



# **Douglas Partners**

*Geotechnics | Environment | Groundwater*

Report on  
Preliminary Site Investigation (Contamination)

Barangaroo Station Construct Only Package  
Hickson Road, Barangaroo

Prepared for  
Watpac Construction Pty Ltd

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Integrated Practical Solutions



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## Executive Summary

Douglas Partners Pty Ltd (DP) has been engaged by Watpac Construction Pty Ltd (BESIX Watpac) to complete this Preliminary Site Investigation (Contamination) (PSI) for the Barangaroo Station Construct Only Package (COP) which is part of the broader Sydney Metro City & Southwest project. The objective of the PSI is to review existing information to determine possible and/or likely contamination at the site that will need to be considered and managed as part of the project.

The station box extent is shown on General Arrangement Plan in Appendix A. The project for BESIX Watpac includes structural and civil completion works to the station box; fit-out testing and commissioning of the new station; installation of a cooling water system and associated pipework; installation of high voltage cabling; Hickson Road precinct works (including road works, landscaping, lighting, etc.), stormwater trunk main works, backfilling and reinstatement of the temporary shaft and removal of the acoustic shed; and removal of the temporary Hickson Road bridge structure. Spoil will be generated from trenching for the stormwater trunk mains, trenching for the cooling water pipes north of the station box, trenching for the HV cabling at Hickson Road (north and south of the station box) and from Hickson Road to the Barangaroo cutaway, and from the existing road pavement on Hickson Road. The construction of the stormwater trunk is the only activity that is expected to require some temporary dewatering due to the depth of trenching. Groundwater seepage and construction water will be collected and pumped to the existing water treatment plant at the site.

Previous, contamination-related reports as well as historical aerial photographs and NSW EPA public registers were reviewed by DP. A summary of site history is as follows:

- The gasworks operated between 1841 and the 1920s at land approximately 25 m to the south of the site. Apart from the gasworks, much of the general Barangaroo area was likely occupied by shipping companies and related merchants and manufacturers in the mid- late 1800s and early 1900s;
- Hickson Road had been established by 1930. Hickson Road and land to the west was likely filled for its construction;
- Warehouses were present at the site in 1930 and may have been associated with the adjacent finger wharves and used for shipping / stevedoring (e.g., as bonds stores);
- By 1970, the finger wharves had been removed. Warehouses at the site were demolished in the 1960s and 1970s. Filling / reclamation of the harbour appears to have taken place following removal of the finger wharves;
- By 1982, the (reclaimed / filled) land to the west of Hickson Road was covered by hardstand (asphalt or concrete) and was used for storage and vehicle access as part of shipping operations, with large warehouses being established beyond the site boundary. Previous reports indicate that fuels and dangerous goods were stored for shipping operations, although these storages were not located within the site boundary. A vehicle wash bay appears to have been positioned adjacent to the site;
- By 2010, structures associated with the shipping operations had been removed and by 2011, a passenger terminal for cruise ships had been established at the western end of the site. The passenger terminal had been removed by 2013;
- By 2014, land to the west of Hickson Road was subject to major construction activities including excavation and earthmoving. The construction activities had been completed by 2016 with the establishment of Nawi Cove, adjacent to the west of the site, and Barangaroo Reserve, a

landscaped area to the north-west. Much of the western part of the site was publicly accessible, with lawn covered areas, trees and pedestrian access; and

- Excavation works for the Barangaroo Station (station box extent), located at the central part of the site occurred in 2018 and 2019 to depths of 16.9 m bgl to 27.7 m bgl. Excavations works for a shaft to the north would have occurred at a similar time and tunnelling for the Metro rail line would have occurred following sufficient excavation of the station box. Most of the site west of the excavation was used as part of contractor compounds.

A series of NSW EPA Notices and licences were issued by the NSW EPA for the former gasworks site (approximately 25 m to the south of the site). The Notices and licences have since been withdrawn or surrendered; however, the former gasworks remains on the list of contaminated sites notified to the EPA. Presumably, the withdrawal of Notices is due to the completion of remediation works at the former gasworks site undertaken between circa 2014 and 2020.

A site walkover was undertaken by a DP Environmental Engineer on 27 October 2021. The site walkover was limited to the ground level areas. Observed site features included Hickson Road and the acoustic shed at the north of the site; an asphalt parking area and a landscaped area next to the building at 25 Hickson Road; large sandstone steps up from Nawi Cove; a water treatment plant; concrete slabs covering much of the construction site area; an area of exposed soil at the western end of the proposed stormwater trunk mains; and Hickson Road at the southern part of the site. Hickson Road (temporarily) bridges over the station box extent.

Based on reviewed site history information, the potential sources of contamination at the site include imported (extensive filling) used to form/level the site; historical spills or leaks of fuels or chemicals; demolition of previous structures containing hazardous building materials; and residual contaminated groundwater. Potential contaminants include metals (primarily arsenic, cadmium, chromium, copper, mercury, nickel, lead and zinc); total petroleum hydrocarbons (TPH); benzene, toluene, ethylbenzene and xylenes (BTEX); polycyclic aromatic hydrocarbons (PAH); volatile organic compounds (VOC); polychlorinated biphenyls (PCB); organochlorine pesticides (OCP), organophosphorus pesticides (OPP); cyanide; phenols, (including cresols); asbestos and ammonia.

Based on a review of previous reports, it is considered that the most highly contaminated soil at the site could be at Hickson Road between the station box extent and the southern site boundary. Given the extensive fill, there is a moderate to high potential for contamination to present at the west of the station box extent. The potential for contamination to the north of the station box extent is considered to be relatively low given that this area does not appear to have been subject to significant filling. The potential for contamination within the station box extent is considered to be extremely low given that contamination sources from within the station box extent have been excavated and removed as part of the station construction.

Acid sulfate soils (ASS) are likely to be present in soils (including fill and natural soils) from between the water table and the top of bedrock. Fill above the water table may also be ASS if it has been originally sourced from beneath the water table. ASS are likely to be present to the west of the station box extent and may be present to the south of the station box extent. ASS are unlikely to be present to the north of the station box extent given the shallow bedrock. An ASS management plan should be prepared for the proposed excavations works.

It is recommended that some *in situ* investigations be undertaken (prior to excavation work) at proposed significant excavation areas to the south and west of the station box extent. The purpose of the *in situ* investigations would be to:

- To gain a better understanding of the extent of ASS and associated liming rates for treatment;
- Determine the preliminary waste classifications of the various soil materials so that materials with (likely) different waste classifications can be segregated (if possible) during excavation. This may minimise quantities of hazardous waste and restricted solid waste requiring disposal; and
- To provide an early indication if materials should not be reused at the site due to levels of contamination potentially posing a risk to human health or ecological receptors.

It is understood, from the site walkover, that some investigations have already commenced to the south and west of the station box extent.

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## **Report on Preliminary Site Investigation (Contamination)**

### **Barangaroo Station Construct Only Package**

### **Hickson Road, Barangaroo**

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#### **1. Introduction**

Douglas Partners Pty Ltd (DP) has been engaged by Watpac Construction Pty Ltd (BESIX Watpac) to complete this preliminary site investigation (Contamination) (PSI) for the Barangaroo Station Construct Only Package (COP) which is part of the broader Sydney Metro City & Southwest project.

At the time of preparing this PSI, most of the station box primary structure at the site had been completed (by others) and BESIX Watpac are to complete the station fit-out and associated civil and landscaping works. The station box extent is shown on General Arrangement Plan in Appendix A. The project for BESIX Watpac includes:

- Structural and civil completion works to the station box;
- Fit-out, testing and commissioning of the new station;
- Installation of a cooling water system within the Barangaroo cutaway and associated trenching and pipework including the connection of the system to an existing network of pipes in Sydney Harbour;
- Installation of high voltage (HV) cabling at Hickson Road and from Hickson Road to the Barangaroo cutaway;
- Hickson Road precinct works including road, footpath, cycleway, landscaping, street lighting, stormwater, utilities works and ventilation pod risers;
- Stormwater trunk mains works from the Hickson Road precinct to an existing pit at the western end of the site;
- Backfilling and surface reinstatement of the temporary northern (Hickson Road) shaft including removal of the acoustic shed; and
- Staging and temporary works required to deliver the permanent works, including removal of the temporary Hickson Road bridge structure.

Spoil will be generated from trenching for the stormwater trunk mains, trenching for the cooling water pipes north of the station box, trenching for the HV cabling at Hickson Road (north and south of the station box) and from Hickson Road to the Barangaroo cutaway (adjacent to the building at 25 Hickson Road), and from the existing road pavement on Hickson Road. The construction of the stormwater trunk is the only activity that is expected to require some temporary dewatering due to the depth of trenching. Groundwater seepage and construction water will be collected and pumped to the existing water treatment plant at the site.

The objective of the PSI is to review existing information to determine possible and/or likely contamination at the site that will need to be considered and managed as part of the project. The information presented in this report is to be used for determining future investigative works and in developing spoil management procedures.

This report must be read in conjunction with all appendices including the notes provided in Appendix B.

The investigation was undertaken under contract Medium Consultant Contract (NSW) number N217-2R29.

## 2. Scope of Works

In brief, the scope of work for the PSI was as follows:

- Review of previous reports (that were made available for review);
- Review of plans for the proposed development;
- Review of soil and geology maps;
- Review of the WaterNSW database for registered groundwater bores;
- Review of historical aerial photographs;
- Review of the NSW EPA website for listed contaminated sites, notices and licenced activities;
- Conduct a site walkover to observe site features; and
- Preparation of this report.

## 3. Site Identification

The site includes the 'Hickson Road Works Extents' and 'Foreshore Reinstatement Extents' shown on the General Arrangement Plan in Appendix A, and covers an area of approximately 1.9 ha. According to NSW Spatial Services, SIX Maps, on 16 September 2021, the site covers:

- Part of Hickson Road which is at the boundary of the suburbs of Millers Point and Barangaroo;
- Lot 1, Deposited Plan 863317 which has a street address of Hickson Road, Miller Point;
- Part of Lot 52, Deposited Plan 1213772 which has a street address of Hickson Road, Barangaroo; and
- Part of Lot 100, Deposited Plan 838323 which has a street address of 25 Hickson Road, Barangaroo.

The approximate site area is shown in Figure 1. The local government authority is the City of Sydney Council.



**Figure 1: Site location**

## **4. Environmental Setting**

### **4.1 Topography**

The ground level at the site is relatively level, at approximately 2.5 m AHD, with the northern end being slightly more elevated and steps down towards Nawi Cove at the west. Adjacent land to the east and at the north is approximately 6 m to 12 m above Hickson Road.

### **4.2 Geology and Soil Landscape**

According to the Sydney 1:100 000 Geology Sheet, the majority of the site is underlain by Hawkesbury Sandstone which comprises medium to coarse grained quartz sandstone, very minor shale and laminite lenses. The western part of the site is within an area of man-made fill which comprises dredged estuarine sand and mud, demolition rubble, industrial and household waste.

According to Sydney 1:100 000 Soils Landscape Sheet, much of the site is within an area of Disturbed Terrain. Parts of the site to the north and south are within the Gymea soil landscape. Disturbed Terrain is where the landscape has been extensively disturbed by human activity and can include land fill. The Gymea landscape has natural soils that have been formed by erosion.

### **4.3 Acid Sulphate Soils**

NSW Acid Sulfate Soil Risk Mapping (1994-1998) data, supplied by NSW Department of Environment and Climate Change, indicates that much of the site is in an area of disturbed terrain where soil investigations are required to assess for acid sulfate soils (ASS) and the depth to ASS is unknown. The northern part of the site is not associated with a risk of ASS.

According to Sydney Local Environmental Plan 2012 ASS maps, the northern part of the site is within Class 5 land. For Class 5 land, development consent is required for carrying out of works by which the water table is likely to be lowered below 1 m AHD on adjacent Class 1, 2, 3 or 4 land. The remainder of the site is not classified on the Sydney Local Environmental Plan 2012 ASS maps.

### **4.4 Groundwater and Surface Water**

A search of the WaterNSW registered groundwater bore database indicated that there are 34 registered groundwater bores within an approximate 500 m radius of the site. A map showing the locations of bores is provided in Appendix C. Two of the bores (GW111570 and GW111571), located approximately 250 m to the north of the site, were installed in 2011 at 4 Towns Place, Miller Point for monitoring purposes. One bore (GW116296) was located near the site, to the west of Hickson Road, but did not have any available data. The other 31 bores (GW113553 to GW113566 and GW113596 to GW113612) were installed at the Barangaroo Delivery Authority property in 2010 to 2011 and were positioned alongside the harbour as well as at the former gasworks site. None of the registered bores are at the subject site. Groundwater quality data was not provided in any of the groundwater work summaries.

Based on topography and information from previous investigations (see Section 5), groundwater at and around the site is expected to be tidally influenced, but generally flow towards the west or north-west and discharge into the nearby Nawi Cove and Sydney Harbour. The Barangaroo station box, however, will impact upon this general flow direction.

Apart from stormwater collected and transferred to the on-site water treatment plant, rainwater that falls at the site is expected to enter the local stormwater system which is presumed to discharge into Sydney Harbour.

## 5. Previous Reports

Below is a list of previous, contamination-related reports that have been made available to DP for review and relate to the site:

- Environmental Resources Management Australia Pty Ltd (ERM), *East Darling Harbour Geotechnical and Environmental Investigation, Summary of Findings*, September 2006 (Reference: 004432RP03 Final) (ERM, 2006);
- ERM, *Environmental Site Assessment, East Darling Harbour, Sydney, NSW, June 2007* (Reference: 0044432RP02 Rev 01 Final) (ERM, 2007);
- ERM, *Additional Investigation Works at Barangaroo, Hickson Road, Millers Point, NSW, July 2008* (Reference: 0080637R03Rev01) (ERM, 2008);
- ERM, *Overarching Remedial Action Plan for The Barangaroo Project Site, Sydney, June 2010* (Reference 0114385RP01 Final) (ERM, 2010);
- ENVIRON Australia Pty Ltd (Environ), *Site Audit Report, Overarching Remedial Plan, Barangaroo, June 2010* (Project Number A121191) (Environ, 2010);
- JBS Environmental Pty Ltd (JBS), *DRAFT Remediation Action Plan, Barangaroo Headland Park, Hickson Road, Sydney, NSW* (Project Number JBS41181-16382 (Rev G)) (JBS, 2011a);
- JBS, *Human Health and Ecological Risk Assessment*, August 2011 (Reference JBS41181-16411 Revision 2) (JBS, 2011b);
- JBS Environmental Pty Ltd (JBS), *Human Health and Ecological Risk Assessment for Proposed Imported Soils, Barangaroo Central, Hickson Road, Sydney, NSW, July 2012* (Reference: JBS42021-50171 Revision C) (JBS, 2012a);
- JBS, *Data Gap Investigation, Barangaroo Central, Hickson Road, Sydney, NSW, August 2012* (Reference: JBS42021-51093 rev C) (JBS, 2012b);
- JBS, *Summary of Remedial Action Plan for Waterfront Promenade and Interim Public Domain, Barangaroo Central, Hickson Road, Sydney NSW, October 2012* (Reference JBS42021-52183) (JBS, 2012c);
- JBS, *Additional Human Health Risk Assessment Calculations - Basement Exposures, Barangaroo Central Residential Development*, January 2013 (Reference: JBS42021-52394) (JBS, 2013a);
- Associate Professor Tim Driscoll, Sydney School of Public Health, Sydney Medical School, University of Sydney, *The Use of Asbestos Contaminated Soils on Barangaroo, Report to the Environment Protection Authority*, March 2013 (Driscoll, 2013);
- JBS, *Human Health Risk Assessment, Barangaroo Central, Hickson Road, Sydney, NSW, May 2013* (Reference: JBS42021-51170 rev C) (JBS, 2013b);
- JBS, *Remedial Action Plan, Barangaroo Central, Hickson Road, Sydney, NSW, May 2013* (Reference: JBS 42021-51725 Rev H) (JBS, 2013c);
- Environ, *Site Audit Report, Remedial Action Plan, Barangaroo Central, July 2013* (Project Number A121473) (Environ, 2013);
- JBS&G, *Assessment of Proposed Implications of Modifications to Barangaroo Central Concept Plan, Barangaroo Central, Hickson Road, Sydney NSW, October 2013* (Reference: 42021-55614 rev 1) (JBS&G, 2013d);

