Appendix R

Technical working paper: Contamination

WestConnex

Roads and Maritime Services

WestConnex – M4-M5 Link

Technical working paper: Contamination

August 2017

Client: Roads and Maritime Services

ABN: 76 236 371 088

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Glossary of terms and abbreviations

Term	Definition
ACM	Asbestos Containing Materials
ADWG	Australian Drinking Water Guidelines
AHD	Australian Height Datum
AMG	Australian Map Grid
ANZECC	Australian and New Zealand Environment and Conservation Council
ASLP	Australian Standard Leaching Procedure
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ASSMAC	Acid Sulfate Soil Management Advisory Council
AST	Above ground Storage Tank
BTEXN	Benzene, Toluene, Ethylbenzene, Xylenes and Naphthalene
CEMP	Construction Environmental Management Plan
CLM Act	*Contaminated Land Management Act 1997*
CoPC	Contaminants of Potential Concern
CPAH	Carcinogenic PAHs
CSJ	CPB Samsung John Holland
CSWMP	Construction Soil and Water Management Plan
CSM	Conceptual Site Model
D2E	Down to Earth
DEC	NSW Department of Environment and Conservation
DECC	NSW Department of Environment and Climate Change
DP&E	NSW Department of Planning and Environment
DP-Water	NSW Department of Primary Industries (Water)
DUAP	NSW Department of Urban Affairs and Planning
EHC	*Environmentally Hazardous Chemicals Act 1985*
EILs	Ecological Investigation Levels
EPL	Environment Protection Licence
ESA	Environmental Site Assessment
HILs	Health Investigation Levels
HSLs	Health Screening Levels
LOR	Limit of Reporting
metres BTOC	Metres Below Top of Casing
NEPM	National Environment Protection (Assessment of Site Contamination) Measure
NEPC	National Environment Protection Council
NEHF	National Environment Health Forum
NHMRC	National Health and Medical Research Council
NSW EPA	NSW Environment Protection Authority
NOW	NSW Office of Water (now the NSW Department of Primary Industries – Water)
OCP	Organochlorine Pesticides
OEH	NSW Office of Environment and Heritage
OEMP	Operational Environmental Management Plan
OPP	Organophosphate Pesticides
PASS	Potential Acid Sulfate Soils
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
PID	Photoionisation Detector
POEO	*Protection of the Environment Operations Act 1997*
PSI	Preliminary Site Investigation
QA/QC	Quality Assurance and Quality Control
RAP	Remedial/Remediation Action Plan
Roads and Maritime	NSW Roads and Maritime Services
RPD	Relative Percent Difference
SAQP	Sampling Analysis and Quality Plan
SEPP	State Environmental Planning Policy

Term	Definition
SQP	Sampling Quality Plan
SMC	Sydney Motorway Corporation
SPOCAS	Suspension Peroxide Oxidation – Combined Acidity and Sulfate
SVOC	Semi Volatile Organic Hydrocarbons
TCLP	Toxicity Characteristic Leaching Procedure
TPH	Total Petroleum Hydrocarbons
TRH	Total Recoverable Hydrocarbons
UPSS	Underground Petroleum Storage System
USEPA	United States Environmental Protection Agency
USCS	Unified Soil Classification Scheme
UST	Underground Storage Tank
VENM	Virgin Excavated Natural Material
VOC	Volatile Organic Compound

Executive summary

Introduction

NSW Roads and Maritime Services (Roads and Maritime) is seeking approval to construct and operate the WestConnex M4-M5 Link (the project), which would comprise a new multi-lane road link between the M4 East Motorway at Haberfield and the New M5 Motorway at St Peters. The project would also include an interchange at Lilyfield and Rozelle (the Rozelle interchange) and a tunnel connection between Anzac Bridge and Victoria Road, east of Iron Cove Bridge (Iron Cove Link). In addition, construction of tunnels, ramps and associated infrastructure to provide connections to the proposed future Western Harbour Tunnel and Beaches Link project would be carried out at the Rozelle interchange.

Purpose and objective

The purpose of this technical working paper is to inform the environmental impact statement (EIS) and address the Secretary's Environment Assessment Requirements (SEARs) by:

- Identifying potential areas and contaminants of concern within the project footprint, which comprises the location of all operational infrastructure and areas where construction activities would occur
- Assessing the potential for groundwater contamination to be present along the tunnel alignment
- Providing a preliminary qualitative assessment, and desktop review of available quantitative data, in relation to contamination risk posed during construction and operation of the project
- Assessing where further investigation should be undertaken or appropriate management procedures should be implemented for the construction and operational phases of the project
- Assessing whether the land is contaminated and if so, whether remediation may be required including confirmation that future assessment and/or remediation would be undertaken in accordance with the current guidelines.

The overall objective of this technical working paper is to identify potential contamination issues associated with land impacted by the project so further assessment can be undertaken or appropriate mitigation measures can be put in place to manage contamination as part of the construction and operation of the project.

Scope

To inform the EIS and address the SEARs, the following scope of work was completed:

- Preliminary screening review of project background/historical information
- Inspection of the project footprint to assist with the identification of potential on and off-site sources of contamination and to understand the general condition of the project footprint
- Review and evaluation of desktop information, including previous contamination reports, relevant to identified areas of contamination concern within the project footprint
- Completion of a number of discrete (Stage 1) desktop preliminary site investigations (PSIs) where ancillary facilities and ground disturbance works are proposed. Based on the findings of the PSIs, intrusive (Stage 2) site investigations were also undertaken at selected locations where a high potential for contamination was identified
- Assessment of the potential impacts of the project and identification of the need for further assessment and/or management measures where required.

To achieve the desired performance outcome, which is to ensure that risks arising from the disturbance and excavation of land and disposal of soil are minimised, including disturbance to acid sulfate soils and site contamination, the following methodology has been adopted:

- Identification of potential or known soil, sediment and groundwater contamination in the project footprint by assessing the existing environment, including review and assessment of relevant reports and soil and groundwater investigation data
- Assessment of the potential contamination impacts of the project during construction and operation phases
- Identification and description of mitigation measures to manage potential or known soil, sediment and groundwater contamination during construction and operation.

During the preparation of this report, the entire project footprint has been assessed, including surface works, ancillary facilities and subsurface works (including tunnelling). Particular emphasis was given to those areas where historical land use activities have impacted soil, sediment and groundwater which may require remediation and/or management during the construction and operation of the project.

Key findings

Based on a review of background information, including NSW Environment Protection Authority (NSW EPA) and local council searches, a number of properties located within the project footprint were identified as having a high risk of contamination which should be investigated during project planning (see **section 4**). These properties generally comprise sites that have potentially been the subject of historically contaminating land uses, including:

- Former industrial and transport infrastructure, along with reclamation within the Rozelle Rail Yards
- Commercial/industrial properties present within or adjacent to the project footprint including but not limited to those on the edge of the Rozelle Rail Yards, manufacturing industries, workshops, timber mills and boat yards
- Areas of historical land reclamation (including unregulated filling activities), particularly along the harbour foreshore near Rozelle Bay
- Structures potentially containing hazardous materials that would be demolished for the project.

Construction impacts and mitigation measures summary

A Construction Environmental Management Plan (CEMP) would be prepared for the project. The CEMP would include management measures for areas within the project footprint identified as being potentially contaminated.

Ancillary facilities and areas within the project footprint that have been assessed as low risk do not require further assessment or remediation and would be managed through the implementation of the CEMP. Sites which are assessed as potentially containing soil or groundwater contamination that could pose an unacceptable risk to human or ecological receptors during construction of the project would require further intrusive site investigation. The following sites would require the completion of targeted site investigations, waste characterisation and preparation of management procedures for acid sulfate soils and hazardous materials assessment as part of the Construction Soil and Water Management Plan (CSWMP) to inform the appropriate management of contamination during the intrusive construction program:

- Ancillary facilities and associated areas of construction disturbance within the project footprint comprising:
  - Parramatta Road West civil and tunnel site at Ashfield (C1b)
  - Darley Road civil and tunnel site at Leichhardt (C4)
  - Rozelle civil and tunnel site at Rozelle (C5)
  - The Crescent civil site at Annandale (C6)
  - Iron Cove Link civil site at Rozelle (C8)
  - Pyrmont Bridge Road tunnel site at Annandale (C9)
  - Campbell Road civil and tunnel site at St Peters (C10) (for areas not previously investigated as part of the New M5 project)

- All contamination investigations will be undertaken by a suitably qualified and experienced person in accordance with guidelines made or approved under the *Contaminated Land Management Act 1997* (NSW)
- Subject to the outcomes of the additional investigations, Remediation Action Plan (RAPs) may be required and implemented in the event that site remediation is warranted prior to construction
- Intrusive works undertaken within the Campbell Road civil and tunnel site (C10) at St Peters that are within the former Alexandria Landfill Environment Protection Licence (EPL) boundary would be required to comply with the existing Golder (2016) remediation action plan (RAP), Landfill Closure Management Plan, EPL and New M5 conditions of approval
- Groundwater and surface water captured as a result of tunnelling activities may be contaminated with suspended solids and increased pH due to tunnel grouting or activities
- Sediment disturbed during the installation of the coffer dam(s) in Rozelle Bay is likely to be contaminated
- Temporary water treatment plants would be constructed at each construction ancillary facility where groundwater is extracted during dewatering and tunnelling. The water encountered during construction and operation would require appropriate monitoring and treatment prior to discharge to receiving water bodies
- The CEMP would incorporate the Roads and Maritime *Unexpected Discovery of Contaminated Lands Procedure* (2013) and an asbestos management plan. The CEMP prepared for implementation during the project and should encompass all construction activities. The plan will accurately reflect the conditions likely to be encountered during construction at various locations within the project footprint
- A CSWMP must be prepared for implementation (as part of the CEMP) during construction of the project
- Management procedures for acid sulfate soils as part of the CSWMP would be prepared for implementation during the project which should encompass the management of potential or actual acid sulfate soils which may be disturbed as part of construction activities associated with the project. The plans will accurately reflect the conditions that may be encountered during construction at various locations within the project footprint.

Operation impacts and mitigation measures summary

Following the completion of construction works, additional site investigations would be required to confirm the suitability of remaining project land proposed to be redeveloped or to meet site handover obligations. In the event that residual contamination is identified, remediation works would be undertaken in accordance with an approved RAP.

The following would be undertaken and implemented prior to the operational phase of the project:

- A NSW EPA Accredited Site Auditor would be engaged to review all contamination reports and evaluate the suitability of a site for a specified use as part of the project
- An Operational Environmental Management Plan (OEMP) must be prepared to manage potential impacts on groundwater and surface water during the operational phases of the project.

Conclusions and recommendations

Based on the findings of this technical working paper, there is potential for localised areas of soil, acid sulfate soil, sediment, fill and groundwater contamination associated with historically contaminating land uses that may be encountered during construction, and further assessment is warranted in some instances. The discovery of contaminated materials is considered most likely to occur during near surface excavation works associated with road and tunnel construction activities.

Following adoption of the mitigation and management measures, which have been recommended to be implemented during the construction and operational phases of the project, the desired performance outcome, which is to ensure that risks arising from the disturbance and excavation of land and disposal of soil are minimised, including disturbance to acid sulfate soils and site contamination, would be satisfactorily achieved.

1 Introduction

NSW Roads and Maritime Services (Roads and Maritime) is seeking approval to construct and operate the WestConnex M4-M5 Link (the project), which would comprise a new multi-lane road link between the M4 East Motorway at Haberfield and the New M5 Motorway at St Peters. The project would also include an interchange at Lilyfield and Rozelle (the Rozelle interchange) and a tunnel connection between Anzac Bridge and Victoria Road, east of Iron Cove Bridge (Iron Cove Link). In addition, construction of tunnels, ramps and associated infrastructure to provide connections to the proposed future Western Harbour Tunnel and Beaches Link project would be carried out at the Rozelle interchange.

Together with the other components of the WestConnex program of works and the proposed future Sydney Gateway, the project would facilitate improved connections between western Sydney, Sydney Airport and Port Botany and south and south-western Sydney, as well as better connectivity between the important economic centres along Sydney's Global Economic Corridor and local communities.

Approval is being sought under Part 5.1 of the *Environmental Planning and Assessment Act 1979* (NSW) (EP&A Act) for the project. A request has been made for the NSW Minister for Planning to specifically declare the project to be State significant infrastructure and also critical State significant infrastructure. An environmental impact statement (EIS) is therefore required.

1.1 Overview of WestConnex and related projects

The M4-M5 Link is part of the WestConnex program of works. Separate planning applications and assessments have been completed for each of the approved WestConnex projects. Roads and Maritime has commissioned Sydney Motorway Corporation (SMC) to deliver WestConnex, on behalf of the NSW Government. However, Roads and Maritime is the proponent for the project.

In addition to linking to other WestConnex projects, the M4-M5 Link would provide connections to the proposed future Western Harbour Tunnel and Beaches Link, the Sydney Gateway (via the St Peters interchange) and the F6 Extension (via the New M5).

The WestConnex program of works, as well as related projects, are shown in **Figure 1-1** and described in **Table 1-1**.

Table 1-1 WestConnex and related projects

Project	Description	Status
WestConnex program of works		
M4 Widening	Widening of the existing M4 Motorway from Parramatta to Homebush.	Planning approval under the EP&A Act granted on 21 December 2014. Open to traffic.
M4 East	Extension of the M4 Motorway in tunnels between Homebush and Haberfield via Concord. Includes provision for a future connection to the M4-M5 Link at the Wattle Street interchange.	Planning approval under the EP&A Act granted on 11 February 2016. Under construction.
King Georges Road Interchange Upgrade	Upgrade of the King Georges Road interchange between the M5 West and the M5 East at Beverly Hills, in preparation for the New M5 project.	Planning approval under the EP&A Act granted on 3 March 2015. Open to traffic.
New M5	Duplication of the M5 East from King Georges Road in Beverly Hills with tunnels from Kingsgrove to a new interchange at St Peters. The St Peters interchange allows for connections to the proposed future Sydney Gateway project and an underground connection to the M4-M5 Link. The New M5 tunnels also include provision for a future connection to the proposed future F6 Extension.	Planning approval under the EP&A Act granted on 20 April 2016. Commonwealth approval under the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) granted on 11 July 2016. Under construction.

Project	Description	Status
M4-M5 Link (the project)	Tunnels connecting to the M4 East at Haberfield (via the Wattle Street interchange) and the New M5 at St Peters (via the St Peters interchange), a new interchange at Rozelle and a link to Victoria Road (the Iron Cove Link). The Rozelle interchange also includes ramps and tunnels for connections to the proposed future Western Harbour Tunnel and Beaches Link project.	The subject of this EIS.
Related projects		
Sydney Gateway	A high-capacity connection between the St Peters interchange (under construction as part of the New M5 project) and the Sydney Airport and Port Botany precinct.	Planning underway by Roads and Maritime and subject to separate environmental assessment and approval.
Western Harbour Tunnel and Beaches Link	The Western Harbour Tunnel component would connect to the M4-M5 Link at the Rozelle interchange, cross underneath Sydney Harbour between the Birchgrove and Waverton areas, and connect with the Warringah Freeway at North Sydney. The Beaches Link component would comprise a tunnel that would connect to the Warringah Freeway, cross underneath Middle Harbour and connect with the Burnt Bridge Creek Deviation at Balgowlah and Wakehurst Parkway at Seaforth. It would also involve the duplication of the Wakehurst Parkway between Seaforth and Frenchs Forest.	Planning underway by Roads and Maritime and subject to separate environmental assessment and approval.
F6 Extension	A proposed motorway link between the New M5 at Arncliffe and the existing M1 Princes Highway at Loftus, generally along the alignment known as the F6 corridor.	Planning underway by Roads and Maritime and subject to separate environmental assessment and approval.

