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Geotechnical and Contamination Assessment

New South Wales Land and Housing Corporation

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22-May-2018

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Phase 1 Environmental Site Assessment and Geotechnical Desktop Study

600-660 Elizabeth Street, Redfern NSW

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Phase 1 Environmental Site Assessment and Geotechnical Desktop Study

600-660 Elizabeth Street, Redfern NSW

Client: New South Wales Land and Housing Corporation

ABN: 24 960 729 253

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Prepared by Kate Holt and Nigel Baker

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			Name/Position	Signature
A	26-Apr-2018	Draft for Client Comment	Joshua Atkinson Senior Engineer	
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Executive Summary

Introduction

AECOM Australia Pty Ltd (AECOM) has been engaged by the New South Wales (NSW) Land and Housing Corporation (LAHC) to undertake a Phase 1 Environmental Site Assessment (ESA) and Geotechnical Desktop Study for the portion of land identified as 600–660 Elizabeth Street, Redfern NSW (hereafter referred to as "the Site").

It is understood that LAHC seeks to provide new social housing and the Site presents a valuable opportunity to deliver a community focused precinct centred on improved public domain and facilities. The high profile site forms part of the wider Redfern social housing estate which has been nominated as a State Significant Precinct (SSP) where building on previous studies, requires detailed investigations on the capacity of existing infrastructure (utilities and transport) and constraints (geotechnical and contamination).

Phase 1 ESA

The objectives of the Phase 1 ESA are to:

- identify the potential for soil and groundwater contamination at the Site.
- provide recommendations for further assessment, which may be required to support the redevelopment of the site for new social housing.

To achieve the objective, the following scope of work was undertaken:

- Review of available and relevant drawings / plans / photographs / databases / reports / council and government records relating to the Site.
- Assessment of areas where potentially contaminating land uses occurred within or in the vicinity of the site.
- Preparation of this report including recommendations made for additional investigations.

The key findings of the Phase 1 ESA are summarised below:

- The Site has primarily been used for a mixture of residential, commercial and/or light industrial purposes, while the surrounding area has been used for commercial/industrial (typically north, south and west of the Site), residential (surrounding the Site) and recreational (east of the Site) purposes.
- A Stage 2 soil and groundwater investigation undertaken by PB (2004) indicated concentrations of lead, benzo(a)pyrene (B(a)P), sum of polycyclic aromatic hydrocarbons (PAHs), toluene, total petroleum hydrocarbons (TPH) C_{10}-C_{36} in soil, heavy metals and up-gradient B(a)P and sum of PAHs in groundwater exceeding the adopted assessment criteria for the proposed residential land use.
- A Site Audit Statement (SAS), (Golder, 2005) concluded that the Site was not suitable for the proposed medium density residential land use and a Remediation Action Plan (RAP) was required to address identified contamination(PB, 2004).
- The preliminary conceptual site model (CSM), (presented in **Section 7.0**) identifies potential sources of contamination, receptors and exposure pathways. Potential sources of contamination identified during the Phase 1 ESA which may impact the condition of soil and groundwater within the Site and its surrounds include the following:
    - Commercial and industrial properties in the immediate surrounding areas including: car servicing and mechanical repairs, manufacturers and a laundry – Waterloo Coin Laundry.
    - Use of fill material of unknown origin: containing or impacted by contaminants.
    - Historical use of asbestos containing materials (ACM) within buildings and structures erected since the 1920s.

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- Historical use of lead based paints on the interior and exterior of historical and current buildings.
- Concentrations of lead and polycyclic aromatic hydrocarbons (PAHs) in soil identified as part of the ERM (2001) investigation.
- Known concentrations of lead, B(a)P, sum of PAHs, toluene, TPH C_{10}-C_{36} in soil, heavy metals and up-gradient B(a)P and sum of PAHs in groundwater and potential acid sulfate soils as noted in the SAS (Golder, 2005) and as identified by PB (2004).

Based on the findings of this Stage 1 ESA and preliminary CSM developed for the Site, AECOM recommends undertaking the following additional stages of work:

- Completion of a hazardous materials (HAZMAT) survey of buildings and associated infrastructure erected since pre-1960s located in the southern portion of the Site prior to demolition works.
- Completion of a Stage 2 contamination assessment to characterise the nature and extent of potential soil and groundwater contamination, targeting the potential areas of concern identified within the Site and also the proposed locations of excavation works. Soil and groundwater samples should be analysed for the identified CoPCs listed in **Section 7.1** and assessed in accordance with the National Environment Protection (Assessment of Site Contamination) Measure 1999 (ASC NEPM, 2013). The cost of the initial Stage 2 contamination assessment would be informed by the proposed development plans for the Site and existing access constraints.

Geotechnical Desktop Study

Development of commercial and residential towers with basements should be practicable on the 600 - 660 Elizabeth Street Redfern site from a geotechnical perspective using conventional structural elements and normal construction techniques.

The ground profile and groundwater conditions at the site are likely to comprise:

- Fill – 0 m to 2 m deep
- Botany Sands – generally Sand, but potentially containing layers and lenses of peat and organic clay
- Residual Soil over Shale or Sandstone Bedrock – The depth to rock is likely to range from 8 m to 12 m across the site.
- Groundwater – at depths of 3 m to 4.5 m. However, levels could rise to the ground surface during heavy or prolonged rainfall.

Geotechnical challenges are likely to include:

- High groundwater table
- Saturated, cohesionless soil layers within the Botany Sands
- Compressible soils
- Interaction with existing services and structures.

These challenges should be able to be managed by conventional retention and foundation systems. Tanked basements are likely to be required due to the potential for shallow groundwater. Relatively stiff boundary retention systems may be required to limit ground displacements beyond the site boundaries.

The further investigations that are planned would provide adequate information for concept design of commercial/residential tower developments with basements.

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1.0 Introduction

AECOM Australia Pty Ltd (AECOM) has been engaged by the New South Wales (NSW) Land and Housing Corporation (LAHC) to undertake a Phase 1 Environmental Site Assessment (ESA) and Geotechnical Desktop Study for the portion of land identified as 600 to 660 Elizabeth Street, Redfern NSW (hereafter referred to as "the Site").

The Site comprises Lots 3, 4 and 5 in deposited plan (DP) 456634 and covers an area of 1.077 hectares (ha). The location of the Site is shown on Figure 1 and the Site Layout is shown on Figure 2 in **Appendix A**.

1.1 Background

It is understood that LAHC seeks to provide new social housing and Site presents a valuable opportunity to deliver a community focused precinct centred on improved public domain and facilities. The high profile Site forms part of the wider Redfern social housing estate which has been nominated as a State Significant Precinct (SSP) where building on previous studies, requires detailed investigations on the capacity of existing infrastructure (utilities and transport) and constraints (geotechnical, contamination).

The purpose of the Phase 1 ESA and Geotechnical Desktop Study is to inform the redevelopment of the site in line with the "Future Directions for Social Housing in NSW" strategy. This assessment will provide a baseline investigation which can be used to inform future planning for the site and highlight constraints early on in the planning process.

1.2 Phase 1 ESA Objectives

The objectives of the Phase 1 ESA are to:

- Identify the potential for soil and groundwater contamination at the Site; and
- Provide recommendations for further assessment required to support the redevelopment of the site for new social housing.

1.3 Phase 1 ESA Scope of Work

To achieve the objective, the following scope of work was undertaken:

- Review of available drawings / plans / reports relating to the site.
- A search of the NSW EPA contaminated land records for the site and surrounding area.
- A search of WorkCover dangerous goods records.
- Review of local council records, including the Council Section 149 certificate for the site
- Review of historical lands title records.
- Review of historical aerial photographs to identify the presence of any potentially contaminating land uses within and surrounding the site.
- Review of published maps (geology, hydrogeology, soil and topography) of the area to gain an understanding of surface and subsurface conditions.
- Search and review of information readily available through the internet (e.g. historic parish maps and online historical information).
- Completion of an Office of Water [NOW] registered groundwater bore database review to identify groundwater bores within the area.
- Assessment of areas where potentially contaminating land uses occurred within or in the vicinity of the site.
- Review of previous investigations relevant to the site provided by LAHC.

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- Preparation of this Phase 1 report including recommendations for additional investigations in those areas where potentially contaminating land uses within or in the vicinity of the site were identified.

1.4 Phase 1 ESA Relevant Guidelines

AECOM completed the Phase 1 ESA with reference to the following guidelines:

- National Environment Protection Measure (NEPM), *Assessment of Site Contamination (ASC) (National Environment Protection Council [NEPC]*, *1999* as amended (2013) (the ASC NEPM).
- NSW EPA (2017). *Contaminated Land Management Guidelines for the NSW Site Auditor Scheme (3rd Edition)*. State of NSW and Environment Protection Authority.
- NSW OEH (2011). *Guidelines for Consultants Reporting on Contaminated Sites*. NSW Government Office of Environment & Heritage (OEH).

1.5 Geotechnical Desktop Study Objectives

The objectives of the desktop geotechnical study were to provide assessments of:

- Ground conditions and groundwater.
- Geotechnical constraints to inform planning and concept design development.
- Further geotechnical investigations.

1.6 Geotechnical Information Sources

The following information was used in the geotechnical desktop study:

- Sydney 1:100,000 Geological Series Sheet 9130.
- The NSW office of Environment and Heritage Acid Sulphate Soil Map.
- Sydney Local Environmental Plan (LEP) 2012, the ASS map Sheet 016 and 017.
- NSW Office of Groundwater borehole information.
- Borehole information from the AECOM database from unrelated projects and boreholes drilled from a previous investigation conducted at the site.

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2.0 Site Identification

The Site identification details are presented in **Table 1**.

Table 1 Site Identification

Item	Description
Site Address	600 to 660 Elizabeth Street, Redfern NSW 2016
Legal Description[1]	Lots 3, 4 and 5 DP 456634
Site Area[2]	Approximately 1.077 ha
Site Owner	NSW Land and Housing Corporation
Local Government Authority	Council of the City of Sydney
Current Zoning[3]	Zone No. 2 (b) Residential (Medium Density) – 600 to 614 Elizabeth Street, Redfern Zone No. 5 Special Uses (Activity Centre) – 616 to 660 Elizabeth Street, Redfern
Current Land Use	Vacant and South Sydney Police Citizens Youth Club (PCYC)
Proposed land use	Social housing
Site Elevation (m AHD) [4]	30
Site Location	Figure 1 **Appendix A**
Site Layout	Figure 2 **Appendix A**

1. Section 149 certificates (refer **Appendix E**) obtained from City of Sydney Council lists 600-614 Elizabeth St as Lots 3, 4 and 5 DP 456634 and 616-660 Elizabeth St as Lots 7 to 11 DP 35793 which are not listed on the current certificate of title or on the NSW Government Spatial Information Exchange
2. Spatial Information Exchange Viewer (www.maps.six.nsw.gov.au)
3. Council of the City of Sydney – South Sydney Local Environmental Plan (LEP) 1998 (as amended)
4. Lotsearch (12 March 2018) *Environmental Risk and Planning Report, 600-660 Elizabeth Street, Redfern, NSW 2016*, Lotsearch Reference: LS002993

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3.0 Previous Environmental Investigations

A summary of the findings of the previous investigations undertaken at the Site are summarised below.

3.1 ERM (2001) Phase 1 Site Contamination Assessment

ERM Australia Pty Limited (ERM) was commissioned by Housing Finance Investment Group to undertake a Phase 1 Contamination Assessment of a number of properties located on Elizabeth Street, Redfern. At the time of the Contamination Assessment, the land located between Elizabeth, Phillip, Moorehead and Kettle Streets was proposed to be redeveloped to comprise 88 new public housing dwellings on the eastern street block and a six-storey housing development comprising 162 residential apartments for private sale on the western street block. The land assessed by ERM as part of the Contamination Assessment incorporated the Site forming the subject of this Phase 1 report and the adjacent land located immediately east of the Site on Moorehead Street.