- JBS&G, *Assessment of Proposed Implications of Modifications to Barangaroo Central Concept Plan, Barangaroo Central, Hickson Road, Sydney NSW*, May 2014 (Reference: 42021-57386) (JBS, 2014);
- Jacobs, *Chatswood to Sydenham, Environmental Impact Statement, Technical Paper 8: Phase 1 Contamination Investigation (incorporating Preliminary Site Investigation)*, May 2016 (Jacobs, 2016);
- DP & Golder Associates Pty Ltd (Golder), *PSC 00013/10701 - Sydney Metro City and Southwest Geotechnical Investigation, Contamination Assessment Report - Tunnels and Station Excavations (TSE), Chatswood to Sydenham*, January 2017 (Report Number 1650773-042-R-Rev0) (DP & Golder, 2017).
- DP, *DRAFT Remediation Action Plan, Sydney Metro City & South West - Tunnel and Station Excavation Works Package Proposed Barangaroo Station, Hickson Road, Barangaroo*, February 2018 (Reference 85608.08.R.006.DftA) (DP, 2018a);
- DP, *Report on Preliminary Site Investigation, Sydney Metro City and South West, Tunnel and Station Excavation Works Package, Proposed Barangaroo Station, Hickson Road, Barangaroo*, March 2018 (Reference 85608.08.R.001.Rev0) (DP, 2018b);
- DP, *DRAFT Supplementary Contamination and Waste Classification Investigation, Sydney Metro City & South West, Tunnel & Station Excavation Works Package, Proposed Barangaroo Station, Hickson Road, Barangaroo, NSW*, June 2018 (Reference 85608.08.R.030.DftA) (DP, 2018c);
- ADE Consulting Group Pty Ltd (ADE), *Acid Sulfate Soil Management Plan, Barangaroo Station Site, Hickson Road, Barangaroo NSW*, June 2018 (Reference SYM-01-14189 / ASSMP1 / v1f) (ADE, 2018);
- Pells Sullivan Meynink (PSM), *Sydney Metro City & Southwest - TSE, DP-R-020 Hydrogeological Interpretive Report*, October 2018 (Reference MCSWTSE-JPS-TPW-GE-RPT-110003-01) (PSM, 2018);
- ADE, *Sampling, Analysis and Quality Plan (SAQP), Sydney Metro & South West, Tunnel & Station Works Package, Hickson Road, Barangaroo*, February 2019 (Reference SYM-10-14428-SAQP.v5d) (ADE, 2019);
- DP, *Addendum to Remediation Action Plan, Sydney Metro City & South West - Tunnel and Station Excavation Works Package, Proposed Barangaroo Station, Hickson Road, Barangaroo*, February 2019 (Reference 85608.08.R.036.Rev2) (DP, 2019);
- Metron, *Barangaroo Station Vapour Intrusion Assessment Report, Stage 2 & 3 Detail Design Underground Stations Design & Technical Services*, August 2021 (Reference SMCSWSBR-MET-SBR-EM-REP-000001) (Metron, 2021); and
- DP, *DRAFT Report on Validation of Remediation, Sydney Metro City & South West - Tunnel and Station Excavation Works Package Barangaroo Station, Hickson Road, Barangaroo*, August 2021 (Reference 85606.20.R.001.DftD) (DP, 2021).

The reports are summarised in the subsections below. It is noted that DP have been provided with other previous contamination-related reports for nearby land (beyond the site boundary), but these have not been listed or summarised herein.

## 5.1 ERM (2006)

ERM (2006) provides a preliminary review of results for ERM (2007).

## 5.2 ERM (2007)

ERM (2007) presents the findings of a Stage 1 Preliminary Site Investigation and Stage 2 Detailed Site Investigation. The ERM (2007) investigation area (referred to in this section as the 'investigation area') was referred to as Lots 1 through 6, Deposited Plan 876514, predominantly located adjacent Hickson Road, Millers Point. It is noted by DP that the investigation area covered a large area (22 ha) to the west of Hickson Road, part of which included the western part of the subject site.

Four large warehouse buildings (transit sheds) for an active stevedoring terminal and an operational passenger terminal building were in the investigation area (in May 2006); however, it is noted by DP that none of these buildings were within the site. The investigation area was predominantly covered with asphalt and concrete and was predominantly used for storage of shipping containers and vehicles. The topography was relatively flat (having been historically cut and filled).

Various merchants, compositors, manufacturers and various shipping companies owned the investigation area prior to 1900 (according to title deeds). A gasworks, operational from 1841, was previously located at the south of the investigation area. Between 1922 and 1925, the gas holders and purifiers were demolished and the gas holding tanks were backfilled. It was stated by ERM that there was limited information regarding the remainder of the investigation area, although there were finger wharves that changed over time and were later removed, and the area was filled. It is noted by DP, that the former gasworks was located approximately 25 m to the south of the site.

Information obtained from WorkCover NSW in August 2006 indicated that two Dangerous Goods Licences (35/032114 and 35/022097) have been held in relation to the investigation area, one by Patrick Stevedores Operations Pty Ltd and the other by Union Bulkships Pty Ltd. Both licences were for above ground storage of LPG. A WorkCover NSW representative indicated that this may not adequately reflect historical and current bulk storage of dangerous goods as WorkCover NSW was not the only relevant dangerous goods authority for the investigation area.

Apart from the former gasworks and historical filling, fuel storage (above ground and below ground), dangerous goods storage, vehicle maintenance activities and wash bays were listed as potential sources of contamination at the investigation area. It appears that dangerous goods stores and fuel storages were not located at the site (or in close proximity to the site), however, a wash bay is indicated to have been located adjacent to the western site boundary (i.e., adjacent to Hickson Road).

A total of 153 soil bores were drilled across the investigation area in mid-2006. Groundwater wells were installed at 24 locations. A relatively higher sampling density was adopted for the former gasworks. It appears that soil bores BH029 and BH034 were drilled within the subject site and numerous bores were drilled in close proximity to the subject site. The borehole locations are included in Figure 4 from ERM (2010), provided in Appendix A of this PSI.

The observed filling depth (up to a depth of 21 m bgl) was highly variable. In the middle of the investigation area, the fill layer was underlain by natural sediments (predominantly sandy clays) then brown/grey fine to medium grained sandstone. Upper levels of filling were predominantly sandy, becoming more clayey with depth. The fill was generally relatively shallow at the eastern part of the investigation area with sandstone bedrock at a generally shallow depth along Hickson Road. Buried drilling obstructions were regularly encountered and possible causes of drilling refusal were listed as large concrete, timber and steel in filling. At BH029, black staining was observed at a depth of 1.5 - 2.2 m bgl. Potential asbestos containing materials were not observed in filling at any sample location. Borehole logs were not provided in the version of the report sighted by DP.

The observed depth to water ranged between 1.7 m bgl and 2.495 m bgl (i.e., at 0.648 m AHD to 0.07 m AHD). The groundwater levels were considered by ERM to be influenced by the tide. Groundwater was generally saline.

Soil samples were analysed for metals (arsenic, cadmium, chromium, copper, mercury, nickel, lead and zinc); polycyclic aromatic hydrocarbons (PAH); total petroleum hydrocarbons (TPH); benzene, toluene, ethylbenzene and xylene (BTEX); polychlorinated biphenyls (PCB); sulfate; total cyanide; phenols; organochlorine pesticides (OCP) and organophosphate pesticides (OPP). Toxicity characteristic leaching procedure (TCLP) for metals was also conducted on selected samples (although these results were not reported). Groundwater samples were analysed for metals, TPH, BTEX, PAH, cyanide, PCB and sulfate. Laboratory certificates were not provided in the version of the report sighted by DP.

Analytical results were compared to criteria sourced from:

- National Environment Protection Council, *National Environment Protection (Assessment of Site Contamination) Measure*, 1999 (NEPC, 1999). Health based investigation levels 'A' (residential with access to soils) and 'E' (parks and recreational open space), and interim urban ecological investigation levels were adopted; and
- NSW EPA, *Guidelines for Assessing Service Station Sites*, 1994 (NSW EPA, 1994).

For soil, there were two primary areas where concentrations of contaminants were above the adopted assessment criteria. One area was located in the vicinity of the former gasworks. The other area was located at the north-west of the investigation area. It is noted by DP that neither of these areas extend into the subject site. The primary contaminants of concern for these two areas were identified as lead, copper, PAH, TPH and BTEX. In addition to the two primary areas, isolated areas of lead and / or PAH impacted soil (at concentrations above the adopted criteria) were identified. Four bores (BH032, BH080, BH121 and BH147) identified as being lead and / or PAH impacted (i.e., with concentrations above the adopted assessment criteria) were in close proximity to the site. Elevated sulfate concentrations were identified in eight samples.

Analytical results for groundwater were compared to criteria sourced from:

- Australian and New Zealand Environment and Conservation Council and Agricultural and Resource Management Council of Australia and New Zealand, *National Water Quality Management Strategy, Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, 2000 (ANZECC & ARMCANZ, 2000); and
- Dutch Intervention Values [no year provided in the report].

Groundwater concentrations above the criteria were reported for cadmium, copper, lead, zinc, total cyanide, PAH (naphthalene, anthracene, benzo(a)pyrene, fluoranthene and phenanthrene) and BTEX. TPH was also detected in numerous groundwater samples. The majority of impacts to groundwater appeared to be related to the impacted soil at the former gasworks. The groundwater contaminants of concern were identified by ERM as PAH, TPH, BTEX, metals and cyanide.

### 5.3 ERM (2008)

ERM (2008) presents the findings of an additional soil and groundwater investigation at Barangaroo. The investigation area (covering 22 ha) was the same as that for ERM (2007) which included the western part of the subject site.

A total of 55 test bores was used to collect soil samples. Groundwater monitoring wells were installed at 13 test bores. The observed profile was typically asphalt or concrete underlain by sand and gravel road base (at depths between 0.08 m bgl and 0.5 m bgl); filling comprising silty, gravelly sand with sandstone floaters and building rubble (at depths between 0.08 m bgl and 15.9 m bgl); then clayey sand and sandy clay (at depths between 3 m bgl and 32.75 m bgl); and then sandstone (at depths between 1.3 m bgl and 32.75 m bgl). Boreholes drilled in the northern and eastern portions had fill immediately overlying bedrock. The observed filling thickness ranged from 1.3 m in the east to 18 m in the west. Black staining and / or a hydrocarbon odour were noted in some boreholes. Free phase tar was observed in the fill, natural soil and sandstone in and around the former gasworks. Free phase tar was observed in the groundwater in one monitoring well situated close to the former gasworks structures.

The effect of tidal fluctuations on groundwater levels was presented and it was considered by ERM that these fluctuations involving sea water may result in dilution of the contaminants in groundwater.

It is noted by DP that BH177 appears to have been drilled at the subject site. The borehole locations are included in Figure 4 from ERM (2010), as provided in Appendix A of this PSI.

Selected soil samples were analysed for metals (arsenic, cadmium, chromium, copper, mercury, nickel, lead and zinc), PAH, TPH, BTEX, PCB, sulfate, cyanide, phenols, asbestos and TCLP (metals and PAH). Groundwater samples were analysed for metals, PAH, TPH, BTEX, PCB, phenols, total cyanide, sulfate and alkalinity.

Analytical results for soil were compared to criteria sourced from:

- NEPC (1999). Health based investigation levels 'D' (high density residential), 'E' (parks and recreational open space) and 'F' (commercial/industrial), and interim urban ecological investigation levels were adopted; and
- NSW EPA (1994).

For soil, elevated concentrations of lead, PAH, TPH and BTEX (above the assessment criteria) were encountered in a number of samples. This included a sample from BH177 which had PAH and benzo(a)pyrene concentrations above the assessment criteria. Phenols and cyanide were detected in some samples, but at concentrations below the adopted assessment criteria. Sulfate concentrations above the assessment criterion) were also encountered in some samples. Leachable metals (primarily lead and zinc) and leachable PAH were identified in some samples. Asbestos was identified in one

sample (which also had building rubble). The maximum concentrations of the contaminants of concern were observed at the former gasworks area.

Analytical results for groundwater were compared to criteria sourced from ANZECC & ARMCANZ (2000).

For groundwater, concentrations of lead, cadmium, copper, mercury, nickel, zinc, TPH, BTEX, naphthalene and other PAH, phenol, cyanide and ammonia above the assessment criteria were encountered.

#### **5.4 ERM (2010)**

ERM (2010) presents an 'overarching' remediation action plan (RAP) for the same area (covering 22 ha) investigated in ERM (2007) and ERM (2008). Options to treat or manage the contamination are presented for different Areas (1 to 4) within the investigation area. Part of the subject site falls within Area 2 and part of the subject site falls within Area 4. Area 1 and Area 3 are approximately 25 m to the south of the subject site.

The preferred remediation option for Area 2 was excavation, *ex situ* treatment (if needed) and reuse of treated materials in other areas. Surplus soils would be disposed off-site.

The preferred remediation option for Area 4 was on-site management. Some hotspots of heavily impacted materials may require excavation, treatment and disposal off-site if it were to be determined that they could not be effectively managed on-site in accordance with a human health and environment risk assessment.

ERM (2010) makes reference to Coffey Environments Pty Ltd (Coffey), *Preliminary Environmental Investigation*, 2008 which has not been sighted by DP. It is noted that bore CEBH1 was positioned at the south of the subject site. The borehole locations are included in Figure 4 from ERM (2010), provided in Appendix A of this PSI. No data or borehole logs from Coffey's investigation were presented in ERM (2010).

#### **5.5 Environ (2010)**

Environ (2010) presents a Site Audit Report on the review of ERM (2010) (as well as other previous reports). The Auditor considered that ERM (2010) provided an adequate basis for development of a RAP or remediation work plan (RWP) for each of the four Areas at Barangaroo.

#### **5.6 JBS (2011a)**

JBS (2011a) comprised a remediation action plan for the 'Headland Park Site'. The western part of the subject site extends into the Headland Park Site. Whilst the plan related to the Headland Park Site, materials (fill / soil / rock) from other parts of the broader Barangaroo site were proposed to be relocated to the Headland Park Site.

A summary of history for the broader Barangaroo site was provided in JBS (2011a). Over the 1900s the precinct was occupied by shipping and related merchants. A gasworks was operated by The Australian Gas Light Company (AGL) over the period of approximately 1840 to 1925. The gasworks (located approximately 25 m to the south of the subject site) extended across what is now Hickson Road. The original shoreline was altered to enable the constitution of a number of finger wharves and associated activities, with these being reclaimed over the period spanning the 1950s to 1970s. From the 1990s, the Barangaroo site was used principally for stevedoring purposes. From circa 2006, the majority of the buildings were demolished, and the land prepared for redevelopment.

A summary of the history of the Headland Park site was also provided in JBS (2011a). From 1840 to 1910 the Headland Park Site was owned by merchants, composers, manufacturers and various shipping companies and was also used for ship berthing and associate activities. Ownership was largely transferred to Sydney Harbour Trust Commissioners (SHTC) in approximately 1910 and the Headland Park Site was largely used for ship berthing and associated activities such as workshops and stores. Ownership was transferred to the Maritime Services Board of NSW and subject to various commercial leases. The finger wharves were removed over time with a significant portion of land reclaimed with fill between 1951 and 1972. In 1998, Marine Ministerial Holding Corporation and Sydney Ports Corporation owned different parts of the Headland Park Site. In 2007-2008, Patrick Stevedores Operations vacated, warehouses were demolished, and the land was predominantly cleared and levelled in preparation for future redevelopment, with the exception of the Temporary Cruise Passenger Terminal.

Results of previous sampling by JBS were referenced including for bore JBS307 which was at the western part of the subject site. Borehole logs were not provided in JBS (2011a). The borehole locations are included in Figure 11 from JBS (2011b), provided in Appendix A.

Remediation works within the Headland Park site were to include excavation of contamination hotspots followed by management on-site or, otherwise, off-site disposal. Where materials were to be reused at the Headland Park Site, ongoing management via the development and implementation of an appropriate Long Term Environmental Management Plan would be required.

## **5.7 JBS (2011b)**

JBS (2011b) is a human health and ecological risk assessment for 'Headland Park' and 'Northern Cove' (now identified as Nawi Cove) development. For the purpose of the risk assessment, Headland Park was to be used for recreational purposes with indoor commercial / industrial exposure limited to 'the Car Park, Cultural Space, and Gardeners'.

It was proposed that surplus materials from the central and southern portions of the larger Barangaroo site would be used within the development. It was estimated that 500 000 m<sup>3</sup> would be required for the final landform. The western part of the subject site encroaches into the area assessed for the risk assessment.

Constituents of potential concern were found by JBS to include metals (copper, lead and zinc), TPH, BTEX, PAH, phenols, cyanides, ammonia, sulfates and asbestos. JBS noted that volatile organic compounds may have also been present (but had not been previously tested).

## 5.8 JBS (2012a)

JBS (2012a) presents a human health and ecological risk assessment for proposed imported soils (filling) for 'Barangaroo Central'. Barangaroo Central refers to the central part of Barangaroo comprising part of (the previous) Lots 5 and 6, Deposited Plan 876514. It was proposed to be initially to be developed as 'Barangaroo Stage 1 Public Domain' and later for a combined high density residential / recreational land use. It appears that the western part of the subject site is within the northern part of Barangaroo Central.

