% upper confidence limit (UCL) of the average concentration for each analyte must be below the adopted site criterion. If the statistical criteria stated above are satisfied, the decision is No. If the statistical criteria are not satisfied, the decision is Yes.
2. Are there any issues relating to the local area background soil concentrations that exceed appropriate criteria?	If the 95% UCL results exceed published background concentrations, the decision is Yes. Otherwise, the decision is No.
3. Are there any unacceptable risks to onsite receptors from groundwater underlying the site?	Are contaminants present in groundwater at concentrations exceeding the adopted criteria and are there any future likely on-site receptors of groundwater that may be at risk during development or future site use? If yes to both, the decision is Yes. Otherwise, the decision is No
4. Are fill materials likely to be environmentally suitable for retention (refer to **Section 5**)?	The leachate water quality data will be assessed against criteria in **Section 10**. If the reported concentrations of COPCs in leachate water were less than the groundwater criteria and/or the data is of an acceptable quality to assist in the preparation of a HHERA, then the decision is Yes. If the reported concentrations of COPCs in leachate water exceed the adopted criteria (**Section 10**) and/or the data identified as not being of an

[19] Statistical analysis will only be done for samples with similar material types.

Decision Required to be Made	Decision Rule
	acceptable quality to assist in preparation of a HHERA, then the decision is No.
5. Are there any unacceptable risks to onsite receptors from vapours underlying the site?	Are there contaminants potentially in soil vapour beneath the site that may migrate to surface and/or accumulate in confined areas during development or future use of the site, based on consideration of appropriate guidance and qualitative assessment of risks? If yes to gas and/or vapours, the decision is Yes. Otherwise, the decision is No
6. Are there any chemical mixtures?	Are there more than one group of contaminants present which increase the risk of harm? If there is, the decision is Yes. Otherwise, the decision is No.
7. Are there any unacceptable aesthetic issues?	If there are any unacceptable aesthetic issues, the decision is Yes. Otherwise, the decision is No.
8. Is there any evidence of, or potential for, migration of contaminants from the site?	Were contaminants present in soil/vapour and/or groundwater at concentrations exceeding the adopted criteria? If yes, the decision is Yes. Otherwise, the decision is No.

9.1.6 Specify 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 the NSW EPA, NEPC (2013), ANZECC (2000[20]), DEC (2007[21]), appropriate indicators of data quality (DQIs used to assess QA/QC) and standard JBS&G procedures for field sampling and handling.

To assess the usability of the data prior to making decisions, the data will be assessed against pre-determined DQIs for completeness, comparability, representativeness, precision and accuracy.

The pre-determined Data Quality Indicators (DQIs) established for the project are discussed below in relation to precision, accuracy, representativeness, comparability, completeness and sensitivity (PARCCS parameters), and are shown in **Table 9.2**.

- **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.

[20] *Australian and New Zealand Guidelines for Fresh and Marine Waste Quality, Volume 1.* Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand, October 2000 (ANZECC 2000)

[21] *Contaminated Sites: Guidelines for the Assessment and Management of Groundwater Contamination*. NSW Department of Environment and Conservation 2007 (DEC 2007)

- **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 laboratory methods, including the limits of reporting, in producing reliable data in relation to the adopted criteria.

If any of the DQIs are not met, further assessment will be necessary to determine whether the non-conformance will significantly affect the usefulness of the data. Corrective actions may include requesting further information from samplers and/or analytical laboratories, downgrading of the quality of the data or alternatively, re-collection of the data.

Table 9.2: Summary of Quality Assurance / Quality Control Program

Data Quality Objectives	Frequency	Data Quality Indicator
Precision		
Blind duplicates (intra laboratory)[4]	1 / 20 samples	<50% RPD[2], asbestos in agreement
Blind duplicates (inter laboratory)[4]	1 / 20 samples	<50% RPD[2], asbestos in agreement
Laboratory duplicates[1,4]	1 / 20 samples	<50% RPD[2], asbestos in agreement
Accuracy		
Surrogate spikes[1]	All organic samples	70-130%
Laboratory control samples[1]	1 per lab batch	70-130%
Matrix spikes[1]	1 per lab batch	70-130%
Representativeness		
Sampling appropriate for media and analytes		-[3]
Samples extracted and analysed within holding times.	-	Soil: organics (14 days), inorganics (6 months) Groundwater: metals (6 months, other than mercury - 28 days), sVOCs (>C_{10} - 7 days), volatiles (<C_{10} - 14 days) Soil vapour: sorbent tubes VOCs/TRH (28 days)
Trip spike[1]	1 per sampling event	70-130% recovery
Storage blank[1]	1 per sampling event	<LOR
Rinsate blank[1]	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[3]
Standard analytical methods used for all analyses	All Samples	All samples[3]
Consistent field conditions, sampling staff and laboratory analysis	All Samples	All samples[3]
Limits of reporting appropriate and consistent	All Samples	All samples[3]
Completeness		
Sample description and COCs completed and appropriate	All Samples	All samples[3]
Appropriate documentation	All Samples	All samples[3]
Satisfactory frequency and result for QC samples	All QA/QC samples	-[3]
Data from critical samples is considered valid	-	Critical samples valid[3]
Sensitivity		

Analytical methods and limits of recovery appropriate for media and adopted site assessment criteria	All Samples	All samples

[1] For soil and groundwater samples only
[2] 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.
[3] A qualitative assessment of compliance with standard procedures and appropriate sample collection methods will be completed during the DQI compliance assessment.
[4] Duplicate samples are not proposed for soil leachate assessment due to the nature of the testing which will not allow sufficient sample volume to be collected for duplicate analysis. Repetition of columns and collection and analysis of multiple pore volumes is considered sufficient to assess data suitability (refer to **Section 9.2.1**).
[5] Duplicate/triplicate soil vapour samples will be collected at a rate of one per 20 primary samples by splitting the flow into the canisters using a three-way valve.

9.1.7 Optimise the Design for Obtaining Data

Various strategies for developing a statistically based sampling plan are identified in EPA (1995[22]), including judgemental, random, systematic and stratified sampling patterns.

Based on review of previous analytical data, soil physical properties as summarised in **Section 4**, and identified data gaps/AECs (**Section 7**), a combination of systematic and targeted sampling design is considered most appropriate for the current investigation to provide sufficient characterisation data.

Soil Investigation

Systematic soil sample locations are proposed to obtain general site environmental data in areas where no/limited data exists, allow for the assessment of potential contaminant leaching and inspection of fill conditions. Targeted (judgemental) soil investigation is proposed to address identified data gaps and provide new data for locations where previous data is uncertain. **Table 9.3** below provides a summary of proposed soil investigation density. Sample locations are shown on **Figure 9**.

Table 9.3: Summary of Additional Soil Locations

Location	~Area (m^2)	EPA (1995) Sampling Density	No. Existing Locations	Approximate Fill Volume (m^3)	Systematic Grid (soil bores)		Added Targeted Locations (soil bores)	Total No. of Locations (including historical)
					~ Spacing	No. Locations		
Site B: Precinct 75 Mixed Use area	10 000	21	27	<10 000	30m	12	12	51

Proposed sample locations are shown on **Figure 9**.

Soil Vapour Investigation

A targeted soil vapour program is proposed as follows:

- **BH222** (**SV19**)**, BH220** (**SV20**) **and BH207** (**SV21**) – in addition to addressing the identified soil data gaps, boreholes at these locations are proposed to be converted into nested soil vapour wells (at depths of 0.1m, 1.5m and 2.5m bgs) to define the lateral/vertical extent of chlorinated hydrocarbon impacts identified near the western extent of the basement. Two rounds of soil vapour sampling and analysis is proposed.
- **BH226** (**SV32**)**, BH227** (**SV33**)**, BH228** (**SV34**)**, BH229 (SV35), BH230 (SV36) and BH231 (SV37)** – soil vapour sampling is proposed in proximity to historical sample location MW5 to characterise/delineate historical VC groundwater impacts. Advancement of six sub slab sample locations is proposed to support site characterisation activities and preparation of a

[22] *Contaminated Sites: Sampling Design Guidelines*. NSW EPA 1995 (EPA 1995)

HHERA. Two rounds of soil vapour sampling and analysis is proposed. Samples will be collected at a depth of 1m bgs as the ground surface within this portion of the site is not paved.

- **SV22** to **SV31** and **SV38 to SV57** - advancement of thirty sub slab sample locations within the Site A: Precinct 75 Commercial area to support site characterisation activities and preparation of a HHERA. Two rounds of soil vapour sampling and analysis is proposed.

This approach is proposed as it is considered sub-slab soil vapour measurements are the most direct evaluation of the potential for vapour intrusion into site structures. Sample locations are shown on **Figure 9**.

Groundwater Investigation

Previous assessment of the site involved the installation of fourteen groundwater monitoring wells locations. Given the identification of additional chlorinated hydrocarbon impacts between EIA (2015) and JBS&G (2016), further assessment of groundwater is warranted. In addition, sample locations BH200 (MW15), BH202 (MW16) and BH219 (MW17) are proposed to be converted into groundwater monitoring wells to define the lateral/vertical extent of chlorinated hydrocarbon impacts identified near the western extent of the basement.

In addition, a groundwater monitoring well (BH224/MW18) will be advanced in proximity to soil vapour location SV13A. An additional groundwater monitoring well (BH 225/MW19) will also be installed in Building 2 down-gradient of historic activities at the south-west corner (varnish thinning etc) and down-gradient of known MAH impacts to groundwater.

Soil bore BH216 in the vicinity of MW5 near existing Buildings 9, 10 and 11 will be converted into a groundwater monitoring well (BH2016/MW20)

Proposed groundwater monitoring well locations are shown on **Figure 9**.

9.2 Field Investigation Methodology

9.2.1 Soil

9.2.1.1 Soil Sampling

Soil samples will be collected via a track mounted drill rig fitted with push tube attachments where volatiles are a COPC, otherwise sample locations will be advanced manually via the use of a 200mm hand auger (i.e. in areas of residential allotment).

Following the collection of discrete samples to a depth of 1m into natural soil, each sample location will be re-drilled with a 200mm auger (where required) to facilitate the collection of bulk samples (fill retention samples, discussed below) and inspection of the fill soil profile.

The concrete covering the ground surface in the majority of locations will be cored to provide access to the underlying soils. Soil samples will be collected directly underneath the concrete (at approximately 0.1 to 0.2m), 0.3m, 0.5m and then at 0.5m intervals to a maximum depth of 1m into natural materials (or prior refusal), whichever is the shallower. At selected locations, sample locations will be advanced up to 6m bgs to facilitate:

- Assess natural soil conditions within the capillary/smear zone;
- To facilitate the installation of soil vapour probes (at depth) above the water table (discussed below); and
- Conversion of soil bores into groundwater monitoring wells (discussed below).

During the collection of soil samples, features such as seepage, discolouration, staining, odours and other indicators of contamination will be recorded on field logs.

Collected samples will be immediately transferred to laboratory supplied sample jars/bags (as appropriate). The sample jars/bags will then be transferred to a chilled ice box for sample preservation prior to and during shipment to the testing laboratory. A chain-of-custody form will be completed and forwarded to the testing laboratory with each sample batch. Based upon field observations, samples will be analysed in accordance with the laboratory schedule (refer to **Table 9.4**).

All samples will remain at the primary laboratory for a period of two months following the receipt of sample results for possible future analysis (subject to holding times) if required.