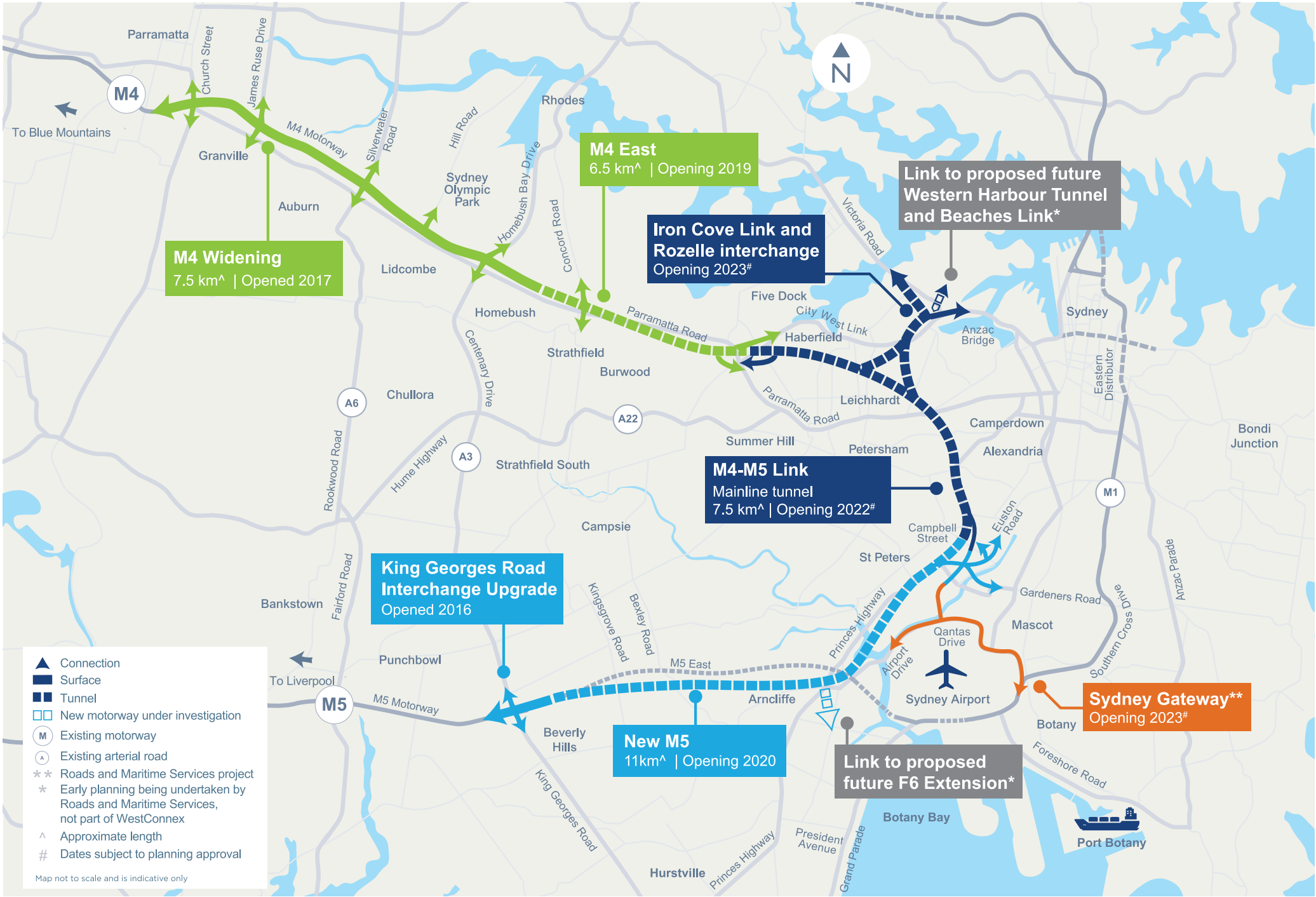


Figure 1-1 Overview of WestConnex and related projects

1.2 Purpose of this report

The purpose of this technical working paper is to inform the EIS and address the Secretary's Environment Assessment Requirements (SEARs) by:

- Completing desktop and intrusive site investigation works to inform the understanding of contamination conditions within the project footprint
- Identifying potential areas and contaminants of concern within the project footprint
- Assessing the potential for groundwater contamination to be present along the tunnel alignment
- Providing a preliminary qualitative assessment, and desktop review of available quantitative data, in relation to contamination risk posed during construction and operation of the project
- Assessing where further investigation should be undertaken or appropriate management procedures should be implemented for the construction and operational phases of the project
- Assessing whether the land may be contaminated and if so, whether remediation may be required including confirmation that future assessment and/or remediation would be undertaken in accordance with the current guidelines.

1.3 SEARs and Agency comments

In preparing this Contamination Assessment Technical Report, the SEARs issued for the project which is relevant to soil and groundwater contamination has been addressed. **Table 1-2** lists the applicable SEARs and where they have been addressed in this report. **Table 1-3** lists the applicable agency comments and where they have been addressed in the report.

Table 1-2 Relevant SEARs addressed in this report

SEARs		
Soils (contamination specific)		
Key issue and desired performance outcomes	**Requirement**	**Section where addressed in this report**
The environmental values of the land, including soils, subsoils and landforms, are protected. Risks arising from the disturbance and excavation of land and disposal of soil are minimised, including disturbance to acid sulfate soils and site contamination.	1. The proponent must verify the risk of acid sulfate soils (Class 1, 2, 3 or 4 on the Acid Sulfate Soil Risk Map) within, and in the area likely to be impacted by, the project.	**Section 4, 5, 6** and **8**
	2. The proponent must assess the impact of the project on acid sulfate soils (including impacts of acid runoff offsite) in accordance with the current guidelines and detail the mitigation measures proposed to minimise potential impacts.	**Section 4, 5, 6** and **8**

SEARs		
Soils (contamination specific)		
	3. The Proponent must assess whether the land is likely to be contaminated and identify if remediation of the land is required, having regard to the ecological and human health risks posed by the contamination in the context of past, existing and likely (or potential) future land uses. Where assessment and/or remediation is required, the Proponent must document how the assessment and/or remediation would be undertaken in accordance with the current guidelines.	
	7. The Proponent must assess the impact of any disturbance of contaminated groundwater and the tunnels should be carefully designed so as to not exacerbate mobilisation of contaminated groundwater and/or prevent contaminated groundwater flow.	**Section 4**, **5**, **6**, **8** and **Appendix T** (Technical working paper: Groundwater) of the EIS.

Table 1-3 Relevant agency comments have been addressed in this report

Agency letters	
NSW Department of Primary Industries (Water)	
Requirement	**Section where addressed in this report**
• The SSI report notes construction of the project has the potential for disturbance of contaminated soils (**section 4.7.2**, page 55). The disturbance of contaminated groundwater is another potential soil, water and contamination-related impact that should be addressed.	**Section 4, 5** and **6**
• The SSI report indicates the project is partly located within Zone 2 of the Botany Sands Groundwater Source Management Zone. It notes within Zone 2, the use of groundwater is banned from domestic use in order to minimise the risk to bore users and to prevent the spread of contamination through pumping (refer to **section 4.9.1**, page 61). As the tunnels are proposed to be constructed in previous industrial areas and highly urbanised areas where potential contamination exists, the tunnels should be carefully designed so as not to exacerbate mobilisation of contaminated groundwater and/or prevent contaminated groundwater flow.	**Section 4, 5** and **6** and **Appendix T** (Technical working paper: Groundwater) of the EIS
Marrickville Council	
Requirement	**Section where addressed in this report**
• Rigorous contaminated land assessments should be undertaken. To date these have been lacking in other WestConnex EISs.	**Section 4, 5, 6** and **8**
• Council is working with a number of regional councils in improving the water quality and environmental health of the Cooks River and Parramatta River. A comprehensive assessment would be needed to evaluate the water quality issues and surface water contamination risks during construction and at operation stages.	**Section 4, 5 and 6** and **Appendix Q** (Technical working paper: Surface water and flooding) of the EIS
• The volume of the groundwater intercepted by the tunnels as seepage is expected to be considerable. The accumulated seepage may be contaminated since the tunnels would be constructed through some old industrial sites with a history of contamination. There would need to be a requirement for ongoing monitoring, treatment and disposal of seepage, with appropriate standards and guidelines. The details of seepage collection locations, pumps, pipe works and treatment facilities would need to be outlined in the EIS. There may be opportunities for reusing the treated seepage volume for non-potable use where high-grade water (or potable water) is not required.	**Section 5.2** and **6.2**
NSW Health	
Requirement	**Section where addressed in this report**
• There is a potential of contaminated land to be discovered in some construction and operational areas of this proposal. We recommend that all contaminated land should be identified and managed in accordance with relevant Australian and international guidelines.	**Section 8**

2 The project

2.1 Project location

The project would be generally located within the City of Sydney and Inner West local government areas (LGAs). The project is located about two to seven kilometres south, southwest and west of the Sydney central business district (CBD) and would cross the suburbs of Ashfield, Haberfield, Leichhardt, Lilyfield, Rozelle, Annandale, Stanmore, Camperdown, Newtown and St Peters. The local context of the project is shown in **Figure 2-1**.

2.2 Overview of the project

Key components of the project are shown in **Figure 2-1** and would include:

- Twin mainline motorway tunnels between the M4 East at Haberfield and the New M5 at St Peters. Each tunnel would be around 7.5 kilometres long and would generally accommodate up to four lanes of traffic in each direction
- Connections of the mainline tunnels to the M4 East project, comprising:
  - A tunnel-to-tunnel connection to the M4 East mainline stub tunnels east of Parramatta Road near Alt Street at Haberfield
  - Entry and exit ramp connections between the mainline tunnels and the Wattle Street interchange at Haberfield (which is currently being constructed as part of the M4 East project)
  - Minor physical integration works with the surface road network at the Wattle Street interchange including road pavement and line marking
- Connections of the mainline tunnels to the New M5 project, comprising:
  - A tunnel-to-tunnel connection to the New M5 mainline stub tunnels north of the Princes Highway near the intersection of Mary Street and Bakers Lane at St Peters
  - Entry and exit ramp connections between the mainline tunnels and the St Peters interchange at St Peters (which is currently being constructed as part of the New M5 project)
  - Minor physical integration works with the surface road network at the St Peters interchange including road pavement and line marking
- An underground interchange at Leichhardt and Annandale (the Inner West subsurface interchange) that would link the mainline tunnels with the Rozelle interchange and the Iron Cove Link (see below)
- A new interchange at Lilyfield and Rozelle (the Rozelle interchange) that would connect the M4-M5 Link mainline tunnels with:
  - City West Link
  - Anzac Bridge
  - The Iron Cove Link (see below)
  - The proposed future Western Harbour Tunnel and Beaches Link
- Construction of connections to the proposed future Western Harbour Tunnel and Beaches Link project as part of the Rozelle interchange, including:
  - Tunnels that would allow for underground mainline connections between the M4 East and New M5 motorways and the proposed future Western Harbour Tunnel and Beaches Link (via the M4-M5 Link mainline tunnels)
  - A dive structure and tunnel portals within the Rozelle Rail Yards, north of the City West Link / The Crescent intersection
  - Entry and exit ramps that would extend north underground from the tunnel portals in the

Rozelle Rail Yards to join the mainline connections to the proposed future Western Harbour Tunnel and Beaches Link

  - A ventilation outlet and ancillary facilities as part of the Rozelle ventilation facility (see below)

- Twin tunnels that would connect Victoria Road near the eastern abutment of Iron Cove Bridge and Anzac Bridge (the Iron Cove Link). Underground entry and exit ramps would also provide a tunnel connection between the Iron Cove Link and the New M5 / St Peters interchange (via the M4-M5 Link mainline tunnels)
- The Rozelle surface works, including:
  - Realigning The Crescent at Annandale, including a new bridge over Whites Creek and modifications to the intersection with City West Link
  - A new intersection on City West Link around 300 metres west of the realigned position of The Crescent, which would provide a connection to and from the New M5/St Peters interchange (via the M4-M5 Link mainline tunnels)
  - Widening and improvement works to the channel and bank of Whites Creek between the light rail bridge and Rozelle Bay at Annandale, to manage flooding and drainage for the surface road network
  - Reconstructing the intersection of The Crescent and Victoria Road at Rozelle, including construction of a new bridge at Victoria Road
  - New and upgraded pedestrian and cyclist infrastructure
  - Landscaping, including the provision of new open space within the Rozelle Rail Yards
- The Iron Cove Link surface works, including:
  - Dive structures and tunnel portals between the westbound and eastbound Victoria Road carriageways, to connect Victoria Road east of Iron Cove Bridge with the Iron Cove Link
  - Realignment of the westbound (southern) carriageway of Victoria Road between Springside Street and the eastern abutment of Iron Cove Bridge
  - Modifications to the existing intersections between Victoria Road and Terry, Clubb, Toelle and Callan streets
  - Landscaping and the establishment of pedestrian and cycle infrastructure
- Five motorway operations complexes; one at Leichhardt (MOC1), three at Rozelle (Rozelle West (MOC2), Rozelle East (MOC3) and Iron Cove Link (MOC4)), and one at St Peters (MOC5). The types of facilities that would be contained within the motorway operations complexes would include substations, water treatment plants, ventilation facilities and outlets, offices, on-site storage and parking for employees
- Tunnel ventilation systems, including ventilation supply and exhaust facilities, axial fans, ventilation outlets and ventilation tunnels
- Three new ventilation facilities, including:
  - The Rozelle ventilation facility at Rozelle
  - The Iron Cove Link ventilation facility at Rozelle
  - The Campbell Road ventilation facility at St Peters
- Fitout (mechanical and electrical) of part of the Parramatta Road ventilation facility at Haberfield (which is currently being constructed as part of M4 East project) for use by the M4-M5 Link project
- Drainage infrastructure to collect surface and groundwater for treatment at dedicated facilities. Water treatment would occur at
  - Two operational water treatment facilities (at Leichhardt and Rozelle)
  - The constructed wetland within the Rozelle Rail Yards
  - A bioretention facility for stormwater runoff within the informal car park at King George Park at

Rozelle (adjacent to Manning Street). A section of the existing informal car park would also be upgraded, including sealing the car park surface and landscaping

- Treated water would flow back to existing watercourses via new, upgraded and existing infrastructure
- Ancillary infrastructure and operational facilities for electronic tolling and traffic control and signage (including electronic signage)
- Emergency access and evacuation facilities, including pedestrian and vehicular cross and long passages and fire and life safety systems
- Utility works, including protection and/or adjustment of existing utilities, removal of redundant utilities and installation of new utilities. A Utilities Management Strategy has been prepared for the project that identifies management options for utilities, including relocation or adjustment. Refer to **Appendix F** (Utilities Management Strategy) of the EIS.

The project does not include:

- Site management works at the Rozelle Rail Yards. These works were separately assessed and determined by Roads and Maritime through a Review of Environmental Factors under Part 5 of the EP&A Act (refer to **Chapter 2** (Assessment process) of the EIS)
- Ongoing motorway maintenance activities during operation
- Operation of the components of the Rozelle interchange which are the tunnels, ramps and associated infrastructure being constructed to provide connections to the proposed future Western Harbour Tunnel and Beaches Link project.