It was anticipated that imported fill materials (estimated to be between 80 000 m<sup>3</sup> and 150 000 m<sup>3</sup>), including surplus materials from other portions of Barangaroo would be used to form the landscaped areas for the Barangaroo Stage 1 Public Domain.

With regard to human health, constituents of potential concern for the assessment of imported soils were listed as ammonia; metals (arsenic, chromium, copper and lead); cyanide; BTEX; styrene; 1,2,4-trimethylbenzene; TPH; PAH; phenol; 2,4-dimethylphenol; and cresols. Asbestos was also noted to be a potential constituent.

With regards to ecology and surface water protection, criteria for assessment of imported soils were established for metals (arsenic, cadmium, chromium (III), chromium (VI), cobalt, copper, lead, mercury, nickel, vanadium and zinc); free cyanide, ammonia, TPH, BTEX, styrene, PAH, phenol, cresols, and 2,4-dimethylphenol.

## 5.9 JBS (2012b)

JBS (2012b) presents the findings of an additional soil and groundwater investigation at Barangaroo Central designed to complement the findings of previous investigations.

Soil sampling was conducted at 52 locations (BH501 to BH552). It appears that BH501, BH502, BH503, BH511, BH523 and BH537 were drilled within the western part of the subject site and a number of other bores were drilled in close proximity of the site. A total of 24 groundwater monitoring wells were installed to complement seven existing monitoring wells. It appears that groundwater monitoring wells MW501 and MW502 were positioned within the western part of the subject site. Borehole logs were provided in JBS (2012b). The borehole locations are included in Figure 7 from JBS (2012b), provided in Appendix A.

Fill materials were observed at each location, generally comprising silty sands, gravelly sands, and silty sandy clays. Fill materials were observed to extend to greater depths at the west of Barangaroo Central. Hydrocarbon odours were observed at four soil sampling locations (but not at the above-listed soil sample locations that were within the subject site). Various odours were observed in groundwater including ammonia and hydrocarbon odours.

Selected soil samples were analysed for metals (arsenic, cadmium, chromium, copper, mercury, nickel, lead and zinc), PAH, volatile organic compounds (VOC), and Suspension Peroxide Oxidation Combined Acidity and Sulphur (SPOCAS). Selected samples were also subject to column leachate testing for metals and PAH. Results for soil were compared to criteria sourced from NEPC (1999) for recreational / open spaces and other ecological criteria determined in JBS (2011b).

For soil, concentrations of PAH in a number of samples were found to be above the adopted investigation criteria for human health. A lead concentration exceeded the adopted health-based investigation criterion in one sample. Concentrations of arsenic, copper, lead, mercury, nickel, zinc and PAH were reported to be above the adopted ecological investigation levels.

Potential ASS were identified in both fill and natural soils.

Selected groundwater samples were analysed for metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc), PAH, ammonia and VOC. Results for groundwater were not compared to assessment criteria.

Metals, PAH, VOC (including BTEX) and ammonia were identified in groundwater at concentrations above the practical quantitation limits.

Tar impacted materials (filling and natural soils) were observed at the south-east of Barangaroo Central and were considered by JBS to be potentially acting as a source of groundwater contamination.

### **5.10 JBS (2012c)**

JBS (2012c) summarised the remedial strategy for the Waterfront Promenade and Interim Public Domain for Barangaroo Central. The summarised information is sourced from an earlier version (Revision E) of JBS (2013c) (see Section 5.14). The Waterfront Promenade and Interim Public Domain area is not clearly shown in JBS (2012c) but may have included some of the western part of the subject site.

### **5.11 JBS (2012a)**

JBS (2013a) provides an assessment of the potential risk associated with soil and groundwater contamination to occupants of proposed basements for residential developments at Barangaroo Central.

The potential constituents of concern for the assessment were identified as ammonia, cyanide, BTEX, PAH, styrene and 1,2,4-trimethylbenzene.

### **5.12 Driscoll (2013)**

Driscoll (2013) provides a review with respect to asbestos contamination at Barangaroo. At the time of the review, construction activities were being undertaken at Barangaroo South and Barangaroo North (which are not part of the site). Barangaroo Central was being used for offices, sheds, car parks, etc. The cruise ship passenger terminal on the junction of Barangaroo North and Barangaroo Central was due to close in April 2013.

Asbestos contamination was identified at Barangaroo South and, during excavation, was found to be more widespread than expected (from borehole data). It is noted that Barangaroo South is outside the subject site boundary. JBS (2011b) allowed for the material at Headland Park to be up to 1% asbestos, as long as the material was buried more than 0.5 m under the surface; however, the possibility of using

material with this degree of contamination in the construction raised concerns amongst several parties. Asbestos in soil had also been identified at Barangaroo North during excavation works (despite not being identified from boreholes).

It was noted by Driscoll that the risk assessment *predicts that the end result of the finished Headland Park would have an acceptably low level of risk arising from potential asbestos exposure, but it does not provide an assessment of the safety or acceptability of the planned work practices.*

Amongst other findings, it was stated that *the initially proposed work practices for re-use of material from the Southern zone were not appropriate because they allowed an asbestos concentration of up to 1% ACM (rather than less than 0.01% as required) and did not require the removal of visible ACM.*

### **5.13 JBS (2013b)**

JBS (2013b) provides a human health risk assessment at Barangaroo Central for the proposed (interim) Barangaroo Central Stage 1 Public Domain development and (final) combined high density residential / recreational development.

The potential constituents of concern for soil were listed as lead and PAH. The potential constituents of concern for groundwater were listed as arsenic, lead, nickel, ammonia, PAH, BTEX, styrene and trimethylbenzenes.

It was concluded that the Barangaroo Central site did not pose an unacceptable level of human health risk for a proposed recreational / open space use subject to growing media (soils) being imported for near surface use in vegetated areas and pavement / surface cover being provided to remaining site areas. It was recommended that a Remedial Action Plan was prepared for the proposed residential use.

### **5.14 JBS (2013c)**

JBS (2013c) presents a remediation action plan for the proposed (interim) Barangaroo Central Stage 1 Public Domain development and (final) combined high density residential / recreational development at Barangaroo Central.

The principal constituents of potential concern were listed as metals (arsenic, cadmium, copper, lead, nickel and zinc), TPH, PAH, monocyclic aromatic hydrocarbons (MAH), and ammonia. Asbestos was also a contaminant of concern.

Asbestos and tar impacted soil at the southern part of Barangaroo Central (i.e., not within the subject site) required remediation. The remediation / management approach was to be as follows:

- JBS considered that surface soils on all of Barangaroo Central were unsuitable to be used as a growing medium and appropriate soils would need to be imported for a growing media in landscaped areas;
- Shallow tar impacted material (<10 m') would be excavated and disposed off-site;

- Deep tar impacted material (>10 m') was to remain *in situ* and be subject to on-going monitoring / management;
- Excavation and off-site removal of the identified asbestos impacted soil. The asbestos was identified as fibre bundles in fill at one location (BH401);
- Incorporation of groundwater control walls for the southern basement; and
- On-going management through development and implementation of a long-term environmental management plan.

### **5.15 Environ (2013)**

Environ (2013) is a Site Audit Report with regard to JBS (2013c).

The Auditor considered that Barangaroo Central could be made suitable for the proposed recreational open space and high-density residential uses subject to conditions. With regard to long term management (post-development) of contamination, the Auditor considered that the management plan must be able to effectively prevent excavation beyond the clean shallow soil, and monitoring of indoor basement space may need to be undertaken.

### **5.16 JBS&G (2013d)**

JBS&G (2013d) presents the implications of modifications (as of September 2013) to the proposed development of Barangaroo Central with respect to contamination and previous assessments. The modifications included changes to the footprints, heights and floor areas of proposed buildings.

It was considered by JBS&G that the proposed modifications did not affect the applicability of previous assessments, although the more recent reports would have to be made consistent with the proposed development.

### **5.17 JBS&G (2014)**

JBS&G (2014) presents the implications of modifications (as of March 2014) to the proposed development of Barangaroo Central with respect to contamination and previous assessments. The modifications included changes to the footprints, heights and floor areas of proposed buildings.

It was considered by JBS&G that the proposed modifications did not affect the applicability of previous assessments, although the more recent reports would have to be made consistent with the proposed development.

### 5.18 Jacobs (2016)

Jacobs (2016) comprises a preliminary (Phase 1) investigation for the Sydney Metro City & Southwest. With regard to proposed works at Barangaroo, findings of the investigation included:

- There was a high probability of encountering ASS;
- There were major industrial developments since the 1950s and 1960s. There were major reclamation works since the 1960s; and
- The former gasworks at Millers Point / Barangaroo was considered to pose a potential risk to construction activities.

### 5.19 DP & Golder (2017)

DP & Golder (2017) presents factual results of a contamination investigation for the proposed Tunnel and Station Excavation (TSE) Works package between Chatswood and Sydenham. The investigation includes boreholes and excavations.

Borehole SRT\_BH034 (coordinates 333721.9 E, 6251995.6 N MGA94 Zone 56) was located at a central part of the subject site (on Hickson Road). Asphalt and concrete pavement (0.4 m thick) was underlain by brown gravelly sand filling with some tile fragments and sandstone cobbles to a depth of 2.2 m bgl. Fill was underlain by orange-brown and grey sand with some ironstone gravel to a depth of 2.65 m bgl, then orange-brown and grey sandstone to a depth of 6 m bgl, dark grey siltstone to a depth of 7.1 m bgl, dark grey laminite to a depth of 9.7 m bgl and grey sandstone to a depth of 25.1 m bgl. Groundwater was observed at a depth of 2.2 m bgl. A groundwater monitoring well was installed at this location.

Borehole SRT\_BH035 (coordinates 333730.8 E, 6251878.8 N MGA94 Zone 56) was located at the southern part of the subject site (on Hickson Road). Asphalt and concrete pavement (0.34 m thick) was underlain by filling to a depth of 4 m bgl. Fill comprised grey and brown sandy gravel; grey, orange and brown sandy cobbles with boulders; orange, red and brown clayey gravelly sand with cobbles; and orange, brown and grey silty sand. Fill was underlain by dark grey gravelly sand with some shells and orange and red clayey sand to a depth of 6.85 m bgl. Natural soil was underlain by orange, brown, red and grey sandstone to a depth of 13.71 m bgl, then grey siltstone to a depth of 14.74 m bgl and grey sandstone to a depth of 31.37 m bgl. A groundwater monitoring well was installed at this location. Groundwater was observed at a depth of 2.75 m bgl.

Borehole SRT\_BH072 (coordinates 333734.1 E, 6251830.8 N MGA94 Zone 56) was located at the southern part of the subject site (on Hickson Road). Asphalt and concrete pavement (0.8 m thick) was underlain by filling to a depth of 3 m bgl. Fill comprised orange and brown, sandstone gravels cobbles and boulders with some sand; and brown clayey sand. Some slag was observed in the filling from a depth of 1.5 m bgl to 3 m bgl. Fill was underlain by black sand; black clayey silt; and orange and brown clayey sand to a depth of 5.23 m. Natural soils were underlain by orange-brown and grey sandstone to a depth of 25.36 m bgl. Groundwater was encountered at a depth of 3.5 m bgl. A groundwater monitoring well was installed at this borehole as well as another, relatively shallow, borehole (SRT BH072A) which was installed immediately next to borehole SRT\_BH072 bgl.

Borehole SRT\_BH073 (coordinates 333734.1 E, 6251830.8 N MGA94 Zone 56) was located on Hickson Road at the central part of the subject site. Asphalt and concrete pavement (0.35 m thick) was underlain by fill comprising orange brown sandstone boulders; black sand; orange brown sandstone cobbles; and orange and grey clayey sand to a depth of 2.3 m bgl. Fill was underlain by grey sand to a depth of 6 m bgl, then red, orange, grey and brown sandstone to a depth of 15 m bgl. A groundwater monitoring well was installed at this borehole. Groundwater was encountered at a depth of 2.2 m bgl.

Selected soil samples from the above listed boreholes were analysed for metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc), TRH, PAH, OCP, PCB, VOC, semi-volatile organic compounds (SVOC), asbestos, cations, electrical conductivity, pH, chloride, sulfate, SPOCAS field test, SPOCAS and chromium reducible sulphur. TCLP analysis (for lead and PAH) was conducted on selected samples. Analytical results for soil were compared to criteria from:

- National Environment Protection Council, *National Environment Protection (Assessment of Site Contamination) Measure*, 1999 amended 2013 (NEPC, 2013). Criteria for a commercial/industrial land use ('D') were adopted;
- NSW EPA, *Waste Classification Guidelines*, 2014 (NSW EPA, 2014); and
- Acid Sulfate Soil Advisory Committee, *Acid Sulfate Soil Manual*, 1998 (ASSMAC, 1998).

For soil samples from SRT\_BH034, reported concentrations of metals and PAH were above the limit of reporting. Reported concentrations of TRH, BTEX, OCP and PCB were below limit of reporting. Results did not indicate the presence of ASS.

For soil samples from SRT\_BH035, reported concentrations of metals, PAH, TRH >C<sub>10</sub>-C<sub>16</sub>, TRH >C<sub>16</sub>-C<sub>34</sub> and TRH >C<sub>34</sub>-C<sub>40</sub> were above the limit of reporting. The concentrations of benzo(a)pyrene TEQ and total PAH in the sample from a depth of 3 m was above the health-based criterion. The concentration of benzo(a)pyrene was also above the criterion for restricted solid waste (i.e., at a hazardous waste concentration). Reported concentrations of BTEX, TRH C<sub>6</sub>-C<sub>10</sub>, OCP and PCB were below the limit of reporting. Asbestos was not detected at the limit of reporting. Results indicated the possibility of the presence of ASS.

For soil samples from SRT\_BH072, reported concentrations of metals, PAH, carbazole (a SVOC), TRH >C<sub>10</sub>-C<sub>16</sub>, TRH >C<sub>16</sub>-C<sub>34</sub> and TRH >C<sub>34</sub>-C<sub>40</sub> were above the limit of reporting. In the sample from depth 1-1.1 m, concentrations of benzo(a)pyrene and PAH were above the criteria for general solid waste (i.e., at restricted solid waste concentrations). In the sample from depth 2.5-2.6 m, concentrations of benzo(a)pyrene and PAH were above the criteria for restricted solid waste (i.e., at hazardous waste concentrations), and concentrations of benzo(a)pyrene TEQ and PAH were above the health-based assessment criteria. Reported concentrations of VOC, BTEX, TRH C<sub>6</sub>-C<sub>10</sub>, OCP and PCB were not detected above the limit of reporting. Asbestos was not detected at the reporting limit. Results indicated the possibility of the presence of ASS.

For soil samples from SRT\_BH073, reported concentrations of metals, PAH, TRH >C<sub>10</sub>-C<sub>16</sub>, TRH >C<sub>16</sub>-C<sub>34</sub>, TRH >C<sub>34</sub>-C<sub>40</sub> were above the limit of reporting. Reported concentrations of BTEX, TRH C<sub>6</sub>-C<sub>10</sub>, OCP and PCB were below the limit of reporting. Asbestos was not detected at the reporting limit. Results indicated the possibility of the presence of ASS.

Analytical results for groundwater testing were assessed against criteria sourced from:

- NEPC (2013). Health screening levels for vapour intrusion for a commercial/industrial land use ('D') were adopted;
- National Health and Medical Research Council and National Resource Management Ministerial Council, *Australian Drinking Water Guidelines*, 2011 (NHMRC & MRMMC, 2011); and
- ANZECC & ARMCANZ (2000).

A groundwater sample from SRT\_BH035 was analysed for metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc, iron and manganese), TRH, BTEX, PAH, alkalinity, ionic balance, total dissolved solids, total organic carbon, total nitrogen, ammonia, phosphate and sulfur reducing clostridium. Concentrations of TRH C<sub>6</sub>-C<sub>10</sub>, benzene and xylene were reported above the limit of reporting but at concentrations within the health-based criteria for vapour intrusion. Concentrations of benzene and xylene were within the ecological criteria.

Groundwater from SRT\_BH072 was analysed for metals (arsenic, boron, cadmium, chromium, cobalt, copper, lead, mercury, nickel, zinc, iron and manganese), TRH, BTEX, PAH, alkalinity, ionic balance, total dissolved solids, total organic carbon, total nitrogen, ammonia, phosphate, total cyanide, VOC and SVOC. Reported concentrations of TRH, benzene, toluene, xylene, chloroform, n-propyl benzene, 1,3,5-trimethyl benzene and sec-butyl benzene were above the limit of reporting. TRH C<sub>6</sub>-C<sub>10</sub>, TRH >C<sub>10</sub>-C<sub>16</sub>, benzene, toluene and xylene concentrations were within the health-based criteria for vapour intrusion. Benzene, toluene and xylene concentrations were within the ecological criteria.