The objective of the Contamination Assessment was to:

- Determine if there was any human health or environmental issues that would preclude the redevelopment of the site.
- Assess the need for any additional site investigation works based on the findings of the Contamination Assessment report.

The scope of the Contamination Assessment involved the review of available information including historical documents, aerial photographs and maps to establish the history of activities undertaken on the Site. A site inspection was undertaken and an intrusive investigation comprising drilling and sampling of soil from 10 boreholes. Soil samples were field screened using a photoionisation detector (PID) for volatile organic compounds (VOCs) and soil samples were analysed for heavy metals (lead only in BH2 to BH5), organochlorine pesticides (OCPs) and polycyclic aromatic hydrocarbons (PAHs).

At the time of the investigation the PCYC was present on the southern portion of the Site. Residential properties on Elizabeth Street within the northern portion of the Site were observed to comprise semi-detached two storey houses. It was noted that small gardens were located at the front and back of the houses. At the time of the site inspection no evidence of underground storage tanks (USTs) were noted. During the site investigation, anecdotal evidence supplied by personnel from the PCYC indicated that the corner of Elizabeth and Phillip Street may have historically been a small rubbish dump. A borehole was advanced in this area to determine if any layers of fill were present.

The sampling regime was based on site access to the PCYC, various housing commission properties and in coordination with the requirements of the geotechnical site investigation. ERM noted that the ten boreholes were evenly spaced across the Site. ERM noted that the investigation was not intended to comply with NSW EPA guidelines and therefore at the time of the Contamination Assessment it was envisaged that additional assessment works would be required to provide adequate site coverage.

Soil samples were collected from each borehole around approximately 0.2 to 0.5 metres below ground surface and analysed. ERM noted that the intent was to characterise the near surface fill material at the site. Soil samples were collected directly from solid stem augers. It is noted that composite samples were collected combining soil from 8 locations across the Site. These results have not been summarised as they are not considered representative of the material on Site.

The Figure 2 sampling location plan indicates that five (BH1 to BH5) of the 10 boreholes were located on the Site located at 600-660 Elizabeth Street Redfern and five boreholes (BH6 to BH10) were located to the east of the Site between Moorehead and Walker Streets.

Fill materials were encountered in all five boreholes ranging from 0.6 (BH2 north-eastern portion) to 2.0 (BH1 south-eastern corner adjacent PCYC) metres below ground surface. Fill materials comprised gravelly sand, sand and clayey sand with brick inclusions. Black staining was noted in BH1 within fill materials. Fill materials were underlain by layers of natural Peaty Sand and Sand. Boreholes were terminated between 3 and 4 metres below ground surface. Saturated soils were encountered in permeable soil materials at approximately 2.5 to 3.0 metres below ground surface.

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The soil analytical results, assessed against the Soil Investigation Level A (SIL A) for proposed residential land use from the NSW EPA (1998) Guidelines for the NSW Site Auditor Scheme, indicated the following:

- OCPs were not detected in any of the soil samples analysed.
- Concentrations of lead on Site ranged from 110 mg/kg (BH4/0.2) to 170 mg/kg (BH3/0.3) which were less than the SIL A criterion for lead of 300 mg/kg.
- Concentrations of lead on the eastern portion (east of the Site) ranged from 130 mg/kg (BH7/0.2) to 650 mg/kg (BH8/0.3). The concentration of lead at BH8/0.3 (located on the southern boundary of the eastern portion of the site i.e. east of the Site) exceeded the SIL A criterion – 300 mg/kg.
- One sample from BH1/0.3 was analysed for PAHs. The results were not presented in the report but ERM noted that concentrations of PAHs, in particular a concentration of benzo(a)pyrene – 9 mg/kg exceeded the adopted SIL A criterion of 1 mg/kg and a concentration of total PAHs – 112.5 mg/kg exceeded the adopted SIL A criterion of 20 mg/kg.

Based on the results obtained as part of the Contamination Assessment, ERM recommended the following additional site investigation:

- Soil sampling across the site to fulfil the sampling density requirements of the NSW EPA (1995) Sampling Design Guidelines. ERM noted that this should include additional boreholes to further assess PAH contamination at BH1 and lead at BH8 (located to the east of the Site).
- Installation of groundwater monitoring wells across the site to assess the potential impact on groundwater.

3.2 Golder (2005) Site Audit Report and Site Audit Statement

AECOM reviewed the following reports:

- Golder Associates Pty Ltd (Golder) (2005) *Site Summary Audit Report (Statutory) Stage 2 Environmental Site Assessment of Lot 1 & 2 in DP435765, and Lots 3, 4 & 5 in DP456634 Redfern, NSW*, June 2005
- NSW EPA Accredited Site Auditor Kylie Lloyd of Golder Associates (23 June 2005) *NSW Site Auditor Scheme Site Audit Statement* (Site Audit Statement No. KJL003). A copy of the Site Audit Statement (SAS) is included in **Appendix G**.

The findings of the Site Audit Report (SAR) and SAS are summarised below:

- The SAS was carried out at the request of Ms Helen Wood on behalf of the Department of Housing and was based on the findings of a Stage 2 ESA prepared by PB (December 2004) which was undertaken across the entire Site. The SAS was issued to review the status of the Site with respect to ground contamination based on investigations by PB (2004) and to conclude whether the Site is suitable for the intended redevelopment of medium density residential landuse.
- The SAS was prepared for part of the Site comprising Lots comprising Lots 3, 4 and 5 in DP 456634 listed on the SAS as 600-602 Elizabeth Street, Redfern NSW 2016 and for the Site immediately east between Walker Street and Moorehead Street and bounded by Kettle Street and Phillip Street listed as Lots 1 and 2 in DP435765 comprising Curtis Place, 44-52 Moorehead Street, 57-75 Walker Street and 35 Kettle Street, Redfern NSW.
- Anecdotal information obtained by PB (2004) indicated that the Site was occupied by residential terraces in the 1940s which were demolished in the 1950s and demolition waste was spread across the Site prior to the construction of the current buildings. Anecdotal information obtained by PB (2004) also indicated a small rubbish dump was once located on the corner of Elizabeth and Phillip Streets. The Auditor noted that the source of fill on the Site was not definitive and agreed that a Phase 2 Investigation was warranted.

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- The SAS noted that the ERM (2001) Phase 1, a Sampling Analysis and Quality Plan (SAQP) prepared by PB (May 2004) and a letter of correspondence from PB dated 28 February 2005 had also been reviewed.
- As part of the Phase 2 ESA undertaken by PB, a total of 32 boreholes (13 [BH101 to BH113] on the western portion i.e. the Site) were drilled to a maximum depth of 3 metres below ground level (m bgl) to allow for the collection of soil samples at the surface, 0.3-0.5 m and then at 0.5 m intervals. Approximately two to four primary samples per borehole (total 63 primary samples – 28 collected from fill materials and 35 from natural soils) were analysed for heavy metals, total petroleum hydrocarbons (TPH), benzene, toluene, ethylbenzene and xylenes (BTEX), PAHs, organochlorine pesticides (OCPs), polychlorinated biphenyls (PCBs) and asbestos.
- PB (2004) installed four groundwater monitoring wells (MW1 to MW4) – MW1 and MW2 were installed on the western portion (i.e. the Site). The depths of well installation were unknown from reviewing the SAR (Golder, 2005). Standing water levels were noted to range from 2.1 to 3.9 m bgl. Four primary groundwater samples were collected and analysed for heavy metals, TPH, BTEX and PAHs.
- Observations undertaken during drilling indicated the Site comprised sandy topsoil fill to 0.2 m bgl which was underlain by sand fill with demolition rubble – broken bricks and concrete, glass, metal, coal, charcoal and ash inclusions. The maximum depth of fill materials was 1.5 m bgl with the exception of BH126 on the eastern boundary adjacent Moorehead Street (i.e. off-Site) where fill materials were encountered to 3.5 m bgl. Natural sands were encountered at an average depth of 1.0 m bgl. In the Western portion of the Site (i.e. the Site) it was noted that a band of peaty clay approximately 2 m in thickness was present underlying the natural sand.
- The soil analytical results were compared to NSW Environment Protection Authority (EPA) (1998) Guidelines for the NSW Site Auditor Scheme – Residential with gardens and accessible soil criteria (health investigation level [HIL]) and provisional phytotoxicity criteria (ecological investigation level [EIL]) and NSW EPA (1994) Guidelines for Assessing Service Station Sites and groundwater analytical results were compared to Australia and New Zealand Environment Conservation Council (ANZECC) (2000) Guidelines for Fresh and Marine Water Quality – trigger values for 95% species protection in freshwater.
- The soil analytical results indicated concentrations of lead, toluene, TPH C_{10}-C_{36}, benzo(a)pyrene and sum of PAHs in selected samples exceeded the HIL and concentrations of copper, lead, zinc and mercury in selected samples exceeded the EIL. No asbestos was detected in any of the 26 samples analysed.
- Three soil samples were collected form peaty clay and were tested for field pH and post oxidation with hydrogen peroxide. The results indicated potential acid sulfate soils.
- The groundwater analytical results indicated concentrations of chromium, copper, lead and zinc above the ANZECC (2000) criteria, however PB (2004) reported they were likely to reflect regional groundwater quality and not representative of Site-derived contamination. Concentrations of benzo(a)pyrene and Sum of PAHs were detected in MW3 (located on the northern boundary of the eastern portion i.e. off-Site) and exceeded the ANZECC (2000) criteria.
- The Auditor noted that "contaminated material in the form of heavy metals, namely, lead, zinc, copper and mercury are present in the fill material across the Site, to depths of up to 2.5 metres in some locations. Elevation concentration of TPH and PAH (in the form of benzo(a)pyrene) have been reported mainly on the western portion of the Site. The TPH and PAH exceedances have been reported in both fill and natural material. The natural organic/clay material below the Site were reported to contain elevated concentrations of TPH fractions. PB performed subsequent speciation of examples of this material reporting that as the aliphatic fractions were greater than the aromatic fractions, then the elevated TPH fractions are likely to be from a natural source. The Auditor does not agree with this assertion and considers further evaluation of this material is required as part of the Remediation Action Plan. The Auditor considers the concentrations of metals, TPH and PAH present at the Site unsuitable for development of the Site for residential purposes. The Auditor agrees with PB that this material be remediated and managed and that a Remediation Action Plan is required. Based on groundwater quality on sites around Sydney, it is

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reasonable to assume that low concentrations of some metals would occur. The Auditor therefore concurs with the PB conclusions that the exceedences of copper, lead and zinc in groundwater are not significant and possibly represent background conditions."