To assess potential contaminant leaching from fill (refer to **Section 5**), ASLP (for volatiles) and a column testing procedure (for semi to non-volatile contaminants) will be adopted at a density of 1 sample per 1,000 m^3. This involves the collection of bulk samples (2 kg samples) from the entire fill horizon at nominated locations (including homogenisation of the soil to replicate the excavation and stockpile process and to ensure a representative sample is collected). Samples will then be submitted for the following analysis:

- In accordance with the WA Department of Environment Regulation, column testing is considered the most representative method to assess potential leaching processes that occur in an aquifer. As such, to assess the potential release of semi to non-volatile constituents that may be leaching from solid materials to contacting water, column leach testing will be performed by Eurofins Analytico in general accordance with the Standard Test Method for Leaching Solid Material in a Column Apparatus (European method NEN 7373, NEN7383 and CMA/2/11/A.9.1[23]). This method is generally acquiescent with Method 1314 of Leaching Environmental Assessment Framework (LEAF). This method is an up-flow percolation column test designed to evaluate the partitioning of leachable constituents from solid material to liquid as a function of cumulative liquid to solid ration (LS). A continuous elution of water is passed at a measured rate through a packed bed of granular material which is then collected at several specified L/S values for analysis. Subsequently, the concentrations of dissolved constituents per L/S fraction is then used to derive the cumulative mass release of contaminants from the column to the passing eluent. The cumulative concentration of contaminants in the resulting leachate is reported as a function of L/S and thus may be used in the assessment of the release of semi to non-volatile constituents to the aquifer; and
- ASLP analysis will be undertaken for volatiles (TRH C_6-C_{10} and VOCs) as the method for leaching solid material in a column apparatus is not considered suitable for the assessment of volatiles.

Samples will be analysed in accordance with the laboratory schedule (refer to **Table 9.4**). Sample locations are shown on **Figure 9**.

9.2.1.2 PID Screening

During site works, sufficient sample material will be collected to allow for field testing using a PID and laboratory analyses to assess the potential presence of VOCs including petroleum/chlorinated hydrocarbons. Samples obtained for PID screening will be placed in a sealed plastic bag for approximately 2 minutes to equilibrate, prior to a PID being attached to the bag. Readings will then be monitored for a period of approximately 30 seconds or until values stabilise and the stabilise/highest reading will be recorded on the borehole logs. The PID will be calibrated prior to the commencement of field works and then check readings will be completed on a daily basis during

[23] This test is ISO 14001: 2004 certified by TÜV and qualified by the Flemish Region (OVAM and Dep. LNE), the Brussels Region (IBGE/BIM), the Walloon Region (DGRNE-OWD) and by the Government of Luxembourg (MEV)

the field program using suitable calibration gas. If required, the PID will be re-calibrated during the field program in accordance with manufacturer's instructions.

9.2.1.3 Duplicate and Triplicate Sample Preparation

Field soil duplicate and triplicate samples will be obtained using the above sampling methods. Each sample will be then divided laterally into three samples with minimal disturbance and placed in clean glass jars or bag (as appropriate). Each sample will then be labelled with a primary, duplicate or triplicate sample identification before being placed in the same chilled esky for transport to the laboratory.

9.2.1.4 Decontamination

Prior to the commencement of sampling activities, non-disposable sampling equipment including sampling trowel/knives will be cleaned with a water/detergent spray, rinsed with water and then air dried. The equipment will then be inspected to ensure that no soil, oil, debris or other contaminants are apparent on the equipment prior to the commencement of works. Sampling equipment will subsequently be decontaminated using the above process between each sampling locations.

9.2.2 Groundwater

New groundwater monitoring wells will be installed within the shallow aquifer at locations shown on **Figure 9** in accordance with the soil sampling methodology in **Section 9.2.1**.

It is anticipated that boreholes will be pre-drilled using push tubes with external casing and/or hollow flight augers to a maximum depth of 6m bgs or 2 m below the encountered groundwater depth, whichever is shallower.

The wells will be constructed from 50 mm unplasticised polyvinyl chloride (UPVC) screen and casing, with appropriate gravel packs, bentonite seals, and lockable caps to complete the wells. The wells will then be completed with steel gatic covers or raised steel casing as appropriate for the site conditions.

The wells will be developed on the same day as installation with a steel bailer or a small submersible pump to ensure adequate connection to the aquifer and remove sediment disturbed during well installation. During development, the bores will be rapidly purged and then allowed to recharge. All wells will then be clearly identified with a fixed permanent label. Existing groundwater monitoring wells will be developed prior to sampling.

All monitoring wells will be sampled using the following procedure:

- Prior to sampling, groundwater levels will be gauged with an interface probe to assess standing groundwater levels (SWLs) and the potential presence of NAPL within the groundwater well;
- Low flow pumping will then be undertaken with a peristaltic pump using new disposable silicone tubing and disposable Low-Density Polyethylene (LDPE) tubing for sampling at each monitoring well to remove standing, static water. The LDPE tubing will be lowered to a maximum depth of two-thirds of the wetted screen length of the monitoring well prior to the commencement of purging;
- Purging of groundwater will then be undertaken generally at a rate of 0.05L to 1L/minute while ensuring that the drawdown does not exceed 300mm (as measured by interface probe) during the pumping event;
- Regular measurement of field parameters including pH, conductivity, redox potential, dissolved oxygen, total dissolved solids (TDS) and temperature will be completed dependent on the purging rate, using a multi-parameter probe/meter and a flow cell;

- During the development, purging and sampling, features such as discolouration, staining, odours and other indications of contamination will be noted;
- Groundwater samples will be obtained using the low-flow peristaltic pump when three consecutive readings of field parameters meet the following criteria: pH ± 0.05; Dissolved oxygen ± 10% or 0.1 mg/L; Electrical conductivity ± 3 %; and Redox potential ± 10 mV (*Vic EPA April 2000 Groundwater Sampling Guidelines*);
- Collected groundwater samples will immediately be transferred to sample containers of appropriate composition, which have been pre-treated in a manner appropriate for the laboratory analysis. Groundwater samples will be obtained in a manner that ensures no headspace remains in the bottles, and where appropriate will be filtered in the field prior to preservation;
- Each of the sample bottles will be labelled with the project ID, date, sampler's initials and unique monitoring well ID (or QC sample name);
- All bottles will be placed directly into a pre-chilled ice chest, for transport to the testing laboratories; and
- Chain of custody documentation will be completed for each batch of samples relinquished to the laboratory.

In addition to the above groundwater characterisation activities, an assessment of hydraulic conductivity will be undertaken by a 'slug test' of five nominated groundwater monitoring wells. The tests will be undertaken by rising head slug tests and carried out as described in the following:

- The depth to water in both wells will be recorded prior to placement of a groundwater data logger at the base of the well;
- A concrete slug will then be lowered into the water column in both wells;
- Once the water level stabilises the slug in the well, the 'slug' will be swiftly removed;
- Data loggers will be installed in both of the selected wells to record water level recovery at 1 second intervals;
- The water levels in each of the wells will be allowed to recover to the original standing water level, or to at least 70% of the initial water level (where this can be achieved within a reasonable period); and
- The rising head data will be assessed using the Hvorslev slug test method to provide estimates of hydraulic conductivity to inform future predictions of fate and transport of chlorinated hydrocarbons, if necessary.

At the completion of sampling at each location, single use sampling equipment will be disposed of and re-useable equipment that potentially contacts groundwater including the interface probe will be decontaminated as per the general procedures discussed above for non-disposable soil sampling equipment. Rinsate samples will be collected daily or per batch to demonstrate the effectiveness of decontamination procedures.

Samples will be analysed in accordance with the laboratory schedule (refer to **Table 9.4**). Sample locations are shown on **Figure 9**.

9.2.3 Soil Vapour

A total of ten sub-slab vapour points are proposed to be advanced across the Site A: Precinct 75 Commercial area to support site characterisation and target identified TCE impact. Sample locations are shown on **Figure 9**.

The vapour assessment activities will comprise sub-slab soil vapour sampling. The proposed methodology has been developed with consideration of the guidance on vapour sampling methods outlined in CRCCARE (2013[24]).

The sub-slab vapour locations will be completed as follows:

- 10mm diameter core holes will be cut through the existing pavement floors.
- 6mm teflon tubing with a stainless-steel tip will be installed within the hole to the depth of the sub-slab area and sealed in place with air drying clay before the sampling works are to commence. Sand will be placed within the hole to a depth of approximately half the slab thickness with the remained of the slab thickness sealed with air drying clay.
- The sample locations will be left to equilibrate for a period of at least 30 minutes prior to the commencement of purging and sampling.
- A MX6 gas detector will be used to purge each probe for a period of at least 5 mins. Gas readings were monitored until oxygen and PID readings stabilise;
- Following this a leak detection evaluation will be completed via placement of an isopropyl alcohol soaked rag over the top of the backfilled borehole to assess the potential occurrence of leaks whilst the gas detector was purging the sample point. Elevated PID readings on the gas detector would indicate a leaking probe. Any leaking probes would be required to be re-installed and re-checked prior to sampling using the same method.
- Attach a laboratory supplied flow regulator (programmed to 10mL/min), to the laboratory supplied summa canister (1L volume). Connect the assembled canister setup to the vapour point tubing using additional section of 6mm Teflon tubing as required;
- Place the canister on a level and stable section of ground near the sampling point, open the canister to commence sample collection. Allow the canister to remain undisturbed over the sampling period, i.e. 100 minutes;
- Close canister on completion of the sampling period and disassemble connection tubing; and
- Submit canister for analysis as per **Section 9.3**.

In addition to the above sub-slab vapour points, at locations BH219, BH220 and BH222 vapor points are proposed to be installed at a depth of sub-slab (0.1m bgs) (using the above methodology), and at 1.5m and 2.5m bgs in proximity of the proposed western basement wall alignment to assess the potential for vapour migration into the future basement. Sample depths may be adjusted based on the encountered groundwater table. The purpose of the works is to provide an assessment of whether soil vapour impacts are restricted to the west or potentially extended further east.

For soil vapour sampling at depth (1.5m and 2.5m), the following methodology will be applied:

- A soil vapour probes will be installed in borehole drilled by hand augering/or via the use of a drill rig to depth of 1.5m and 2.5m bgs;
- 6mm nylon tubing with a stainless-steel tip will be installed to the depth of the borehole, which will be then backfilled with 2mm diameter sand adjoining the base of the sample tube, overlain with a nominal thickness of bentonite chips, and backfill of the balance of the borehole with grout/bentonite chips to create an air tight seal at the ground surface;
- The vapour probes will be left to equilibrate for a period of 24 hours prior to sampling;

[24] *Technical Report No.23 Petroleum Hydrocarbon Vapour Intrusion Assessment*. Australia Guidance, July 2013, CRC for Contamination Assessment and Remediation of the Environment (CRCCARE 2013)

- A MX6 gas detector was then used to purge each probe for a period of at least 5 mins. Gas readings were monitored until oxygen and PID readings stabilise;
- Following this a leak detection evaluation will be completed via placement of an isopropyl alcohol soaked rag over the top of the backfilled borehole to assess the potential occurrence of leaks whilst the gas detector is purging the sample point. Elevated PID readings on the gas detector will indicate a leaking probe. Any leaking probes will be required to be re-installed and re-checked prior to sampling using the same method;
- Attach a laboratory supplied flow regulator (programmed to 10mL/min), to the laboratory supplied summa canister (1L volume). Connect the assembled canister setup to the vapour point tubing using additional section of 6mm Teflon tubing as required;
- Place the canister on a level and stable section of ground near the sampling point, open the canister to commence sample collection. Allow the canister to remain undisturbed over the sampling period, i.e. 100 minutes;
- Close canister on completion of the sampling period and disassemble connection tubing; and
- Submit canister for analysis as per **Section 9.3**.

Sample locations BH226/**SV32, BH227**/SV33, BH228/SV34, BH229/SV35, BH230/SV36 and BH231/SV37 will be installed at a depth of 1m bgs using the above methodology.