A groundwater sample from SRT\_BH072A was analysed for metals (arsenic, cadmium, chromium, cobalt, copper, lead, mercury, nickel, zinc, iron and manganese), TRH, BTEX, PAH, SVOC, VOC, alkalinity, ionic balance, total dissolved solids, total organic carbon, total nitrogen, ammonia, phosphate and total cyanide. Reported concentrations of naphthalene, acenaphthene and 2,4-dimethylphenol were above the limit of reporting. Naphthalene was reported at a concentration slightly above the ecological criterion (but within the health-based criterion for vapour intrusion).

Groundwater from SRT\_BH073 was analysed for metals (arsenic, cadmium, chromium, cobalt, copper, lead, mercury, nickel, zinc, iron and manganese), TRH, BTEX, PAH, VOC, SVOC, alkalinity, ionic balance, total dissolved solids, total organic carbon, total nitrogen, ammonia and phosphate. Reported concentrations of TRH C<sub>6</sub>-C<sub>10</sub>, toluene, xylene, 1,3,5-trimethyl benzene, 1,2,4-trimethyl benzene and naphthalene were above the limit of reporting. Concentrations of TRH C<sub>6</sub>-C<sub>10</sub>, toluene, xylene and naphthalene were within the health-based criteria for vapour intrusion. Concentrations of xylene and naphthalene were within the ecological based criteria. A manganese concentration above the ecological criterion was reported.

## 5.20 ADE (2018)

ADE (2018) provides a management plan for ASS materials to be excavated from the Barangaroo Station (station box extent). It was stated that all fill and natural soils below the observed groundwater levels (1.45 m bgl), except for sandstone bedrock, should be treated as though they potentially contain ASS until such time as analytical results confirm otherwise. A minimum liming rate for excavated ASS was calculated by ADE to be 19.1 kg ag lime (CaCO<sub>3</sub>) / tonne.

## 5.21 DP (2018a)

DP (2018a) provides a draft remediation action plan that is specific to the station box extent (as shown on the General Arrangement Plan, Appendix A). The excavation at the station box extent was to be to depths of 27.4 m bgl (at Hickson Road) and 16.9 m bgl (at the west). In brief, the remediation strategy comprised:

- *Ex situ* waste classification of spoil from the archaeological excavations followed by off-site disposal;
- Excavation of fill with a restricted solid waste or hazardous waste classification for off-site disposal followed by validation testing;
- Excavation of remaining fill (classified as general solid waste) and management of potential ASS accordance with the ASS management plan for off-site disposal;
- Enactment of an unexpected fines protocol if signs of contamination are noted during excavation;
- Excavation of natural soils and disposal in accordance a waste classification and the ASS management plan; and
- Testing of the upper surface of potential virgin excavated natural material (VENM) followed by off-site disposal of identified non -VENM soils and off-site disposal of VENM.

Any contaminated groundwater was to be assessed and managed as required by the environmental protection licence for the project.

Sampling frequencies and field methods for sample collection were outlined for the remediation / validation works. Laboratory analytical requirements were also outlined.

## 5.22 DP (2018b)

DP (2018a) comprised a preliminary site investigation particular to the station box extent (as shown on the General Arrangement Plan, Appendix A) and the northern shaft on Hickson Road. The investigation comprised a review of previous reports; a review of geology maps, soil maps and the registered groundwater bore database; a review of historical information including title deeds, aerial photographs, NSW EPA public registers, and a Section 149 certificate; and a site walkover.

Aerial photographs indicated that Hickson Road and nearby properties to the east were constructed prior to 1930. Parts of Hickson Road were likely filled for its construction according to the Soil Landscape Sheet and previous investigations. According to historical title deeds and previous reports, two previous warehouses, constructed prior to 1930, were likely used as part of shipping and stevedoring operations up until the 1960s. One of the warehouses had been demolished by 1970. The other was demolished by 1982. The former gasworks, approximately 100 m to the south of the station box extent operated between 1841 and the 1920s.

By 1970, the finger wharves adjacent to the station box extent had been removed and extensive filling of the harbour had commenced. By 1982, the western part of the station box extent and adjacent land to the west had been completely transformed. At this time, the western part of the site was part of large area used for shipping operations. Previous reports indicated that fuels and dangerous goods were stored for shipping operations, although these storages (including above ground and below ground

tanks) were not located at or near to the station box extent. A vehicle wash bay appeared to have been positioned adjacent to and west of the station box extent. By 2010, structures associated with the shipping operations had been removed.

By 2012, a passenger terminal for cruise ships had been established to the west of the station box extent and a structure had been built at the western part of the station box extent and was presumably associated with the terminal. The passenger terminal had been removed by 2013 and (likely) site sheds had been positioned at the western part of the station box extent at that time. Some construction activities at Barangaroo North and Barangaroo South appeared to have commenced by 2012 and became more intensive in 2013.

In 2014, Barangaroo Central, Barangaroo North and Nawi Cove were subject to extensive earthworks. The western part of the station box extent appeared to have been occupied by site sheds for these works. By 2017, these site sheds had been removed and replaced by a lawn and new trees, although a small part of the station box extent was being used for site sheds or storage containers for nearby construction activities. Aerial photographs indicate that the station box extent was not subject to extensive earthworks between 2013 and 2017 despite the establishment of the lawn area. It was presumed that clean topsoil was imported into the lawn area as a growth medium, although it is noted that a validation of remediation report had not been sighted by DP.

Identified potential sources of contamination included imported filling, historical spills or leaks of fuels or chemicals, demolition of structures containing hazardous building materials and contaminated groundwater from off-site.

A sampling and analysis plan for a detailed site investigation was prepared. The proposed sampling was to be from the drilling of test bores, the excavation of test pits, and groundwater monitoring wells across the station box extent and northern shaft. Selected soil samples were to be analysed for metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc), free cyanide, TRH, BTEX, PAH, OCP, OPP, PCB, total phenols, VOC and asbestos (and possibly coal tar and TRH with silica gel clean up). Soil samples were also to be subject to ASS field screening and SPOCAS and/or Chromium Reducible Sulphur tests. Groundwater samples were to be analysed for hardness, dissolved (aluminium, arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, zinc, iron and manganese), ionic balance (chloride, carbonate, bicarbonate, sulfate, sodium, potassium, calcium and magnesium), total dissolved solids, sulfide, forms of nitrogen (total nitrogen, nitrate, and ammonia), total organic carbon, TRH, BTEX, PAH, OCP, OPP, PCB, speciated phenols, free cyanide and VOC.

### 5.23 DP (2018c)

The purpose of DP (2018c) was to supplement the findings of DP, *Report on Detailed Site Investigation, Sydney Metro City and South West, Tunnel and Station Excavation Works Package, Proposed Barangaroo Station, Hickson Road, Barangaroo*, May 2018 (Ref 85608.08.R.001 Rev1) at the station box extent (as shown on Drawing 1, Appendix A). DP (2018c) provides the results of soil and groundwater investigations undertaken by DP.

The detailed site investigation comprised drilling of 16 boreholes and installation of eight (five deep and three shallow) groundwater monitoring wells, and the collection and analysis of representative soil samples from bore holes and groundwater samples from monitoring wells. The detailed site investigation locations (BRBH01, BRBH03, BRBH05, BRBH06, BRBH09, BRBH12, BRBH14, BRBH21,

BRMW02, BRMW04, BRMW07, BRMW10, BRMW11, BRMW15, BRMW16 and BRMW17) are shown on Drawing 1 (extracted from DP (2018c)), Appendix A. Elevated lead concentrations for soil were noted and metals, PAH, OCP and TRH were identified in groundwater.

DP, *Acid Sulphate Soil Management Plan, Sydney Metro City and South West, Tunnel and Station Excavation Works Package, Proposed Barangaroo Station, Hickson Road, Barangaroo*, April 2018 (Ref 85608.08.R.001 Rev1) stated that, *based on current results, all soils sourced from between the water table and the top of sandstone should be managed as potentially containing ASS unless previous or additional in situ and / or ex situ testing shows otherwise. However, this may be able to be further refined with further testing.*

Field work for DP (2018c) include drilling of seven boreholes (BRBH22 to BRBH28). The sample locations are shown on Drawing 1 (extracted from DP (2018c)), Appendix A. Selected soil samples were analysed for metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc), free cyanide, TRH, BTEX, PAH, OCP, OPP, PCB, total phenols, VOC and asbestos. For the purpose of waste classification assessment, a TCLP test was conducted on selected filling samples with elevated concentrations of contaminants. Selected fill and natural soil samples were also screened for ASS and analysed for chromium reducible sulphur suite (for ASS). Analytical results were assessed against criteria from NEPC (2013), NSW EPA (2014), and ASSMAC (1998).

At the seven boreholes for DP (2016c), fill (typically beneath asphaltic concrete and/or concrete slabs) was encountered to variable depths of up to 5.95 m bgl. Fill comprised road base materials and dark brown / grey / black / orange / yellow sand, clayey sand and sandy clay with some fine to coarse gravel and crushed sandstone. Fill was underlain by yellow to light grey sandstone. Anthropogenic inclusions such as brick, concrete or asphalt were observed in the fill in a number of boreholes. Groundwater was observed at depths ranging between 1.5 m and 3.1 m bgl. A slight sulfur odour was noted in the fill at one location (and could be associated with ASS).

The borehole logs for the detailed site investigation show that fill depths were between 0.4 m and 14 m bgl. Fill comprised roadbase (grey sandy gravel) and brown / grey / orange / yellow clay, sand and gravel. Fill was underlain by brown / yellow / grey sand and clayey sand at some locations, and by grey / yellow / orange / brown sandy clay and silty sandy clay at other locations. Yellow / white / grey sandstone was encountered from depths of between 0.7 m and 14 m. Groundwater was encountered at some locations, at depths between 1.9 m and 2.5 m bgl.

For soil, elevated concentrations, with respect to the health-based site assessment criteria, of benzo(a)pyrene TEQ and lead were noted. The results for ASS testing identified ASS to be present in the fill and natural soils between the water table and sandstone bedrock. The liming rates determined by the laboratory for samples identified as ASS were between 1.6 kg and 44 kg of CaCO<sub>3</sub> per tonne of soil. Based on elevated total PAH, benzo(a)pyrene, lead and mercury concentrations, some of the fill was provisionally classified as hazardous waste and restricted solid waste (with the remainder classified a general solid waste). Natural soils above the bedrock could not be classified as VENM given the presence of ASS. Some of the sandstone bedrock could not be classified as VENM due to the presence of PAH and / or metals.

#### **5.24 PSM (2018)**

PSM (2018) provides a hydrogeological interpretive report for the Tunnel and Station Excavation works for the Marrickville to Chatswood section of Sydney Metro. Two primary sources of contamination which may influence the quality of water draining into the planned Barangaroo station box cut and cavern were identified to be the former gasworks located approximately 100 to the south and reclaimed lands to the immediate west. Significant in context to the tunnel and station excavation works is that the most contaminated groundwater is in the sandstone and not the overlying alluvium.

#### **5.25 ADE (2019)**

ADE presents a Sampling, Analysis & Quality Plan (SAQP) for the waste classification of fill and (chemically) impacted natural materials to be excavated during construction works at the Barangaroo Station (station box extent) as part of the Sydney Metro & South West, Tunnel & Station Works Package. The proposed analytical suite to address the contaminants of potential concern were listed by ADE and included: metals (mercury, cadmium, lead, arsenic, chromium, copper, nickel, zinc and manganese), PAH, TRH, BTEX, asbestos, PCB, OCP, OPP, phenols, ammonia, cyanide, VOC, and field screening tests and chromium reducible sulfur for ASS.

#### **5.26 DP (2019)**

DP (2019) provides an addendum to DP (2018a) for the station box extent. Monitoring of groundwater seepage into the station box and sampling from new groundwater wells was proposed. Contaminants to be assessed included: OCP, PAH, TRH, BTEX, monocyclic aromatic hydrocarbons (MAH), cyanide, ammonia, phenol and metals.

#### **5.27 Metron (2021)**

Metron (2021) provides a vapour intrusion risk assessment for the Barangaroo Station as part of the Tunnel and Station Excavation works package. Chemicals of potential concern (in groundwater) for the assessment included TRH, benzene, toluene, ethylbenzene, xylene, naphthalene, ammonia and phenols.

#### **5.28 DP (2021)**

DP (2021) presents the methodology and results for the validation of remediation undertaken for the station box extent.

DP (2021) records that piling works commenced in February 2018 and general excavation works began in July 2018 and were completed in November 2019. Excavation depths were 27.7 m bgl at Hickson Road and 16.9 m bgl at the western portion.

Waste classification assessments were conducted on both *in situ* and stockpiled soils. Some of the stockpiles were identified to contain ASS and supplementary reports were prepared following lime-treatment. Excavated soil and rock was disposed as either general solid waste, restricted solid waste, hazardous waste, excavated natural material (ENM) or VENM.

To segregate waste types, delineation sampling was undertaken. Delineation samples were tested for PAH and / or metals (most commonly lead).

Discharge water monitoring was undertaken by the on-site contractors. It was understood that water discharge reporting was to NSW EPA in accordance with their environmental protection licence requirements. Water samples were tested for TRH, VOC, PAH, OCP, phenols, ammonia, cyanide, oil and grease, pH, total suspended solids (TSS), turbidity, alkalinity, calcium, chloride, sulfate, metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc, chromium VI, chromium III, iron, manganese and aluminium).

It was concluded that all on-site contamination sources (at the station box extent) had been removed and appropriately validated and do not pose a risk to future site users; and off-site sources have been assessed to not present a risk to human health (to future users of the station box extent development).

The validation report was to be reviewed by a Site Auditor and formed the basis for the issuance of a Site Audit Statement.

## 6. Historical Aerial Photography

Historical aerial photographs were obtained and are provided in Appendix D. The aerial photographs were reviewed to identify possible past uses and features of the site and surrounding area. The findings are summarised below.

**1930:** Despite the low quality of the image, it appears that Hickson Road had been established (at the eastern part of the site) and warehouses were present at the site, to the west of Hickson Road. The warehouses may have been associated with the adjacent finger wharves and used for shipping / stevedoring. A road was present in between warehouses. The western part of the site was part of Sydney Harbour and the western-most part of the site appears to have been at one of the finger wharves. Bridges crossed over Hickson Road. The land surrounding the site was developed with primarily (apparent) residences to the east and primarily (apparent) commercial and industrial properties at the north.

**1943:** It appears that the site and surrounding area was relatively unchanged since 1930.

**1951:** It appears that the site and surrounding area was relatively unchanged since 1943.

**1961:** It appears that the site and surrounding area was relatively unchanged since 1951.

**1970:** One of the warehouse buildings which covered part of the site had been removed (since 1961) along with the nearby finger wharves. It appears that filling (reclamation) of the harbour was taking place to the west and south-west where finger wharves were previously located. The site and surroundings were otherwise relatively unchanged since 1961.

**1982:** Warehouses and the road in between the warehouses had been removed and substantial filling had occurred at the site to the west of Hickson Road (since 1970). The land (to the west of Hickson Road) was covered by hardstand (asphalt or concrete) and was used for storage and vehicle access as part of shipping operations. A bridge over Hickson Road had been removed since 1970. Large warehouses had been established beyond the site boundary where there had been extensive filling. Many of the commercial and industrial structures on nearby land to the north-west had been removed.

**1991:** Apart from a structure being established at the site, to the west of Hickson Road, it appears that the site and surrounding land was relatively unchanged since 1982.

**2000:** Apart from the planting of trees on the western side of Hickson Road, the site appears to have been relatively unchanged since 1991. The surrounding land also appears to have been relatively unchanged.

**2007:** The site appears to have been relatively unchanged since 2000. A large building appears to have been established at nearby land to the north.

**2011:** The site and nearby land to the north-west, west and south-west was no longer used for shipping operations, with the large warehouses (beyond the site boundary) being removed leaving concrete or asphalt hardstand. A passenger terminal for cruise ships had been established at the western end of the site and adjacent land.

**2014:** Land to the west of Hickson Road, including the site, was subject to major construction activities including excavation and earthmoving. Site sheds (or similar structures) appear to have been established at the site, alongside Hickson Road. The passenger terminal had been removed. What appears to be water treatment facilities had been established at nearby land to the south-west of the site.

**2016:** The construction activities in 2014 appear to have been completed, with the establishment of Nawi Cove, adjacent to the west of the site, and Barangaroo Reserve, a landscaped area to the north-west. Much of the western part of the site was publicly accessible, with lawn covered areas, trees and pedestrian access. Part of the western part of the site remained as hardstand as with much of the adjacent land to the south-west. Much of the nearby land to the north and east of the site was used for residential and commercial purposes.