Temporary construction ancillary facilities and temporary works to facilitate the construction of the project would also be required.

2.2.1 Staged construction and opening of the project

It is anticipated the project would be constructed and opened to traffic in two stages (as shown in **Figure 2-1**).

Stage 1 would include:

- Construction of the mainline tunnels between the M4 East at Haberfield and the New M5 at St Peters, stub tunnels to the Rozelle interchange (at the Inner West subsurface interchange) and ancillary infrastructure at the Darley Road motorway operations complex (MOC1) and Campbell Road motorway operations complex (MOC5)
- These works are anticipated to commence in 2018 with the mainline tunnels open to traffic in 2022. At the completion of Stage 1, the mainline tunnels would operate with two traffic lanes in each direction. This would increase to generally four lanes at the completion of Stage 2, when the full project is operational.

Stage 2 would include:

- Construction of the Rozelle interchange and Iron Cove Link including:
  - Connections to the stub tunnels at the Inner West subsurface interchange (built during Stage 1)
  - Ancillary infrastructure at the Rozelle West motorway operations complex (MOC2), Rozelle East motorway operations complex (MOC3) and Iron Cove Link motorway operations complex (MOC4)
  - Connections to the surface road network at Lilyfield and Rozelle
  - Construction of tunnels, ramps and associated infrastructure as part of the Rozelle interchange to provide connections to the proposed future Western Harbour Tunnel and Beaches Link project
- Stage 2 works are expected to commence in 2019 with these components of the project open to traffic in 2023.

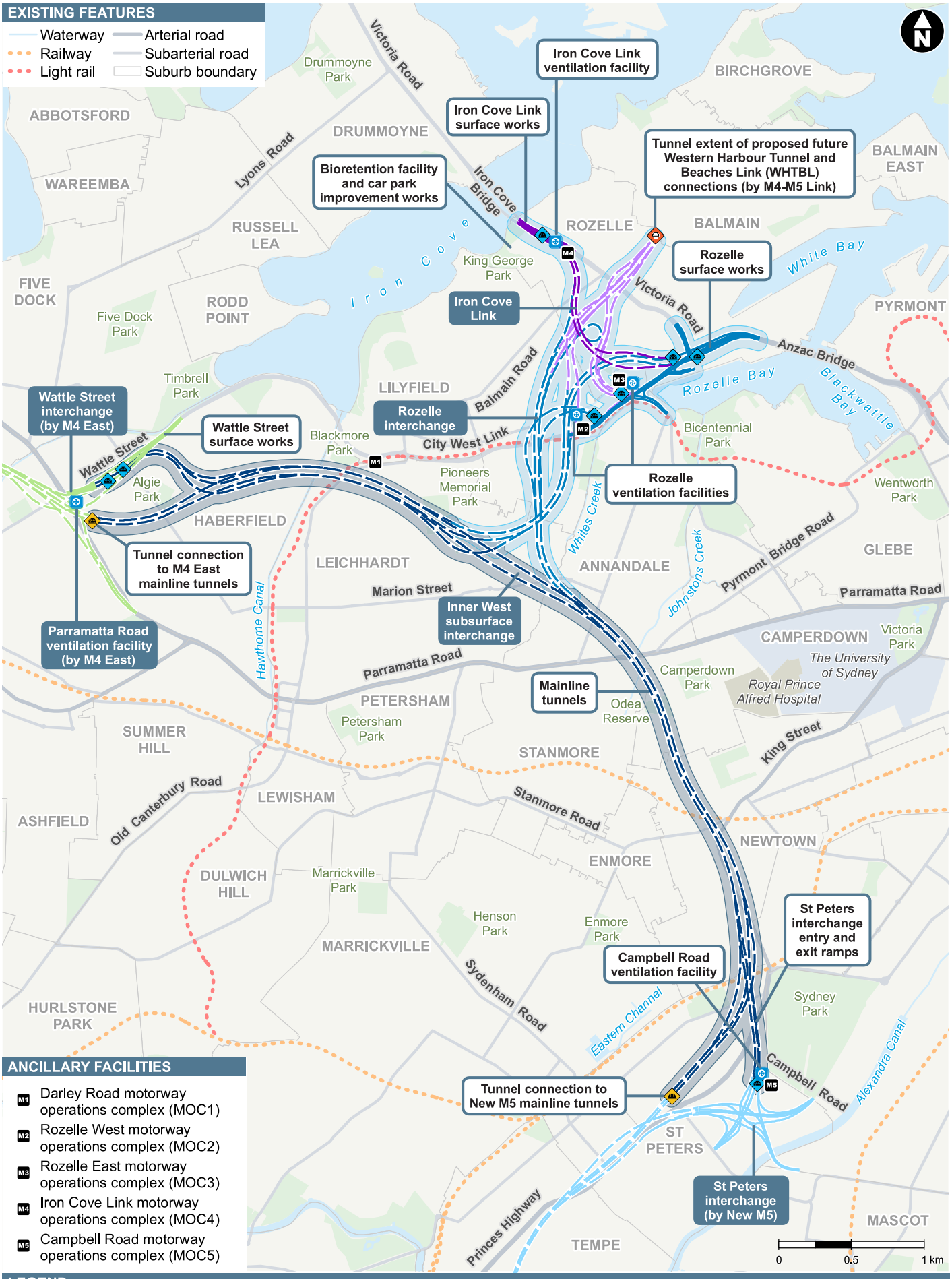


Figure 2-1 Overview of the project

2.3 Construction activities

An overview of the key construction features of the project is shown in **Figure 2-2** and would generally include:

- Enabling and temporary works, including provision of construction power and water supply, ancillary site establishment including establishment of acoustic sheds and construction hoarding, demolition works, property adjustments and public and active transport modifications (if required)
- Construction of the road tunnels, interchanges, intersections and roadside infrastructure
- Haulage of spoil generated during tunnelling and excavation activities
- Fitout of the road tunnels and support infrastructure, including ventilation and emergency response systems
- Construction and fitout of the motorway operations complexes and other ancillary operations buildings
- Realignment, modification or replacement of surface roads, bridges and underpasses
- Implementation of environmental management and pollution control facilities for the project.

A more detailed overview of construction activities is provided in **Table 2-1**.

Table 2-1 Overview of construction activities

Component	Typical activities
Site establishment and enabling works	• Vegetation clearing and removal • Utility works • Traffic management measures • Install safety and environmental controls • Install site fencing and hoarding • Establish temporary noise attenuation measures • Demolish buildings and structures • Carry out site clearing • Heritage salvage or conservation works (if required) • Establish construction ancillary facilities and access • Establish acoustic sheds • Supply utilities (including construction power) to construction facilities • Establish temporary pedestrian and cyclist diversions.
Tunnelling	• Construct temporary access tunnels • Excavation of mainline tunnels, entry and exit ramps and associated tunnelled infrastructure and install ground support • Spoil management and haulage • Finishing works in tunnel and provision of permanent tunnel services • Test plant and equipment.

Component	Typical activities
Surface earthworks and structures	• Vegetation clearing and removal • Topsoil stripping • Excavate new cut and fill areas • Construct dive and cut-and-cover tunnel structures • Install stabilisation and excavation support (retention systems) such as sheet pile walls, diaphragm walls and secant pile walls (where required) • Construct required retaining structures • Excavate new road levels.
Bridge works	• Construct piers and abutments • Construct headstock • Construct bridge deck, slabs and girders • Demolish and remove redundant bridges.
Drainage	• Construct new pits and pipes • Construct new groundwater drainage system • Connect drainage to existing network • Construct sumps in tunnels as required • Construct water quality basins, constructed wetland and bioretention facility and basin • Construct drainage channels • Construct spill containment basin • Construct onsite detention tanks • Adjustments to existing drainage infrastructure where impacted • Carry out widening and naturalisation of a section of Whites Creek • Demolish and remove redundant drainage.
Pavement	• Lay select layers and base • Lay road pavement surfacing • Construct pavement drainage.
Operational ancillary facilities	• Install ventilation systems and facilities • Construct water treatment facilities • Construct fire pump rooms and install water tanks • Test and commission plant and equipment • Construct electrical substations to supply permanent power to the project.

Component	Typical activities
Finishing works	• Line mark to new road surfaces • Erect directional and other signage and other roadside furniture such as street lighting • Erect toll gantries and other control systems • Construct pedestrian and cycle paths • Carry out earthworks at disturbed areas to establish the finished landform • Carry out landscaping • Closure and backfill of temporary access tunnels (except where these are to be used for inspection and/or maintenance purposes) • Site demobilisation and preparation of the site for a future use.

Twelve construction ancillary facilities are described in this EIS (as listed below).To assist in informing the development of a construction methodology that would manage constructability constraints and the need for construction to occur in a safe and efficient manner, while minimising impacts on local communities, the environment, and users of the surrounding road and other transport networks, two possible combinations of construction ancillary facilities at Haberfield and Ashfield have been assessed in this EIS. The construction ancillary facilities that comprise these options have been grouped together in this EIS and are denoted by the suffix a (for Option A) or b (for Option B).

The construction ancillary facilities required to support construction of the project include:

- Construction ancillary facilities at Haberfield (Option A), comprising:
  - Wattle Street civil and tunnel site (C1a)
  - Haberfield civil and tunnel site (C2a)
  - Northcote Street civil site (C3a)
- Construction ancillary facilities at Ashfield and Haberfield (Option B), comprising:
  - Parramatta Road West civil and tunnel site (C1b)
  - Haberfield civil site (C2b)
  - Parramatta Road East civil site (C3b)
- Darley Road civil and tunnel site (C4)
- Rozelle civil and tunnel site (C5)
- The Crescent civil site (C6)
- Victoria Road civil site (C7)
- Iron Cove Link civil site (C8)
- Pyrmont Bridge Road tunnel site (C9)
- Campbell Road civil and tunnel site (C10).

The number, location and layout of construction ancillary facilities would be finalised as part of detailed construction planning during detailed design and would meet the environmental performance outcomes stated in the EIS and the Submissions and Preferred Infrastructure Report and satisfy criteria identified in any relevant conditions of approval.

The construction ancillary facilities would be used for a mix of civil surface works, tunnelling support, construction workforce parking and administrative purposes. Wherever possible, construction sites would be co-located with the operational footprint to minimise property acquisition and temporary disruption. The layout and access arrangements for the construction ancillary facilities are based on

the concept design only and would be confirmed and refined in response to submissions received during the exhibition of this EIS and during detailed design.

2.3.1 Construction program

The total period of construction works for the project is expected to be around five years, with commissioning occurring concurrently with the final stages of construction. An indicative construction program is shown in **Table 2-2**.

Table 2-2 Indicative construction program

Construction activity	Indicative construction timeframe																							
	2018				2019				2020				2021				2022				2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Mainline tunnels																								
Site establishment and establishment of construction ancillary facilities			■	■	■	■	■	■	■	■														
Utility works and connections			■	■	■	■	■	■																
Tunnel construction				■	■	■	■	■	■	■	■	■	■											
Portal construction				■	■	■	■	■																
Construction of permanent operational facilities												■	■	■	■	■								
Mechanical and electrical fitout works													■	■	■	■								
Establishment of tolling facilities															■	■								
Site rehabilitation and landscaping																■	■	■	■					
Surface road works																■	■	■	■					
Demobilisation and rehabilitation																			■	■				
Testing and commissioning																■	■	■	■					
Rozelle interchange and Iron Cove Link																								
Site establishment and establishment of construction ancillary facilities				■	■	■	■	■																
Utility works and connections and site remediation				■	■	■	■	■																
Tunnel construction									■	■	■	■	■	■	■	■	■							
Portal construction						■	■	■																
Construction of surface road works						■	■	■	■	■	■	■	■	■	■	■	■	■	■	■				

Construction activity	Indicative construction timeframe																							
	2018				2019				2020				2021				2022				2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Construction of permanent operational facilities																								
Mechanical and electrical fitout works																								
Establishment of tolling facilities																								
Site rehabilitation and landscaping																								
Demobilisation and rehabilitation																								
Testing and commissioning																								

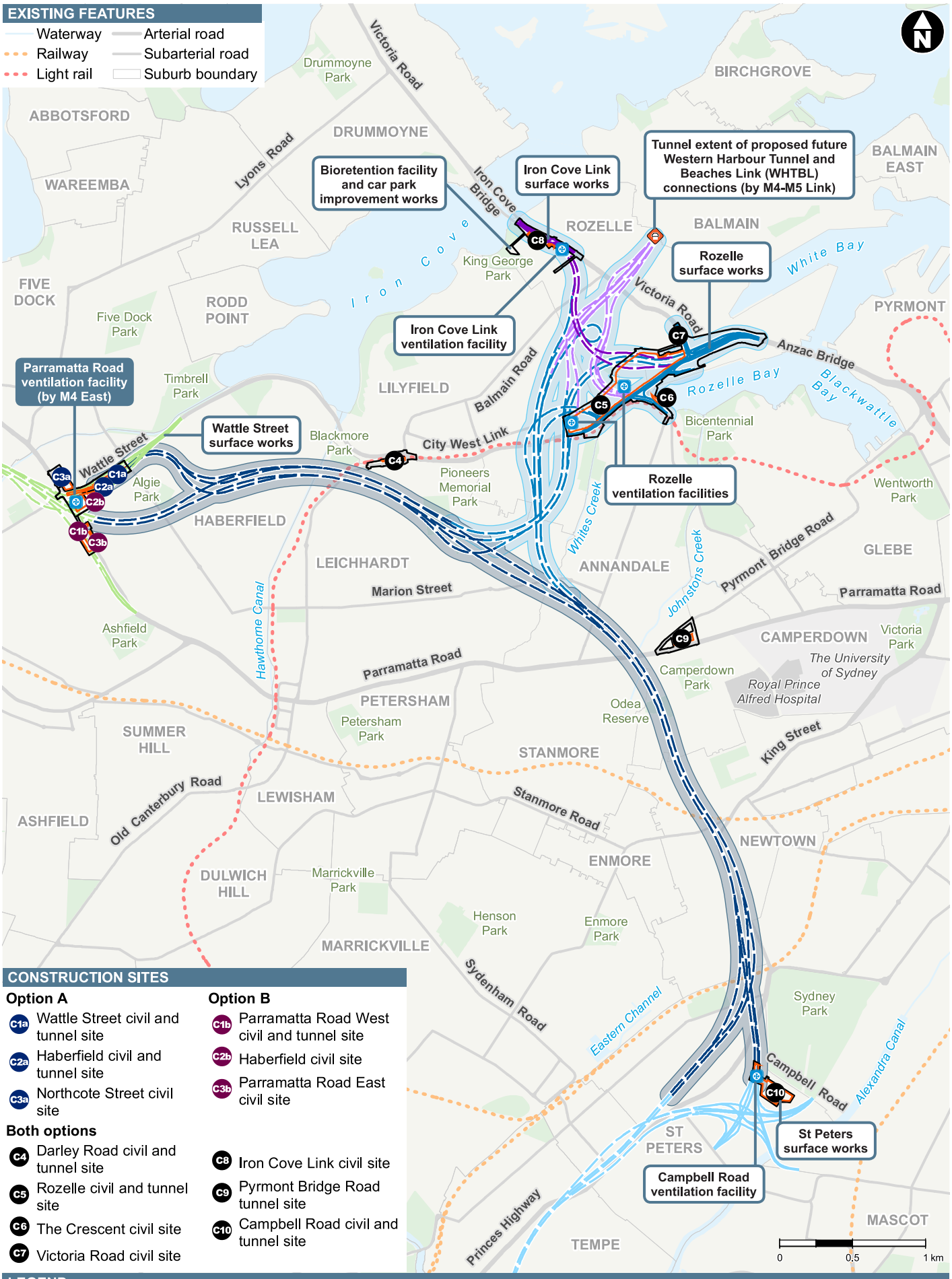


Figure 2-2 Overview of project footprint and ancillary facilities

3 Assessment methodology

3.1 Relevant legislation, guidelines and policies

The relevant legislation, policies and guidelines for contaminated land in NSW that have been considered during the preparation of this report include:

- *Contaminated Land Management Act 1997* (NSW) (CLM Act)
- *Protection of the Environment Operations Act 1997* (NSW) (POEO Act)
- *Environmentally Hazardous Chemicals Act 1985* (NSW) (EHC Act)
- State Environment Planning Policy No 55 – Remediation of Land (SEPP 55).