Duplicate/triplicate vapour samples will be collected at a rate of one per 20 primary samples by splitting the flow into the canisters using a three-way valve.

An ambient air sample will be collected as per the methodology in JBS&G (2016c) to assess whether sub-slab soil vapour TCE concentrations underlying Building 1 represent an unacceptable risk to current/future commercial users.

Samples will be analysed in accordance with the laboratory schedule (refer to **Table 9.4**). Sample locations are shown on **Figure 9**.

9.3 Laboratory Analysis

JBS&G will contract Eurofins MGT (Eurofins) as the primary laboratory, with Envirolab Services Pty Ltd (Envirolab) as the secondary laboratory. All laboratories are NATA registered for the required analyses. In addition, the laboratories will be required to meet JBS&G's internal QA/QC requirements.

Table 9.4: Proposed Analytical Schedule

Location and Sample Type	No. of Sample Locations	Analyses (exc. QA/QC)
Soil		
Site B: Precinct 75 Mixed Use area (~1ha)	24 additional locations	Heavy metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Zn) - 30 samples PAH - 30 samples TRH – 20 samples VOCs - 20 samples (to be used around areas of paint manufacturing) Asbestos (500 mL per NEPM) - 15 samples PCBs - 6 samples TCLP (metals/PAHs) - 6 samples pH, CEC - 2 samples TOC - 5 samples
Soil Leachate Testing		
Representative Samples from the Site B: Precinct 75 Mixed Use area	10 Samples to be Collected from the above Sample Locations (<10,000m^3 @ 1 sample per 1,000m^3)	Heavy metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Zn) - 10 samples TRH - 10 samples PAH - 10 samples VOCs - 10 samples (the elute will be adjusted to a pH of 5.7 to ensure the

Location and Sample Type	No. of Sample Locations	Analyses (exc. QA/QC)
		release of contaminants from the column is representative of site leachate potential)
Groundwater		
Groundwater monitoring wells	20 locations (14 existing and 6 new)	Heavy metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Zn) - 20 samples PAH (low levels) - 20 samples TRH/BTEX - 20 samples VOCs– 20 samples pH - 20 samples TDS - 20 samples Ammonia - 20 samples Nitrate - 20 samples
Soil Vapour		
Sub-slab Soil Vapour	30 locations (2 rounds) (0.2m bgs)	TRH/BTEX - 60 samples VOCs - 60 samples Isopropanol - 60 samples
Vapour at Depth (adjacent MW5)	6 locations (2 rounds) (1.0m bgs)	TRH/BTEX - 12 samples VOCs - 12 samples Isopropanol - 12 samples
Vapour at Depth (basement extent)	3 locations (2 rounds) (0.1m 1.5m and 2.5 m bgs)	TRH/BTEX - 18 samples VOCs - 18 samples Isopropanol - 18 samples
Ambient Air		
Ambient air within Building 1	1 location	VOCs - 2 sample

10. Assessment Criteria

10.1 Regulatory Guidelines

The investigation will be 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, 1997 (OEH 2011).
- *Contaminated Sites: Guidelines for the NSW Site Auditor Scheme*, 2nd Edition. NSW EPA, 2006 (DEC 2006).
- *Contaminated Sites: Guidelines on Duty to Report Contamination under the Contaminated Land Management Act 1997.* NSW EPA 2015 (EPA 2015).
- *Contaminated Sites: Guidelines for the Assessment and Management of Groundwater Contamination.* NSW Department of Environment and Conservation March 2007 (DEC 2007).
- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Australian and New Zealand Environment and Conservation Council and Agricultural and Resource Management Council of Australia and New Zealand, October 2000 (ANZECC 2000).
- *Australian Drinking Water Guidelines 6. NHMRC, 2011 (NHMRC 2011).*
- *Guideline for the Assessment and Management of Sites Impacted by Hazardous Ground Gases.* NSW EPA 2012 (EPA 2012).
- *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).
- *Guidelines for Managing Risks in Recreational Water* (NHMRC 2008).

10.2 Assessment Criteria

As per the decision process for assessment assessing urban sites (DEC 2006), a set of health and ecological assessment thresholds derived from NEPM (2013) will be used for evaluation of site contamination data collected for this assessment.

As noted in **Section 2.3**, the site is proposed to be redeveloped as a mixed-use precinct including residential, commercial and recreational land uses. With consideration to the proposed development and for the purpose of site characterisation to refine the remedial extent the following land use criteria's have been adopted:

<u>Site B: Precinct 75 Mixed Use area</u>

- Built Areas – NEPC (2013) HIL/HSL Residential with Minimal Access to Soils (HIL/HSL- B);
- Park Lands - NEPC (2013) HILs/HSLs Public Open Space (recreational) (HIL- C); and
- Consideration will also be given to generic and site-specific ecological investigations levels EILs/ESLs.

In some cases, a commercial industrial scenario may be applicable in areas where basement car parking underlies residential developments or where residential apartments are located above commercial suits (Building 8). Following implementation of this DGI SAQP, further details/amendments to land use criteria will be included in the RWP to be prepared for the site.

Site A: Precinct 75 Commercial area

- Commercial Precinct – NEPC (2013) HILs/HSLs: Commercial/Industrial Land Uses (HIL- D); and
- Consideration will also be given to generic and site-specific EILs/ESLs.

10.2.1 Soil Assessment Criteria

As per the decision process for assessment of urban renewal site (DEC 2006), a set of health and ecological assessment thresholds derived from ASC NEPM will be used for evaluation of site contamination data collected for this assessment.

The following soil criteria have been adopted for the sites based on the identified land use scenarios:

- HILs as provided in the NEPM (2013);
- HSLs for petroleum hydrocarbons considering potential for vapour intrusion, fine grained as provided in the NEPM (2013);
- EILs/ESLs, fine grained soils as provided in the ASC NEPM;
- Direct contact HSLs provided in CRCCARE (2011[25]); and
- Management limits provided in the NEPM (2013).

10.2.2 Groundwater Assessment Criteria

DEC (2007) *'Guidelines for the Assessment and Management of Groundwater Contamination'* instructs that groundwater investigation levels (GILs) be based on a consideration of groundwater's environmental values. Environmental values are defined in ANZECC (2000) as

"*…particular values or uses of the environment that are important for a healthy ecosystem or for public benefit, welfare, safety or health which require protection from the effects of pollution, waste discharges and deposit".*

NEPM (2013) presents six environmental values which are required to be considered in the assessment of contaminated groundwater including:

- Aquatic ecosystems;
- Aquaculture and human consumers of food;
- Agricultural water;
- Recreation and aesthetics;
- Drinking water; and
- Industrial water.

Current and projected concentrations in groundwater are required to be compared to the GILs at the points of existing and realistic future use for each relevant environmental value.

[25] *Technical Report No.10 Health screening levels for petroleum hydrocarbons in soil and groundwater Part 2: Application*. Australia Guidance, September 2011, CRC for Contamination Assessment and Remediation of the Environment (CRCCARE 2011)

DEC (2007) instructs that all environmental values of groundwater be identified to allow development of appropriate GILs. NSW Government (2006) '*Environmental Objectives for Water Quality and River Flow*' are nominated as an appropriate source of environmental values.

The analytical data for this assessment will be compared against the following groundwater criteria:

- NEPC (2013) criteria for the protection of marine water;
- Recreation (PCR) criteria derived in accordance with NHMRC (2008) and NHMRC (2011, as amended 2016)[26]; and
- Vapour intrusion based HSLs provided in the NEPM (2013).

Marine water ecosystem values have been adopted given the location of the site and the assumption that nearby water receptors are brackish to marine. Recreational criteria are based on guidance in NHMRC (2008) which indicates concentrations of substances 10 times drinking water values.

The leachate water quality data will be assessed against criteria above as an initial screen. Site-specific environmental risk criteria may also be developed where appropriate.

10.2.3 Soil Vapour Assessment Criteria

The following soil vapour criteria will be adopted for the site based on the land use scenario:

- HSLs for petroleum hydrocarbons, fine grained as provided in the NEPM (2013); and
- Interim soil vapour HILs as provided in the NEPM (2013) for chlorinated hydrocarbons.

10.2.4 Ambient Air Assessment Criteria

The following soil vapour criteria will be adopted for the site based on the land use scenario:

- Interim soil vapour HILs as provided in the NEPM (2013) for chlorinated hydrocarbons (with an attenuation factor of 0.1); and
- US EPA RSL Industrial Air when guidelines are not present in the adopted HIL or HSL.

10.2.5 Adopted Screening Levels

Where there are no NSW EPA endorsed thresholds for individual COPC the LOR will be adopted as an initial screening value for the purposes of this assessment.

[26] In accordance with relevant guidance, where irrigation criteria is applied, consideration to drinking water criteria should be given.

11. Data Assessment and Reporting

On completion of field works, a draft investigation report will be submitted for client/Site Auditor review, following which a final report will be issued.

The report shall be prepared to meet the requirements similar to a detailed site investigation as per OEH (2011) reporting guidelines. As well as relevant content of the SAQP, the report shall contain:

- Copies of relevant field documentation including calibration certificates;
- Copies of investigation field logs and well construction details;
- Photos of the site recording aspects of the work undertaken;
- Copies of sample summary tables prepared showing all analyte results as compared to appropriate assessment criteria;
- Copies of all laboratory documentation;
- Site plans showing all sample locations and locations of any assessment criteria exceedances;
- An assessment of QA/QC including calculation of all required DQIs. Where field or laboratory based DQIs fail SAQP objectives, comprehensive discussions will be provided as to the source of the failure and potential implications as to data quality;
- An assessment of compliance with the acceptable limits for decision error as determined in the DQOs for each analyte recorded at a concentration above the laboratory detection limit. Where acceptable limits for decision error are not met for any analyte, requirements for additional sampling and analysis to meet acceptable limits of decision error will be determined as per the procedure provided to AS4482.1-2005;
- Updating of the CSM from that included in the SAQP, based on environmental data and observations made during the site investigation;
- Statistical analysis of analyte data sets as identified exceeding adopted assessment criteria as appropriate using the US EPA ProUCL package;
- An assessment of the source(s) of identified contamination, the risks from contamination within the context of the site operations/use, giving consideration to exposure pathways and potential receptors; and
- An assessment on the characterisation and distribution of contaminants within the site.

Following preparation of the DGI report, a HHERA will be prepared for the site to support the fill retention strategy and refine the remedial extent, with the refined extent of remedial works to be documented in a RWP to be prepared for the site.