**2019:** The excavation for Barangaroo Station was present at Hickson Road and extended to the west of Hickson Road. Most of the site west of the excavation was used as part of the contractor compounds although the north-western part of the site remained similar to that in 2016. Hickson Road had been modified to provide vehicle access over the excavation and to the contractor compounds. A structure, associated with the Barangaroo Station construction activities, had been established at the north of the site on Hickson Road. Adjacent land to the south-west of the site appears to have been intensively used as a contractor compound (for activities not associated with Barangaroo Station). Land surrounding the site to the east and north had remained relatively unchanged since 2016.

**2021:** The site was similar to that in 2019, although construction activities within Barangaroo Station excavation were well underway. Some of the nearby land to the south-west of the site was no longer used as a contractor compound. Otherwise, land surrounding the site appears to have been relatively unchanged since 2019.

## 7. NSW EPA Public Registers

A search of the NSW EPA website on 22 September 2021 indicated that:

- A licence under the *Protection of the Environment Operations Act, 1997* (POEO Act) was issued to Multiplex Constructions (NSW) Pty Ltd in 2000 for the discharge of water at Walsh Bay Pier 8/9, Towns Place, Millers Point for the repair of the pier structure. This location is approximately 130 m to the north-east of the subject site. The licence was surrendered in 2001;
- A licence under the POEO Act, was originally issued to Infrastructure NSW / Barangaroo Delivery Authority in 2010 for the premises at Barangaroo and a portion of Hickson Road (near to 30-38 Hickson Road). Scheduled activities under the licence included: contaminated groundwater treatment; crushing, grinding or separating; land-based extractive activity; and shipping in bulk. Monitoring of air quality, ambient water quality and discharge water quality was required at certain locations. Water concentration limits were set for metals, PAH, ammonia, TPH, BTEX, cyanide, oil and grease, pH, phenol, total suspended solids and turbidity. NSW EPA conducted a compliance audit in 2013. Non-compliances were listed under the licence which was surrendered in 2019;
- Penalty Notices were issued to Barangaroo Delivery Authority and Acciona Infrastructure Projects Australia Pty Ltd in 2016 for polluting waters at Barangaroo (Barangaroo South / Central and a portion of Hickson Road near to 30-38 Hickson Road);
- In 2017, a licence was issued to John Holland Pty Ltd for the Sydney Metro City & Southwest tunnels and excavation works. The scheduled activities were listed as concrete works and railway infrastructure. Monitoring of water discharge points was required. Water concentration limits were provided for oil and grease, pH and total suspended solids;
- Under the *Contaminated Land Management Act, 1997* (CLM Act), the Former AGL Gasworks at Berths 5, 6, and 7 (already demolished) and part of Hickson Road had a series of Notices issued by NSW EPA including:
  - o A declaration of investigation area in 2007;
  - o A Declaration of Remediation Site in 2009 which, as of 2020, is no longer in force. The land to which the declaration related included part Lot 5 and part Lot 3 in Deposited Plan 876514, and part of Hickson Road adjacent to 30-38 Hickson Road. This area is located approximately 25 m to the south of the subject site. The EPA believed that the site was contaminated with gasworks waste and particularly waste tar as a result of the previous use of the site as a gasworks plant. The chemical composition of gasworks waste was listed to include: PAH, BTEX, TPH, ammonia, phenol and cyanide. Groundwater was found to be contaminated and impacting on surrounding areas;
  - o An approved Voluntary Management Proposal in 2010 which, as of 2015, was withdrawn;
  - o A Management Order in 2015 which, as of 2020, is no longer in force as it had been completed; and
  - o A Site Audit Statement in 2017.
- Under the CLM Act, the Former AGL Gasworks at 36 Hickson Road (Lot 12, DP1065410), listed as being owned by Delmo (No.2) Pty Ltd, has two former Notices. A declaration of investigation area was listed in 2007. The land to which the declaration related included part Lot 5 and part Lot 3 in Deposited Plan 876514, Lot 12 in Deposited Plan 1065410 and part of Hickson Road adjacent to these Lots. The EPA believed that the site was contaminated with PAH, BTEX, copper, lead, phenol and cyanide. Groundwater in the area was found to be contaminated with these chemicals. A Notice to end the significantly contaminated land declaration and management order was issued

in 2009 following a review of investigation results. Lot 12 in Deposited Plan 1065410 is located approximately 100 m to the south of the subject site;

- Several sites in the suburb of Millers Point are on the 'List of NSW contaminated sites notified to the EPA' under the CLM Act. These include:
  - o The Moores Wharf underground petroleum storage system at 4 Towns Place (located approximately 170 m to the north of the subject site);
  - o The former AGL Gasworks at 30-34 Hickson Road (located adjacent to the south of the subject site);
  - o The former AGL Gasworks at 36 Hickson Road (located approximately 100 m to the south of the site);
  - o The former AGL Gasworks at 38 Hickson Road and road reserve (located approximately 140 m to the south of the subject site); and
  - o The former AGL Gasworks at Berths 5, 6 and 7 (already demolished) and part Hickson Road.

## 8. Site Walkover

A site walkover was undertaken by a DP Environmental Engineer on 27 October 2021. The site walkover was limited to the ground level areas of the site. The station box, shaft and tunnels (i.e., areas of previous deep excavation works at the site) were not accessed. Site photographs are provided in Appendix E. Observed features of the site were as follows:

- Hickson Road, at the north of the site, and the acoustic shed for the shaft to the north of the Dalgety Road Bridge. Site sheds were also beneath the bridge;
- An asphalt parking area (to the south of the building at 25 Hickson Road which is off-site and used as a site office);
- A landscaped area next to the building at 25 Hickson Road which leads to “The Cutaway at Barangaroo Reserve”. This area was publicly accessible;
- Large sandstone steps up from Nawi Cove at the west of the site. Temporary fencing allowed for pedestrian access near the bay but not to the sandstone steps;
- Construction hoarding separated pedestrian access alongside Nawi Cove and Sydney Harbour to the construction site which could be accessed from Hickson Road;
- The water treatment plant was situated (within the construction site) to the west of the station box extent. Sludge collection skip bins were observed at the water treatment plant;
- Concrete slabs covered the majority of the construction site to the west of the station box extent;
- An area of exposed soil was present at the western end of the proposed stormwater trunk mains. It was understood that some test pitting investigative works had recently occurred and no soil had been removed from this area; and
- Hickson Road was present at the southern part of the site (to the south of the station box extent). Hickson Road (temporarily) bridges over the station box extent.

Features surrounding site included:

- North: Hickson Road, and commercial and residential buildings;
- North-west: Barangaroo Reserve;
- West: part of the construction site, then a landscaped area alongside Nawi Cove and Sydney Harbour;
- South-west: construction site (mainly vacant), then commercial developments;
- South: Hickson Road and part of the construction site area; and
- West: A sandstone and concrete wall, High Street (which is approximately 10 m above the site), and commercial and residential buildings.

## 9. Discussion

### 9.1 Site History Summary

A summary of site history, based on information reviewed for this report (summarised in previous Sections), is provided below:

- The gasworks operated between 1841 and the 1920s at land approximately 25 m to the south of the subject site. The gas holders and purifiers were demolished and the gas holding tanks backfilled between 1922 and 1925. Apart from the gasworks, much of the general Barangaroo area was likely occupied by shipping companies and related merchants and manufacturers in the mid-late 1800s and early 1900s;
- Hickson Road had been established by 1930. According to the Soil Landscape sheet and previous investigations, part of Hickson Road and land to the west (including at the site) was likely filled for its construction;
- Warehouses were present at the site in 1930 and may have been associated with the adjacent finger wharves and used for shipping / stevedoring (e.g., as bonds stores). A road was present between the warehouses. Part of the site comprised a section of Sydney Harbour and the western-most part of the site appears to have been located at one of the finger wharves;
- By 1970, the finger wharves had been removed. Warehouses at the site (and presumably the road in between the warehouses) were demolished in the 1960s and 1970s. Filling / reclamation of the harbour appears to have taken place following removal of the finger wharves;
- By 1982, the (reclaimed / filled) land to the west of Hickson Road (including at the site) was covered by hardstand (asphalt or concrete) and was used for storage and vehicle access as part of shipping operations, with large warehouses being established beyond the site boundary. Previous reports indicate that fuels and dangerous goods were stored for shipping operations, although these storages (including above ground and below ground tanks) were not located within the site boundary. A vehicle wash bay appears to have been positioned adjacent to the site, alongside Hickson Road;
- By 2010, structures associated with the shipping operations had been removed and by 2011, a passenger terminal for cruise ships had been established at the western end of the site. The passenger terminal had been removed by 2013;

- By 2014, land to the west of Hickson Road, including the site, was subject to major construction activities including excavation and earthmoving. Site sheds (or similar structures) appear to have been established at the site, alongside Hickson Road. The construction activities had been completed by 2016 with the establishment of Nawi Cove, adjacent to the west of the site, and Barangaroo Reserve, a landscaped area to the north-west. Significant volumes of soil may have been transported from the central and southern portions of the Barangaroo area and placed at the reserve (however, a validation report to confirm this reuse has not been sighted by DP). Much of the western part of the site was publicly accessible, with lawn covered areas, trees and pedestrian access; and
- Excavation works for the Barangaroo Station (station box extent), located at the central part of the site occurred in 2018 and 2019 to depths of 16.9 m bgl to 27.7 m bgl. Excavations works for a shaft to the north would have occurred at a similar time and tunnelling for the Metro rail line would have occurred following sufficient excavation of the station box. Most of the site west of the excavation was used as part of contractor compounds. In 2019, adjacent land to the south-west of the site appears to have been intensively used as a contractor compound (for activities not associated with Barangaroo Station) and, by 2021, this land was no longer used as a contractor compound.

A series of NSW EPA Notices and licences were issued by the NSW EPA for the former gasworks site (approximately 25 m to the south of the subject site). The Notices and licences have since been withdrawn or surrendered; however, the former gasworks remains on the list of contaminated sites notified to the EPA. Presumably, the withdrawal of Notices is due to the completion of remediation works at the former gasworks site undertaken between circa 2014 and 2020.

## 9.2 Potential Sources of Contamination and Associated Contaminants

Based on reviewed site history information, the potential sources of contamination at the site are as follows:

- S1 - Imported (extensive) filling used to form/level the site. There appears to be multiple stages of historical filling at the site including prior to the construction of Hickson Road and during the 1970s at the western part of the site. Some of the filling material may have originated from the nearby former gasworks site (a contaminated source). Potential contaminants include: metals (primarily arsenic, cadmium, chromium, copper, mercury, nickel, lead and zinc), TPH, BTEX, PAH, VOC, PCB, OCP, OPP, cyanide, phenols (including cresols), asbestos and ammonia;
- S2 - Historical spills or leaks of fuels or chemicals used at the site (such as during previous shipping operations and similar activities). Potential contaminants include: TPH, BTEX, PAH, VOC, metals and phenols;
- S3 - Demolition of previous structures containing hazardous building materials. Potential contaminants include: PCB (from electrical fixtures), asbestos and lead (from lead-based paint); and
- S4 - Residual contaminated groundwater impacted from historical filling, historical spills or leaks of fuels or chemicals (such as during previous shipping operations and similar activities), or from the (off-site) former gasworks. Potential contaminants include: metals, TPH, BTEX, PAH, VOC, cyanide, phenols (including cresols) and ammonia.

Given that there has been significant land disturbance at the site from circa 2014, much of the contamination data obtained from previous investigations may not be characteristic of the current distribution of materials, site arrangement and contamination status. However, based on a review of previous reports, it is considered that the most highly contaminated soil at the site could be at Hickson Road between the station box extent and the southern site boundary.

Given the extensive fill, there is a moderate to high potential for contamination to present at the west of the station box extent. The potential for contamination to the north of the station box extent is considered to be relatively low given that this area does not appear to have been subject to significant filling.

The potential for contamination within the station box extent is considered to be extremely low given that contamination sources from within the station box extent have been excavated and removed as part of the station construction.

### 9.3 Potential Receptors

Potential receptors of contamination have been identified to include:

- R1 - Future site users;
- R2 - Construction workers (for the project);
- R3 - Future maintenance workers;
- R4 - Adjacent land users;
- R5 - Surface water body (beyond site boundary);
- R6 - Groundwater;
- R7 - Terrestrial ecology; and
- R8 - In-ground building structures.

### 9.4 Potential Pathways

Potential pathways for contamination to impact receptors include the following:

- P1 - Ingestion and dermal contact with soil;
- P2 - Inhalation of dust;
- P3 - Inhalation of vapours;
- P4 - Surface water runoff;
- P5 - Leaching of contaminants and vertical migration into groundwater;
- P6 - Lateral migration of groundwater;
- P7 - Direct contact with terrestrial ecology; and
- P8 - Direct contact of contaminated ground with in-ground structures.

## 9.5 Preliminary Conceptual Site Model

A Conceptual Site Model (CSM) is a representation of site-related information regarding contamination sources, receptors and exposure pathways between those sources and receptors. The CSM provides the framework for identifying how the site became contaminated and how potential receptors may be exposed to contamination either in the present or the future i.e., it enables an assessment of the potential source - pathway - receptor linkages (complete pathways). The possible pathways between the above listed sources and receptors are provided in Table 1.

**Table 1: Preliminary Conceptual Site Model**

| Source                                                                                                                      | Transport Pathway                                                                                                                           | Receptor                                                     |
|-----------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|
| S1 - Filling<br>S2 - Historical spills of leaks<br>S3 - Hazardous building materials from demolition of previous structures | P1 - Ingestion and dermal contact with soil                                                                                                 | R1 - Future site users                                       |
|                                                                                                                             | P2 - Inhalation of dust                                                                                                                     | R2 - Construction workers                                    |
|                                                                                                                             | P3 - Inhalation of vapours                                                                                                                  | R3 - Future maintenance workers                              |
|                                                                                                                             | P2 - Inhalation of dust                                                                                                                     | R4 - Adjacent land users                                     |
|                                                                                                                             | P3 - Inhalation of vapours                                                                                                                  |                                                              |
|                                                                                                                             | P4 - Surface water runoff<br>P5 - Leaching of contaminants and vertical migration into groundwater<br>P6 - Lateral migration of groundwater | R5 - Surface water body                                      |
|                                                                                                                             | P5 - Leaching of contaminants and vertical migration into groundwater                                                                       | R6 - Groundwater                                             |
| P7 - Direct contact with terrestrial ecology                                                                                | R7 - Terrestrial ecology                                                                                                                    |                                                              |
| P7 - Direct contact of contaminated ground with in-ground structures                                                        | R8 - In-ground building structures                                                                                                          |                                                              |
| S4 - Residual contaminated groundwater                                                                                      | P3 - Inhalation of vapours                                                                                                                  | R1 - Future site users                                       |
|                                                                                                                             | P1 - Ingestion and dermal contact with soil<br>P3 - Inhalation of vapours                                                                   | R2 - Construction workers<br>R3 - Future maintenance workers |
|                                                                                                                             | P5 - Leaching of contaminants and vertical migration into groundwater<br>P6 - Lateral migration of groundwater                              | R5 - Surface water body                                      |
|                                                                                                                             | P5 - Leaching of contaminants and vertical migration into groundwater                                                                       | R6 - Groundwater                                             |

It is noted that the human health risk to future Barangaroo Station users (at the station box extent) from vapours from contaminated groundwater has been assessed in Metron (2021) and discussed DP (2021).

## 10. Conclusion

Potential sources of contamination have been identified as imported (extensive) filling used to form / level the site; historical spills or leaks of fuels or chemicals used at the site; demolition of previous structures containing hazardous materials; and residual contaminated groundwater. Potential contaminants associated with these activities have been identified. The southern and western parts of the site have been identified as locations with an elevated potential for soil contamination.

ASS are likely to be present in soils (including fill and natural soils) from between the water table and the top of bedrock. Fill above the water table may also be ASS if it has been originally sourced from beneath the water table. ASS are likely to be present to the west of the station box extent and may be present to the south of the station box extent. ASS are unlikely to be present to the north of the station box extent given the shallow bedrock. An ASS management plan should be prepared for the proposed excavations works.

Based on the results of this PSI, it is considered that testing is required to determine the waste classification of soils and bedrock for off-site disposal, the need for treatment of ASS, and the suitability of soil/ rock for re-use on site (from a contamination perspective), as applicable. Given that there has been significant land disturbance (and potential redistribution of materials) at the site since circa 2014 (including for the TSE project and previous construction projects at Barangaroo Reserve, Nawi Cove and Barangaroo Central) which has not been captured in previous reports (apart for the station box extent), it is considered that the contamination data presented in previous reports (outside of the station box extent) cannot be relied upon for waste classification assessment purposes.