The following guidelines which are relevant to the assessment of potentially contaminated land in NSW that have been considered during the preparation of this report include:

- (NSW Environment Protection Authority (NSW EPA 2015). *Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997*
- (NSW Department of Environment and Conservation (DEC 2006). *Guidelines for the Site Auditor Scheme* (2nd Edition)
- (NSW Department of Urban Affairs and Planning (DUAP) and NSW EPA 1998). *Managing Land Contamination*, Planning Guidelines SEPP 55-Remediation of Land
- (NSW DEC 2007). *Guidelines for the Assessment and Management of Groundwater Contamination*
- (National Environment Protection Council (NEPC) 1999). *National Environment Protection (Assessment of Site Contamination) Measure 2013* (ASC NEPM 2013)
- (NSW EPA 2016). *Environmental Guidelines: Solid Waste Landfills*, Second Edition
- NSW Office of Environment and Heritage (OEH) 2011). *Guidelines for Consultants Reporting on Contaminated Sites*
- (NSW EPA 2012). *Guidelines for the Assessment and Management of Sites Impacted by Hazardous Ground Gasses*
- Australian and New Zealand Environment and Conservation Council (ANZECC) & Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000). *National Water Quality Management Strategy, Paper No. 4*, *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, Volume 1, The Guidelines, October 2000
- Acid Sulfate Soils Management Advisory Committee (ASSMAC), 1998. *Acid Sulfate Soils Assessment Guidelines*. August 1998.

3.2 Methodology

To achieve the desired performance outcome, which is to ensure that risks arising from the disturbance and excavation of land and disposal of soil are minimised, including disturbance to acid sulfate soils and site contamination, the following methodology has been adopted:

1. Identification of potential or known soil and groundwater contamination in the project footprint by assessing the existing environment, including review and assessment of previous reports and soil and groundwater investigation data relevant to the project
2. Assessment of the potential contamination impacts of the project during construction and operation
3. Identification and description of mitigation measures to manage potential or known soil and groundwater contamination during construction and operation.

The methodologies for the following are outlined in **sections 3.2.1** to **3.2.3** and include:

- Assessment of the existing environment for the project footprint
- Preliminary qualitative risk assessment for the potential construction and operational impacts.

3.2.1 Methodology for assessing the project footprint

Recent contamination assessment and investigation reports have been prepared by AECOM and other consultants for the proposed ancillary facilities and surrounding areas incorporating the project footprint. The assessments included the following:

- Review of background information including relevant historical reports relating to each ancillary facility and the project footprint
- Review of relevant Lands Title Office documents for land within the ancillary facility boundary to evaluate whether historical land uses were likely to have caused soil and groundwater contamination
- Review of council records, including section 149 certificates for land within the ancillary facility boundary to evaluate whether the presence of contaminated land has been identified on Council records
- Search of the NSW EPA records of notices and list of NSW contaminated sites notified to NSW EPA
- Review of available historical photographs, including aerial photographs, for the ancillary facilities and project footprint, which may provide an indication of historically contaminating land uses
- Review of historical businesses within and in proximity to the ancillary facilities and project footprint from information provided in the 1950, 1970 and 1991 Universal Business Directories Pty Ltd (UBD) business directories to identify potentially contaminating industries
- A preliminary assessment of the nature and location of infrastructure, hazardous materials and other features located within and in proximity to the ancillary facilities and project footprint, both current and historical
- Review of available published geological and hydrogeological information for the ancillary facilities and project footprint
- Search of the NSW Government's groundwater bore database for groundwater bores within a one kilometre radius of the ancillary facilities, to assist in gaining an understanding of regional hydrogeology
- Completion of site inspections to assist with the identification of potential on and off-site sources of contamination and to understand the general condition of the project footprint and surrounds.

Intrusive investigations were also undertaken along the tunnel alignment, including:

- Combined geotechnical and contamination investigations completed within the project footprint
- Soil and groundwater investigations at the Rozelle Rail Yards, where a high potential for contamination was identified to be present as a result of historical land use activities and where significant earthworks are required to be undertaken for the project
- Soil and sediment investigations in areas of proposed intrusive construction works at The Crescent and adjacent Rozelle Bay where a high potential for contamination was identified to be present as a result of historical land use activities.

Based on this information, the areas and contaminants of concern around ancillary facilities and the project footprint were identified. A list of the reports used to support the assessment of contamination risks associated with each ancillary facility and surrounding areas incorporating the project footprint is provided in **Table 3-1** and summarised in **sections 4.1** to **4.13**.

Table 3-1 Previous reports for the assessment of the ancillary facilities and surrounding areas incorporating the project footprint

Area	Previous Reports
C1a – Wattle Street civil and tunnel site at Haberfield	• GHD (2014) WestConnex Delivery Authority Phase II Contamination & Acid Sulfate Soil Investigation and Assessment • GHD Pty Ltd (GHD) (2015) Appendix P of the Environmental Impact Statement M4 Motorway East Soil and Land Contamination Assessment • Ramboll Environ (2016a) RE: Technical Note – Environmental Advice – WCX M4E Eastern Ventilation Facility • Ramboll Environ (2016b) RE: Technical Note – Environmental Advice – WCX M4E Wattle Street Civil Compound – Reg Coady Reserve • Ramboll Environ (2016c) Phase Environmental Site Assessment, WestConnex M4 East, draft in preparation • Down to Earth (D2E) Waste and Material Classification, Cnr Parramatta Road and Walker Avenue, Haberfield
C2a – Haberfield civil and tunnel site C2b – Haberfield civil site	• GHD (2014) WestConnex Delivery Authority Phase II Contamination & Acid Sulfate Soil Investigation and Assessment • GHD Pty Ltd (GHD) (2015) Appendix P of the Environmental Impact Statement M4 Motorway East Soil and Land Contamination Assessment • Ramboll Environ (2016a) RE: Technical Note – Environmental Advice – WCX M4E Eastern Ventilation Facility • Ramboll Environ (2016c) Phase Environmental Site Assessment, WestConnex M4 East, draft in preparation • Down to Earth (D2E) Waste and Material Classification, Cnr Parramatta Road and Walker Avenue, Haberfield
C3a – Northcote Street civil site at Haberfield	• GHD Pty Ltd (GHD) (2015) Appendix P of the Environmental Impact Statement M4 Motorway East Soil and Land Contamination Assessment
C1b – Parramatta Road West civil and tunnel site at Ashfield	• GHD Pty Ltd (GHD) (2015) Appendix P of the Environmental Impact Statement M4 Motorway East Soil and Land Contamination Assessment
C3b – Parramatta Road East civil site at Haberfield	• GHD Pty Ltd (GHD) (2015) Appendix P of the Environmental Impact Statement M4 Motorway East Soil and Land Contamination Assessment
C4 – Darley Road civil and tunnel site at Leichhardt	• AECOM, 2016a. Stage 1 Preliminary Site Investigation, Hawthorne Canal • PPK Environment and Infrastructure (PPK), 2001. Phase 1 Environmental Site Assessment 7 Darley Road, Leichhardt, NSW • Environmental Investigation Services (EIS), 2002. Environmental Site Screening for Proposed Supermarket Development, 7 Darley Road, Leichhardt, NSW • HLA-Envirosciences Pty Ltd (HLA), 2007. Additional Environmental Site Assessment, 7 Darley Road, Leichhardt, NSW

Area	Previous Reports
C5 – Rozelle civil and tunnel site at Rozelle	• ERM, 2002. Stage 1 and 2 Environmental Site Assessment, Brenan Street, Lilyfield • Parsons Brinkerhoff Pty Ltd (PB), 2003a. Rozelle Marshalling Yards Redevelopment, Environmental Site Assessment • PB, 2003b. Rozelle Marshalling Yards Redevelopment, Remedial Action Plan (Final Report) • GHD Pty Ltd, 2004. Rozelle Marshalling Yards, Statement of Environmental Effects – Site Preparation Works (Final Draft) • ENSR Australia Pty Ltd, 2008. Advice Relating to Management of Contamination, Bays Precinct (Draft) • Coffey Environmental Pty Ltd (Coffey), 2009 North West Metro Contract 136 Contamination Assessment Report • Sinclair Knight Merz (SKM), 2009. Technical Paper for Spoil Management for the CBD Metro Environment Assessment • SKM, 2011. Asbestos Assessment – Rozelle Marshalling Yard • SKM, 2009. CBD Metro Environment Assessment: Contaminated Lands Constraints Assessment • AECOM, 2016b. WestConnex M4-M5 Link Rozelle Interchange Phase 1 Environmental Site Assessment • AECOM, 2016c WestConnex M4-M5 Link Factual Contamination Report • Roads and Maritime Services, 2016. Rozelle Rail Yards – Site Management Works Review of Environmental Factors
C6 – The Crescent civil site at Annandale	• AECOM, 2016b. WestConnex M4-M5 Link Rozelle Interchange Phase 1 Environmental Site Assessment • AECOM, 2016c WestConnex M4-M5 Link Factual Contamination Report • Jacobs (2015b) Lots 21/22, DP1151746 Rozelle Bay – NSW Roads & Maritime Services, Site Access and Management Procedures. Final, ExeC1a4/0341
C7 – Victoria Road civil site at Rozelle	• AECOM, 2016b. WestConnex M4-M5 Link Rozelle Interchange Phase 1 Environmental Site Assessment
C8 – Iron Cove Link civil site at Rozelle	• AECOM, 2016d. Preliminary Site Investigation, Iron Cove Portal and Construction ancillary facilities
C9 – Pyrmont Bridge Road tunnel site at Annandale	• AECOM, 2016e. Preliminary site Investigation, Pyrmont Bridge Road Tunnel Site.

Area	Previous Reports
C10 – Campbell Road civil and tunnel site at St Peters	• AECOM, 2014. Phase 1 Environmental Site Assessment, Alexandria Landfill Site Acquisition Area, St Peters • AECOM, 2015a. Phase 1 Environmental Site Assessment, Local Road Upgrades, St Peters, Mascot and Alexandria, NSW • AECOM, 2015b. WestConnex Stage 2: M5 Factual Contamination Assessment. 60327128_CI_RPT03_Draft_20150422 • AECOM, 2015c. Characterisation of the Bradshaw Mountain Stockpile – Resource Recovery Order for Potential Excavated Natural Material Exemption (Draft) • AECOM, 2015d. Phase 2 Environmental Site Assessment Alexandria Landfill, 10-16 Albert Street, NSW. 60327128_Draft Phase 2 ESA_20150506_A • AECOM, 2015e. Alexandria Landfill Closure Hydrogeological Assessment, Alexandria Landfill, 10-16 Albert Street, St Peters, NSW. 60327128_Draft Hydro Report_20150512_RevA • AECOM, 2015f. Alexandria Landfill, Landfill Management Closure Plan. 60327128_Draft LCMP_20151021_RevC • AECOM, 2015g. WestConnex New M5, Technical Working Paper: Contamination

3.2.2 Tunnel alignment

To assess the potential for groundwater contamination to be present along the proposed tunnel alignment, information from the following sources was reviewed to identify former and current potentially contaminating land uses:

- Search of the NSW EPA list of contaminated sites notified to NSW EPA and the 'Contaminated Land: Record of Notices' within around 500 metres of the tunnel alignment
- Selected historical images including aerial photographs for the tunnel alignment and surrounds
- Selected historical survey maps for the tunnel alignment and surrounds
- Review of available groundwater monitoring results
- Information from the previous reports listed in **Table 3-1** were also used to assess potential impacts on the tunnel alignment.

Given the length of the tunnel alignment and the location of proposed ancillary facilities, tunnel portals and interchange locations, the tunnel alignment was split into the following sections for ease of interpretation (see **sections 4.14.1** to **4.14.5**)

- St Peters to Newtown: Mary Street at St Peters to Lord Street at Newtown
- Newtown to Camperdown: Lord Street at Newtown to Bishopgate Lane at Camperdown
- Camperdown to Annandale: Bishopgate Lane at Camperdown to Whites Creek at Annandale
- Annandale to Haberfield: Whites Creek at Annandale to Parramatta Road at Haberfield
- Rozelle to Iron Cove and Balmain: City West Link at Annandale to Wellington Street and Theodore Street at Balmain.

3.2.3 Preliminary qualitative risk assessment methodology

To assess the potential construction and operational impacts for the project, a preliminary qualitative risk assessment was undertaken based on the review of information. The methodology for the risk assessment is detailed in **Table 3-2**.

Table 3-2 Preliminary qualitative risk assessment methodology

Preliminary qualitative risk assessment methodology	
Construction	**Operation**
Identification of areas and contaminants of concern	
Identified using the methodology outlined in **section 3.2.1**.	
Likelihood of contamination to be present and likely extent of impacts	
Identified by review of information presented in **section 4**.	
Potential migration pathways	
• Dust generation • Excavation and disposal or reuse of soils • Extraction and disposal or reuse of groundwater from dewatering or drainage • Migration of groundwater via preferential pathways • Surface water erosion.	• Extraction of groundwater in drainage systems • Migration of groundwater via preferential pathways • Surface water erosion.
Potential receptors	
• Project construction workers and visitors • Surrounding land users such as the general public and nearby residents and commercial workers • Receiving water bodies.	• Intrusive maintenance workers • Future site users of final land use such as commercial, open space or residential • Ecological receptors • Receiving water bodies.
Potential exposure pathways	
• Direct contact, ingestion or inhalation by human receptors • Uptake by aquatic flora and intake by aquatic fauna.	• Direct contact, ingestion or inhalation by human receptors and fauna • Uptake by terrestrial and aquatic flora and intake by aquatic fauna.

To identify the risk rating, the preliminary qualitative contamination risk assessment matrix in **Table 3-3** was used. See **Table 5-1** for the risk assessment of construction impacts and **Table 6-1** for the risk assessment of operation impacts.

Table 3-3 Preliminary qualitative risk assessment matrix

Consequence	Likelihood of soil or groundwater contamination to be present				
	Very unlikely to be present at concentrations above the relevant assessment criteria and limited in extent	**Potentially present at concentrations above the relevant assessment criteria and limited in extent**	**Potentially present at concentrations above the relevant assessment criteria and widespread**	**Most likely present at concentrations above the relevant assessment criteria and widespread**	**Known to be present at concentrations above the relevant assessment criteria and widespread**
No or unlikely exposure pathway for human or ecological receptor's either now or during or post construction*	Low	Low	Low	Medium	Medium
Exposure pathway for human or ecological receptors likely to be present and complete either now, during or post construction*	Low	Medium	Medium	High	High
Exposure pathway for human or ecological receptors present and are complete either now, during or post construction*	Medium	Medium	High	High	High

Notes: * without implementation of appropriate controls or remediation as recommended in the management of construction and operational impacts - **section 8**.