12. 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: 53113	
Client: JVMC Pty Ltd	
Version: R01 Rev 0	Date: 25-Aug-2017
Drawn By: RF	Checked By: NC
Scale 1:5,000	

0 50 100
metres

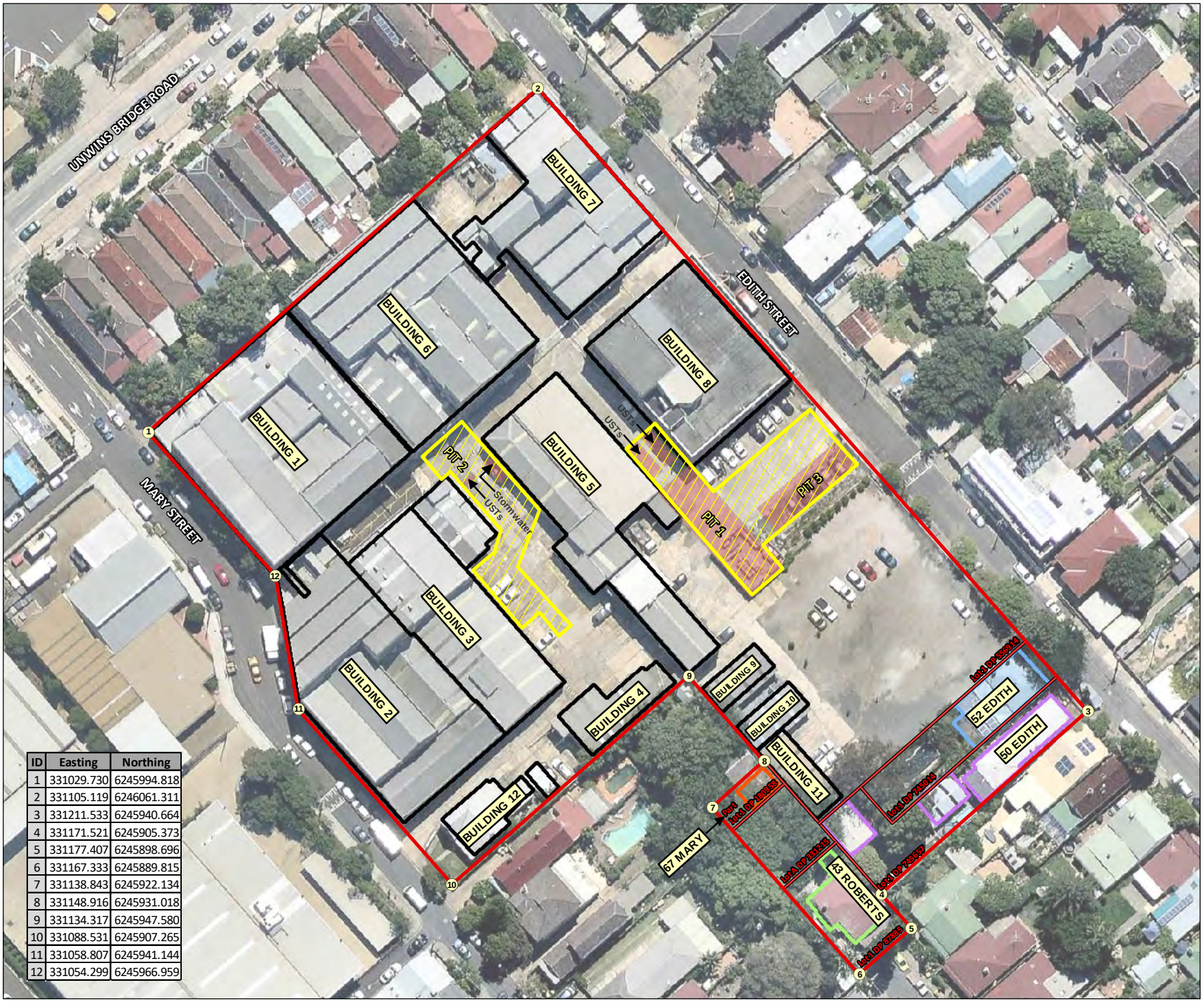
Coor. Sys. GDA 1994 MGA Zone 56

St Peters, NSW

SITE LOCATION

FIGURE 1:

File Name: 53113_01
Reference: https://maps.six.nsw.gov.au/



ID	Easting	Northing
1	331029.730	6245994.818
2	331105.119	6246061.311
3	331211.533	6245940.664
4	331171.521	6245905.373
5	331177.407	6245898.696
6	331167.333	6245889.815
7	331138.843	6245922.134
8	331148.916	6245931.018
9	331134.317	6245947.580
10	331088.531	6245907.265
11	331058.807	6245941.144
12	331054.299	6245966.959

Legend:

- Approximate Site Boundary
- Cadastre - Lot & DP Boundaries
- Pits (Former Potential Petroleum/Chemical Storage)
- Area of GPR Survey

Current Layout - Building Footprint

- 67 Mary Street
- 73 Mary Street
- 50 Edith Street
- 52 Edith Street
- 43 Roberts Street

JBS&G

Job No: 53113

Client: JVMC Pty Ltd

Version: R01 Rev 0 | Date: 25-Aug-2017

Drawn By: RF | Checked By: NC

Scale 1:1,000

0 10 20
metres

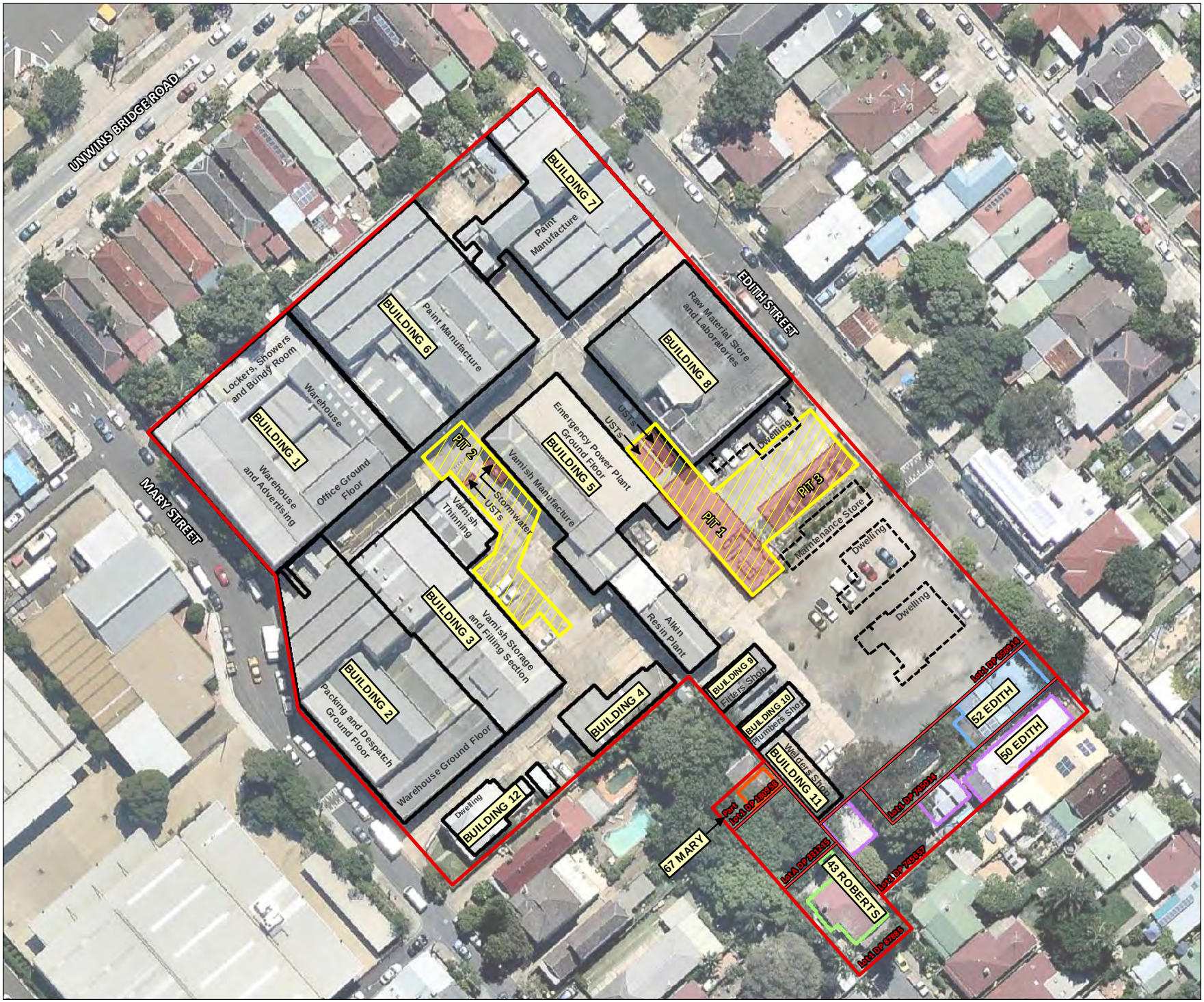
Coor. Sys. GDA 1994 MGA Zone 56

St Peters, NSW

CURRENT SITE LAYOUT AND FEATURES

FIGURE 2:

File Name: 53113_02
Reference: https://maps.six.nsw.gov.au/



Legend:

- Approximate Site Boundary
- Cadastre - Lot & DP Boundaries
- Pits (Former Potential Petroleum/Chemical Storage)
- Area of GPR Survey

Current Layout - Building Footprint

- 67 Mary Street
- 73 Mary Street
- 50 Edith Street
- 52 Edith Street
- 43 Roberts Street
- Former Buildings

JBS&G

Job No: 53113

Client: JVMC Pty Ltd

Version: R01 Rev 0	Date: 25-Aug-2017
Drawn By: RF	Checked By: NC

Scale 1:1,000

0 10 20
metres

Coor. Sys. GDA 1994 MGA Zone 56

St Peters, NSW

HISTORICAL SITE LAYOUT AND FEATURES

FIGURE 3:

File Name: 53113_03
Reference: https://maps.six.nsw.gov.au/

Legend:

- Approximate Site Boundary
- Site A: Precinct 75
- Site B: Precinct 75 Mixed Use Redevelopment

Integrated Basement Extent

- Basement - B1 (FFL 8.400-11.850
- Basement - B2 (FFL 7.200-8.750

JBS&G

Job No: 53113

Client: JVMC Pty Ltd

Version: R01 Rev 0	Date: 25-Aug-2017
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Scale 1:1,000

0 10 20

metres

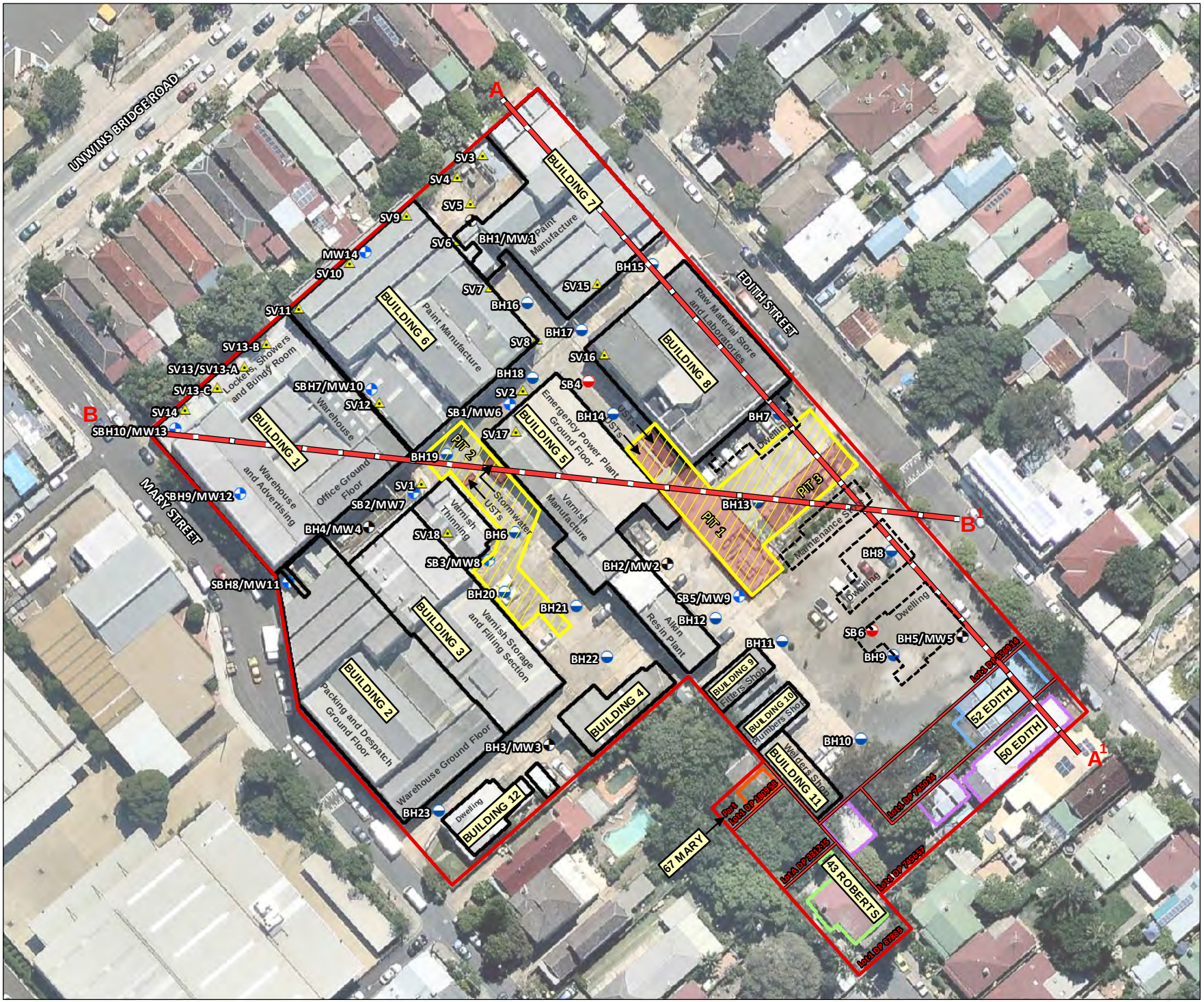
Coor. Sys. GDA 1994 MGA Zone 56

St Peters, NSW

PROPOSED SITE LAYOUT

FIGURE 4:

File Name: 53113_04
Reference: https://maps.six.nsw.gov.au/



Legend:

- Approximate Site Boundary
- Cadastre - Lot & DP Boundaries
- Pits (Former Potential Petroleum/Chemical Storage)
- Area of GPR Survey

Current Layout - Building Footprint

- 67 Mary Street
- 73 Mary Street
- 50 Edith Street
- 52 Edith Street
- 43 Roberts Street
- Former Buildings

Historical Sample Locations

- Monitoring Well Location - EIA 2014/2015
- Monitoring Well Location - JBS&G 2016
- Soil Sample Location - EIA 2014/2015
- Soil Sample Location - JBS&G 2016
- Sub-Slab Vapour Location - JBS&G 2016
- Transect Location (see Figure 6A & 6B)

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Job No: 53113

Client: JVMC Pty Ltd

Version: R01 Rev 0	Date: 25-Aug-2017
Drawn By: RF	Checked By: NC

Scale 1:1,000

0 10 20
metres

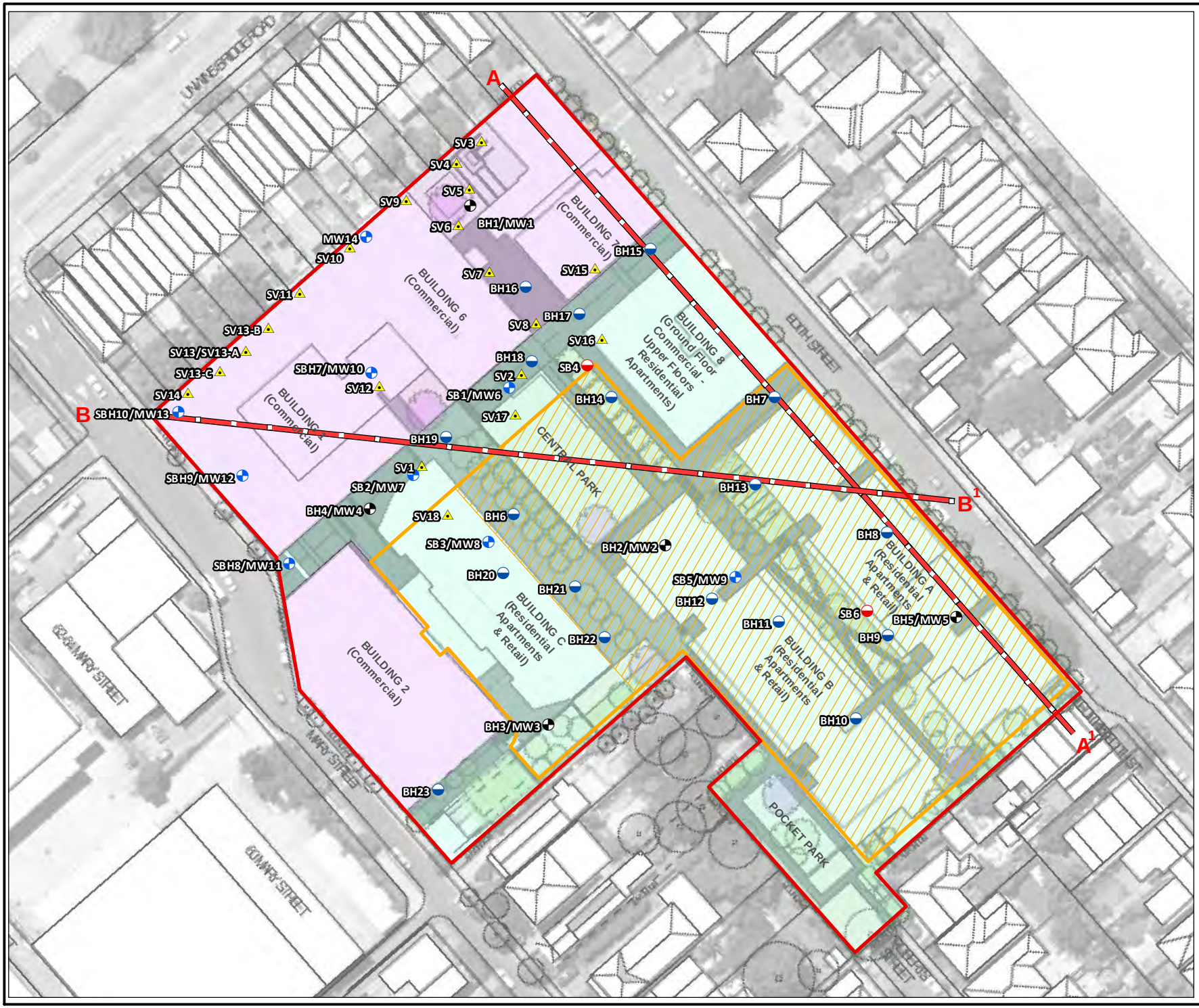
Coor. Sys. GDA 1994 MGA Zone 56

St Peters, NSW

HISTORICAL SITE LAYOUT AND HISTORICAL SAMPLE LOCATIONS

FIGURE 5A:

File Name: 53113_05A
Reference: https://maps.six.nsw.gov.au/



Legend:

- Approximate Site Boundary
- Site A: Precinct 75 Commercial
- Site B: Precinct 75 Mixed Use Redevelopment

Integrated Basement Extent

- Basement - B1 (FFL 8.400-11.850 mAHD)
- Basement - B2 (FFL 7.200-8.750 mAHD)
- Transect Location (see Figure 6A & 6B)

Historical Sample Locations

- Monitoring Well Location - EIA 2014/2015
- Monitoring Well Location - JBS&G 2016
- Soil Sample Location - EIA 2014/2015
- Soil Sample Location - JBS&G 2016
- Sub-Slab Vapour Location - JBS&G 2016

JBS&G

Job No: 53113

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Scale 1:1,000

0 10 20
metres

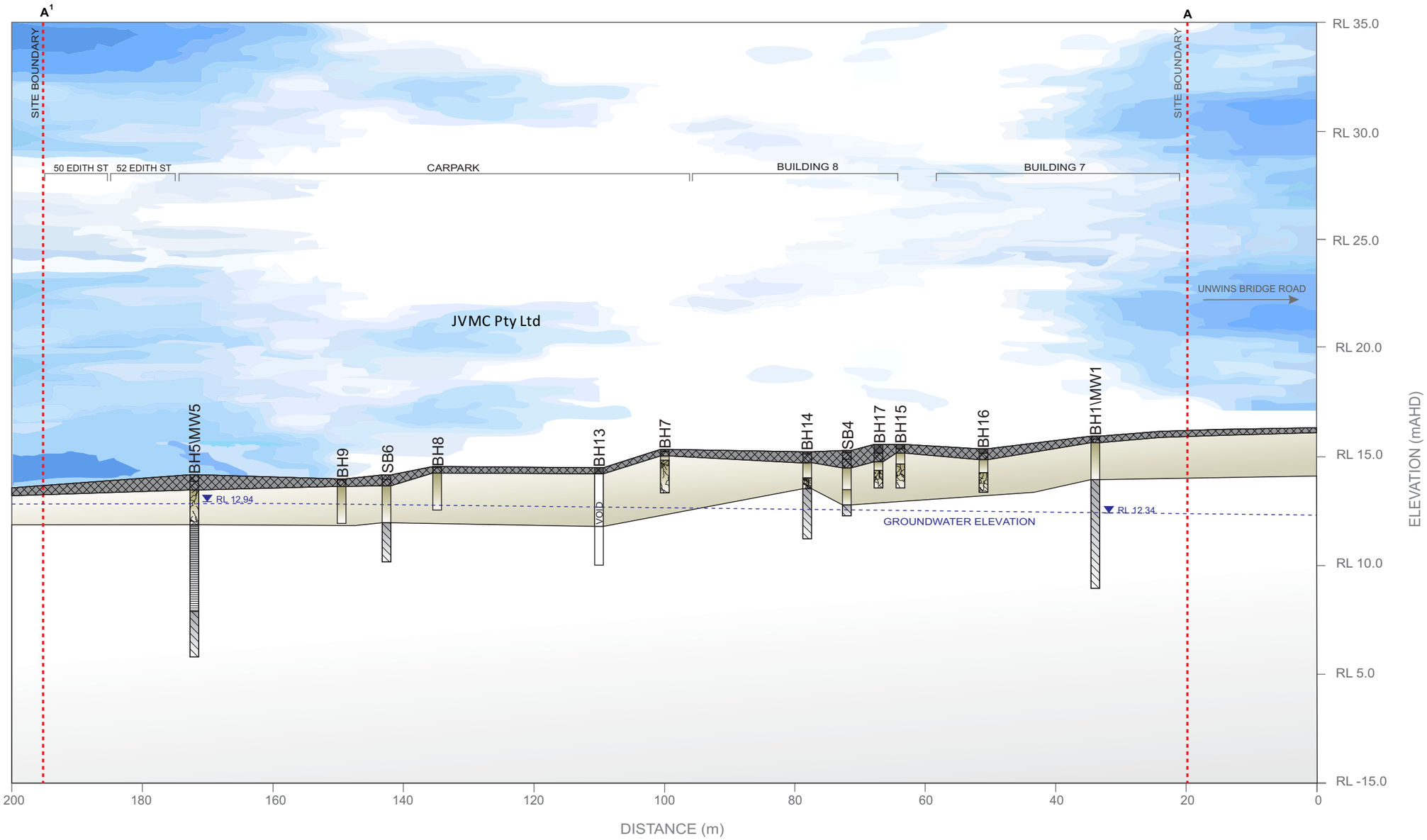
Coor. Sys. GDA 1994 MGA Zone 56

St Peters, NSW

PROPOSED SITE LAYOUT AND HISTORICAL SAMPLE LOCATIONS

FIGURE 5B:

File Name: 53113_05B
Reference: https://maps.six.nsw.gov.au/



Legend:

- CONCRETE/FILL
- Silty CLAY
- CLAY
- MUDSTONE
- SHALE
- Inferred Groundwater Elevation

JBS&G

Job No: 53113	
Client: JVMC Pty Ltd	
Version: R01 Rev 0	Date: 24-Aug-2017
Drawn By: RF	Checked By: NC