It is recommended that some *in situ* investigations be undertaken (prior to excavation work) at proposed significant excavation areas to the south and west of the station box extent. The purpose of the *in situ* investigations would be to:

- To gain a better understanding of the extent of ASS and associated liming rates for treatment;
- Determine the preliminary waste classifications of the various soil materials so that materials with (likely) different waste classifications can be segregated (if possible) during excavation. This may minimise quantities of hazardous waste and restricted solid waste requiring disposal; and
- To provide an early indication if materials should not be reused at the site due to levels of contamination potentially posing a risk to identified human health or ecological receptors.

It is understood, from the site walkover, that some investigations have already commenced to the south and west of the station box extent.

## 11. Limitations

Douglas Partners (DP) has prepared this report (or services) for this project at Hickson Road, Barangaroo in accordance with Medium Consultant Contract (NSW) number N217-2R29 and DP's proposal number SYD201190.P.002.Rev2 (dated 25 August 2021). The work was carried out under contract number N217-2R29. This report is provided for the exclusive use of Watpac Construction Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after field testing has been completed.

DP's advice is based upon the conditions encountered during previous investigations. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

The assessment of atypical safety hazards arising from this advice is restricted to the (geotechnical / environmental / groundwater) components set out in this report and based on known project conditions and stated design advice and assumptions. While some recommendations for safe controls may be provided, detailed 'safety in design' assessment is outside the current scope of this report and requires additional project data and assessment.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

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**Douglas Partners Pty Ltd**

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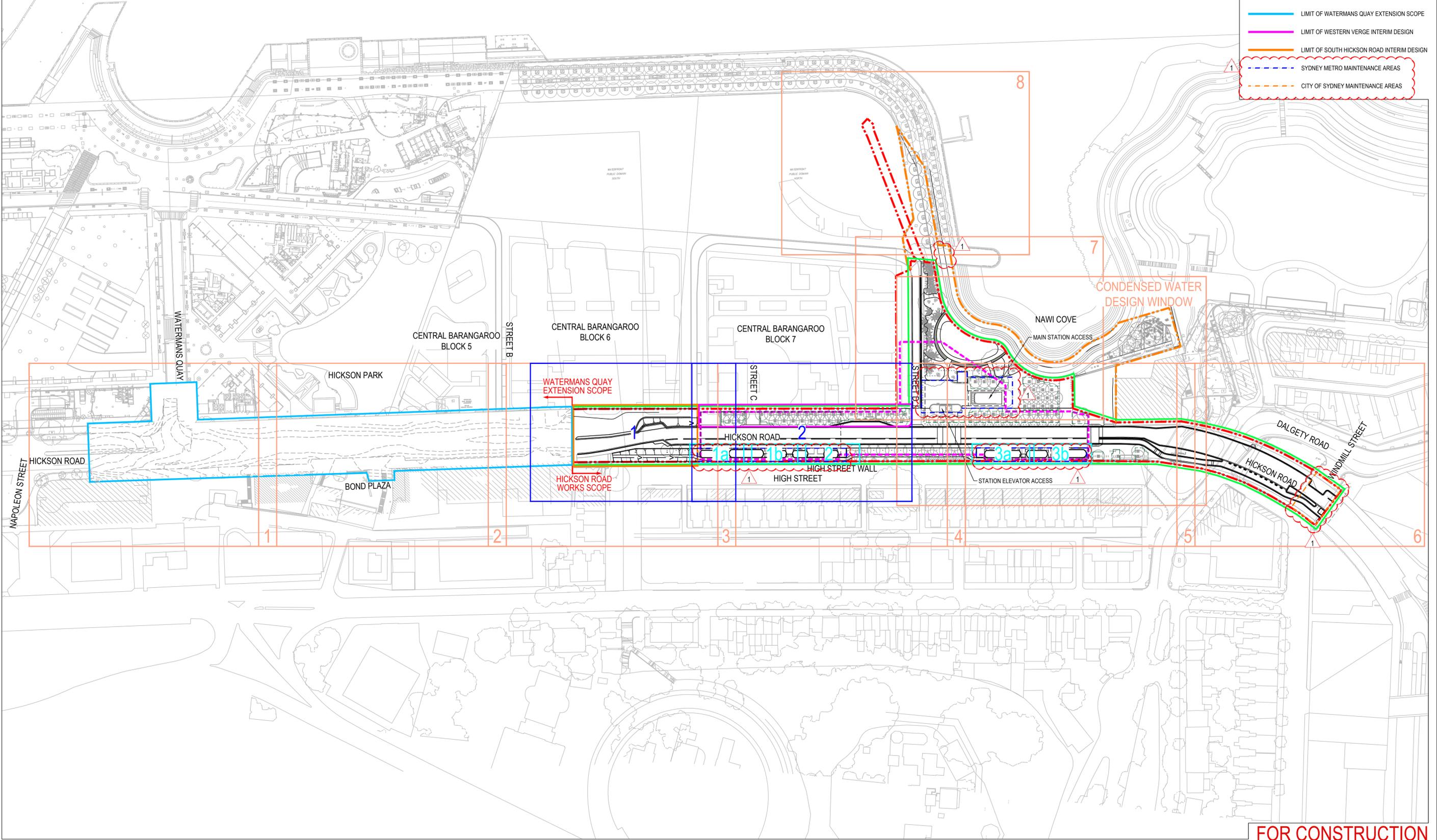
## Appendix A

---

Drawings



| LEGEND |                                            |
|--------|--------------------------------------------|
|        | HICKSON ROAD WORKS EXTENTS                 |
|        | FORESHORE REINSTATEMENT EXTENTS            |
|        | STATION BOX EXTENT                         |
|        | LIMIT OF HICKSON ROAD WORKS SCOPE          |
|        | LIMIT OF WATERMANS QUAY EXTENSION SCOPE    |
|        | LIMIT OF WESTERN VERGE INTERIM DESIGN      |
|        | LIMIT OF SOUTH HICKSON ROAD INTERIM DESIGN |
|        | SYDNEY METRO MAINTENANCE AREAS             |
|        | CITY OF SYDNEY MAINTENANCE AREAS           |

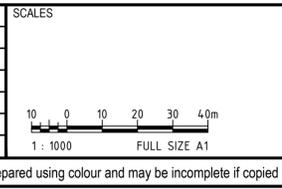


**FOR CONSTRUCTION**

Plot Date: 02/07/21 - 16:35  
Caf File: C:\pwworking\au\pwworking\0171682\SMCSWSBR-MET-SBR-CE-DWG-010101.dwg

100mm AT FULL SIZE

| REV. | BY   | DATE       | DESCRIPTION                            | APPD. |
|------|------|------------|----------------------------------------|-------|
| 0    | PBGS | 18/06/2021 | HICKSON ROAD REVISED EXTENTS AFC ISSUE | GD    |
| 1    | PBGS | 02/07/2021 | AFC UPDATES                            |       |



NOTE: Do not scale from this drawing.

ALT. DRG No SMCSWSBR-MET-SBR-CE-DWG-010101 1



CLIENT

Service Providers

|              |              |            |
|--------------|--------------|------------|
| DRAWN        | P.B.G.SANTOS | 02/07/2021 |
| DESIGNED     | B.TOWNSEND   | 02/07/2021 |
| DRG CHECK    | J.HEYDON     | 02/07/2021 |
| DESIGN CHECK | J.HALL       | 02/07/2021 |
| APPROVED     | A.MOHAMAD    | 02/07/2021 |

**SYDNEY METRO**

BARANGAROO STATION  
CIVIL ENGINEERING  
GENERAL ARRANGEMENT PLAN

|                                        |              |   |
|----------------------------------------|--------------|---|
| STATUS: STAGE 3 DESIGN                 | SHEET 1 OF 1 | © |
| DRG No. SMCSWSBR-MET-SBR-CE-DWG-010101 | REV.         | 1 |



**Legend**  
 Remediation Site  
 Approximate Location of Former Gasworks Structures  
• Additional ERM Soil Bores  
• Existing ERM Soil Bores  
• Cofely Soil Bores  
 Lot Boundaries  
 Existing or Former Site Features  
 Approximate Boundary of Landuse Zones

**Figure 4**  
**Soil Bore Locations**  
 Client: Barangaroo Delivery Authority  
 Project: Barangaroo Overarching RAP  
 Drawing No: 01143855\_RAP\_GIS004\_R0.mxd  
 Date: 15/04/2010  
 Drawn by: JF  
 Scale: Refer to Scale Bar  
 Environmental Resources Management Australia Pty Ltd  
 Building C, 33 Saunders St, Pyrmont, NSW 2009  
 Telephone: +61 2 8584 8888  
 Reviewed by: PL  
 Maps and figures contained within this document may be based on third party data. They are not to scale and are intended for use as a guide only. ERM does not warrant the accuracy of any such maps or figures.





Source: Base Image www.nearmap.com (23-10-2011)

© 2012 JBS Environmental Pty Ltd

|                            |                      |      |           |
|----------------------------|----------------------|------|-----------|
| 0 15 30 60 m               |                      |      |           |
| Scale: 1:1,500             |                      |      |           |
| Datum: MGA94 Zone 56 - AHD |                      |      |           |
| A4                         |                      |      |           |
|                            |                      |      |           |
| A                          | Original Issue - R04 | RF   | 26-6-2012 |
| Rev                        | Description          | Drn. | Date:     |

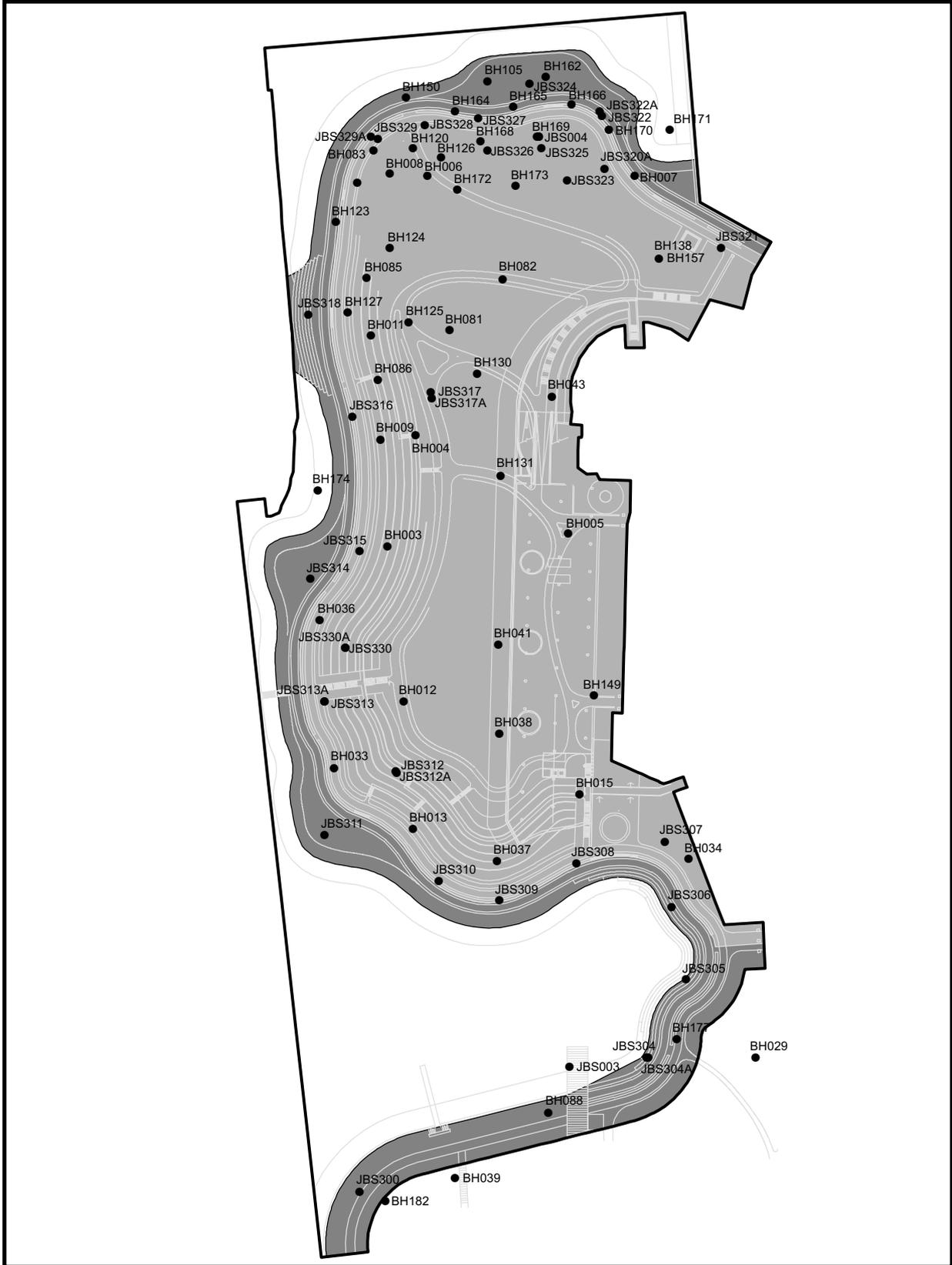
|                                                  |
|--------------------------------------------------|
| Soil Sample Locations (JBS May 2012)             |
| Historic Soil Sample Locations                   |
| Approximate Site Boundary - Baragaroo Central    |
| Overlap of Area Already Assessed (Headland Park) |
| Residential Building Basements / Carparks        |
| Inaccessible for soil and groundwater sampling   |
| DECCW Area - Approximate Extent                  |

**Figure 7: Current Soil Sample Locations**

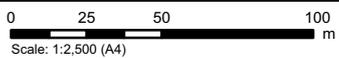
Client: Baragaroo Delivery Authority

Project: Baragaroo - Central

Job No: 42021 File Name: 42021\_07



©2011 JBS Environmental Pty Ltd



Datum: MGA94 Zone 56

|     |                |    |           |
|-----|----------------|----|-----------|
| A4  |                |    |           |
| D2  | Revision       | RF | 21-1-2011 |
| D1  | Original Issue | RF | 20-1-2011 |
| Rev | Description    | By | Date      |

**Legend:**

- Extent of Clay Layer
- Site Boundary
- Proposed Site Layout
- Sample Location



**Figure 11: Sample Locations**

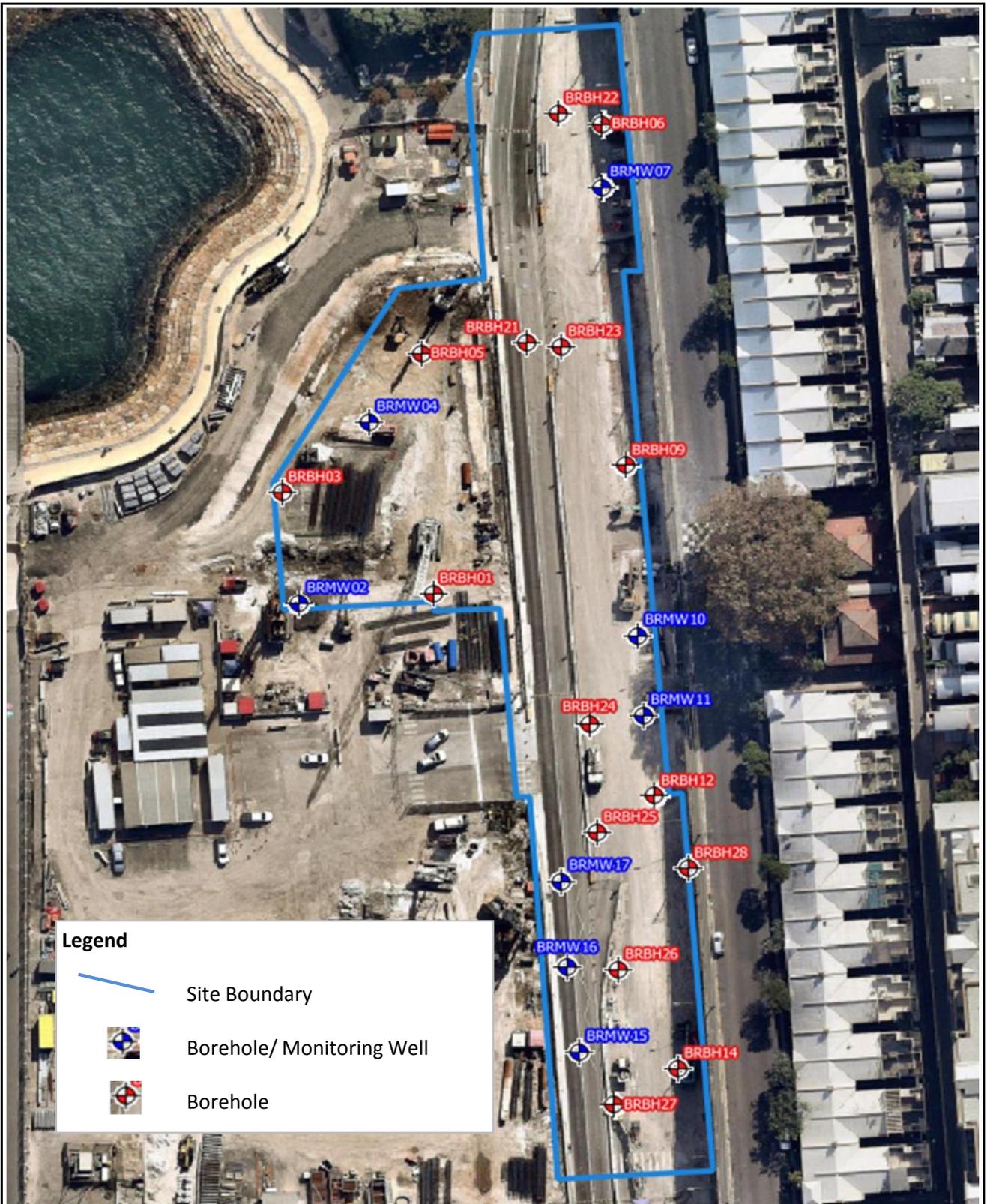
Client: Barangaroo Delivery Authority

Project: Barangaroo Headland Park

Job No: 41181

File Name: 41181\_11a





**Legend**

-  Site Boundary
-  Borehole/ Monitoring Well
-  Borehole



**Sample Locations**  
 Sydney Metro City & South West,  
 Tunnel & Station Works Package  
 Hickson Road, Barangaroo

PROJECT: 85608.04

DWG No: 1

REV: 0

CLIENT: John Holland CPB Ghella JV

DATE: 15.06.18

---

## **Appendix B**

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Notes About this Report

# About this Report

# Douglas Partners



## Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

## Copyright

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

## Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

## Groundwater

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

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;

- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

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

## Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

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

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

# *About this Report*

## **Site Anomalies**

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

## **Information for Contractual Purposes**

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

## **Site Inspection**

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

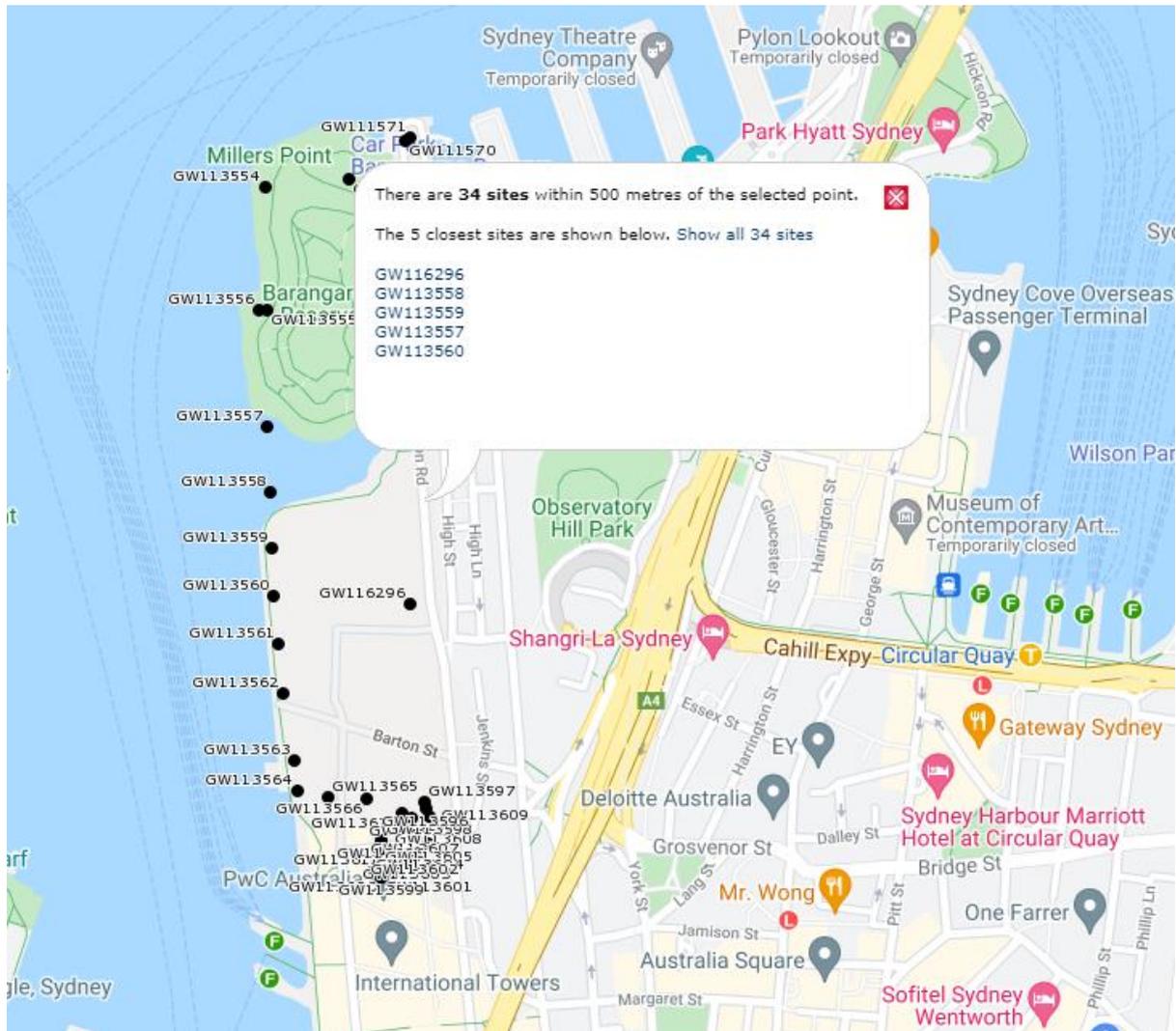
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## **Appendix C**

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### Map of Registered Groundwater Bores

## Results of Groundwater Bore Search (16 September 2021)



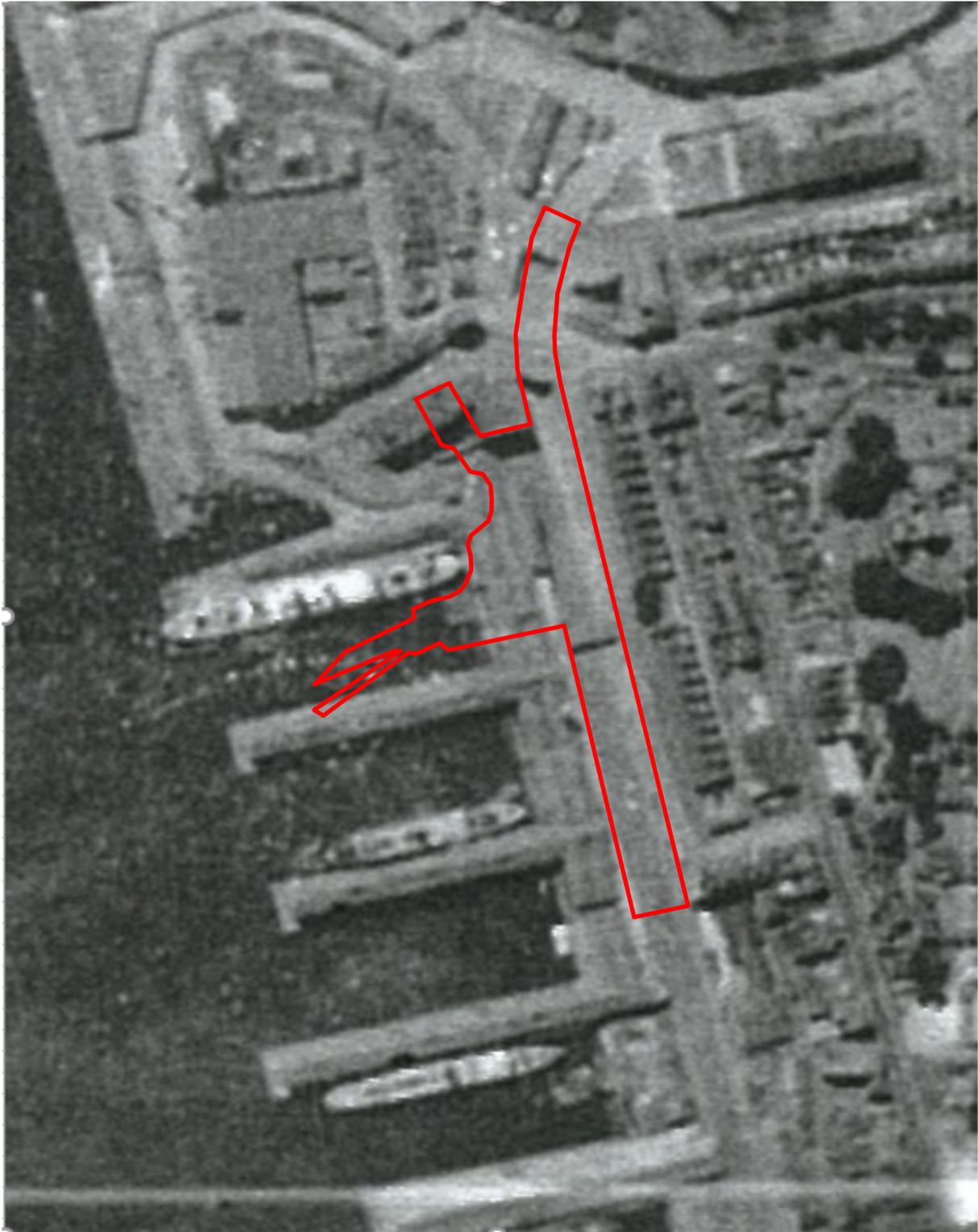
Source: <https://realtimedata.waternsw.com.au/water.stm>

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## **Appendix D**

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Historical Aerial Photographs



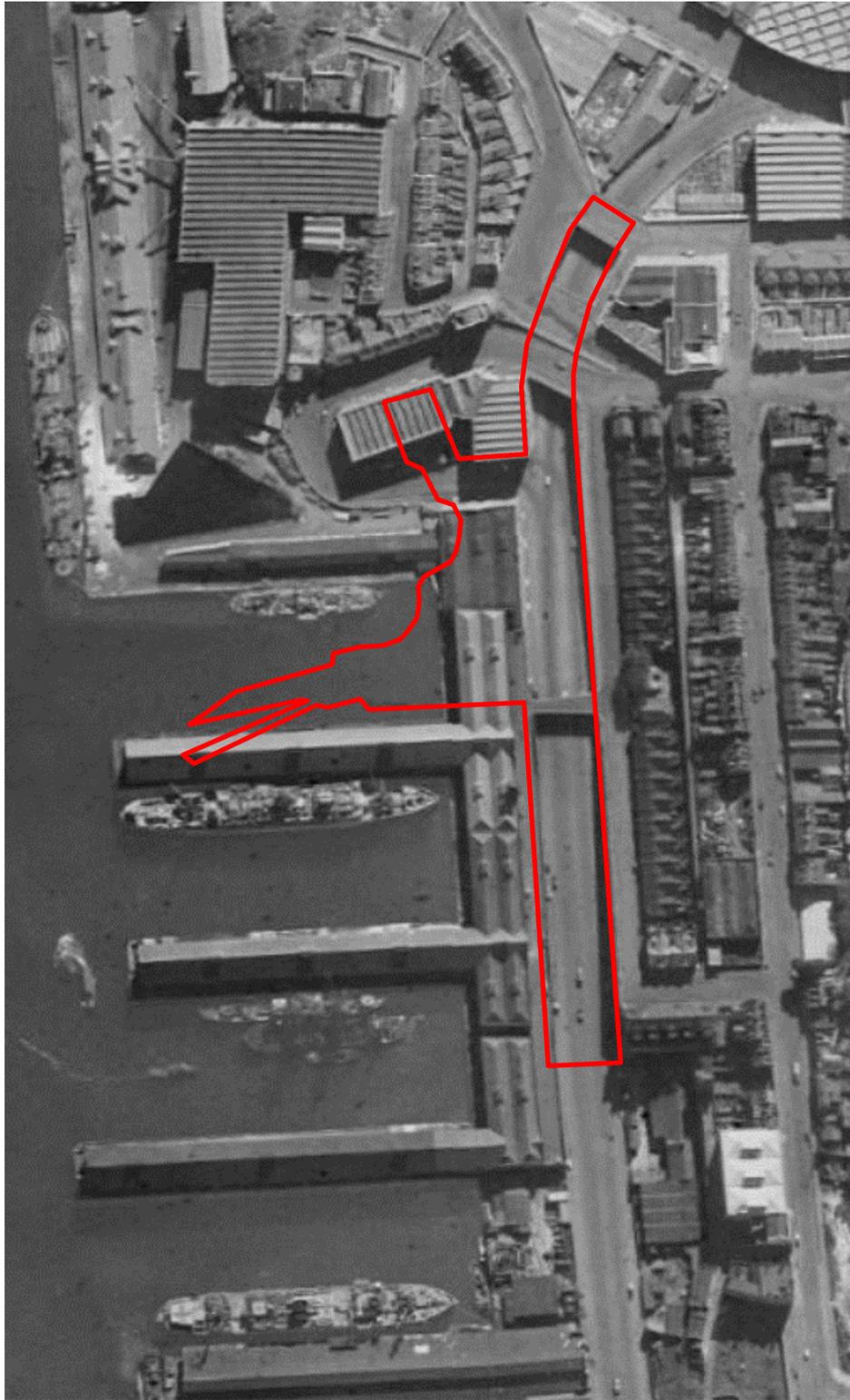
Source: Spatial Services



**Legend**

— Approximate Site Boundary

|                                                                                     |                                                                                                                     |                    |
|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|--------------------|
|  | <b>1930 Aerial Photograph</b><br><b>Barangaroo Station Constuct Only Package</b><br><b>Hickson Road, Barangaroo</b> | PROJECT: 209150.00 |
|                                                                                     | CLIENT: Watpac Construction Pty Ltd                                                                                 | PLATE No: D1       |
|                                                                                     |                                                                                                                     | REV: 0             |
|                                                                                     |                                                                                                                     | DATE: 21-Sep-21    |



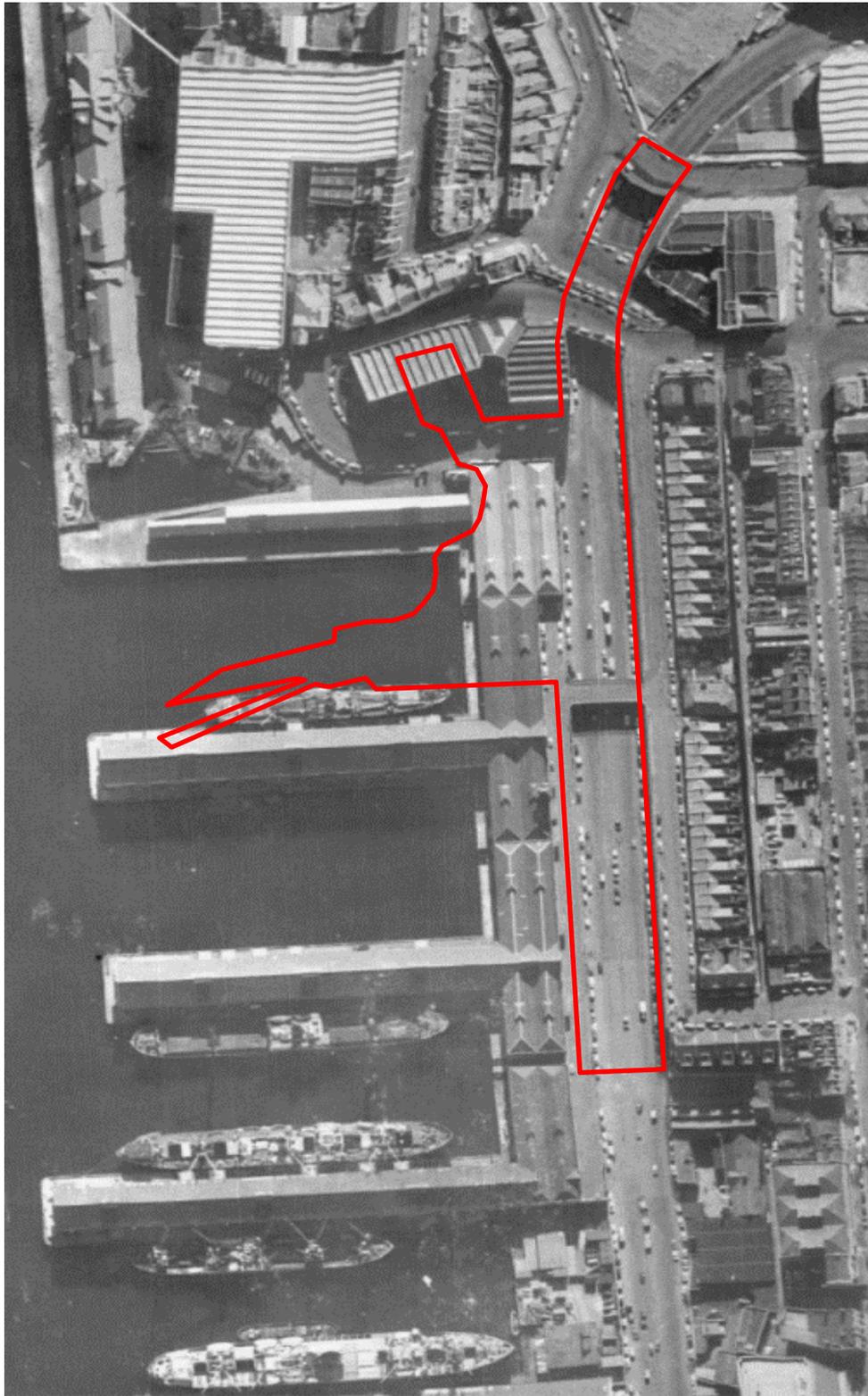
Source: Metromap



**Legend**

 Approximate Site Boundary

|                                                                                     |                                                                                                                                |                    |
|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|--------------------|
|  | <b>1943 Aerial Photograph</b><br><b>Barangaroo Station Construct Only</b><br><b>Package</b><br><b>Hickson Road, Barangaroo</b> | PROJECT: 209150.00 |
|                                                                                     |                                                                                                                                | PLATE No: D2       |
|                                                                                     |                                                                                                                                | REV: 0             |
|                                                                                     | CLIENT: Watpac Construction Pty Ltd                                                                                            | DATE: 21-Sep-21    |