4 Existing environment

4.1 C1a – Wattle Street civil and tunnel site at Haberfield

4.1.1 Site description and surrounding land use

The Wattle Street civil and tunnel site at Haberfield (C1a) would be used where Option A is selected as the preferred construction option at Haberfield. Refer to **Chapter 6** (Construction work) of the EIS for further information on Option A and Option B.

The Wattle Street civil and tunnel site at Haberfield is within the project footprint of the Wattle Street (City West Link) interchange construction zone for the M4 East project. The site is shown in **Figure 4-1** and would be located in an area comprising former residential properties, demolished as part of the M4 East project. The site is currently being utilised as a construction ancillary facility for the M4 East project.

The site slopes to the northeast and southwest and is surrounded by the land uses described in **Table 4-1**.

Table 4-1 Surrounding land use – Wattle Street civil and tunnel site at Haberfield (C1a)

Direction	Description of surrounding land use and proximity to the site
North	• Wattle Street followed by low density residential properties and Reg Coady Reserve (120 metres topographically down-gradient) (northeast) • Dobroyd Canal (Iron Cove Creek) (250 metres topographically down-gradient from the centre of C1a)
South	• Low density residential properties
East	• Ramsay Street followed by low density residential properties (topographically down-gradient)
West	• Parramatta Road • M4 East construction ancillary facilities and commercial/industrial properties along Parramatta Road. Some/all of these construction ancillary facilities would subsequently be used for M4-M5 Link construction.

Figure 4-1 Wattle Street civil and tunnel site at Haberfield (C1a)

4.1.2 Previous intrusive investigations

Limited investigations were undertaken by GHD (2015) to inform the M4 East EIS, within the Wattle Street civil and tunnel site (C1a) at Haberfield. GHD concluded that acquired commercial and residential properties may contain hazardous building materials and that further assessment should be completed prior to the commencement of demolition works. In addition, the Soil and Land Contamination Assessment (GHD September 2015), concluded that 'While contamination such as asbestos (reported at depth), metals, polycyclic aromatic hydrocarbons (PAHs) and hydrocarbons are not considered to present an imminent risk to human health or the environment, they would require appropriate management during the construction phase, the risks can be managed through a Construction Environmental Management Plan (CEMP) that would include an unexpected finds protocol to handle any latent contamination, groundwater, waste management and acid sulfate soils.'

The closest down-gradient groundwater monitoring well is 200 metres to the southwest of the site. The monitoring well was sampled by GHD (2015) for: metals; total recoverable hydrocarbons (TRH); benzene, toluene, ethylbenzene and xylenes (BTEX); PAHs; volatile organic compounds (VOCs) and organochlorine pesticides (OCPs). Concentrations of copper, nickel and zinc exceeded the ASC NEPM (NEPC 2013) Groundwater Investigation Levels (GILs) for freshwater.

Following M4 East project approval and prior to M4 East establishment works as part of the M4 East project, Ramboll Environ (2016a) prepared a technical note containing environmental advice for the management of contamination at a site located at the corner of Wattle Street and Parramatta Road within the M4-M5 Link project footprint and immediately south and adjacent to the proposed C1a ancillary facility within the C2a or C2b ancillary facility.

The objective of the technical note was to provide the M4 East contractor with guidance in relation to site specific circumstances and procedures that should be implemented for the management of contaminated materials at the site. The technical note reviewed the findings of the GHD Phase 2 Contamination and Acid Sulfate Soil Investigation and Assessment (September 2014) completed within the vicinity of the site, along with a Ramboll Environ Phase 2 Contaminated Land Assessment (2016c), and a Down to Earth (D2E) waste classification (June 2016). The results of the technical note are summarised as follows:

- GHD (2014) installed one well within 500 metres of the site, screened in the Hawkesbury Sandstone aquifer, which reported a standing water level 4.98 metres below top of casing. Two boreholes drilled 20 metres south and southwest of the site reported 0.7 metres of fill materials with no exceedances in the soil samples analysed. One borehole was converted to a monitoring well screened within the shale aquifer, with a standing water level of 2.595 metres below top of casing
- Ramboll Environ (2016c) investigated nine locations at four sites within the site in M4 East footprint and collected 26 soil samples and four groundwater samples. The locations were chosen to target potential contamination which could be encountered during construction works, such as during the excavation of the wheel wash and the sedimentation basin. Friable asbestos was detected in three locations at depths 0.2, 0.5 and 0.6 metres below ground level. One piece of bonded asbestos containing materials was identified on the surface at one location and one minor zinc exceedance of the ecological investigation level in shallow topsoil was reported at one location. Elevated metals in groundwater were reported to exceed the ANZECC 95 per cent trigger values for the protection of aquatic ecosystems in marine waters. Lead was also reported to exceed the ANZECC (2000) recreational guideline at one location. Ramboll Environ (2016b) considered these exceedances in groundwater to be representative of background concentrations
- Based on the results of Ramboll Environ (2016c) classified the material as Special Waste – Asbestos unless it could be demonstrated that the material was free of asbestos by a Sampling Quality Plan (SQP). The area where asbestos containing material (ACM) fragment was detected was considered to be classified as General Solid Waste following removal of identified ACM fragment(s). Ramboll Environ (2016a) considered the natural materials below the fill materials to be classified as Virgin Excavated Natural Material (VENM)

- D2E (2016) undertook *in situ* waste classification sampling over an area of 10,000 m² to a depth of 1.7 metres below ground level – the anticipated subgrade level for surface works. Ramboll (2016a) noted that the assessed area only partly covered the site compound and also extended beyond the compound boundary. D2E concluded that the fill material which extended to 0.6 metres below ground surface would be classified as General Solid Waste with the exception of a 25.7 metre hotspot of asbestos contaminated soils (fibres and fragment[s]). D2E (2016) considered the natural materials below the fill materials to be classified as VENM. D2E undertook a second waste classification on the remaining portion of the site over an area of 4000 square metres. D2E concluded that the "upper soil/fill horizon" was classified as General Solid Waste and the underlying natural soils met the definition of VENM
- A.D. Envirotech (ADE 2016) completed an Asbestos Materials Inspection and Risk Assessment of the topsoil and materials within the former location of the central building footing at 1A Wattle Street Haberfield following notification of an unexpected find by the M4 East contractor. A 50 square metre delineated exclusion zone was established which included the former building footing, soil at surface, building material and soil to a depth of 0.5 metres below ground level. An assessment was undertaken which included a site walkover, one test-pit, collection of two soil samples and collection of two potential fibre cement samples for analysis. Results indicated fibre cement samples contained asbestos; soil samples did not indicate the presence of asbestos.

Ramboll Environ (2016a) indicated the materials impacted by friable and bonded asbestos would be managed as part of the Construction Contaminated Land Management Plan (CCLMP) (November 2015) and associated sub-plan Asbestos Management Plan (AMP) (December 2015). Ramboll Environ (2016a) detailed a remediation and validation strategy specific to the identified contaminants within the site.

Ramboll Environ (2016b) prepared another technical note for the M4 East Wattle Street Civil Compound located at Reg Coady Reserve (dated 15 August 2016) to be used during site establishment of the construction ancillary facilities and construction of motorway infrastructure as part of the M4 East project. It is noted that Reg Coady Reserve is located approximately 120 metres topographically down-gradient of the proposed M4-M5 Link project footprint (Wattle Street civil and tunnel site (C1a)).

The technical note reviewed available previous investigation reports and concluded that there were seven areas of environmental concern within Reg Coady Reserve. Contaminants of concern identified in soil included ACM, friable asbestos, lead, TRH, zinc, Total PAHs and acid sulfate soils. Ramboll Environ (2016b) indicated that the impacted materials would be managed in accordance with the CCLMP (November 2015) and the AMP (December 2015). The technical note also detailed a remediation and validation strategy specific to the identified contaminants within the M4 East Wattle Street civil compound.

4.1.3 Site history

A review of historical aerial photographs for the area and certificates of titles for selected commercial/industrial properties was undertaken for the GHD 2015 report prepared as part of the WestConnex M4 East EIS. Key findings relevant to the Wattle Street civil and tunnel site at Haberfield were:

- Historical aerial photographs from between 1930 and 2014 showed that low density residential properties were located within and surrounding the site
- A car sales yard was located 130 metres topographically down-gradient and southwest of the site (225–227 Parramatta Road), which was a former laundry/dry cleaner from 1919 to 1982
- A car service centre was located 125 metres topographically down-gradient and southwest of the site (235–237 Parramatta Road).

A search of the NSW EPA records of notices and list of NSW contaminated sites notified to the NSW EPA and the public register under section 308 of the *Protection of the Environment Operations Act 1997* (NSW) (POEO Act) was undertaken on 2 September 2015. There were no sites identified within 500 metres of the site (GHD 2015). Demolition of properties acquired for the M4 East project commenced in March 2016.

4.1.4 Soil and geology

The Wattle Street civil and tunnel site at Haberfield is underlain by Gymea erosional soils. The soils are underlain by Hawkesbury Sandstone which consists of medium to coarse grained quartz sandstone, very minor shale and laminate lenses and Ashfield Shale which consists of shale and laminate.

GHD (2015) noted that generalised stratigraphy within the vicinity of the site (M4 East EIS Section 6: Dobroyd Canal [Iron Cove Creek] to Bland Street [including Wattle Street]) comprised:

- Concrete or hardstand at ground level – thickness 0.1 to 0.13 metres
- Fill comprising gravelly and sandy clays from ground level to 0.13 metres – thickness 0.25 to 0.7 metres
- Residual clay with traces of gravels from 0.25 to 2.5 metres – thickness 1.1 to 1.9 metres
- Weathered shale from 1.5 to 2.5 metres – thickness not determined
- Sandstone from 2.3 metres – thickness not determined.

4.1.5 Hydrogeology

Based on previous investigations and registered groundwater bore data presented in the GHD 2015 report, shallow groundwater in the surrounding area is at between 2.5 and five metres below ground surface in sandstone and weathered shale. Monitoring well HB_BH03 is screened within the sandstone near the C1a ancillary facility and the standing water level was monitored at between two and 2.5 metres below ground level (*M4-M5 Link Groundwater Monitoring Interpretive Report – June to November 2016* AECOM 2017a).

4.1.6 Acid sulfate soils

According to information provided by NSW Department of Planning and Environment (DP&E) (Acid Sulfate Data Source Accessed 05/02/2015) acid sulfate risk map, the site is within Class 5 mapped land Class 2 land is located around 200 metres to the northeast (see **Figure 4-2**). Areas mapped as Class 5 have no known occurrence of acid sulfate soils. Works within 500 metres of adjacent Class 1, 2, 3 or 4 land that is below one metre Australian Height Datum (AHD) presents an environmental risk if the water table is lowered.

4.1.7 Areas and contaminants of concern

The key areas and contaminants of concern within the Wattle Street civil and tunnel site at Haberfield are summarised in **Table 4-2**.

Table 4-2 Areas and contaminants of concern – Wattle Street civil and tunnel site at Haberfield (C1a)

Property	Description	CoPC*
C1a Former residential properties	No areas of concern expected with the exception of: • Residual contamination arising from the demolition/construction of former buildings • Use of lead paint which may have resulted in localised areas of ACM fragments and lead paint flakes in soil Use of the site as a construction ancillary facilities for the WestConnex M4 East project and associated potential for construction leaks and spills • Demolition activities, use of plant and machinery and excavation activities. The site will be demobilised and earthworks carried out by the M4 East contractor to provide finished levels that are generally consistent with the original ground surface before being handed over to the M4-M5 Link contractor. At the completion of M4-M5 Link construction, the landscaping (where applicable) and residual land obligations as detailed in the M4 East Urban Design and Landscape Plan and Residual Land Management Plan will be carried out.	Lead, asbestos, metals, PAHs and hydrocarbons
Off-site sources	Potential contaminating land uses are located topographically down-gradient of the site and are therefore unlikely to impact the Wattle Street civil and tunnel site.	None anticipated

Note: * CoPC Contaminants of Potential Concern

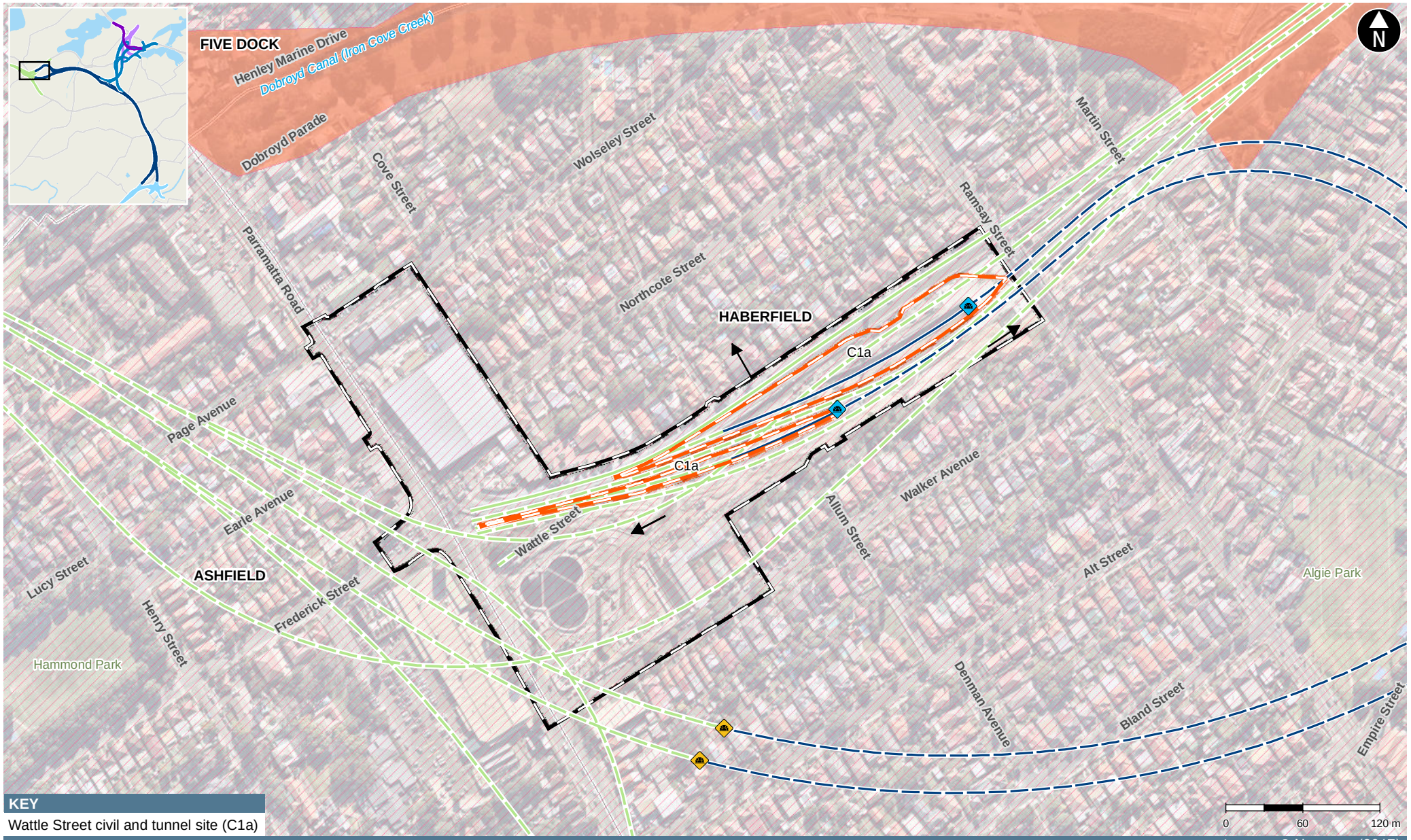


Figure 4-2 Wattle Street civil and tunnel site at Haberfield (C1a) - acid sulfate soils

4.2 C2a – Haberfield civil and tunnel site at Haberfield

4.2.1 Site description and surrounding land use

The Haberfield civil and tunnel site at Haberfield (C2a) would be used where Option A is selected as the preferred construction option at Haberfield. This site would be used as Haberfield civil site at Haberfield (C2b) if Option B is selected as the preferred option at Haberfield. Refer to **Chapter 6** (Construction work) of the EIS for further information on Option A and Option B.