- The Auditor assessment of risk indicated the following:
  - Potential receptors: residents, workers, visitors and trespassers exposed to any surface soils and utility or construction workers involved in excavations at the Site, either associated with developing the ultimate Site end use of at subsequent times;
  - Exposure pathways for surface soils – dermal contact, inhalation of dust and incidental ingestion and subsurface soils – dermal contact, inhalation of dust and incidental ingestion;
  - Elevated concentrations of lead were identified on the south-east of the Site where access to soils is currently limited due to the presence of grass of asphalt;
  - Elevated concentrations of TPH to a depth of 1.5 m bgl across the western portion of the Site. The Auditor recommended additional evidence be required such as TPH analysis of soil samples using silica gel clean up to determine the potential source;
  - Elevated concentrations of PAH were noted in the top 0.5 m of material across the Site;
  - PB concluded that based on the Phase 2 findings there was insufficient evidence of a historical rubbish dump in the south-west corner of the Site;
  - There is high potential for acid sulfate soils across the Site;
  - The risk associated with exposure to surface soils, impacted with concentrations of contaminants in exceedence of HILs, by residents on-Site in its current state is considered to be significant;
  - The contaminant levels in soils have the potential for exposure of organisms and indicate that ecological impacts, if relevant, from the fill would be notable;
  - Given the Site will be redeveloped for residential land use, aesthetic impacts (i.e. visual and odour), must be addressed during the redevelopment of the Site; and
  - The Auditor considers that based on the results of the soil and groundwater investigation, the potential for migration of contaminants from the Site is considered to be low.
- The SAS indicated that the nature and extent of the contamination has been appropriately determined and "The Auditor concludes that the land in its present form is not suitable for medium density residential land use, and to achieve suitability a Remediation Action Plan is required to address the contamination encountered during the Stage 2 Environmental Site Assessment."

AECOM notes that based on a review of historical aerial images the eastern portion of the Site (i.e. off-Site) between Moorehead and Walker Streets was redeveloped with high density residential land use post 2004.

3.3 PB (2007) Remediation Status Letter

Documents obtained by LAHC from City of Sydney Council included a letter addressed to LFA Pty Ltd (an architectural firm who designed "Redfern East Social Housing Project" immediately east of the Site) written by Parsons Brinckerhoff Australia Pty Limited (PB) dated 14 May 2007 titled *Re: Findings of Phase 2 ESA and remedial requirements, Redfern*.

The letter noted that the eastern portion of the Site was investigated by PB (2004) comprising Lot 1 and 2 of DP 435765 which was "proposed to be developed for 40 town houses and 66 apartments (following demolition of the existing housing and remediation)." In the letter PB concluded that "while potential environmental constraints to redevelopment of the Site have been identified, the previous Phase 2 ESA concluded that by excavation and off Site disposal of the impacted soils the Site can be adequately remediated to a level suitable for residential land use. Based upon the extent and nature of the contamination PB considers that the Site can be remediated to a level suitable for ongoing residential (with soils access) land use."

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3.4 AECOM (2012) Phase 1 Contamination Assessment

AECOM prepared a Phase 1 contamination assessment for Scott Carver Pty Ltd on behalf of Department of Finance and Services (DoFS) for two public housing sites at Redfern and Waterloo (the Study Area) as documented in *Phase 1 Contamination Assessment, Redfern Waterloo Sustainable Servicing and Supporting Infrastructure*, 13 August 2012. It is noted that the Study Area assessed by AECOM (2012) comprised the Site within the Redfern (eastern) portion as well as land immediately north and east of the Site. It also included the Waterloo (western) portion located approximately 350 m south-west of the Site.

The purpose of the assessment was to evaluate the land use suitability and potential contamination issues of the Study Area.

The objectives of the Phase 1 contamination assessment were to carry out a broad scale evaluation of known or likely areas of contaminated land within and around the Study Area, specifically to:

- Identify known or likely sources of contamination within the Study Area that may affect the outcomes of the Urban Renewal Study (URS).
- Identify specific locations within the Study Area which are likely to be unsuitable/require remediation for residential re-development based on historical/current land use activities.
- Provide recommendations on any further contamination investigations required to support changes in zoning or for future divestment purposes.

Potential sources of contamination that were identified during this assessment, which may impact the condition of soil and groundwater within the eastern portion of the Study Area, include the following:

- Within eastern portion of the Study Area:
    - Use of fill material of unknown origin across the Study Area that could potentially contain contaminants of potential concern (CoPC) including asbestos, heavy metals, TPH and PAHs.
    - Historical use of asbestos containing material (ACM) within buildings erected since the 1920s.
    - Historical use of lead based paints on the interior and exterior of historical and current residential buildings.
- Surrounding the eastern portion of the Study Area:
    - Sites listed on the office of Environment and Heritage (OEH) Contaminated Land Record of Notices, located to the south and east of the Study Area, on Bourke Street and Young Street.
    - Contaminated sites notified to the EPA.
    - Surrounding retail petroleum service stations.
    - Surrounding dry cleaning outlets.
    - Groundwater beneath the Study Area that may be contaminated from the historical commercial and industrial land uses in surrounding areas.

Specific locations/areas could not be identified where fill material may have been used or lead and/or asbestos contamination is likely to be present as it may be variably present across the entire Study Area.

The Phase 1 contamination assessment identified a generally low potential for significant contamination to be present within the Study Area. However, based on the size of the proposed re-development, the report identified there was a potential for contamination to be present which may not be consistent with the proposed redevelopment plans. AECOM recommended that, for due diligence purposes, Stage 2 intrusive investigations should be undertaken to further evaluate the contamination status of the Study Area. It was noted that the investigations could be undertaken in a staged approach in accordance with the requirements of the overall Study Area Master Plan.

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4.0 Site Condition and Surrounding Environment

4.1 Current Land Use

At the time this Phase 1 ESA was undertaken (March 2018) the northern portion of the Site was predominantly vacant and comprised grass and trees surrounded by a chain wire fence. The southern portion of the Site was occupied by South Sydney PCYC and comprised a large building in the south-western portion of the Site and sporting courts including basketball and playing equipment in the south-eastern portion of the Site surrounded by chain wire fence.

4.2 Surrounding Land Use

The land uses surrounding the Site are summarised as follows:

- North: Kettle Street cul de sac, followed by medium to high density social housing and Annie Green Court aged care facility. Further north, Redfern Street and additional high density social housing and low to medium density residential land use. Some commercial premises (cafes, restaurants and shops) are present to the north-west along Elizabeth Street and Redfern Street.
- West: Elizabeth Street, Redfern Park and Redfern Oval. Further east lies Chalmers Street, Redfern Community Hall, Woolworths Redfern, The Salvation Army, Redfern War Memorial and low to medium density residential land use.
- South: Phillip Street – low to medium density residential land use and commercial premises along Elizabeth Street. KU James Cahill Preschool is located to the south-west along Raglan Street.
- East: Walker Street cul de sac – medium to high density residential land use, high density social housing to the north-east. Further east, Morehead Street, high density social housing including Poets Corner shopping centre comprising a medical centre, a preschool and a pharmacy.

4.3 Site Features and Observations

Photographs of site features are presented in plates in the Photolog in **Appendix B**. Site features and inspection observations are summarised below:

- A chain metal wire fence was present around the northern (vacant) portion of the Site.
- The northern portion was vacant and comprised patchy grass cover with fill materials (including building rubble and a piece of slag [refer **Plate 5**]) visible across the surface. Possible building footings and blocks of concrete were also observed (refer **Plates 2**, **4** and **8**).
- A stockpile of mulch material and a sewer manhole were observed in the centre of the northern portion of the Site (refer **Plates 3** and **7**).
- An existing groundwater monitoring well was observed adjacent the northern Site boundary (refer **Plate 1**) and a possible existing borehole location was observed in the PCYC carpark adjacent the southern Site boundary (refer **Plate 17**).
- A large building housing the South Sydney PCYC is present on the south-western portion of the Site (refer **Plates 12** and **13**).
- Sporting (including basketball) courts and playing equipment are present in the south-eastern portion of the Site behind the South Sydney PCYC (refer **Plates 18**, **19** and **20**).
- Numerous underground services and above ground connection points were visible in footpaths surrounding the Site and at gated entrances along the eastern and western boundaries to historical residential premises in the northern portion of the Site (refer **Plate 24**).

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4.4 Topography and Drainage

The elevation of the Site, based on the Lotsearch (2018) Environmental Risk and Planning Report (refer to **Appendix C**), is approximately 30 m AHD and is predominantly flat with slight undulations and a very slight slope towards the south. The surrounding land is relatively flat with slight slopes down to the south and south-west.

4.5 Surface Water

No surface water was observed at the Site during the inspection. The nearest surface water body is the concrete lined drain of Sheas Creek, located approximately 1 km south-west of the south-western Site boundary. Sheas Creek flows in a south-westerly direction to Alexandra Canal which joins the Cooks River at the north-western boundary of Sydney Airport and subsequently flows south and east to connect to Botany Bay. The surface of the northern portion of the Site is predominantly unsealed grass cover and the southern portion of the Site is predominantly sealed with concrete or bitumen. Any overland flow is anticipated to flow in the stormwater drains surrounding the Site.

4.6 Geology

The Sydney 1:100,000 Geological Series Sheet in the Lotsearch (2018) report (refer **Appendix B**) indicates that the Site is located within medium to fine grained 'marine' sands with podsols (Qhd) of the Quaternary era.

The following geological units may be encountered in the locality:

- Quaternary era: man-made fill (dredged estuarine sand and mud, demolition rubble, industrial and household waste) overlying silty to peaty quartz sand, silt and clay with ferruginous and humic cementation in places and common shell layers (mf/Qha).
- Quaternary era: medium to fine grained, marine sand with podsols (Qhd), commonly referred to as 'Botany Sands'.
- Ashfield Shale (Rwa).
- Hawkesbury Sandstone or possibly Mittagong Formation over Hawkesbury Sandstone.

The Ashfield Shale is expected below the alluvium across most of the Site and surrounding area. However, the boundary between the Ashfield Shale and Hawkesbury Sandstone is not well defined in this area. The known unit extents indicate that the boundary lies between Redfern Station and the Moore Park Entertainment Precinct.

The geological sheet describes the Ashfield Shale as black to dark grey shale and laminite. The Mittagong formation is an intermediate unit sometimes present between the Ashfield Shale and Hawkesbury Sandstone. It is sometimes referred to as transition beds between the fine-grained Ashfield Shale and relatively coarse-grained Hawkesbury Sandstone and is described as shale, laminite, and medium grained quartz sandstone. The Hawkesbury Sandstone is described as medium to coarse-grained quartz sandstone, very minor shale and laminite lenses.

A dyke is located approximately 600 m north-east of the north-eastern boundary of the Site. The dyke runs south-west to north-east and extends from north-west of Redfern station to the south-eastern corner of Prince Alfred Park.

4.7 Soils

The Sydney 1:100,000 Soil Landscapes Series sheet in the Lotsearch (2018) report indicated that the Site is located within the Tuggerah (AEtg) group derived from Aeolian processes.

The Site comprises coastal plains and dunes, lagoons and swampy areas: chief soils are leached sands. Associated dunes are siliceous sands and/or calcerous sands fringing the coastline and swampy areas of soils and soils with peaty surfaces.

The area surrounding the site is made up of the Tuggerah (AEtg) group derived from Aeolian processes, Disturbed Terrain (DTxx) and the Blacktown (REbt) group derived from residual processes.

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4.8 Acid Sulfate Soils

The Sydney Local Environmental Plan (2012) in the Lotsearch (2018) report (**Appendix B**) maps the Site as Class 5 which indicates that:

- Works within 500 metres of adjacent Class 1, 2, 3, or 4 land, that is below 5m AHD and by which the watertable is likely to be lowered below 1m AHD on adjacent Class 1, 2, 3 or 4 land, presents an environmental risk.
- There are no classes other than Class 5 within a 500 m radius of the Site.

4.9 Hydrogeology

The Bureau of Meteorology Australian Groundwater Explorer indicated that the aquifers on the Site and surrounding areas are likely to comprise – porous, extensive aquifers of high productivity.

A search of the Bureau of Meteorology Australian Groundwater Explorer and NSW Department of Primary Industries, Office of Water "Pinneena" database indicated that 24 groundwater bores were located within a 400 m radius of the Site. The data is summarised included in the Lotsearch (2018) report (refer **Appendix B**).