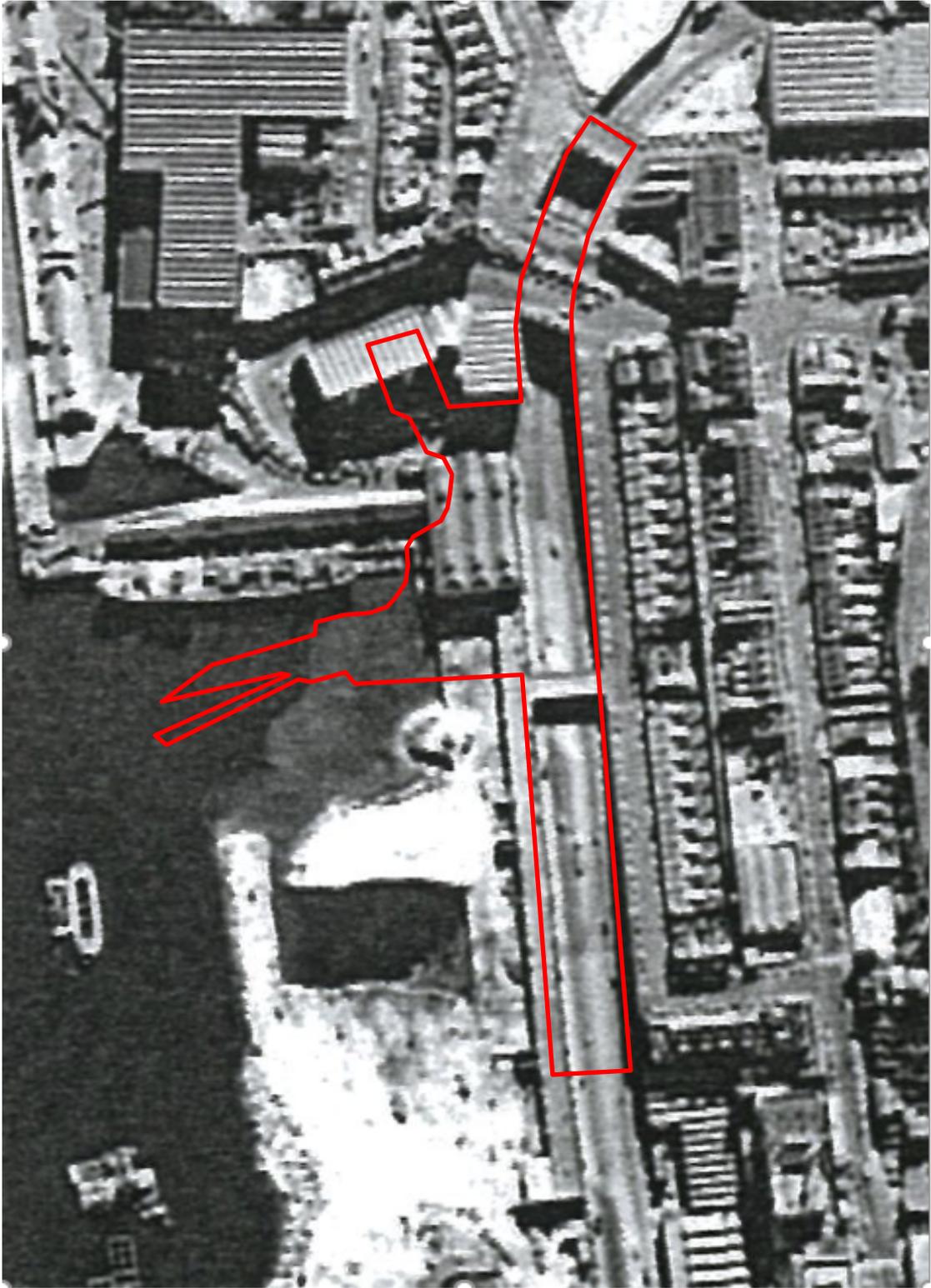
Source: Metromap



**Legend**

— Approximate Site Boundary

|                                                                                     |                                                                                                                                |                    |
|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|--------------------|
|  | <b>1961 Aerial Photograph</b><br><b>Barangaroo Station Construct Only</b><br><b>Package</b><br><b>Hickson Road, Barangaroo</b> | PROJECT: 209150.00 |
|                                                                                     |                                                                                                                                | PLATE No: D3       |
|                                                                                     |                                                                                                                                | REV: 0             |
|                                                                                     | CLIENT: Watpac Construction Pty Ltd                                                                                            | DATE: 21-Sep-21    |



Source: Spatial Services (photograph taken 7 July 1970)



**Legend**

— Approximate Site Boundary



**1970 Aerial Photograph**  
**Barangaroo Station Constuct Only**  
**Package**  
**Hickson Road, Barangaroo**

CLIENT: Watpac Construction Pty Ltd

PROJECT: 209150.00

PLATE No: D4

REV: 0

DATE: 21-Sep-21



Source: Metromap



**Legend**

 Approximate Site Boundary



**1982 Aerial Photograph**  
**Barangaroo Station Construct Only**  
**Package**  
**Hickson Road, Barangaroo**

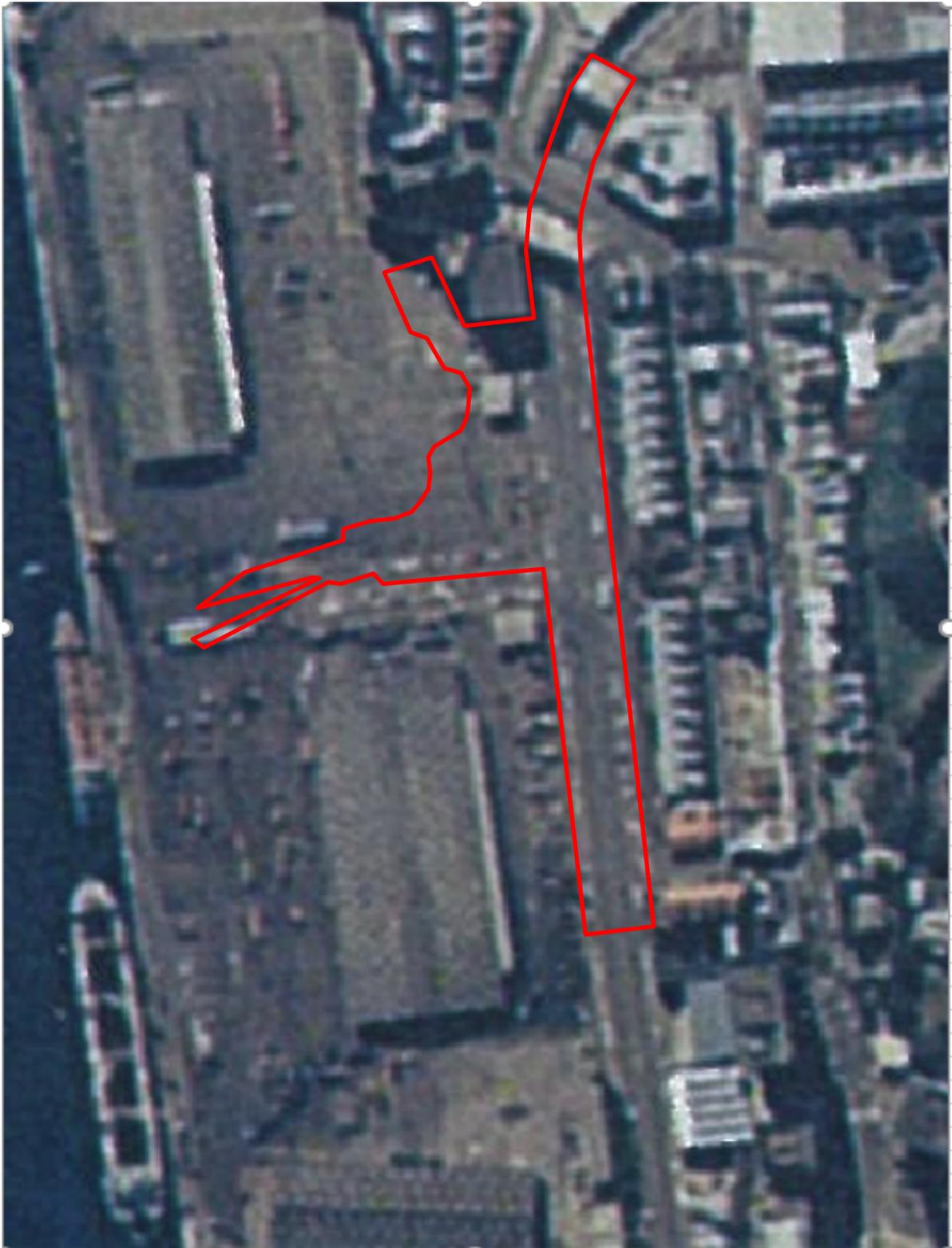
CLIENT: Watpac Construction Pty Ltd

PROJECT: 209150.00

PLATE No: D5

REV: 0

DATE: 21-Sep-21



Source: Spatial Services (photograph taken 9 May 1991)



**Legend**

 Approximate Site Boundary

|                                                                                     |                                                                                                                               |                    |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|--------------------|
|  | <b>1991 Aerial Photograph</b><br><b>Barangaroo Station Constuct Only</b><br><b>Package</b><br><b>Hickson Road, Barangaroo</b> | PROJECT: 209150.00 |
|                                                                                     |                                                                                                                               | PLATE No: D6       |
|                                                                                     |                                                                                                                               | REV: 0             |
|                                                                                     | CLIENT: Watpac Construction Pty Ltd                                                                                           | DATE: 21-Sep-21    |



Source: Metromap



**Legend**

——— Approximate Site Boundary

|                                                                                     |                                                                                                                                |                                              |
|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|
|  | <b>2000 Aerial Photograph</b><br><b>Barangaroo Station Construct Only</b><br><b>Package</b><br><b>Hickson Road, Barangaroo</b> | PROJECT: 209150.00<br>PLATE No: D7<br>REV: 0 |
|                                                                                     | CLIENT: Watpac Construction Pty Ltd                                                                                            | DATE: 21-Sep-21                              |



Source: Metromap (photograph taken 14 February 2007)



**Legend**

 Approximate Site Boundary



**2007 Aerial Photograph**  
**Barangaroo Station Construct Only**  
**Package**  
**Hickson Road, Barangaroo**

CLIENT: Watpac Construction Pty Ltd

PROJECT: 209150.00

PLATE No: D8

REV: 0

DATE: 21-Sep-21



Source: Metromap (photograph taken 31 January 2011)



**Legend**

— Approximate Site Boundary



**2011 Aerial Photograph**  
**Barangaroo Station Construct Only**  
**Package**  
**Hickson Road, Barangaroo**

CLIENT: Watpac Construction Pty Ltd

PROJECT: 209150.00

PLATE No: D9

REV: 0

DATE: 21-Sep-21



Source: Metromap (photograph taken 16 January 2014)



**Legend**

Approximate Site Boundary

|                                                                                     |                                                  |                    |
|-------------------------------------------------------------------------------------|--------------------------------------------------|--------------------|
|  | <b>2014 Aerial Photograph</b>                    | PROJECT: 209150.00 |
|                                                                                     | <b>Barangaroo Station Construct Only Package</b> | PLATE No: D10      |
|                                                                                     | <b>Hickson Road, Barangaroo</b>                  | REV: 0             |
|                                                                                     | CLIENT: Watpac Construction Pty Ltd              | DATE: 21-Sep-21    |



Source: Metromap (photograph taken 4 May 2016)



**Legend**

— Approximate Site Boundary



**2016 Aerial Photograph**  
**Barangaroo Station Construct Only**  
**Package**  
**Hickson Road, Barangaroo**

CLIENT: Watpac Construction Pty Ltd

PROJECT: 209150.00

PLATE No: D11

REV: 0

DATE: 21-Sep-21



Source: Metromap (photograph taken 12 February 2019)



**Legend**

— Approximate Site Boundary



**2019 Aerial Photograph**  
**Barangaroo Station Construct Only**  
**Package**  
**Hickson Road, Barangaroo**

CLIENT: Watpac Construction Pty Ltd

PROJECT: 209150.00

PLATE No: D12

REV: 0

DATE: 21-Sep-21



Source: Metromap (photograph taken 30 July 2021)



**Legend**

 Approximate Site Boundary

|                                                                                     |                                                  |                    |
|-------------------------------------------------------------------------------------|--------------------------------------------------|--------------------|
|  | <b>2021 Aerial Photograph</b>                    | PROJECT: 209150.00 |
|                                                                                     | <b>Barangaroo Station Construct Only Package</b> | PLATE No: D13      |
|                                                                                     | <b>Hickson Road, Barangaroo</b>                  | REV: 0             |
|                                                                                     | CLIENT: Watpac Construction Pty Ltd              | DATE: 21-Sep-21    |

---

## **Appendix E**

---

Site Photographs



Photograph 1 - Northern end of site (Hickson Road)



Photograph 2 - Northern end of site (Hickson Road)

|                                                                                     |                                                  |                    |
|-------------------------------------------------------------------------------------|--------------------------------------------------|--------------------|
|  | <b>Site Photographs</b>                          | PROJECT: 209150.00 |
|                                                                                     | <b>Barangaroo Station Construct Only Package</b> | PLATE No: E1       |
|                                                                                     | <b>Hickson Road, Barangaroo</b>                  | REV: 0             |
|                                                                                     | CLIENT: Watpac Construction Pty Ltd              | DATE: 27-Oct-21    |



Photograph 3 - Parking area in front of building at 25 Hickson Road



Photograph 4 - Landscaped area adjacent to the west of building at 25 Hickson Road

|                                                                                     |                                                  |                    |
|-------------------------------------------------------------------------------------|--------------------------------------------------|--------------------|
|  | <b>Site Photographs</b>                          | PROJECT: 209150.00 |
|                                                                                     | <b>Barangaroo Station Construct Only Package</b> | PLATE No: E2       |
|                                                                                     | <b>Hickson Road, Barangaroo</b>                  | REV: 0             |
|                                                                                     | CLIENT: Watpac Construction Pty Ltd              | DATE: 27-Oct-21    |



Photograph 5 - Eastern part of Nawi Cove



Photograph 6 - Water treatment plant



Site Photographs  
 Barangaroo Station Construct Only  
 Package

Hickson Road, Barangaroo

CLIENT: Watpac Construction Pty Ltd

PROJECT: 209150.00

PLATE No: E3

REV: 0

DATE: 27-Oct-21



Photograph 7 - Water treatment plant



Photograph 8 - Western part of site



**Site Photographs**  
**Barangaroo Station Construct Only**  
**Package**

**Hickson Road, Barangaroo**

CLIENT: Watpac Construction Pty Ltd

PROJECT: 209150.00

PLATE No: E4

REV: 0

DATE: 27-Oct-21



Photograph 9 - Western part of site where there has been recent test pits



Photograph 10 - Southern end of site (Hickson Road)



**Site Photographs**  
**Barangaroo Station Construct Only**  
**Package**

**Hickson Road, Barangaroo**

CLIENT: Watpac Construction Pty Ltd

PROJECT: 209150.00

PLATE No: E5

REV: 0

DATE: 27-Oct-21