The site is shown in **Figure 4-3** and would be located in an area comprising former residential and commercial properties, demolished as part of the M4 East project. The site is currently being utilised as a construction ancillary facility for the M4 East project.

The Haberfield civil and tunnel site at Haberfield slopes to the southwest and is surrounded by the land uses described in **Table 4-3**.

Table 4-3 Surrounding land use – Haberfield civil and tunnel site at Haberfield (C2a) or Haberfield civil site at Haberfield (C2b)

Direction	Description of surrounding land use and proximity to the site
North	• Construction ancillary facilities being used by the M4 East project and residential properties • Dobroyd Canal (Iron Cove Creek) 400 metres north.
South	• Walker Avenue, a gym and then mixed residential and commercial land use (fronting Parramatta Road).
East	• Residential properties (adjacent and up-gradient) surrounding Walker Avenue and Allum Street.
West	• Parramatta Road, then commercial premises (Bunnings Warehouse), The Infants Home preschool and long day care centre on Ilford Avenue.

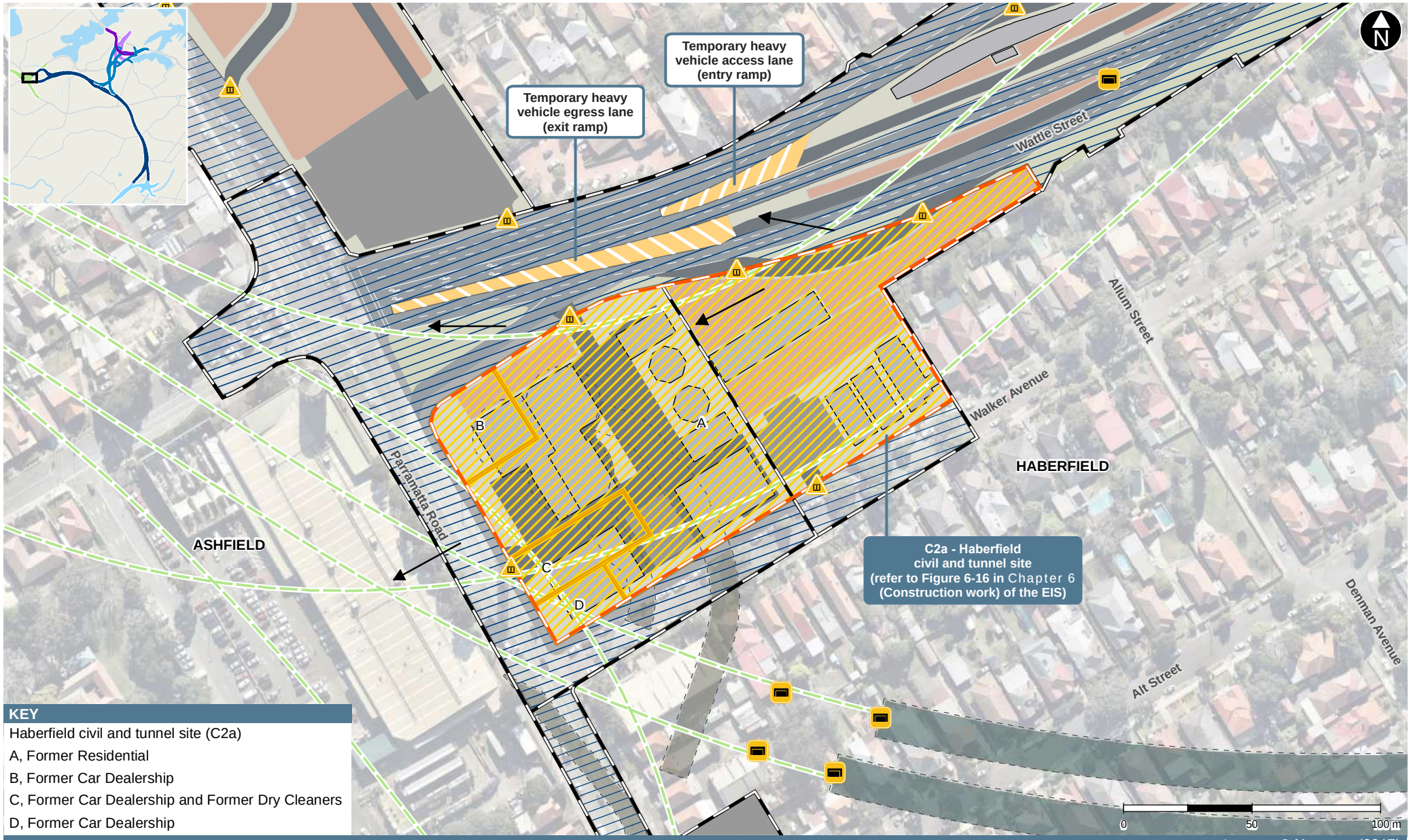


Figure 4-3 Haberfield civil and tunnel site at Haberfield (C2a)

4.2.2 Previous intrusive investigations

GHD (2015) undertook limited investigations to inform the M4 East EIS (Appendix P, September 2015), which encompasses the site of the Haberfield ancillary facility. The GHD report concluded that acquired commercial and residential properties may contain hazardous building materials and that further assessment should be completed prior to any demolition works. In addition, the Soil and Land Contamination Assessment (GHD September 2015), concluded that 'While contamination such as asbestos (reported at depth), metals, PAHs and hydrocarbons are not considered to present an imminent risk to human health or the environment, they would require appropriate management during the construction phase, The risks can be managed through an EMP that would include an unexpected finds protocol to handle any latent contamination, groundwater, waste management and acid sulfate soils.'

Prior to establishment of the M4 East project site, Ramboll Environ (2016a) prepared a technical note containing environmental advice for the management of contamination. It is noted that the site is located at the corner of Wattle Street and Parramatta Road within the proposed M4-M5 Link project footprint and immediately south and adjacent to the C1a ancillary facility within the C2a or C2b ancillary facility. The findings of this technical memo are summarised previously in **section 4.1.2**.

4.2.3 Site history

A review of historical aerial photographs for the area and certificates of titles for selected commercial/industrial properties were undertaken for the GHD 2015 report. Key information relevant to the Haberfield ancillary facility is described in **Table 4-4**.

Table 4-4 Site history pre-M4 East works – Haberfield civil and tunnel site at Haberfield (C2a) or Haberfield civil site at Haberfield (C2b)

Property	Site history summary
A 14 residential houses and one unit block	• All properties appear to have been residential properties since at least the 1930s to the present day based on the historical aerial photographs.
B Car Dealership	• According to the historical titles the property was owned by various private owners (1912 to 1962 and 1973 to 1976), Motor Car Dealer Herbert Thomas Millington (1962 to 1973), British and Continental Cars (1976 to 2013) and Sonar Australia Pty Ltd (2013 to 2015) • The historical aerial photographs showed that the site consisted of three residential houses until the 1960s. Based on this information it appears that the site was used as a car dealership since 1962.
C Car Dealership (former dry cleaner)	• According to the historical titles the property was owned by a merchant (1895 to 1919), a laundry proprietor (1919 to 1954), leased to a laundry proprietorship (1954 to 1982) and APS Property Management Pty Ltd (2013 to present) • The historical aerials showed that a commercial type building was located on the site until the 1980s where the building appeared to have been demolished and replaced with the present day car dealership yard and garage building at the rear • GHD (2015) identified a former laundry/dry cleaner located on the corner of Walker Avenue and Parramatta Road, located around 100 metres north of the C3b site which was classified by GHD as moderate potential for contamination a borehole sampled on the corner of this property did not report any detections of asbestos or any exceedances of the ASC NEPM (NEPC, 2013) health investigation levels for proposed recreational open space and commercial/industrial land uses and no exceedances of the ASC NEPM (NEPC, 2013) management limits for residential/parkland land use

Property	Site history summary
	• Lotsearch (2017) 1970 UBD Business Directory search identified a Bells Laundry located at 225 Parramatta Road, Haberfield within the C2a or C2b ancillary facility. The Bells Laundry site was listed in the 1950 UBD Business Directory as 227 Parramatta Road within the C2a or C2b ancillary facility.
D Car Dealership	• According to the historical titles the property was owned by various private owners (1892 to 1968), Pye Motors Pty Ltd (1968 to 1984), various commercial leases (1984 to 1997), Careful Car Company Pty Ltd (1997 to 2013) and APS Property Management (2013 to 2015) • The property appeared to be a commercial building or shop that fronted onto Parramatta Road until it was demolished in the 1970s and the present • Based on the above information it appears the property was used as a car dealership since 1968. The commercial use of the site prior to 1968 is unknown.

4.2.4 Soil and geology

The Haberfield ancillary facility is underlain by Gymea erosional soils. The soils are underlain by Hawkesbury Sandstone which consists of medium to coarse grained quartz sandstone, very minor shale and laminate lenses and Ashfield Shale which consists of shale and laminate.

GHD (2015) noted that generalised stratigraphy within the vicinity of the C2a or C2b site (M4 East EIS Section 6: Dobroyd Canal [Iron Cove Creek] to Bland Street [including Wattle Street]) comprised:

- Concrete or hardstand at ground level – thickness 0.1 to 0.13 metres
- Fill comprising gravelly and sandy clays from ground level to 0.13 metres – thickness 0.25 to 0.7 metres
- Residual clay with traces of gravels from 0.25 to 2.5 metres – thickness 1.1 to 1.9 metres
- Weathered shale from 1.5 to 2.5 metres – thickness not determined
- Sandstone from 2.3 metres – thickness not determined.

4.2.5 Hydrogeology

Based on previous investigations and registered groundwater bore data presented in the GHD 2015 report, shallow groundwater in the surrounding area is at between 2.5 and five metres below ground level in sandstone and weathered shale.

4.2.6 Acid sulfate soils

According to information provided by DP&E (Acid Sulfate Data Source Accessed 05/02/2015: NSW Crown Copyright – Planning and Environment Creative Commons 3.0 © Commonwealth of Australia) acid sulfate risk map, the site is within Class 5 mapped land with Class 2 land located 370 metres to the north and 490 metres to the northeast (see **Figure 4-4**). Areas mapped as Class 5 have no known occurrence of acid sulfate soils. Works within 500 metres of adjacent Class 1, 2, 3 or 4 land that is below one metre AHD, presents an environmental risk if the water table is lowered.

4.2.7 Areas and contaminants of concern

The key areas and contaminants of concern within the site are described in **Table 4-5**.

Table 4-5 Areas and contaminants of concern – Haberfield civil and tunnel site at Haberfield (C2a) or Haberfield civil site at Haberfield (C2b)

Property	Description	CoPC
C2a/C2b ancillary facility	Use of the site as a construction ancillary facility for the WestConnex M4 East project and associated potential for construction leaks and spills. Demolition activities, use of plant and machinery and excavation activities. The site will be demobilised and earthworks carried out by the M4 East contractor to provide finished levels that are consistent with the original ground surface, before being handed over to the M4-M5 Link contractor. At the completion of M4-M5 Link construction, the landscaping (where applicable) and residual land obligations as detailed in the M4 East Urban Design and Landscape Plan and Residual Land Management Plan will be carried out.	Lead, asbestos, metals, PAHs and hydrocarbons
A 14 former residential houses and one unit block	No areas of concern expected with the exception of the demolition/construction of former buildings and use of lead paint which may have resulted in localised areas of ACM and lead paint flakes in soil.	Lead, asbestos
B Car Dealership	Small scale mechanical workshops may have been operational within the property, which may have historically stored and handled oils, fuels and solvents. Three houses were also historically demolished within the property which may have resulted in localised areas of ACM fragments and lead paint flakes in soil.	TRH, BTEXN, PAHs, VOCs, lead, asbestos
C Car Dealership (former dry cleaner)	A laundry may have operated on the site between 1919 and 1982, which may have included dry cleaning. Dry cleaners historically used white spirits, kerosene, carbon tetrachloride, trichloroethylene (TCE), perchloroethylene (Perc), as cleaning solvents until the 1990s. Fluorocarbon based dry cleaning was used in Australia from 1990 until it was banned in 1997 [1,1,2 trichloro-1,2,2-trifluroethane and 1,1,1-Trichloroethane (TCA)]. The former commercial building was also demolished within the property which may have resulted in localised areas of ACM fragments and lead paint flakes in soil.	TRH, VHCs, lead, asbestos
D Car Dealership	Small scale mechanical workshops may have been operational within the property, which may have historically stored and handled oils, fuels and solvents. A former building in the centre of the property was demolished in the 1970s, which may have resulted in localised areas of ACM fragments and lead paint flakes in soil.	TRH, BTEXN, PAHs, VOCs, lead, asbestos
Off-site sources	Potential contaminating land uses are located topographically down-gradient of the site and are therefore unlikely to impact the Parramatta Road ventilation facility site.	Nil