Based on the registered groundwater bore data, there was insufficient standing water level data to determine depth to groundwater. However, based on the findings of previous investigations at the Site (ERM, 2001) shallow groundwater is anticipated to be present at an approximate depth of 2.5 m to 5 m and is anticipated to flow in a south to south-westerly direction towards Sheas Creek. The closest registered bore to the Site is used for recreation (located within Redfern Oval). Other registered groundwater bores used for monitoring purposes are located south-east of the Site within commercial/industrial properties along Bourke Street, Waterloo.

4.10 Regional Meteorology

Climate data was obtained from the Bureau of Meteorology (BOM) website (www.bom.gov.au). The BOM weather station (066062), located at Sydney Observatory (approximately 4.4 km from the Site) indicated the following:

- Average annual rainfall of 1,215.7 mm, with June typically the wettest months (>130 mm per month).
- Average maximum temperature of 21.8^{o}C, ranging from 26.0^{o}C in January to 16.4^{o}C in July.
- Average minimum temperature of 13.8^{o}C, ranging from 18.8^{o}C in January and February to 8.1^{o}C in July.

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5.0 Preliminary Geotechnical Model

We have used borehole information from within a radius of about 0.4 km of the site to develop the preliminary geotechnical model in **Table 2**. This included some boreholes drilled within the site boundaries, although the borehole locations are not known reliably. The boreholes, drilled to depths of up to 6.5 m, provide information on Fill and the upper Quaternary Sediments, known as the Botany Sands.

Future construction methodology on this site will largely be driven by depth to rock and the planned land-use. Locally deeper Fill or Botany Sands could be found than indicated in our inferred model. The Botany Sands is likely to be underlain by Residual Soils formed by weathering of the underlying Shale or Sandstone bedrock.

Table 2 - Indicative Ground Profile

Geotechnical Unit	Description	Depth to Top of Unit (m)	Unit thickness (m)
1. Fill	Variable Sands or Clays: Containing Silt, Gravel, possibly waste materials	Ground surface	1.2 to 2
2. Botany Sands	Peat/Sandy Silt: Very loose / very soft, SPT 'N' values ranging from 0 to 2 Sand: Generally medium dense, SPT 'N' values ranging from 11 to 31	1.2 to 2	4 to 6
3. Residual Soil	Clay: generally firm to stiff	1.8 to 4.3	1.1 to 2.2
4. Bedrock	(Note 2)	8 to 12	(Note 1)
4a Shale	Class V and IV Shale		
4b Shale	Class III or better Shale		
4c Sandstone	Class V Sandstone		
4d Sandstone	Class IV or better Sandstone		

Notes on **Table 2**

1. There is likely to be between 1 m and 4 m of relatively poor quality rock (Class V and IV Shale or Class V Sandstone) over better quality rock.
2. Rock class as defined in Pells et al 1998.
3. The unit depths, thicknesses and material properties presented in **Table 2** should not be assumed to represent the extremes that may be encountered across the site. Actual unit boundaries and material propertied can be highly variable, particularly for fill. Features such as erosional palaeochannels, faults and igneous intrusions into the sedimentary bedrock sequences can affect bedrock surfaces within the Sydney region.

5.1 Groundwater

Groundwater is likely to be relatively shallow in this locality. Groundwater strikes during drilling at the site have been recorded in Unit 2 – Botany Sands, at depths ranging from 3 m to 4.5 m.

The permeability of the soils and the weather conditions prior to drilling will affect the accuracy of this data and may not reflect long-term groundwater conditions at the site. The site is relatively low lying and groundwater may rise to the ground surface during heavy or prolonged rainfall.

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6.0 Phase 1 ESA Search Results

6.1 Site Zoning and Land Use

The northern (currently vacant) portion of the Site is currently zoned Zone 2 (b) Residential (Medium Density) under the South Sydney Local Environment Plan 1998. The southern portion of the Site is zoned Zone 5 Special Uses (Activity Centre) which is currently in use by the South Sydney PCYC.

6.2 Aerial Photographs

Historical aerial photographs were reviewed to identify former land uses that may have the potential to be sources of contamination. The photographs were obtained from the NSW Department of Land and Property Management Authority (DLPMA) and are summarised in **Table 3** below.

Table 3 Historical Aerial Photograph Review Summary

Photograph Details	Description
February 1930 Run 16 Black and White (**Figure F3**)	**Site:** The photograph is of poor quality. The entire Site predominantly comprised blocks of terraced housing. **Surrounds:** Similarly, land located immediately to the north, west, east and south of the Site comprised blocks of terraced housing. Redfern Park and oval is visible immediately west of the Site. Further to the west, south and north, terraced housing is visible and some larger warehouse buildings. To the south-east numerous warehouses and vacant land are visible along Bourke Street.
June 1942 Run 5 Black and White (**Figure F4**)	**Site:** As per the 1930 aerial photograph. **Surrounds:** As per the 1930 aerial photograph, with more prominent warehouse buildings visible to the south and east which may be indicative of increased industrial activity.
May 1951 Run 14 Black and White (**Figure F5**)	**Site:** The Site is vacant and appears to be unsealed, terraces have been removed. **Surrounds:** As per the 1942 aerial photograph with more prominent warehouse buildings to the north, south and south east. The Site immediately to the east of the Site has been cleared and is vacant and unsealed and some sites further north on Redfern Street have been cleared of buildings and portions are unsealed.
1961 Run 36E Black and White (**Figure F6**)	**Site:** Extensive re-development of the Site, where most of the terraced housing was removed and free-standing L and T shaped buildings, likely to be residential apartments appear to have been erected. A large building is visible in the south-western corner (possible current building used for South Sydney PCYC). **Surrounds:** As per the 1951 aerial photograph. Increased residential density of terrace housing surrounding the Site. The vacant sites noted in the 1951 aerial photograph immediately east and further north have been redeveloped with apartment buildings similar to the Site, with the exception of a vacant unsealed portion of land immediately north-east of the Site which remains undeveloped.
July 1970 Run 18 Black and White (**Figure F7**)	**Site:** As per the 1961 aerial photograph. **Surrounds:** As per the 1961 aerial photograph. The vacant portion of land immediately north-east has been developed with a large high density X shaped building likely to be residential apartments.
August 1982 Run 23 Colour (**Figure F8**)	**Site:** As per the 1970 aerial photograph. **Surrounds:** As per the 1970 aerial photograph. Extensive redevelopment of areas to the west of the Site with removal of terrace housing and replacement with high rise apartment buildings.
October 1994 Run 11 Colour (**Figures F9**)	**Site:** As per the 1981 aerial photograph, with increased vegetation growth around the apartment buildings in the northern portion of the Site. Basketball courts are visible in the south-eastern corner of the Site. **Surrounds:** As per the 1982 aerial photograph.

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Photograph Details	Description
October 2004 Colour (**Figure F10**)	**Site:** As per the 1994 aerial photograph, with increased vegetation growth around the apartment buildings in the northern portion of the Site. **Surrounds:** As per the 1994 aerial photograph, with the removal of most of the warehouse buildings on one of the properties listed under Section 58 of the *Contaminated Land Management Act 1997* (OEH, 2012) located south-east of the Site along Bourke Street.

6.3 Historical Database Records

A summary of the historical database records pertaining to the Site and immediate surrounds are summarised in **Table 4** to **Table 7** below.

Table 4 1950 Historical Database Records

Activity	Name	Address	Distance	Direction
Engineers General and/or manufacturing and/or mechanical	Cheney J.S. Pty Ltd	219 Elizabeth Street Redfern	On-Site	Premises Match
Sports Goods manufacturers, wood ware manufacturers	Munro James Pty Ltd	172-194 Walker Street, Redfern	On-Site	Premises Match
Chemical manufacturers	Corbett, W.H.	Phillips Street, Waterloo	On-Site	Road Match
Motor Garage and/or engineers	Scholtz E.N.	231 Elizabeth Street, Redfern	On-Site	Road Match

Table 5 1970 Historical Database Records

Activity	Name	Address	Distance and Direction
Smallgoods manufacturers and/or wholesalers	Dandy Bacon & Small goods	Phillip Street, Redfern	On-site
Footwear manufacturers and/or wholesalers	Hirst, E.E. Shoe Co	632 Elizabeth Street, Redfern	On-site
Smallgoods manufacturers and/or wholesalers	NSW Bacon Products Pty Ltd	Phillip Street, Redfern	On-site
Clubs and/or Sporting Bodies	South Sydney Police Citizens Boys Club	638 Elizabeth Street, Redfern	On-site
Motor garage and/or engineer and/or service station	BP Waterloo Service Station	Moorehead Street, Waterloo	Road match - 90 m south-east

Table 6 1975 to 1978 Historical Database Records

Activity	Name	Address	Distance	Direction
Clubs and/or Sporting Bodies	South Sydney Police Citizens Boys Club	638 Elizabeth Street, Redfern	On-site	
Motor garage and/or engineer and/or service station	BP Waterloo Service Station	Moorehead Street, Waterloo	Road match - 90 m	South-east

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Table 7 1982 to 1986 Historical Database Records

Activity	Name	Address	Distance and Direction
Clubs and/or Sporting Bodies	South Sydney Police Citizens Boys Club	638 Elizabeth Street, Redfern	On-site
Clothing manufacturers and/or wholesalers and/or mens and/or boys wear	Merkury Clothing, Elizabeth Street, Redfern	Road Match	On-site
Health Centres and/or Clinics	Redfern Baby Health Centre, Redfern Park	Road Match	132 m west
Laundries and/or Laundrettes	Waterloo Coin Laundry	635 Elizabeth Street, Waterloo	42 m south-west

6.4 NSW EPA Records

6.4.1 List of Contaminated Sites Notified to NSW EPA

A search of the NSW EPA contaminated lands database, which evaluates whether the Site or surrounding properties were listed under Section 58 of the *Contaminated Land Management Act 1997*, was presented in the Lotsearch (2018) report. No listings for the Site were indicated. Fourteen properties within a 1km radius of the Site were on the NSW EPA Contaminated land list and are summarised in **Table 8** below:

Table 8 Site Notified as Contaminated to NSW EPA (within 1km radius of the Site)

Map ID (Appendix C)	Site	Address	Activity that caused Contamination	EPA Site Management Class	Distance and Direction
1409	Lawrence Dry Cleaners	887-893 Bourke Street, Waterloo	Unclassified	Contamination currently regulated under CLM Act	272 m south-east
1137	Former Printing Works	101a Marriott Street, Redfern	Other industry	Regulation under CLM Act not required	295 m east
13453	BP-branded Jasbe Surry Hills	411 Cleveland Street, Redfern	Service Station	Regulation under CLM Act not required	570 m north-east
4842	Diversity Waterloo	1-13 Archibald Avenue, Waterloo	Other industry	Under assessment	604 m south
13525	Iconic (Former Chubb Factory) Waterloo	830-838 Elizabeth Street, Waterloo	Other industry	Under assessment	654 m south
1410	Proposed Construction Site	2 John Street, Waterloo	Other industry	Regulation under CLM Act not required	673 m south-west
1136	BP Service Station	116 Regent Street, Redfern	Service Station	Regulation under CLM Act not required	694 m west
13414	Alexandria Gardens	146-156 Wyndham Street & 146-156 Botany Road, Alexandria	Unclassified	Under assessment	726 m south-west

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Map ID (Appendix C)	Site	Address	Activity that caused Contamination	EPA Site Management Class	Distance and Direction
13435	Formerly Gas N Go Alexandria (fully redeveloped into residential apartment as of September 2016)	10-20 Botany Road, Alexandria	Service Station	Under assessment	736 m west
1255	Woolworths Petrol Surry Hills	475 Cleveland Street, Surry Hills	Service Station	Regulation under CLM Act not required	791 m north-east
1411	Shell Coles Express Service Station	867-877 South Dowling Street, Waterloo	Service Station	Regulation under CLM Act not required	842 m south-east
13493	22-24 Archibald Avenue	22-24 Archibald Avenue, Waterloo	Other petroleum	Under assessment	842 m south-east
458	Australian Technology Park	Henderson Road, Eveleigh	Other industry	Regulation under CLM Act not required	876 m west
28	Caltex Alexandria Service Station	133 Wyndham Street corner McEvoy Street, Alexandria	Service Station	Regulation under CLM Act not required	911 m south-west

A copy of the NSW EPA search record including explanation of the management classes is provided within the Lotsearch (2018) report in **Appendix C**.