Scale: Vertical Exageration 3:1

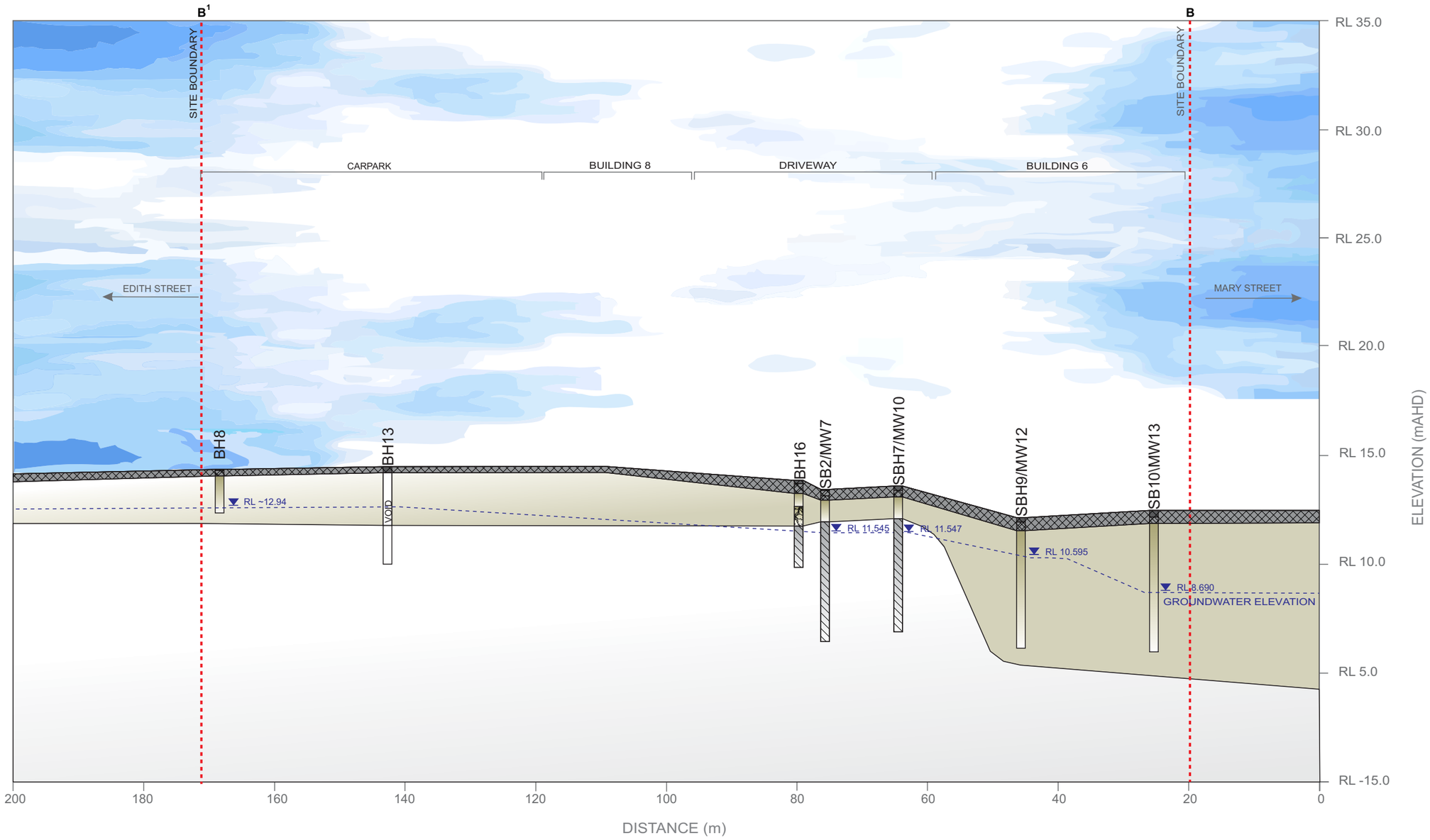
0 10 20
metres

Coord. Sys. GDA 1994 MGA Zone 56

St Peters, NSW

CROSS SECTION A-A^1
(Location of transect on Figure 5A & 5B)

FIGURE 6a:



Legend:

- CONCRETE/FILL
- Silty CLAY
- CLAY
- MUDSTONE
- SHALE
- Inferred Groundwater Elevation

JBS&G

Job No: 53113

Client: JVMC Pty Ltd

Version: R01 Rev 0	Date: 24-Aug-2017
Drawn By: RF	Checked By: NC

Scale: Vertical Exageration 3:1

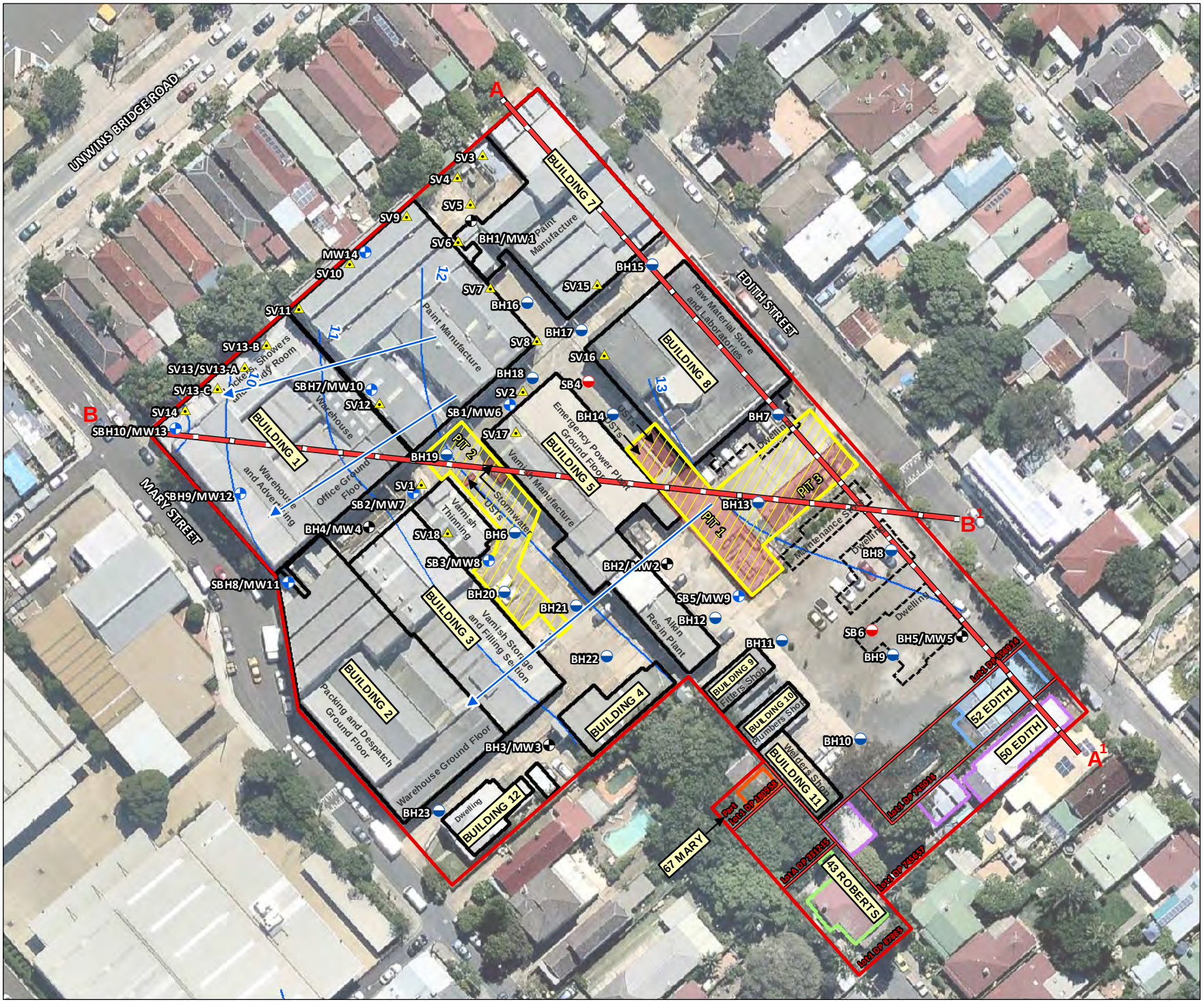
0 10 20
metres

Coord. Sys. GDA 1994 MGA Zone 56

St Peters, NSW

CROSS SECTION B-B^{1}
(Location of transect on Figure 5A & 5B)

FIGURE 6b:



Legend:

- Approximate Property Boundary
- Cadastre - Lot & DP Boundaries
- Pits (Former Potential Petroleum/Chemical Storage)
- Area of GPR Survey

Current Layout - Building Footprint

- 67 Mary Street
- 73 Mary Street
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- 52 Edith Street
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- Former Buildings

Historical Sample Locations

- Monitoring Well Location - EIA 2014/2015
- Monitoring Well Location - JBS&G 2016
- Soil Sample Location - EIA 2014/2015
- Soil Sample Location - JBS&G 2016
- Sub-Slab Vapour Location - JBS&G 2015/2016
- Transect Location (see Figure 6a & 6b)
- Inferred Groundwater Contour(m AHD) - July 20, 2015

JBS&G

Job No: 53113

Client: JVMC Pty Ltd

Version: R01 Rev 0	Date: 24-Aug-2017
Drawn By: RF	Checked By: NC

Scale 1:1,000

0 10 20
metres

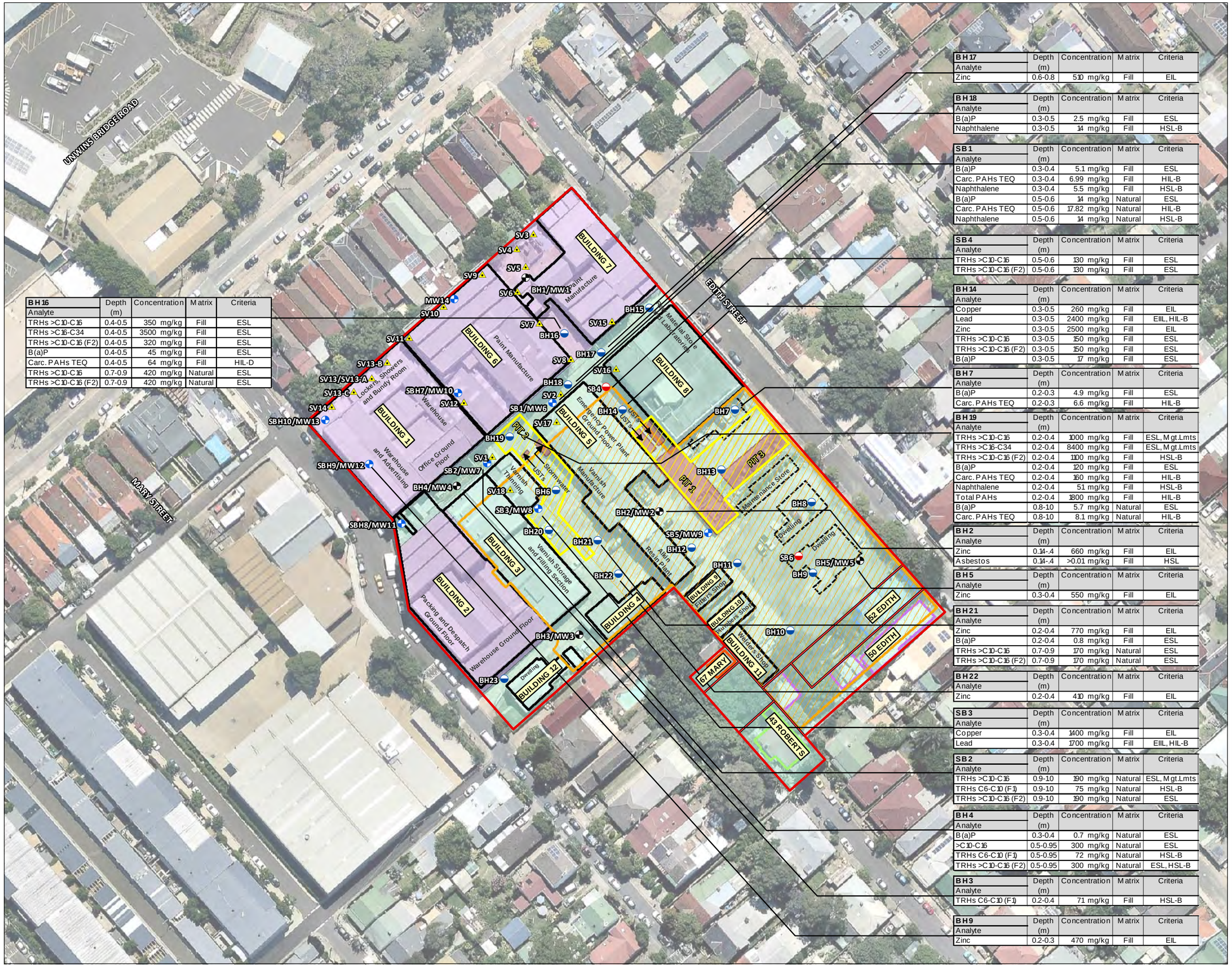
Coor. Sys. GDA 1994 MGA Zone 56

St Peters, NSW

INFERRED GROUNDWATER FLOW DIRECTION

FIGURE 7:

File Name: 53113_07
Reference: https://maps.six.nsw.gov.au/



BH16	Depth	Concentration	Matrix	Criteria
Analyte	(m)			
TRHs >C10-C16	0.4-0.5	350 mg/kg	Fill	ESL
TRHs >C16-C34	0.4-0.5	3500 mg/kg	Fill	ESL
TRHs >C10-C16 (F2)	0.4-0.5	320 mg/kg	Fill	ESL
B(a)P	0.4-0.5	45 mg/kg	Fill	ESL
Carc. PAHs TEQ	0.4-0.5	64 mg/kg	Fill	HIL-D
TRHs >C10-C16	0.7-0.9	420 mg/kg	Natural	ESL
TRHs >C10-C16 (F2)	0.7-0.9	420 mg/kg	Natural	ESL

BH17	Depth	Concentration	Matrix	Criteria
Analyte	(m)			
Zinc	0.6-0.8	510 mg/kg	Fill	EIL

BH18	Depth	Concentration	Matrix	Criteria
Analyte	(m)			
B(a)P	0.3-0.5	2.5 mg/kg	Fill	ESL
Naphthalene	0.3-0.5	14 mg/kg	Fill	HSL-B

SB1	Depth	Concentration	Matrix	Criteria
Analyte	(m)			
B(a)P	0.3-0.4	5.1 mg/kg	Fill	ESL
Carc. PAHs TEQ	0.3-0.4	6.99 mg/kg	Fill	HIL-B
Naphthalene	0.3-0.4	5.5 mg/kg	Fill	HSL-B
B(a)P	0.5-0.6	14 mg/kg	Natural	ESL
Carc. PAHs TEQ	0.5-0.6	17.82 mg/kg	Natural	HIL-B
Naphthalene	0.5-0.6	14 mg/kg	Natural	HSL-B

SB4	Depth	Concentration	Matrix	Criteria
Analyte	(m)			
TRHs >C10-C16	0.5-0.6	130 mg/kg	Fill	ESL
TRHs >C10-C16 (F2)	0.5-0.6	130 mg/kg	Fill	ESL

BH14	Depth	Concentration	Matrix	Criteria
Analyte	(m)			
Copper	0.3-0.5	260 mg/kg	Fill	EIL
Lead	0.3-0.5	2400 mg/kg	Fill	EIL, HIL-B
Zinc	0.3-0.5	2500 mg/kg	Fill	EIL
TRHs >C10-C16	0.3-0.5	150 mg/kg	Fill	ESL
TRHs >C10-C16 (F2)	0.3-0.5	150 mg/kg	Fill	ESL
B(a)P	0.3-0.5	17 mg/kg	Fill	ESL

BH7	Depth	Concentration	Matrix	Criteria
Analyte	(m)			
B(a)P	0.2-0.3	4.9 mg/kg	Fill	ESL
Carc. PAHs TEQ	0.2-0.3	6.6 mg/kg	Fill	HIL-B

BH19	Depth	Concentration	Matrix	Criteria
Analyte	(m)			
TRHs >C10-C16	0.2-0.4	1000 mg/kg	Fill	ESL, Mgt.Lmts
TRHs >C16-C34	0.2-0.4	8400 mg/kg	Fill	ESL, Mgt.Lmts
TRHs >C10-C16 (F2)	0.2-0.4	1100 mg/kg	Fill	HSL-B
B(a)P	0.2-0.4	120 mg/kg	Fill	ESL
Carc. PAHs TEQ	0.2-0.4	160 mg/kg	Fill	HIL-B
Naphthalene	0.2-0.4	51 mg/kg	Fill	HSL-B
Total PAHs	0.2-0.4	1800 mg/kg	Fill	HIL-B
B(a)P	0.8-10	5.7 mg/kg	Natural	ESL
Carc. PAHs TEQ	0.8-10	8.1 mg/kg	Natural	HIL-B

BH2	Depth	Concentration	Matrix	Criteria
Analyte	(m)			
Zinc	0.14-.4	660 mg/kg	Fill	EIL
Asbestos	0.14-.4	>0.01 mg/kg	Fill	HSL

BH5	Depth	Concentration	Matrix	Criteria
Analyte	(m)			
Zinc	0.3-0.4	550 mg/kg	Fill	EIL

BH21	Depth	Concentration	Matrix	Criteria
Analyte	(m)			
Zinc	0.2-0.4	770 mg/kg	Fill	EIL
B(a)P	0.2-0.4	0.8 mg/kg	Fill	ESL
TRHs >C10-C16	0.7-0.9	170 mg/kg	Natural	ESL
TRHs >C10-C16 (F2)	0.7-0.9	170 mg/kg	Natural	ESL

BH22	Depth	Concentration	Matrix	Criteria
Analyte	(m)			
Zinc	0.2-0.4	410 mg/kg	Fill	EIL

SB3	Depth	Concentration	Matrix	Criteria
Analyte	(m)			
Copper	0.3-0.4	1400 mg/kg	Fill	EIL
Lead	0.3-0.4	1700 mg/kg	Fill	EIL, HIL-B

SB2	Depth	Concentration	Matrix	Criteria
Analyte	(m)			
TRHs >C10-C16	0.9-10	190 mg/kg	Natural	ESL, Mgt.Lmts
TRHs C6-C10 (F1)	0.9-10	75 mg/kg	Natural	HSL-B
TRHs >C10-C16 (F2)	0.9-10	190 mg/kg	Natural	ESL

BH4	Depth	Concentration	Matrix	Criteria
Analyte	(m)			
B(a)P	0.3-0.4	0.7 mg/kg	Natural	ESL
>C10-C16	0.5-0.95	300 mg/kg	Natural	ESL
TRHs C6-C10 (F1)	0.5-0.95	72 mg/kg	Natural	HSL-B
TRHs >C10-C16 (F2)	0.5-0.95	300 mg/kg	Natural	ESL, HSL-B

BH3	Depth	Concentration	Matrix	Criteria
Analyte	(m)			
TRHs C6-C10 (F1)	0.2-0.4	71 mg/kg	Fill	HSL-B

BH9	Depth	Concentration	Matrix	Criteria
Analyte	(m)			
Zinc	0.2-0.3	470 mg/kg	Fill	EIL

Legend:

- Approximate Property Boundary
- Cadastre - Lot & DP Boundaries
- Pits (Former Potential Petroleum/Chemical Storage)
- Area of GPR Survey
- Site A: Precinct 75 Commercial
- Site B: Precinct 75 Mixed Use Redevelopment
- Basement - B1 (FFL 8.400-11.850 mAHD)
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- Monitoring Well Location - JBS&G 2016
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- Soil Sample Location - JBS&G 2016
- Sub-Slab Vapour Location - JBS&G 2016

JBS&G

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Drawn By: RF | Checked By: NC

Scale:1:1,000

0 10 20
metres

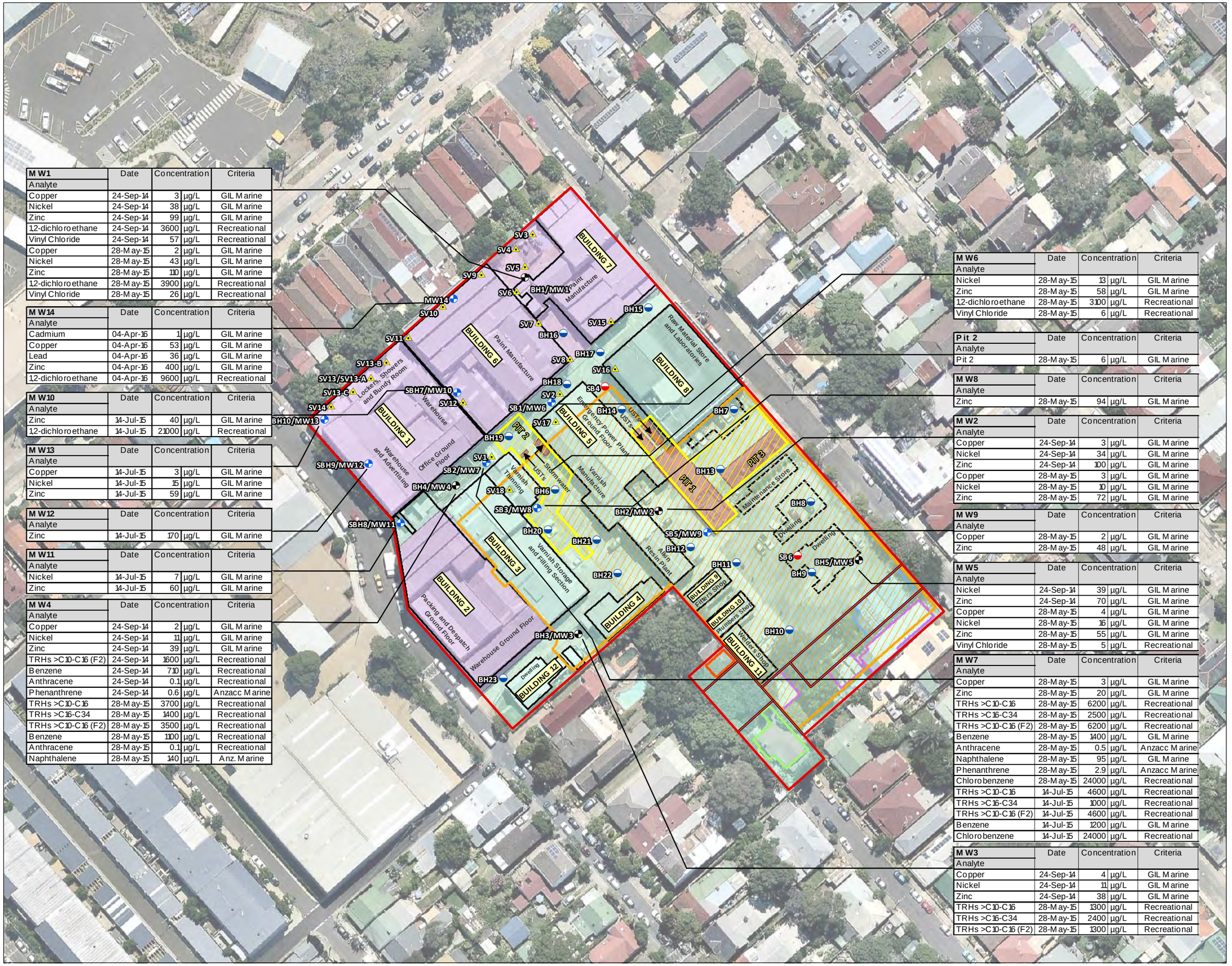
Coord. Sys. GDA 1994 MGA Zone 56

St Peters, NSW

HISTORICAL SOIL EXCEEDANCES

FIGURE 8A:

Document Path: 53113_08A
Reference: https://maps.six.nsw.gov.au/



M W1	Date	Concentration		Criteria
Analyte				
Copper	24-Sep-14	3	µg/L	GIL Marine
Nickel	24-Sep-14	38	µg/L	GIL Marine
Zinc	24-Sep-14	99	µg/L	GIL Marine
1,2-dichloroethane	24-Sep-14	3600	µg/L	Recreational
Vinyl Chloride	24-Sep-14	57	µg/L	Recreational
Copper	28-May-15	2	µg/L	GIL Marine
Nickel	28-May-15	43	µg/L	GIL Marine
Zinc	28-May-15	110	µg/L	GIL Marine
1,2-dichloroethane	28-May-15	3900	µg/L	Recreational
Vinyl Chloride	28-May-15	26	µg/L	Recreational

M W14	Date	Concentration		Criteria
Analyte				
Cadmium	04-Apr-16	1	µg/L	GIL Marine
Copper	04-Apr-16	53	µg/L	GIL Marine
Lead	04-Apr-16	36	µg/L	GIL Marine
Zinc	04-Apr-16	400	µg/L	GIL Marine
1,2-dichloroethane	04-Apr-16	9600	µg/L	Recreational

M W10	Date	Concentration		Criteria
Analyte				
Zinc	14-Jul-15	40	µg/L	GIL Marine
1,2-dichloroethane	14-Jul-15	21000	µg/L	Recreational

M W13	Date	Concentration		Criteria
Analyte				
Copper	14-Jul-15	3	µg/L	GIL Marine
Nickel	14-Jul-15	15	µg/L	GIL Marine
Zinc	14-Jul-15	59	µg/L	GIL Marine

M W12	Date	Concentration		Criteria
Analyte				
Zinc	14-Jul-15	170	µg/L	GIL Marine

M W11	Date	Concentration		Criteria
Analyte				
Nickel	14-Jul-15	7	µg/L	GIL Marine
Zinc	14-Jul-15	60	µg/L	GIL Marine

M W4	Date	Concentration		Criteria
Analyte				
Copper	24-Sep-14	2	µg/L	GIL Marine
Nickel	24-Sep-14	11	µg/L	GIL Marine
Zinc	24-Sep-14	39	µg/L	GIL Marine
TRHs >C10-C16 (F2)	24-Sep-14	1600	µg/L	Recreational
Benzene	24-Sep-14	710	µg/L	Recreational
Anthracene	24-Sep-14	0.1	µg/L	Recreational
Phenanthrene	24-Sep-14	0.6	µg/L	Anzacc Marine
TRHs >C10-C16	28-May-15	3700	µg/L	Recreational
TRHs >C16-C34	28-May-15	1400	µg/L	Recreational
TRHs >C10-C16 (F2)	28-May-15	3500	µg/L	Recreational
Benzene	28-May-15	1100	µg/L	Recreational
Anthracene	28-May-15	0.1	µg/L	Recreational
Naphthalene	28-May-15	140	µg/L	Anz. Marine

M W6	Date	Concentration		Criteria
Analyte				
Nickel	28-May-15	13	µg/L	GIL Marine
Zinc	28-May-15	58	µg/L	GIL Marine
1,2-dichloroethane	28-May-15	3100	µg/L	Recreational
Vinyl Chloride	28-May-15	6	µg/L	Recreational

Pit 2	Date	Concentration		Criteria
Analyte				
Pit 2	28-May-15	6	µg/L	GIL Marine

M W8	Date	Concentration		Criteria
Analyte				
Zinc	28-May-15	94	µg/L	GIL Marine

M W2	Date	Concentration		Criteria
Analyte				
Copper	24-Sep-14	3	µg/L	GIL Marine
Nickel	24-Sep-14	34	µg/L	GIL Marine
Zinc	24-Sep-14	100	µg/L	GIL Marine
Copper	28-May-15	3	µg/L	GIL Marine
Nickel	28-May-15	10	µg/L	GIL Marine
Zinc	28-May-15	72	µg/L	GIL Marine

M W9	Date	Concentration		Criteria
Analyte				
Copper	28-May-15	2	µg/L	GIL Marine
Zinc	28-May-15	48	µg/L	GIL Marine

M W5	Date	Concentration		Criteria
Analyte				
Nickel	24-Sep-14	39	µg/L	GIL Marine
Zinc	24-Sep-14	70	µg/L	GIL Marine
Copper	28-May-15	4	µg/L	GIL Marine
Nickel	28-May-15	16	µg/L	GIL Marine
Zinc	28-May-15	55	µg/L	GIL Marine
Vinyl Chloride	28-May-15	5	µg/L	Recreational

M W7	Date	Concentration		Criteria
Analyte				
Copper	28-May-15	3	µg/L	GIL Marine
Zinc	28-May-15	20	µg/L	GIL Marine
TRHs >C10-C16	28-May-15	6200	µg/L	Recreational
TRHs >C16-C34	28-May-15	2500	µg/L	Recreational
TRHs >C10-C16 (F2)	28-May-15	6200	µg/L	Recreational
Benzene	28-May-15	1400	µg/L	GIL Marine
Anthracene	28-May-15	0.5	µg/L	Anzacc Marine
Naphthalene	28-May-15	95	µg/L	GIL Marine
Phenanthrene	28-May-15	2.9	µg/L	Anzacc Marine
Chlorobenzene	28-May-15	24000	µg/L	Recreational
TRHs >C10-C16	14-Jul-15	4600	µg/L	Recreational
TRHs >C16-C34	14-Jul-15	1000	µg/L	Recreational
TRHs >C10-C16 (F2)	14-Jul-15	4600	µg/L	Recreational
Benzene	14-Jul-15	1200	µg/L	GIL Marine
Chlorobenzene	14-Jul-15	24000	µg/L	Recreational

M W3	Date	Concentration		Criteria
Analyte				
Copper	24-Sep-14	4	µg/L	GIL Marine
Nickel	24-Sep-14	11	µg/L	GIL Marine
Zinc	24-Sep-14	38	µg/L	GIL Marine
TRHs >C10-C16	28-May-15	1300	µg/L	Recreational
TRHs >C16-C34	28-May-15	2400	µg/L	Recreational
TRHs >C10-C16 (F2)	28-May-15	1300	µg/L	Recreational

Legend:

- Approximate Property Boundary
- Cadastre - Lot & DP Boundaries
- Pits (Former Potential Petroleum/Chemical Storage)
- Area of GPR Survey
- Site A: Precinct 75 Commercial
- Site B: Precinct 75 Mixed Use Redevelopment
- Basement - B1 (FFL 8.400-11.850 mAHD)
- Basement - B2 (FFL 7.200-8.750 mAHD)

Current Layout - Building Footprint

- 67 Mary Street
- 73 Mary Street
- 50 Edith Street
- 52 Edith Street
- 43 Roberts Street
- Former Buildings

Historical Sample Locations

- Monitoring Well Location - EIA 2014/2015
- Monitoring Well Location - JBS&G 2016
- Soil Sample Location - EIA 2014/2015
- Soil Sample Location - JBS&G 2016
- Sub-Slab Vapour Location - JBS&G 2016

JBS&G

Job No: 53113

Client: JVMC Pty Ltd

Version: R01 Rev 0 | Date: 24-Aug-2017

Drawn By: RF | Checked By: NC

Scale: 1:1,000

0 10 20
metres

Coord. Sys. GDA 1994 MGA Zone 56

St Peters, NSW

HISTORICAL GROUNDWATER EXCEEDANCES

FIGURE 8B:

Document Path: 53113_08B
Reference: https://maps.six.nsw.gov.au/

SV13-B (Summa)	Date	Concentration		Criteria
Analyte				
Trichloroethene	24-Mar-16	7.8	mg/m³	HIL-B & HIL-D

SV13 (Front)	Date	Concentration		Criteria
Analyte				
Trichloroethene	06-Aug-15	7	mg/m³	HIL-B & HIL-D

SV13-A (Summa Lab Dup.)	Date	Concentration		Criteria
Analyte				
Trichloroethene	24-Mar-16	6.5	mg/m³	HIL-B & HIL-D

SV13-A (Summa)	Date	Concentration		Criteria
Analyte				
Trichloroethene	24-Mar-16	32	mg/m³	HIL-B & HIL-D

Legend:

- Approximate Property Boundary
- Cadastre - Lot & DP Boundaries
- Pits (Former Potential Petroleum/Chemical Storage)
- Area of GPR Survey
- Site A: Precinct 75 Commercial
- Site B: Precinct 75 Mixed Use Redevelopment
- Basement - B1 (FFL 8.400-11.850 mAHD)
- Basement - B2 (FFL 7.200-8.750 mAHD)

Current Layout - Building Footprint

- 67 Mary Street
- 73 Mary Street
- 50 Edith Street
- 52 Edith Street
- 43 Roberts Street
- Former Buildings

Historical Sample Locations

- Monitoring Well Location - EIA 2014/2015
- Monitoring Well Location - JBS&G 2016
- Soil Sample Location - EIA 2014/2015
- Soil Sample Location - JBS&G 2016
- Sub-Slab Vapour Location - JBS&G 2015/2016

JBS&G

Job No: 53113	
Client: JVMC Pty Ltd	
Version: R01 Rev 0	Date: 25-Aug-2017
Drawn By: RF	Checked By: NC
Scale:1:1,000	

0 10 20
metres

Coord. Sys. GDA 1994 MGA Zone 56

St Peters, NSW

HISTORICAL SOL VAPOUR EXCEEDANCES

FIGURE 8C:

Document Path: 53113_08C
Reference: https://maps.six.nsw.gov.au/

Legend:

- Cadastre - Lot & DP Boundaries
- Pits (Former Potential Petroleum/Chemical Storage)
- Area of GPR Survey
- Site A: Precinct 75 Commercial
- Site B: Precinct 75 Mixed Use Redevelopment
- Basement - B1 (FFL 8.400-11.850 mAHD)
- Basement - B2 (FFL 7.200-8.750 mAHD)

Current Layout - Building Footprint

- 67 Mary Street
- 73 Mary Street
- 50 Edith Street
- 52 Edith Street
- 43 Roberts Street
- Former Buildings

Historical Sample Locations

- Monitoring Well Location - EIA 2014/2015
- Monitoring Well Location - JBS&G 2016
- Soil Sample Location - EIA 2014/2015
- Soil Sample Location - JBS&G 2016
- Sub-Slab Vapour Location - JBS&G 2016

Areas of Environmental Concern

- AEC 1
- AEC 2
- AEC 4

Proposed Sample Locations

- Borehole Location
- Groundwater Monitoring Well Location
- Sub-Slab Soil Vapour Location
- Soil Vapour Well Location

JBS&G

Job No: 53113	
Client: JVMC Pty Ltd	
Version: R01 Rev 0	Date: 25-Aug-2017
Drawn By: RF	Checked By: NC

Scale: 1:750

0 10 20
metres

Coord. Sys. GDA 1994 MGA Zone 56

St Peters, NSW

AEC AND DATA GAP SAMPLING LOCATIONS

FIGURE 9:

Document Path: 53113_09
Reference: https://maps.six.nsw.gov.au/