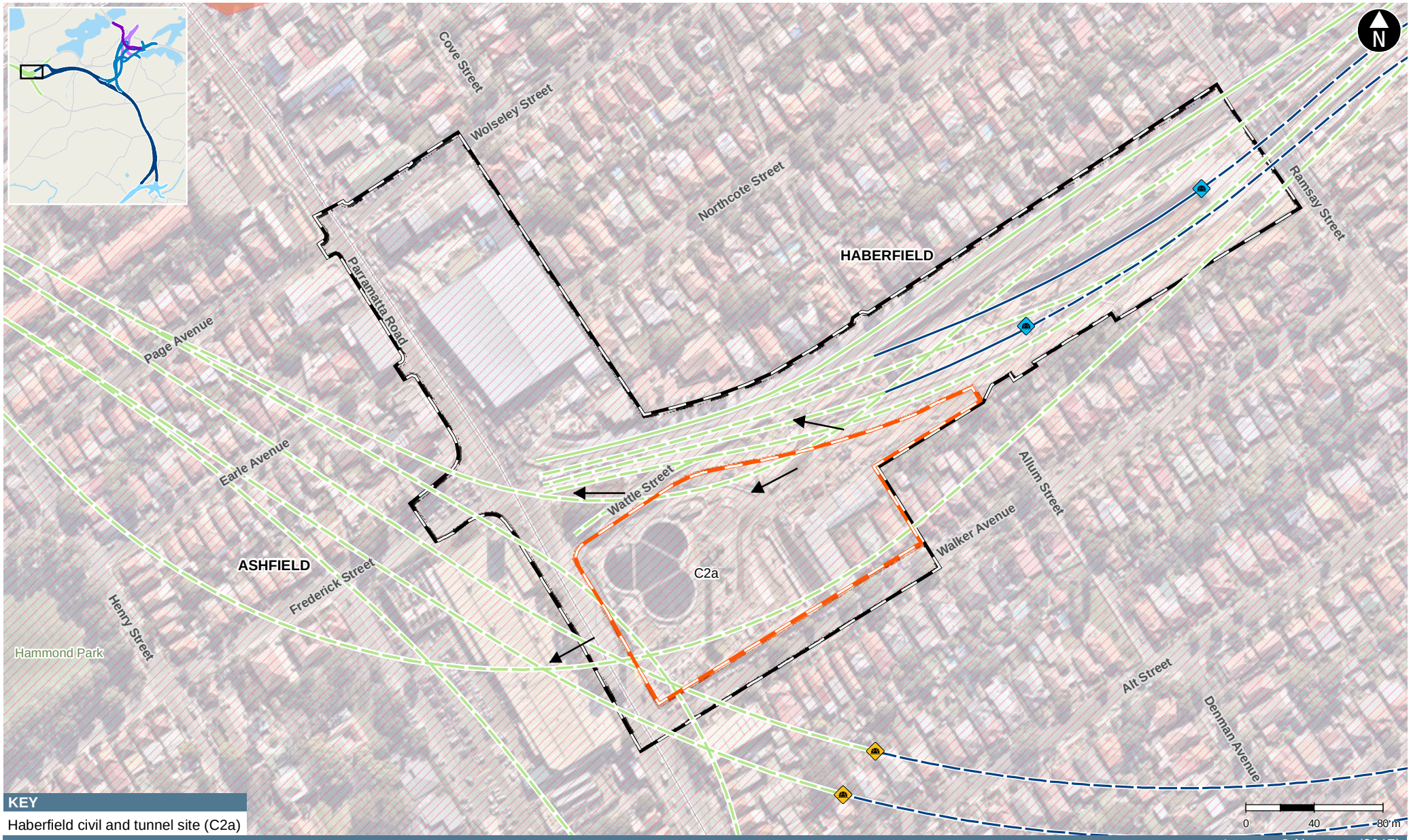


Figure 4-4 Haberfield civil and tunnel site at Haberfield (C2a) - acid sulfate soils

4.3 C3a – Northcote Street civil site at Haberfield

4.3.1 Site description and surrounding land use

The Northcote Street civil site at Haberfield (C3a) would be used where Option A is selected as the preferred construction option at Haberfield. Refer to **Chapter 6** (Construction work) of the EIS for further information on Option A and Option B.

The site is shown in **Figure 4-5** and would be located in an area comprising former residential and commercial properties, demolished as part of the M4 East project. The site is currently being utilised as a construction ancillary facility for the M4 East project.

The Northcote Street civil site slopes to the west and is surrounded by the land use described in **Table 4-6**.

Table 4-6 Surrounding land use – Northcote Street civil site at Haberfield (C3a)

Direction	Description of surrounding land use and proximity to the site
North	• Wolseley Street • Muirs Prestige Smash Repairs (20 metres north and across gradient) • Speedway Service Station (35 metres north and across gradient) • Automotive Hospital (80 metres north and across gradient) • Platinum Car Wash Café (former petrol station) (100 metres north and across gradient) • Little VIPs Childcare Centre (100 metres north and across gradient) • Dobroyd Canal (Iron Cove Creek) (195 metres north).
South	• Wattle Street • C2a Haberfield civil and tunnel site at Haberfield (see **section 4.2**) • Residential properties (45 metres across gradient) along Wattle Street • Bunnings warehouse (45 metres down-gradient) front Parramatta Road.
East	• Residential properties (adjacent and up-gradient) along Northcote Street.
West	• Parramatta Road • Various retail shops and fast food restaurants (20 metres down-gradient) • Residential properties (70 metres down-gradient).

Figure 4-5 Northcote Street civil site at Haberfield (C3a)

There were no sites listed on the NSW EPA record of notices or list of sites notified to the NSW EPA within 500 metres of the site (GHD 2015).

4.3.2 Previous intrusive investigations

GHD (2015) undertook limited investigations to inform the M4 East EIS (Appendix P, September 2015), which encompasses the Northcote Street civil site at Haberfield. The GHD report concluded that acquired commercial and residential properties may contain hazardous building materials and recommended that further assessment should be completed prior to any demolition works. In addition, the Soil and Land Contamination Assessment (GHD September 2015), concluded that 'While contamination such as asbestos (reported at depth), metals, PAHs and hydrocarbons are not considered to present an imminent risk to human health or the environment, they would require appropriate management during the construction phase, The risks can be managed through an EMP that would include an unexpected finds protocol to handle any latent contamination, groundwater, waste management and acid sulfate soils.'

4.3.3 Site history

A review of historical aerial photographs for the area and certificates of titles for selected commercial/industrial properties were undertaken for the GHD 2015 report. The information was reviewed and the Northcote Street civil site history is described in **Table 4-7**. The site history predates building demolition works which commenced in 2016 for the M4 East project.

Table 4-7 Site history pre-M4 East Works – Northcote Street civil site at Haberfield (C3a)

Property	Site history summary
C3a-A Six residential houses	• The six houses appeared to be present since the 1930 historical aerial photograph until 2016.
C3a-B Garden shop and service station	• The property was owned by various private owners (1907 to 1963 and 2000 to 2015), Amoco Australia Pty Ltd (a petroleum company) (1963 to 1980) and Garden Art Foundations (1980 to 2000) • Based on the historical aerials the property was formerly residential, and contained a corner shop or hotel which was demolished, and an Amoco service station constructed in the 1960s • The service station was then used as a garden shop from 1980 until 2016.
C3a-C Car Mechanic Workshop	• According to historical titles the property was previously owned by The Northcotstate Company Ltd (1907 to 1911), various private owners (1911 to 1973 and 1981 to 1998), Cousins Truck Sales (NSW) Pty Ltd, Moranda Pty Ltd (1979 to 1981) and Bill and Tina Hatzivasiloiou H Jax Quickfit Properties (1998 to 2015) • Based on the historical aerials the property was previously three residential properties until they were demolished and a truck dealership constructed in the late 1970s/early 1980s • The property was then used as a wheel alignment and tyre workshop until 2016.
C3a-D Car Dealership	• According to historical titles the property was previously owned by The Northcote Estate Company Ltd (1907 to 1914) and various private owners (1911 to 2015) • Based on the historical aerials the property was previously two residential properties that were demolished and converted into a commercial business in the 1970s • In the 1980s there was an additional commercial rectangular building in the centre of the site and cars parked across the site. The additional building

Property	Site history summary
	was demolished by the mid-1990s • Based on the historical aerials it appears that the site has been used as a car dealership and a possible mechanics until 2016.
C3a-E Liquor store	• According to historical titles the property was owned by The Northcote Estate Company Ltd (1907 to 1911), various private owners (1907 to 1988), Pesutu Pty Ltd (liquor retailer) (1988 to 2009) and Reo Costi lease to Liquorland (2009 to 2015) • Based on the historical aerials it appears that the site was formerly part of four residential houses that were demolished in the late 1960s/early 1970s. The site was then used as a liquor shop and car park since 1988 • The use of the property between the 1970s and 1988 is unknown • The property was used as a Liquor store until 2016.
C3a-F Automotive Workshop	• According to historical titles the property was previously owned by The Northcote Estate Company Ltd (1910 to 1912), various private owners (1912 to 1965, 1970 to 1977 and 2011 to 2015), the Commissioner of Main Roads (1965 to 1970), and British and Continental Cars (Haberfield) Pty Ltd (1977 to 2011) • Based on the historical aerials the property was previously part of three residential properties that were acquired and demolished for the widening of Wattle Street in the 1960s • The property was then used as a car dealership until 2011 and was then converted for use as a mechanics workshop until 2016.

4.3.4 Soil and geology

The Northcote Street civil site at Haberfield is underlain by Gymea erosional soils. The soils are underlain by Hawkesbury Sandstone which consists of medium to coarse grained quartz sandstone, very minor shale and laminate lenses and Ashfield Shale which consists of shale and laminate.

GHD (2015) noted that generalised stratigraphy within the vicinity of the C3a (M4 East EIS Section 6: Dobroyd Canal [Iron Cove Creek] to Bland Street [including Wattle Street]) comprised:

- Concrete or hardstand at ground level – thickness 0.1 to 0.13 metres
- Fill comprising gravelly and sandy clays from ground level to 0.13 metres – thickness 0.25 to 0.7 metres
- Residual clay with traces of gravels from 0.25 to 2.5 metres – thickness 1.1 to 1.9 metres
- Weathered shale from 1.5 to 2.5 metres – thickness not determined
- Sandstone from 2.3 metres – thickness not determined.

4.3.5 Hydrogeology

Based on previous investigations and registered groundwater bore data presented in the GHD 2015 report, shallow groundwater in the surrounding area is at between 2.5 and five metres below ground level in sandstone and weathered shale.

4.3.6 Acid sulfate soils

According to information provided by DP&E (Acid Sulfate Data Source Accessed 05/02/2015: NSW Crown Copyright – Planning and Environment Creative Commons 3.0© Commonwealth of Australia) acid sulfate risk map the site is within Class 5 mapped land with Class 2 land located 150 metres north and 430 metres to the northeast (see **Figure 4-6**). Areas mapped as Class 5 have no known

occurrence of acid sulfate soils. Works within 500 metres of adjacent Class 1, 2, 3 or 4 land that is below one metre AHD presents an environmental risk if the water table is lowered.

4.3.7 Areas and contaminants of concern

The key areas and contaminants of concern within the Northcote Street civil site are described in **Table 4-8**.

Table 4-8 Areas and contaminants of concern – Northcote Street civil site at Haberfield (C3a)

Area	Description	CoPC
C3a Northcote Street civil site	Use of the site as a construction ancillary facility for the WestConnex M4 East project and associated potential for construction leaks and spills. Demolition activities, use of plant and machinery and excavation activities. The site will be demobilised and earthworks carried out by the M4 East contractor to provide finished levels that are consistent with the original ground surface before being handed over to the M4-M5 Link contractor. At the completion of M4-M5 Link construction, the residual land obligations as detailed in the M4 East Residual Land Management Plan will be carried out.	TRH, BTEX, PAHs, VOCs, lead, asbestos
Northeast corner of the site (C3a/2)	The property on the corner of Wolseley Street and Parramatta Road was formerly a petrol station that may have also contained a mechanics workshop. Based on the appearance of the building and site it is possible that the former underground petroleum storage system (UPSS) including underground storage tanks (USTs) and pipelines may still be *in situ*. There is a medium to high risk of soil and groundwater contamination from historical leaks from the former UPSS.	TRH, BTEX, PAHs and lead
Central (C3a/3 and C3a/4) and southern portion of the site (C3a/6)	Three properties within the site contained or likely contained mechanical workshops which may have historically stored and handled oils, fuels and solvents. The properties may have formally contained hoists, underground waste oil tanks, oil/water interceptor pits, inspection pits and drains which could leak into the subsurface.	TRH, BTEX, PAHs, VOCs, lead

Figure 4-6 Northcote Street civil site at Haberfield (C3a) - acid sulfate soils

4.4 C1b – Parramatta Road West civil and tunnel site at Ashfield

4.4.1 Site description and surrounding area

The Parramatta Road West civil and tunnel site (C1b) at Ashfield would be used where Option B is selected as the preferred construction option at Haberfield and Ashfield. Refer to **Chapter 6** (Construction work) of the EIS for further information on Option A and Option B.

The C1b site is shown in **Figure 4-7** and is located within the Inner West LGA. The land is currently utilised for commercial purposes (including a car dealership and associated maintenance facilities). The C1b site drains north towards Dobroyd Canal (Iron Cove Creek) and is surrounded by land uses as detailed in **Table 4-9**.

Table 4-9 Surrounding land use – Parramatta Road West civil and tunnel site, Ashfield (C1b)

Direction	Description of surrounding land use and proximity to the site
North	• Great Western Highway/Parramatta Road • Alt Street • Northern portion of the C3b site (currently Muirs Kia (Sales) 201–203 Parramatta Road, Ashfield) • Further north, residential and commercial/industrial land use, followed by Walker Avenue.
South	• Bland Street • Vacant sites (202–204 and 220 Parramatta Road, Ashfield), formerly Brescia Furniture Showroom (destroyed by fire), and 192 Parramatta Road, Ashfield, formerly car sales yard (Sydney GPS Motors), and currently occupied by the M4 East contractor for construction purposes (M4 East Parramatta Road civil site C10) and low to medium density residential along Bland and Chandos Streets.
East	• C3b site – currently Muirs Holden and Muirs Kia Sales • Low density residential housing on Bland and Alt Streets.
West	• Low to high density residential housing on Bland and Alt Streets • Chaya's Family Day Care on Alt Street (about 50 metres west of the C1b site).

It is understood that this site would be demobilised and earthworks would be carried out to restore the surface levels to generally pre-construction levels at the end of construction. The future use of the land would be determined in accordance with the Residual Land Management Plan to be prepared for the project.

Figure 4-7 Parramatta Road West civil and tunnel site at Ashfield (C1b)

4.4.2 Previous investigations

AECOM is aware of the following relevant reports completed for the site and surrounding lands (obtained from the M4 East EIS and requested by AECOM as part of this Technical Contamination Assessment):

- GHD Pty Ltd (GHD) (2015) Appendix P of the Environmental Impact Statement M4 Motorway East Soil and Land Contamination Assessment, September 2015
- Lotsearch (2017) Environmental Risk and Planning Report – Parramatta Road, Ashfield, NSW 2131, 6 June 2017.

4.4.3 Site history

A review of historical aerial photographs for the area was provided in the Lotsearch 2017 report and site history information provided in the GHD (2015) M4 East EIS – Soil and Land Contamination Assessment. Key information relevant to the Parramatta Road West civil and tunnel site is described in **Table 4-10**.

Table 4-10 Site history – Parramatta Road West civil and tunnel site, Ashfield (C1b)

Property	Site history summary
C1b Parramatta Road West civil and tunnel site	• GHD (2015) noted that the site and surrounds comprised predominantly residential land use throughout 1930s to 1960s. In 1970s commercial buildings and car yards were visible on both sides of Parramatta Road between Alt Street and Bland Street. In 1990 commercial development had increased along Parramatta Road and development had further increased between 1990 and 2002 • GHD (2015) and Lotsearch (2017) noted that a search of the NSW EPA register did not identify any contaminated sites, any notified contaminated sites and any licensed activities within a 500 metre radius of the site, with the exception of CPB contractors for WestConnex M4 East road construction works located 180 metres northwest of the site • The site appears to have been used as a car sales yard since the 1970s, confirmed by 1970 UBD Business Directory search provided by Lotsearch (2017) • The Lotsearch (2017) 1970 UBD Business Directory search also indicated that part of the site was owned by Muirs Motors Pty Ltd and part was owned by Palmers Car Sales • The Lotsearch (2017) 1950 UBD Business Directory search indicated the site was used by various commercial/industrial businesses including Purdle's Service Station at 252 Parramatta Road Ashfield. 130 Bland Street, Ashfield was the only site in possession by Muirs Motors in 1950.
C3b Parramatta Road East civil site (east of C1b on the opposite side of Parramatta Road)	• As above • The Lotsearch (2017) 1970 UBD Business Directory search indicated the site was owned by Renno Motors Pty Ltd. A newsagency and television repairs and sales business was also present on the C3b site • A borehole.
1 Former mechanical workshop and car saleyard (Parramatta Road, Ashfield)	• GHD (2015) identified a mechanical workshop and car saleyard located around 20 metres north of the C1b site which was classified by GHD as high potential for contamination. No detailed information on this property was noted in the GHD (2015) report • The Lotsearch (2017) report noted that the 1991 UBD Business Directory search indicated that a Motor brake lining manufacturer and/or distributor was present at this site.