6.4.2 NSW EPA Contaminated Land Record of Notices

A review of the NSW EPA website (www.epa.nsw.gov.au) in the Lotsearch (2018) report to evaluate if the EPA has issued a regulatory notice in relation to the Project Area under Section 60 of the *Contaminated Land Management Act 1997* (*CLM Act 1997*), indicated that there were no current or former notices for the Site. Two properties within a 1km radius of the Site were listed as having current and/or former notices; the information is summarised in Table 9 below:

Table 9 NSW EPA Contaminated Records of Notice (within 1km radius of the Site)

Map ID (Appendix C)	Site	Address	Notices	Distance and Direction
331	Lawrence Dry Cleaners	887-893 Bourke Street, Waterloo	8 current and 3 former	272 m south-east
367	Formerly Gas N Go Alexandria (fully redeveloped into residential apartment as of September 2016)	10-20 Botany Road, Alexandria	2 current	736 m west

Former Gas N Go, Alexandria (located 119 m north-west of the Precinct). A Preliminary Investigation Order was issued on 30 May 2016 and an Amendment or Repeal of Order was issued on 30 November 2016.

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Lawrence Dry Cleaners, Waterloo (located 361 m east of the Precinct). The seven current notices are detailed below:

- Declaration of Investigation Area issued 31 October 2003
- Agreed Voluntary Investigation Proposal issued 4 May 2004
- Declaration of a Remediation Site issued on 2 November 2005
- Management Order issued 26 May 2011 and amended on 28 August 2014
- Amendment of Repeal of Order issued on 27 February 2015
- Amendment of Repeal of Order issued on 9 February 2016

A copy of the search is provided in the Lotsearch (2018) report in **Appendix C**.

Both sites are located a considerable distance and hydraulically down-gradient of the Site.

6.4.3 NSW EPA Per- and Poly-fluorinated Alkylated Substances (PFAS) Investigation Program

There were no Sites being investigated by NSW EPA for the presence of PFAS within a 1km radius of the Site.

6.5 Historical Certificates of Title

A review of historical Certificates of Title was undertaken, a summary of which is provided below:

Table 10 Summary of Title Search

Year	Proprietor
(Lots 3 to 5 DP 456634)	
1997 – to date	New South Wales Land and Housing Corporation
1997 – to date	*Current lease to The Federation of New South Wales Police Citizen Boys Club, of Lots 7-11 DP 35793*
(Lots 3 to 5 DP 436293 – CTVol 6587 Fol 56)	
1957 – 1997	The Housing Commission of New South Wales
(Part Portion 400 Parish Alexandria – Area 10 ½ Perches – CTVol 2457 Fol 26)	
1944 – 1952	Claud Sidney Buck, restaurant proprietor
1944 – 1944	The Commissioner for Road Transport and Tramways
1914 – 1944	*Lease to Charles Boz, of Redfern*
1914 – 1944	Chief Commissioner for Railways and Tramways
(Part Portion 400 Parish Alexandria – Area 6 Acres 2 Roods 2 ½ Perches – CTVol 2531 Fol 93)	
1933 – 1952	The Permanent Trustee Company of New South Wales Limited
1914 – 1933	Thomas Saywell, esquire
(Alderson Street, Redfern – Area 1 Rood 15 ¾ Perches – Government Gazette 17 November 1950 Folio 3397)	
1950 – 1952	The Housing Commission of New South Wales
Prior – 1950	Road

The title search records indicate that portions of the Site have been owned by NSW Land and Housing Corporation since 1950. Portions of the Site have historically been used for private uses (including residential activities and possible agricultural activities such as sheep grazing and farming) between

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1914 and 1933 and between 1944 and 1952, as a roadway prior to 1950 and owned by State transport authorities between 1914 and 1944.

Copies of the historical certificates of title are included in **Appendix D**.

6.6 Section 149 Certificate

As noted in **Table 1** the Section 149 planning certificates obtained from City of Sydney Council lists 600-614 Elizabeth St as Lots 3, 4 and 5 in DP 456634 and 616-660 Elizabeth St as Lots 7 to 11 in DP 35793 which are not listed on the current certificate of title or on the NSW Government Spatial Information Exchange.

A review of the Planning Certificates from City of Sydney Council, issued 9 March 2018 and 26 March 20118 under Section 10.7 of the *Environmental Planning and Assessment Act 1979* was undertaken, as summarised below:

600-614 Elizabeth Street Redfern

- The Site is currently zoned as 2B Residential (medium density) under Clause 12 South Sydney Local Environmental Plan 1998.
- The land is affected by the City of Sydney Contaminated Land Development Control Plan 2004 adopted by the Council, which may restrict the land if the potential for the risk of land contamination exists.
- The land to which the S149 certificate relates is the subject of a site audit statement within the meaning of that act, a copy of which has been provided to Council.
- The development on this land or part of this land is subject to flood related development controls.
- The City of Sydney Development Contributions Plan 2015 – in operation as of 1 July 2016 may apply to this property.
- The land subject of the S149(5) certificate contains, or has contained, contaminants identified in one or more reports or records held by Council.

616-660 Elizabeth Street Redfern

- The Site is currently zoned as 5 Special Uses Zone under Clause 15 of South Sydney Local Environment Plan 1998.
- This property may be identified as being of state heritage significance and entered on the State Heritage register. To confirm whether the site is listed under the Heritage Act 1977 a Section 167 Certificate should be obtained from the NSW Heritage Office.
- The land is affected by the City of Sydney Contaminated Land Development Control Plan 2004 adopted by the Council, which may restrict the land if the potential for the risk of land contamination exists.
- The development on this land or part of this land is subject to flood related development controls.
- The City of Sydney Development Contributions Plan 2015 – in operation as of 1 July 2016 may apply to this property.

It is noted that the S149 certificate for Lots 7 to 11 in DP 35793 comprising 616-660 Elizabeth Street Redfern did not state that an SAS applied to the land despite the SAS being applicable to this portion of land. It is understood that Lots 7 to 11 in DP 35793 relate to the PCYC lease encompassing the southern portion of the Site.

Copies of the certificates are included in **Appendix E**.

6.7 SafeWork NSW Storage of Hazardous Chemicals site search

A request for review of the Stored Chemical Information Database (SCID), maintained by SafeWork NSW, was undertaken on dangerous goods (DG) and storage of hazardous chemicals information for

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the Site on 22 March 2018. SafeWork NSW responded on 6 April 2018 and indicated that there were no records pertaining to the Site located at 600-660 Elizabeth Street Redfern.

The SafeWork NSW search documentation is presented in **Appendix F**.

6.8 Unexploded Ordnance

A search of the Australian Department of Defence Unexploded Ordnance (UXO) Contamination database was conducted on 23 March 2018 to evaluate whether the Site or surrounding areas were listed. There were no records of UXO contamination in the City of Sydney Local Government Area.

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7.0 Phase 1 ESA – Preliminary Conceptual Site Model

Based on the available historical information relating to the Site and neighbouring properties and Site observations, identified historical potentially contaminating activities include:

- Imported fill material of unknown origin and quality used to level the Site.
- Demolition of historical terrace houses (prior to 1951, refer **Section 6.2**) and structures on Site and surrounding sites.
- Possible historical use of the Site for agricultural purposes (refer **Section 6.5**).
- Possible use of building materials including asbestos and lead paint within the historical building present on the southern portion of the Site, which was constructed in the 1960's (refer **Section 6.2**) and may need to be demolished as part of the proposed redevelopment of the Site.
- Possible storage of plant/machinery and road materials/infrastructure associated with the historical ownership of the Site by various state transport authorities (refer **Section 6.5**).
- Historical land uses Laundry, motor garages and manufacturers on-Site and immediately surrounding i.e. less than 50 m from the Site (refer **Section 6.3**).
- Based on ERM (2001) and PB (2004), possible historical landfilling in the south-eastern portion of the Site (refer **Section 3.1**).
- Known concentrations of lead, B(a)P, sum of PAHs, toluene, TPH C_{10}-C_{36} in soil, heavy metals and up-gradient B(a)P and sum of PAHs in groundwater and potential acid sulfate soils as noted in the SAR (Golder, 2005), refer **Section 3.2**.

7.1 Contaminants of Potential Concern

Based on the available data, contaminants of potential concern (CoPC) at the Site were identified as:

- Heavy metals: may occur in fill of unknown origin and quality and historical use of the Site by various state transport authorities. Common metal contaminants include arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc.
- Petroleum hydrocarbons: from fuels, solvents and oils. Petroleum hydrocarbons are generally quantified by analytical laboratories as TPH and total recoverable hydrocarbons (TRH) and as four fractions of hydrocarbons grouped into ranges of volatility.
- BTEX: typically found in petroleum fuels and to a lesser extent, diesel fuels.
- PAHs and Phenols: related to some petroleum hydrocarbon use, waste and lubricating oils. PAH and phenols are also potentially present in bitumen/asphalt, creosote, ash, incompletely combusted materials and fill material of unknown origin and quality.
- Volatile Organic Compounds (VOCs) and Semi-volatile Organic Compounds (SVOCs): VOC compounds may contain monocyclic aromatic hydrocarbons (including BTEX compounds) and volatile hydrocarbons (such as solvents potentially stored historically at the Site). SVOC compounds may include organochloride pesticides and/or organophosphate pesticides, which may have historically been used at the Site or be present in fill material of unknown origin and quality.
- Polychlorinated biphenyls (PCBs): related to electrical equipment and can be present in fill of unknown origin and quality.
- Asbestos: Commonly used in building construction materials up until the mid-1980s. Potentially present within fill materials of unknown origin and quality and old building structures.

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Table 11 below summarises the potential areas of environmental concern and CoPC for this investigation.

Table 11 Summary of Areas and Contaminants of Potential Concern

Potential Areas of Environmental Concern	Potential Contaminants of Concern
Use of the site by various state transport authorities and storage of materials, equipment, plant, machinery	Metals, TRH, BTEX, PAHs, VOCs, SVOCs, PCBs
Historical use of the Site for Agricultural purposes	OCPs, OPPs
Demolition and presence of historical buildings (terraces and PCYC building)	Lead, PCBs, asbestos
Historical up-gradient laundry	VOCs, SVOCs
Use of imported fill materials on the Site	Metals, TRH, BTEX, PAHs, VOCs, SVOCs, PCBs and asbestos
Known contaminants in soil and groundwater as identified by PB (2004)	Lead, B(a)P, sum of PAHs, toluene, TPH C_{10}-C_{36} in soil, heavy metals and up-gradient B(a)P and sum of PAHs in groundwater and Suspension Oxidation Combined Acidity Sulfur (SPOCAS)

7.2 Potential Receptors of Contamination

Based on the current and future potential land use of the Site, and inferred groundwater flow direction (south and south-west), the potential human receptors for the Site were identified as:

- Current and potential future on site workers and visitors.
- Current and potential future on site intrusive maintenance workers.
- Beneficial users of unregistered groundwater bores close to the Site.
- Current and potential workers, visitors and intrusive maintenance workers on adjacent and nearby commercial properties.
- Sheas Creek, located approximately 1 km south-west of the Site. Given that Sheas Creek is a highly disturbed ecosystem which is unlikely to be used for recreational purposes, it has been included as a potential human receptor as a conservative measure.

A groundwater bore search indicated that 24 groundwater bores were registered within a 400 m radius of the Site. The majority of bores were located along Bourke Street, Waterloo industrial area and were installed for monitoring purposes with the exception of one bore used for recreation purposes located in Redfern Oval - cross-gradient and to the west of the Site and is therefore not considered to be a potential receptor of potential contamination from the Site. Given that the Site is located in a metropolitan area with access to reticulated water, it is considered unlikely that residents would be accessing bore water on Site for drinking or irrigation purposes in the foreseeable future.

The anticipated groundwater direction indicates that the Sheas Creek would be the nearest receiving aquatic environment of groundwater and infiltrated surface water from the Site. Consequently Sheas Creek is considered to be the primary ecological receptor.

7.3 Transport Mechanisms

Potential transport mechanisms for site-derived contaminants (if present) are summarised in **Table 12**.

Table 12 Contamination Transport Mechanisms

Transport Mechanism	Details
Leaching of soil contaminants	Contaminants may leach to groundwater from subsurface soils
Wind erosion and atmospheric dispersion of upper layers of surficial soil	Contaminants in surface soil may be dispersed by wind as dust and inhaled
Groundwater flow	Dissolved phase contaminants in groundwater may migrate due to groundwater flow.
Vapour and gas migration	Volatile contaminants may migrate as vapours and gas through the subsurface and accumulate in structures or buildings.

7.4 Potential Exposure Pathways

For a receptor to be exposed to a chemical contaminant, a complete exposure pathway must exist. An exposure pathway describes the course a chemical or physical agent takes from the source to the exposed individual or receptor.

Potential contact with impacted soil derived from vapour by on and off-site commercial and maintenance workers is considered to be low, given that no historical underground storage of fuels has been identified at the Site. However, PB (2004) detected concentrations of B(a)P, sum of PAHs, toluene and TPH C_{10}-C_{36} in soil. Given the age of this data, further assessment of volatile contaminants in soil is considered warranted.

Based on the current Site conditions, there is potential for contact with impacted soil/groundwater on site during excavation works. For future intrusive maintenance works, there are potentially complete contaminant exposure pathways. These linkages should be considered in a site-specific risk assessment prior to any proposed intrusive works and a construction environment management plan (CEMP) should be prepared to manage any identified risks.

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8.0 Discussion and Recommendations

8.1 Geotechnical Considerations and Risks

Commercial and residential development with basements should be practicable on this site from a geotechnical perspective, using conventional structural elements and normal construction techniques. However, some geotechnical challenges exist such as:

- High groundwater table and the potential for rapid rises in groundwater level during heavy rainfall events: There is the potential for groundwater to rise to the ground surface during flooding events.
- Ground conditions affecting construction methodologies, particularly retention system and building foundation design: There may be saturated, cohesionless soils within the Botany Sands. These will require watertight retention systems and basement slabs to prevent groundwater inflows and running sands.
- Compressible soils: Peat and organic clays may be encountered within the Botany Sands. Such soils will be compressible and this would affect shallow footing performance or make shallow footings impracticable. Compressible soils may result in down drag loadings on piles.
- Interaction with existing services and structures: There are no buildings on the site boundaries as the site is bounded by roads on all sides. However, due to the high permeability soils in the area, construction impacts can extend for significant distances and will have to be considered when designing temporary and permanent work.
- The risk associated with underground services: Retention system design will have to consider the risk of excavation induced ground movements on existing services. Relatively stiff boundary retention systems may be required to limit ground displacements.

In the following sections, preliminary comments and recommendations are provided on geotechnical issues associated with basement excavation, retention systems and building foundations.

8.1.1 Unsupported Excavations

Bulk excavations and trenches where groundwater is well below the base of the excavation will require batters and benches consistent with the nature of the material. Retention systems will be required where there is poor ground or insufficient room to form unsupported batters.

For excavations on site that are remote from site boundaries, it may be practicable to form unsupported batters above the groundwater table. However, the variable fill and the potential for peat and organic soils may result in batters having to be relatively flat. Unsupported batters will not be feasible immediately adjacent to site boundaries and are unlikely to be practicable where surcharge loads would apply at the crest of a batter.

8.1.2 Groundwater and Excavation Retention Systems

8.1.2.1 Groundwater

The Botany Sands are often laterally continuous and of high permeability. A tanked retention system will be required for the development of basements through such soils. Dewatering using drilled or jetted spear points may be possible within an excavation enclosed by a groundwater cut-off such as a sheet pile wall. Excavations should be able to be maintained dry by pumping from sumps, provided lateral inflows from the overlying sands are cut off. This could be achieved if tanked basement walls such as driven steel sheet piles, a diaphragm wall or secant piles walls extend into the Residual Soil or Bedrock.

A hydrostatic slab would be required to tank the base of the excavation. The need for full tanking will depend on regulatory authority approvals. The NSW Office of Water is likely to require tanking to mitigate impact on groundwater in the area. However, if it can be demonstrated that basements penetrate into a very low permeability strata then it may be possible to adopt a semi-tanked basement.

In a semi tanked basement the retaining walls would be tanked and the basement slab designed with a drainage layer to relieve any hydrostatic pressures from groundwater inflows through the

foundations. The drainage system would need to be designed with flushing points to clean out mineral precipitants to prevent blockage of drainage pipes. Such a semi-drained basement would be subject to regulatory approvals.

8.1.2.2 Retention System Structures

Bored soldier pile walls with shotcrete infill panels or contiguous bored piles are unlikely to be practicable through the Botany Sands. These wall types are not suitable for cohesionless and/or saturated soils.

Driven steel sheet piles could be considered to form a temporary retention system to allow dewatering and excavation prior to constructing a permanent cast in place, reinforced concrete retaining wall. The sheet piles may have to be sacrificial where used as formwork for permanent retaining walls. There may be issues with noise and vibration if driven sheet piles are used.

Secant pile walls are practicable for basements. Such walls need to be constructed carefully to maintain pile verticality and avoid gaps between piles through which groundwater and soil could flow. For basements deeper than two levels deep, the risks associated with piling tolerances increase and a diaphragm wall will be less likely to be defective and leak.

If temporary ground anchors are required, the anchor heads will need to be carefully and permanently sealed up to prevent groundwater and soil ingress if groundwater is above the anchor heads.

Depending on factors such as construction sequence and structural stiffness, even well-constructed, anchored retaining walls can deflect laterally in the order of 0.1 % to 0.3 % of the wall height. Detailed soil-structure interaction analysis should be carried out to assess the lateral and vertical ground movements that could result from basement excavation as well as the structural loads acting on the retaining system.

8.1.3 Temporary Ground Anchors

Typically, exclusion zones are declared around buried infrastructure such as cables, pipelines and tunnels. Such exclusion zones restrict the imposition of additional stressed on the ground that may affect the buried infrastructure. The feasibility of installing temporary ground anchors should consider such exclusion zones as they may prevent anchors being adopted or require them to be inclined more steeply, which reduces their efficiency.

8.1.4 Foundations

The building loads for high-rise residential/commercial towers are likely to be relatively heavy and require piled foundations to rock. Open bores piles are unlikely to be practicable unless temporary liners are installed through the Fill and Botany Sands and a seal can be achieved in the residual soils or bedrock. Driven piles may be feasible from a geotechnical perspective, but hard driving conditions may be found if there are obstructions within fill or cemented layers within the Botany Sands. There are also likely to be issues with noise and vibration if driven piles are adopted.

Bored piles supported by casing and/or drilling fluids, or Continuous flight auger (CFA) piles should be practicable.

Care will be required if CFA piles are required to have long sockets into relatively high strength rock, resulting in slow auger penetration rates. If there are loose sands within the Botany Sands, they could be drawn into the auger while the rock socket is being drilled. This can result in loosening of the sands and potentially unexpected ground movements near the piles. This aspect should be further assessed with additional investigation of the sand density, as the risk is lower in more dense sands.

Piles should be designed in accordance with AS 2159-2009 using a geotechnical strength reduction factor, Φ_g, to check pile capacity under Ultimate Limit State (ULS) loads. The value will depend on a calculated Average Risk Rating (ARR) that considers various factors such as the level of investigation, level of redundancy in capacity, pile load testing, and level of construction review. Serviceability should be checked by calculating settlements under SLS loads.

Piles may be subject to down drag forces if compressible soils within the Botany Sands remain below basement levels. These loads do not reduce the geotechnical capacity of the piles but affect structural capacity.

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8.1.5 Pavements

Ground treatment is likely to be required to form pavement subgrades. Existing fill may be suitable but will require geotechnical assessment, excavation and re-compaction to an appropriate specification. Peat or organic clays typically have very poor strength properties and are unsuitable for pavement subgrade. Such materials are likely to have to be excavated and replaced or covered with imported bridging material.

If unsuitable materials such as uncompacted fills, waste materials or organic soils are exposed at bulk excavation levels then they will require treatment to form construction work platforms for general construction plant and piling rigs. Dig out and replace or bridging over such materials will require geotechnical design and the use of imported granular materials, possibly with added geotextile or geogrid reinforcement.

8.2 Further Geotechnical Investigations

This desktop study has been based on a limited number of boreholes from within and surrounding the site. More detailed geotechnical models will be required for design of basements and foundations.

We have not located site specific borehole information giving rock levels. The inferred bedrock level is RL+18 m to RL+22 m AHD (depths of 8 m to 12 m) based on regional borehole data. The current proposal is to drill three boreholes to 15 m depth (or into Class III Shale) and three boreholes to refusal. This should provide information on soil and bedrock for concept design. At this stage, the scope of investigation does not require revision but should be reassessed based on conditions encountered on site during the fieldwork that is planned.

We recommend that groundwater monitoring wells be installed to allow water levels to be measured and permeability testing to assist with basement design.

8.3 Phase 1 ESA Conclusions

The Phase 1 ESA has identified and documented the general environmental condition and risks from current and past land uses which may have resulted in contamination at the Site. The key findings of the Phase 1 ESA are summarised below:

- The Site has primarily been used for residential and/or commercial/light industrial purposes, while the surrounding area has been used for commercial/industrial (typically north, south and west of the Site), residential (surrounding the Site) and recreational (east of the Site) purposes.
- A Stage 2 soil and groundwater investigation undertaken by PB (2004) indicated concentrations of lead, B(a)P, sum of PAHs, toluene, TPH C_{10}-C_{36} in soil, heavy metals and up-gradient B(a)P and sum of PAHs in groundwater in exceedence of adopted assessment criteria for proposed residential land use.
- An SAS for the Site (Golder, 2005) concluded that the Site was not suitable for proposed medium density residential land use and a Remediation Action Plan (RAP) was required to address contamination identified by PB (2004).
- The preliminary CSM (presented in **Section 7.0**) identifies potential sources of contamination, receptors and exposure pathways. Potential sources of contamination identified during the Phase 1 ESA which may impact the condition of soil and groundwater within the Site and its surrounds include the following:
    - Commercial and industrial properties in the immediate surrounding areas, including: car servicing and mechanical repairs, manufacturers and a laundry – Waterloo Coin Laundry.
    - Use of fill material of unknown origin: potentially containing or impacted by contaminants.
    - Historical use of asbestos containing materials (ACM) within buildings and structures erected since the 1920s.
    - Historical use of lead based paints on the interior and exterior of historical and current buildings.

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- Concentrations of lead and PAHs in soil identified as part of the ERM (2001) investigation.
- Known concentrations of lead, B(a)P, sum of PAHs, toluene, TPH C_{10}-C_{36} in soil, heavy metals and up-gradient B(a)P and sum of PAHs in groundwater and potential acid sulfate soils as noted in the SAS (Golder, 2005) and as identified by PB (2004).

Of the potential receptor pathway linkages identified in the preliminary CSM, the following four linkages present a risk to human health and/or the environment that are expected to have implications for remediation/management costs:

1. The historical and current commercial/industrial activities undertaken within the Site and surrounding areas have possibly resulted in contaminants of potential concern (CoPC) being released into the environment. Although it is understood that the redeveloped Site is likely to comprise high density residential and commercial facilities with limited access to soil, future sub-slab intrusive works may be required for service maintenance purposes. As such, there is a potential for workers to come into direct contact (i.e. incidental ingestion and/or dermal contact) with and/or inhale CoPC in soil/dust. Should contamination be identified during phase 2 investigation works it would be recommended that basements and services trenches will be tanked so as to minimise groundwater infiltration.
2. A long history of construction and demolition activities on the Site, potentially depositing CoPC such as asbestos containing materials (ACM) and lead onto the soil. Therefore, there is a potential for intrusive maintenance workers to come into direct contact (i.e. incidental ingestion and/or dermal contact) with and/or inhale asbestos and lead in soil/dust.
3. Fill materials (including building demolition rubble e.g. bricks and building footings, concrete blocks etc.) are visible in the northern vacant portion of the Site and, based on the Site history, are likely to be present across the Site. Imported fill material of unknown origin can contain a range of CoPC. Therefore, there is a potential for intrusive maintenance workers to come into direct contact (i.e. incidental ingestion and/or dermal contact) with and/or inhale CoPC in soil/dust. Additionally, future residents, commercial workers or construction/intrusive maintenance workers may be exposed to volatile CoPC via inhalation if not managed or remediated appropriately.
4. Concentrations of lead, B(a)P, sum of PAHs, toluene, TPH C_{10}-C_{36} in soil, heavy metals and up-gradient B(a)P and sum of PAHs in groundwater and potential acid sulfate soils as noted in the SAS (Golder, 2005) and as identified by PB (2004). It is noted that the investigations were conducted some time ago in 2004 and therefore condition of soil and groundwater at the Site may have since changed.

8.4 Phase 1 ESA Recommendations

Based on the findings of this Stage 1 ESA and preliminary CSM developed for the Site, AECOM recommends undertaking the following additional stages of work:

- Completion of a HAZMAT survey of remaining buildings located on the southern portion of the Site.
- Review of the Section 167 certificate to confirm if the Site is identified as being of state heritage significance.
- Completion of a Stage 2 contamination assessment (combined with the recommended Stage 2 geotechnical investigation) to characterise the nature and extent of potential soil and groundwater contamination, targeting the potential areas of concern identified within the Site and also the proposed locations of excavation works required a part of the proposed development. Soil and groundwater samples should be analysed for the identified CoPCs listed in **Section 7.1** and assessed in accordance with the National Environment Protection (Assessment of Site Contamination) Measure 1999 (ASC NEPM, 2013). The design and cost of the Stage 2 contamination assessment would be informed by the proposed development plans for the Site and existing access constraints.
- The Stage 2 contamination assessment would likely incorporate the following elements:

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- Preparation of a SAQP, which will include an assessment of:
  - Data quality objective (DQO) development.
  - Refinement of the CSM for the Site.
  - Confirmation of proposed sampling and analysis program, incorporating the findings of this Stage 1 ESA. The sampling program would likely comprise a combination of targeted and grid based sampling focusing on identified areas of concern.
  - Consideration would also be given to the requirement for waste classification sampling and analysis in the event that offsite disposal of material will be required.
- Preparation of a site specific Health and Safety Plan (HASP) including consideration of environmental management.
- Project management including subcontractor management, access approvals, stakeholder liaison, etc.
- Field Investigation comprising:
  - Service location in all areas that will be subject to intrusive investigations.
  - Drilling work and monitoring well installation.
  - Groundwater and soil sampling.
  - Survey of newly installed monitoring wells to a site specific datum to facilitate understanding of inferred groundwater flow direction.
  - Laboratory analysis of soil and groundwater samples.

Based on the results of the stage 2 contamination assessment, remediation and/or management of impacted areas may be required to mitigate risks during the construction works program and for the future proposed development. Any remediation works which may be required as an outcome of the Stage 2 contamination assessment would be informed by the preparation of a RAP.

It is noted that the information detailed within the RAP may also be used to inform the following:

- Provision of tender documentation for redevelopment works.
- Validation sampling based on the scope outlined in the RAP following completion of remediation works. It is noted that the validation sampling scope would likely incorporate the following requirements:
  - Groundwater and soil validation sampling.
  - Laboratory analysis of soil and groundwater samples.
  - Preparation of a validation report.
- Development of a CEMP to manage risks to construction and maintenance workers from impacted soils and groundwater during the redevelopment of the Site.
- Development of a Materials Management Plan to include a strategy for the management of materials so that impacted material can be potentially reused in less sensitive areas or managed within the Site to minimise off-site disposal of excavated material to a licensed landfill.

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9.0 Important information about this report

Client details, scope and reliance

AECOM has prepared this report for the sole use of the Client and for a specific purpose, each as expressly stated in the report. No other party should rely on this report without the prior written consent of AECOM. AECOM undertakes no duty, nor accepts any responsibility, to any third party who may rely upon or use this report. This report has been prepared based on the Client's description of its requirements and AECOM's experience, having regarding assumptions that AECOM can reasonably be expected to make in accordance with sound professional principles. AECOM's findings represent its reasonable judgment within the time and budget context of its commission and utilising the information available to it at the time.

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Standard of care

AECOM has prepared this report using the standard of reasonable skill, care and diligence required of a consultant performing the same or similar Services. The report should be read in full. No warranty, expressed or implied, is made as to the professional advice included in this report.

Data sources

AECOM may have relied on information provided by the Client and third parties (Information Providers) to produce this report and arrive at its conclusions. AECOM has not verified information provided by the Information Providers (unless specifically agreed as part of AECOM's scope of work) and we assume no responsibility and make no representations with respect to the adequacy, accuracy or completeness of such information. AECOM assumes no responsibility for inaccuracies in reporting by the Information Providers including, without limitation, by the Client's employees or representatives or for inaccuracies in any other data source whether provided in writing or orally used in preparing or presenting the report.

Variability in conditions and limitations of data

Subsurface conditions are formed through a variety of natural processes and can be altered by human activities. The behaviour of the ground, groundwater and contaminants are complex and conditions can vary across a particular site. As a result, subsurface conditions cannot be exhaustively defined by investigations at discrete locations. Therefore, it is unlikely that the results and assessments expressed in this report will represent conditions at any location removed from the specific points of sampling. The precision with which conditions can be inferred depends largely on the uniformity of subsurface conditions and on the frequency and method of sampling as constrained by factors such as project budget and time limitations and physical constraints.

Furthermore, subsurface conditions can change over time, which should be considered when interpreting or using the data within this report.

Verification of opinions and recommendations

The opinions and recommendations in this report apply to the proposed development and the site existing at the time of our investigation and cannot necessarily apply to changes in the proposed development or site changes of which AECOM is not aware and has not had the opportunity to evaluate. Our recommendations should be considered to be preliminary and subject to verification during project implementation. If conditions encountered at the site are subsequently found to differ significantly from those anticipated, AECOM must be notified and be provided with an opportunity to review the recommendations.

D R A F T

10.0 References

AECOM Australia Pty Ltd (AECOM) (2012) *Phase 1 Contamination Assessment, Redfern Waterloo Sustainable Servicing and Supporting Infrastructure*, 4 December 2012

Environmental Resources Management Australia Pty Ltd (ERM) (2001) *Elizabeth Street Redfern, NSW, Phase 1 Site Contamination Assessment*, April 2001

Golder Associates Pty Ltd (Golder) (2005) *Site Summary Audit Report (Statutory) Stage 2 Environmental Site Assessment of Lot 1 & 2 in DP435765, and Lots 3, 4 & 5 in DP456634 Redfern, NSW*, June 2005; including Site Audit Statement by NSW EPA Accredited Site Auditor Kylie Lloyd of Golder Associates (23 June 2005) *NSW Site Auditor Scheme Site Audit Statement* (Site Audit Statement No. KJL003).

Lotsearch (12 March 2018) *Environmental Risk and Planning Report, 600-660 Elizabeth Street, Redfern, NSW 2016*, Lotsearch Reference: LS002993

National Environment Protection Council (NEPC). *National Environment Protection (Assessment of Site Contamination) Measure 1999 as amended (the 2013 amended ASC NEPM), Schedule B(1) Guideline on Investigation Levels for Soil and Groundwater.*

NSW Department of Environment and Conservation (DEC) 2007. Guidelines for the Assessment and Management of Groundwater Contamination March 2007.

NSW Environment Protection Authority (EPA) 1995. *Sampling Design Guidelines*, September 1995.

NSW Environment Protection Authority (EPA) 2011. *Guidelines for Consultants Reporting on Contaminated Sites*, November 1997.

NSW EPA (2017). *Contaminated Land Management Guidelines for the NSW Site Auditor Scheme (3rd Edition)*. State of NSW and Environment Protection Authority.

Parsons Brinckerhoff Australia Pty Limited (2007) *Re: Findings of Phase 2 ESA and remedial requirements, Redfern*, 14 May 2007

Appendix A

Figures

AECOM Imagine it. Delivered.

SITE LOCATION PLAN

Phase 1 Environmental Site Assessment and Geotechnical Desktop Study
Geotechnical and Contamination Assessment
600-660 Elizabeth Street, Redfern NSW 2016

FIGURE 1

AECOM Imagine it. Delivered.

SITE LAYOUT

Phase 1 Environmental Site Assessment and Geotechnical Desktop Study
Geotechnical and Contamination Assessment
600-660 Elizabeth Street, Redfern NSW 2016

FIGURE 2

AECOM Imagine it. Delivered.

AERIAL PHOTOGRAPH - 1930

Phase 1 Environmental Site Assessment and Geotechnical Desktop Study
Geotechnical and Contamination Assessment
600-660 Elizabeth Street, Redfern NSW 2016

FIGURE 3

AECOM Imagine it. Delivered.

AERIAL PHOTOGRAPH - 1942

Phase 1 Environmental Site Assessment and Geotechnical Desktop Study
Geotechnical and Contamination Assessment
600-660 Elizabeth Street, Redfern NSW 2016

FIGURE 4

AECOM Imagine it. Delivered.

AERIAL PHOTOGRAPH - 1951

Phase 1 Environmental Site Assessment and Geotechnical Desktop Study
Geotechnical and Contamination Assessment
600-660 Elizabeth Street, Redfern NSW 2016

FIGURE 5

AECOM Imagine it. Delivered.

AERIAL PHOTOGRAPH - 1961

Phase 1 Environmental Site Assessment and Geotechnical Desktop Study
Geotechnical and Contamination Assessment
600-660 Elizabeth Street, Redfern NSW 2016

FIGURE 6

AECOM Imagine it. Delivered.

AERIAL PHOTOGRAPH - 1970

Phase 1 Environmental Site Assessment and Geotechnical Desktop Study
Geotechnical and Contamination Assessment
600-660 Elizabeth Street, Redfern NSW 2016

FIGURE 7

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AERIAL PHOTOGRAPH - 1982

Phase 1 Environmental Site Assessment and Geotechnical Desktop Study
Geotechnical and Contamination Assessment
600-660 Elizabeth Street, Redfern NSW 2016

FIGURE 8

AECOM Imagine it. Delivered.

AERIAL PHOTOGRAPH - 1994

Phase 1 Environmental Site Assessment and Geotechnical Desktop Study
Geotechnical and Contamination Assessment
600-660 Elizabeth Street, Redfern NSW 2016

FIGURE 9

AECOM Imagine it. Delivered.

AERIAL PHOTOGRAPH - 2004

Phase 1 Environmental Site Assessment and Geotechnical Desktop Study
Geotechnical and Contamination Assessment
600-660 Elizabeth Street, Redfern NSW 2016

FIGURE 10

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Appendix B

Lotsearch (2018) report

Environmental Risk and Planning Report

600-660 Elizabeth Street, Redfern, NSW 2016

Report Date: 12 Mar 2018 15:05:41

Lotsearch Reference: LS002993

Disclaimer:
The purpose of this report is to provide an overview of some of the site history, environmental risk and planning information available, affecting an individual address or geographical area in which the property is located. It is not a substitute for an on-site inspection or review of other available reports and records. It is not intended to be, and should not be taken to be, a rating or assessment of the desirability or market value of the property or its features.
You should obtain independent advice before you make any decision based on the information within the report.
The detailed terms applicable to use of this report are set out at the end of this report.

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Location Confidences

Where Lotsearch has had to georeference features from supplied addresses, a location confidence has been assigned to the data record. This indicates a confidence to the positional accuracy of the feature. Where applicable, a code is given under the field heading “LC” or “LocConf”. These codes lookup to the following location confidences:

LC Code	Location Confidence
1	Georeferenced to the site location / premise or part of site
2	Georeferenced with the confidence of the general/approximate area
3	Georeferenced to the road or rail
4	Georeferenced to the road intersection
5	Feature is a buffered point
6	Land adjacent to Georeferenced Site
7	Georeferenced to a network of features

Dataset Listing

Datasets contained within this report, detailing their source and data currency:

Dataset Name	Custodian	Supply Date	Currency Date	Update Frequency	Dataset Buffer (m)	No. Features Onsite	No. Features within 100m	No. Features within Buffer
Cadastre Boundaries	Dept. Finance, Services & Innovation	12/03/2018	12/03/2018	Daily	-	-	-	-
Topographic Data	Dept. Finance, Services & Innovation	11/01/2018	11/01/2018	As required	-	-	-	-
List of NSW contaminated sites notified to EPA	Environment Protection Authority	05/03/2018	09/02/2018	Monthly	1000	0	0	14
Contaminated Land: Records of Notice	Environment Protection Authority	05/03/2018	05/03/2018	Monthly	1000	0	0	2
Former Gasworks	Environment Protection Authority	05/03/2018	12/09/2017	Monthly	1000	0	0	0
National Waste Management Site Database	Geoscience Australia	02/02/2018	07/03/2017	Quarterly	1000	0	0	0
EPA PFAS Investigation Program	Environment Protection Authority	07/03/2018	07/03/2018	Monthly	2000	0	0	1
EPA Other Sites with Contamination Issues	Environment Protection Authority	11/01/2018	11/01/2018	Quarterly	1000	0	0	0
Licensed Activities under the POEO Act 1997	Environment Protection Authority	09/03/2018	09/03/2018	Monthly	1000	0	0	3
Delicensed POEO Activities still Regulated by the EPA	Environment Protection Authority	09/03/2018	09/03/2018	Monthly	1000	0	0	4
Former POEO Licensed Activities now revoked or surrendered	Environment Protection Authority	09/03/2018	09/03/2018	Monthly	1000	0	0	8
UPSS Environmentally Sensitive Zones	Environment Protection Authority	14/04/2015	12/01/2010	As required	1000	1	1	1
UBD Business to Business Directory 1991 (Premise & Intersection Matches)	Hardie Grant			Not required	150	0	0	0
UBD Business to Business Directory 1991 (Road & Area Matches)	Hardie Grant			Not required	150	-	0	0
UBD Business to Business Directory 1986 (Premise & Intersection Matches)	Hardie Grant			Not required	150	1	30	34
UBD Business to Business Directory 1986 (Road & Area Matches)	Hardie Grant			Not required	150	-	2	2
UBD Business Directory 1982 (Premise & Intersection Matches)	Hardie Grant			Not required	150	1	23	28
UBD Business Directory 1982 (Road & Area Matches)	Hardie Grant			Not required	150	-	0	0
UBD Business Directory 1978 (Premise & Intersection Matches)	Hardie Grant			Not required	150	1	11	15
UBD Business Directory 1978 (Road & Area Matches)	Hardie Grant			Not required	150	-	3	3
UBD Business Directory 1975 (Premise & Intersection Matches)	Hardie Grant			Not required	150	1	17	23
UBD Business Directory 1975 (Road & Area Matches)	Hardie Grant			Not required	150	-	3	3
UBD Business Directory 1970 (Premise & Intersection Matches)	Hardie Grant			Not required	150	0	18	30
UBD Business Directory 1970 (Road & Area Matches)	Hardie Grant			Not required	150	-	8	8
UBD Business Directory 1965 (Premise & Intersection Matches)	Hardie Grant			Not required	150	0	22	32
UBD Business Directory 1965 (Road & Area Matches)	Hardie Grant			Not required	150	-	2	2
UBD Business Directory 1961 (Premise & Intersection Matches)	Hardie Grant			Not required	150	0	21	35
UBD Business Directory 1961 (Road & Area Matches)	Hardie Grant			Not required	150	-	6	6
UBD Business Directory 1950 (Premise & Intersection Matches)	Hardie Grant			Not required	150	5	38	47
UBD Business Directory 1950 (Road & Area Matches)	Hardie Grant			Not required	150	-	17	17
UBD Business Directory Drycleaners & Motor Garages/Service Stations (Premise & Intersection Matches)	Hardie Grant			Not required	500	0	1	82
UBD Business Directory Drycleaners & Motor Garages/Service Stations (Road & Area Matches)	Hardie Grant			Not required	500	-	4	29

Dataset Name	Custodian	Supply Date	Currency Date	Update Frequency	Dataset Buffer (m)	No. Features Onsite	No. Features within 100m	No. Features within Buffer
Points of Interest	Dept. Finance, Services & Innovation	11/01/2018	11/01/2018	Annually	1000	1	2	97
Tanks (Areas)	Dept. Finance, Services & Innovation	11/01/2018	11/01/2018	Annually	1000	0	0	0
Tanks (Points)	Dept. Finance, Services & Innovation	11/01/2018	11/01/2018	Annually	1000	0	0	0
Major Easements	Dept. Finance, Services & Innovation	08/01/2018	08/01/2018	As required	1000	0	0	6
State Forest	Dept. Finance, Services & Innovation	18/01/2018	18/01/2018	As required	1000	0	0	0
NSW National Parks and Wildlife Service Reserves	NSW Office of Environment & Heritage	18/01/2018	30/09/2017	Annually	1000	0	0	0
Hydrogeology Map of Australia	Commonwealth of Australia (Geoscience Australia)	08/10/2014	17/03/2000	As required	1000	1	1	1
Groundwater Boreholes	NSW Dept. of Primary Industries - Office of Water / Water Administration Ministerial Corporation; Commonwealth of Australia (Bureau of Meteorology)	21/03/2016	01/12/2015	Annually	2000	0	0	384
Geological Units 1:100,000	NSW Dept. of Industry, Resources & Energy	20/08/2014		None planned	1000	1	-	3
Geological Structures 1:100,000	NSW Dept. of Industry, Resources & Energy	20/08/2014		None planned	1000	0	-	1
Naturally Occurring Asbestos Potential	NSW Dept. of Industry, Resources & Energy	04/12/2015	24/09/2015	Unknown	1000	0	0	0
Soil Landscapes	NSW Office of Environment & Heritage	12/08/2014		None planned	1000	1	-	3
Atlas of Australian Soils	CSIRO	19/05/2017	17/02/2011	As required	1000	1	1	3
Standard Local Environmental Plan Acid Sulfate Soils	NSW Planning and Environment	07/10/2016	07/10/2016	As required	500	1	-	-
Atlas of Australian Acid Sulfate Soils	CSIRO	19/01/2017	21/02/2013	As required	1000	1	1	2
Dryland Salinity - National Assessment	National Land and Water Resources Audit	18/07/2014	12/05/2013	None planned	1000	0	0	0
Dryland Salinity Potential of Western Sydney	NSW Office of Environment & Heritage	12/05/2017	01/01/2002	None planned	1000	-	-	-
Mining Subsidence Districts	Dept. Finance, Services & Innovation	13/07/2017	01/07/2017	As required	1000	0	0	0
SEPP 14 - Coastal Wetlands	NSW Planning and Environment	17/12/2015	24/10/2008	Annually	1000	0	0	0
SEPP 26 - Littoral Rainforest	NSW Planning and Environment	17/12/2015	05/02/1988	Annually	1000	0	0	0
SEPP 71 - Coastal Protection	NSW Planning and Environment	17/12/2015	01/08/2003	Annually	1000	0	0	0
SEPP Major Developments 2005	NSW Planning and Environment	09/03/2013	25/05/2005	Under Review	1000	0	0	1
SEPP Strategic Land Use Areas	NSW Planning and Environment	01/08/2017	28/01/2014	Annually	1000	0	0	0
LEP - Land Zoning	NSW Planning and Environment	29/01/2018	19/01/2018	Quarterly	1000	0	4	133
LEP - Minimum Subdivision Lot Size	NSW Planning and Environment	29/01/2018	19/01/2018	Quarterly	0	0	-	-
LEP - Height of Building	NSW Planning and Environment	29/01/2018	19/01/2018	Quarterly	0	0	-	-
LEP - Floor Space Ratio	NSW Planning and Environment	29/01/2018	19/01/2018	Quarterly	0	0	-	-
LEP - Land Application	NSW Planning and Environment	29/01/2018	19/01/2018	Quarterly	0	1	-	-
LEP - Land Reservation Acquisition	NSW Planning and Environment	29/01/2018	19/01/2018	Quarterly	0	0	-	-
State Heritage Items	NSW Office of Environment & Heritage	05/02/2018	30/09/2016	Quarterly	1000	0	0	14
Local Heritage Items	NSW Planning and Environment	05/02/2018	19/01/2018	Quarterly	1000	1	6	274
Bush Fire Prone Land	NSW Rural Fire Service	05/02/2018	23/01/2018	Quarterly	1000	0	0	0
Native Vegetation of the Sydney Metropolitan Area	NSW Office of Environment & Heritage	01/03/2017	16/12/2016	As required	1000	0	1	1
RAMSAR Wetlands	Commonwealth of Australia Department of the Environment	08/10/2014	24/06/2011	As required	1000	0	0	0
Groundwater Dependent Ecosystems	The Bureau of Meteorology	14/08/2017	15/05/2017	Unknown	1000	0	0	0
Inflow Dependent Ecosystems Likelihood	The Bureau of Meteorology	14/08/2017	15/05/2017	Unknown	1000	0	0	0

Dataset Name	Custodian	Supply Date	Currency Date	Update Frequency	Dataset Buffer (m)	No. Features Onsite	No. Features within 100m	No. Features within Buffer
NSW BioNet Species Sightings	NSW Office of Environment & Heritage	09/03/2018	09/03/2018	Daily	10000	-	-	-