4.4.4 Soils and geology

According to the NSW Department of Industry, Resources and Energy (2017), 1:100,000 Sydney geology map sheet, the site geology consists of the following units:

- Triassic Ashfield Shale of the Wianamatta Group, characterised by black to dark grey shale and laminate
- According to information provided by OEH the soil landscape within the site consists mostly of Blacktown Residual Soils.

GHD (2015) noted that generalised stratigraphy within the vicinity of the C1b (M4 East EIS Section 6: Dobroyd Canal [Iron Cove Creek] to Bland Street [including Wattle Street]) comprised:

- Concrete or hardstand at ground level – thickness 0.1 to 0.13 metres
- Fill comprising gravelly and sandy clays from ground level to 0.13 metres – thickness 0.25 to 0.7 metres
- Residual clay with traces of gravels from 0.25 to 2.5 metres – thickness 1.1 to 1.9 metres
- Weathered shale from 1.5 to 2.5 metres – thickness not determined
- Sandstone from 2.3 metres – thickness not determined.

4.4.5 Hydrogeology

According to data provided by the NSW Department of Primary Industries (Water) (DPI-Water), Water Administration Ministerial Corporation and Commonwealth of Australia (Bureau of Meteorology) in the Lotsearch (2017) report, there are no registered groundwater wells located within the C1b site and six registered groundwater wells were within 500 metres of the C1b site. The purpose of all groundwater wells within 500 metres of the C1b site was for monitoring.

GHD (2015) noted that a groundwater monitoring well BH1369 was installed as part of the GHD 2014 investigation, about 100 metres north of the C1b site on the western side of Parramatta Road. The screened stratum was noted to be weathered shale and the standing water level was noted to be 2.594 metres below top of casing. The depth of the monitoring well was 8.5 metres below ground level.

GHD (2015) also noted that a groundwater monitoring well BH1373 was installed as part of the GHD 2014 investigation about 40 metres south of the C1b and C3b sites on Bland Street. The screened stratum was noted to be weathered shale and the standing water level was noted to be 1.71 metres below top of casing. The depth of the monitoring well was 8.0 metres below ground level.

Deep groundwater is expected to be present as a porous and extensive productive aquifer in the underlying Hawkesbury Sandstone. GHD (2015) noted the hydrogeology is dominated by shale, siltstone and other sedimentary basins with low potential for groundwater movement and salinity levels greater than 14,000 milligrams per litre (Department of Water Resources 1987). Groundwater is expected to be shallow and flow in a northerly direction towards Dobroyd Canal (Iron Cove Creek).

4.4.6 Acid sulfate soils

The site and surrounding areas are predominantly mapped with Class 5 acid sulfate risk potential. This equates to a generally low risk except where works have the potential to lower the water table below one metre AHD (see **Figure 4-8)**.

GHD (2015) noted that no acid sulfate soil testing was undertaken as part of their assessment as minimal construction disturbance was proposed as part of the M4 East works within the vicinity of disturbed terrain/reclaimed land.

4.4.7 Areas and contaminants of concern

The following areas and contaminants of concern were identified in **Table 4-11**.

Table 4-11 Activities and areas of potential concern – Parramatta Road West civil and tunnel site, Ashfield (C1b)

Area	Potential contamination sources	Main PCoC
Previously identified contamination in soil and groundwater		
GHD undertook soil sampling works at one borehole (BH1371) on the C1b site in 2014 and two groundwater monitoring wells (BH1369 and BH1373) within the project footprint	Data provided in GHD (2015) from boreholes sampled by GHD in 2014 indicated: • No visual or olfactory evidence of soil contamination was observed during sampling • Exceedances of benzo(a)pyrene toxicity equivalency quotient (B[a]P TEQ) in BH1371 (located on the northern portion of C1b, adjacent to Alt Street) sample depth 0.5 to 0.6 metres below ground surface was 7.9 milligrams per kilogram and exceeded the ASC NEPM (NEPC, 2013) criterion for recreational land use • BH1373 (installed around 40 metres south of C1b and C3b, screened in weathered shale) detected concentrations of B(a)P TEQ in soil at 0.5 metres and 2.0 metres in exceedance of health investigation level C for proposed recreational open space • Groundwater monitoring well BH1369 (installed around 100 metres north of site 3b) and BH1373 (installed around 40 metres south of site 3b and site 1b), both screened in shale, detected concentrations of metals copper, nickel and zinc in exceedance of groundwater investigation levels • Waste classification assessment and TCLP B(a)P analysis of sample BH1371 0.5-0.6 indicated the material would be classified as general solid waste • Waste classification assessment and TCLP B(a)P analysis of samples BH1373 0.5 and 2.0 indicated the material would be classified as general solid waste.	• PAHs • Metals
Former and current car sales and servicing and former service station		
Within the C1b ancillary facility and project footprint	The C1b site and adjacent C3b site have been used for the purposes of car sales yards and servicing since the 1970s. In addition, historical land use surrounding the site has identified service stations, mechanics and garages. It's possible that former underground petroleum storage system (UPSS) including underground storage tanks (USTs) and pipelines may be present on the site to support these site uses. There is also potential for soil and groundwater contamination from historical leaks from the former UPSS. Three properties within the site contained or likely contained mechanical workshops which may have	• Metals (mainly lead) • Total recoverable hydrocarbons (TRH) • Benzene, toluene, ethylbenzene and xylene (BTEX) • Polycyclic aromatic hydrocarbons (PAHs) • Volatile organic compounds

Area	Potential contamination sources	Main PCoC
	historically stored and handled oils, fuels and solvents. The properties may have formally contained hoists, underground waste oil tanks, oil/water interceptor pits, inspection pits and drains which could leak into the subsurface.	(VOCs)
Hazardous building materials		
Numerous buildings within and surrounding the site were present on historical aerial photographs prior to 1970. In addition, the GHD (2015) report noted that the site and surrounding areas predominantly comprised residential land use up to 1970 when commercial/industrial development along Parramatta Road increased.	Potential that C1b site and adjacent areas within the project footprint currently or formally contained buildings that are or were potentially constructed with ACM, lead paint or contained fittings with PCBs. Demolition or degradation of the buildings (paint flaking, ACM weathering) may have resulted in contamination of surface soils. GHD (2015) also noted that there are numerous buildings within the Haberfield project footprint which are being acquired as part of the M4 East works which have the potential to contain hazardous building materials.	• Lead • Asbestos • PCBs
Imported fill		
Areas of the site and immediate surrounds may have been filled using sources of uncontrolled and potentially contaminated fill.	Areas of the site and surrounding areas may have been filled using sources of uncontrolled and potentially contaminated fill.	• Metals • TRH • BTEX • PAHs • Phenols • OCPs • OPPs • PCBs • VOCs • Asbestos

Figure 4-8 Parramatta road West civil and tunnel site at Ashfield (C1b) - acid sulfate soils

4.5 C2b – Haberfield civil site at Haberfield

The Haberfield civil site (C2b) would be used for civil construction where Option B is selected as the preferred construction option at Haberfield. If Option A is selected as the preferred option at Haberfield, the Haberfield civil and tunnel site (C2a) would be used (see **section 4.2**).

It is noted that the ancillary facility boundary for C2b is smaller than the ancillary facility boundary for C2a. The construction activities within this site would differ under Option A (site would support tunnelling) and Option B (site would not support tunnelling), as discussed in **sections 5** and **8** – the assessment and management of construction impacts. Therefore information relevant to the site description and surrounding area, previous investigations, site history, soils and geology, hydrogeology, acid sulfate soils, areas and contaminants of potential concern remain the same as those discussed in **sections 4.2.1** to **4.2.7**.

The Haberfield civil site (C2b) is shown in **Figure 4-9** and acid sulfate soils in **Figure 4-10**.

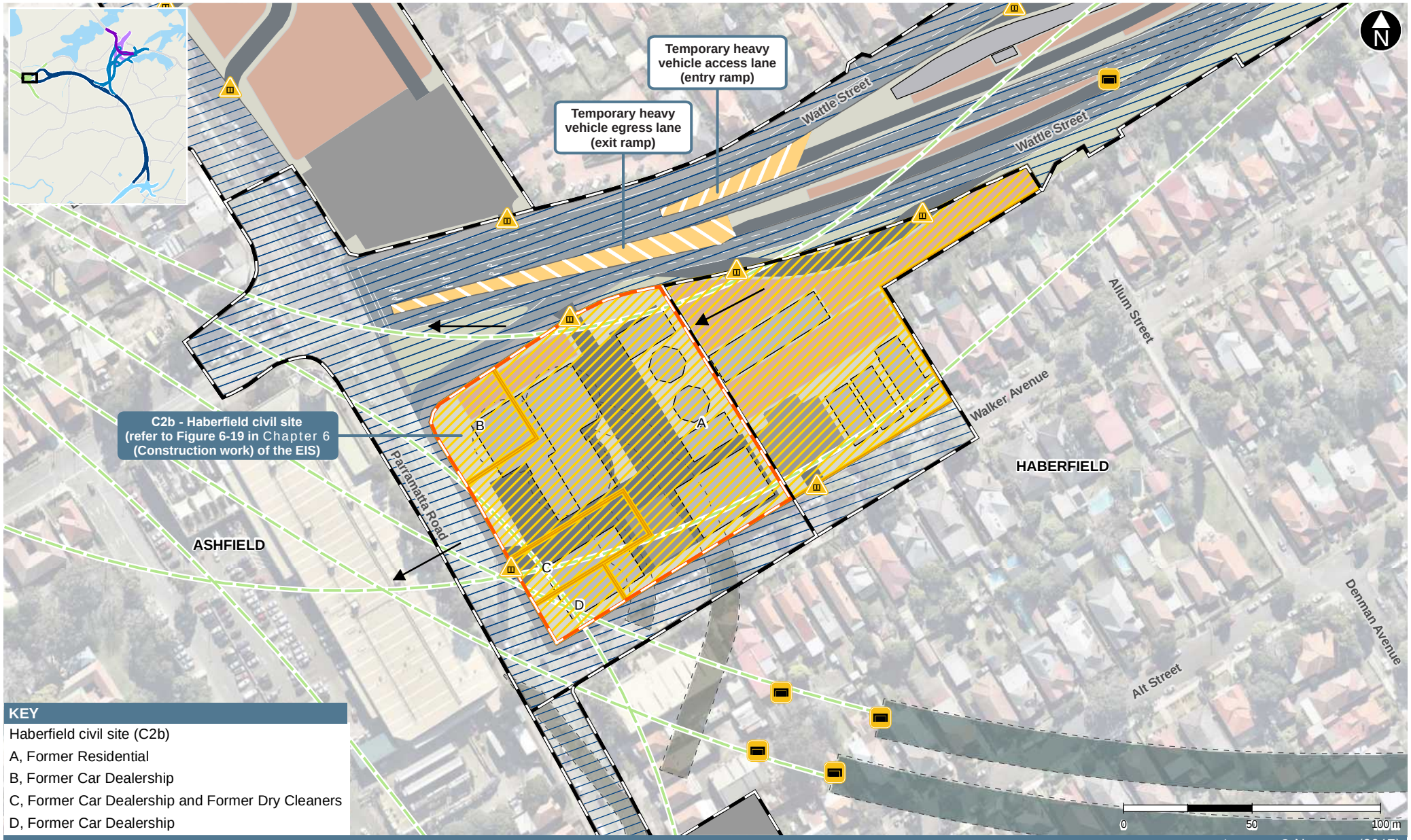


Figure 4-9 Haberfield civil site at Haberfield (C2b)

Figure 4-10 Haberfield civil site at Haberfield (C2b) - acid sulfate soils

4.6 C3b – Parramatta Road East civil site at Haberfield

4.6.1 Site description and surrounding area

The Parramatta Road East civil site (C3b) would be used where Option B is selected as the preferred construction option at Haberfield. Refer to **Chapter 6** (Construction work) of the EIS for further information on Option A and Option B.

The site is shown in **Figure 4-11** and would be located within the Inner West Council LGA in area currently comprising commercial properties (including a car dealership and associated maintenance facilities).

The Parramatta Road East civil site drains north towards Dobroyd Canal (Iron Cove Creek) and is surrounded by land uses as detailed in **Table 4-12**.

The site would be demobilised and earthworks would be carried out to restore the surface levels to generally pre-construction levels at the end of construction. The future use of the land would be determined in accordance with the Residual Land Management Plan to be prepared for the project.

Table 4-12 Surrounding land use – Parramatta Road East civil site, Haberfield (C3b)

Direction	Description of surrounding land use and proximity to the site
North	• Alt Street and Walker Avenue • Former laundry/dry cleaner as identified by GHD (2015) on corner of Walker Avenue and Parramatta Road • Further north, residential and commercial/industrial land use (including car sales yard identified by GHD (2015), followed by Wattle Street.
South	• Great Western Highway/Parramatta Road • Bland Street • Juvenile Justice – Yasmar training facility located between Bland Street and Chandos Street on Parramatta Road • Vacant sites (202–204 and 220 Parramatta Road, Ashfield) formerly Brescia Furniture Showroom (destroyed by fire) and 192 Parramatta Road, Ashfield, formerly car sales yard (Sydney GPS Motors) currently occupied by the M4 East contractor for construction purposes (M4 East Parramatta Road civil site C10) and low to medium density residential along Bland and Chandos Streets.
East	• Low density residential housing on Bland and Alt Streets • Haberfield Public school on the corner of Bland Street and Denman Avenue.
West	• Great Western Highway/Parramatta Road • C1b site currently Muirs Holden Automotive servicing and sales and Roads and Maritime land with various commercial leases on corner of Bland Street and Parramatta Road • Low to high density residential housing on Bland and Alt Streets • Chaya's Family Day Care on Alt Street (about 50 metres west of the C1b site).

4.6.2 Previous investigations

AECOM is aware of the following relevant reports completed for the site and surrounding lands (obtained from the M4 East EIS and requested by AECOM as part of this Technical Contamination Assessment):

- GHD Pty Ltd (GHD) (2015) Appendix P of the Environmental Impact Statement M4 Motorway East Soil and Land Contamination Assessment, September 2015
- Lotsearch (2017) Environmental Risk and Planning Report – Parramatta Road, Ashfield, NSW 2131, 6 June 2017.

Figure 4-11 Parramatta Road East civil site at Haberfield (C3b)

4.6.3 Site history

A review of historical aerial photographs for the area was provided in the Lotsearch 2017 report and site history information provided in the GHD (2015) M4 East EIS – Soil and Land Contamination Assessment. Key information relevant to the Parramatta Road West civil and tunnel site is described in **Table 4-13**.

Table 4-13 Site history – Parramatta Road East civil site, Haberfield (C3b)

Property	Site history summary
C3b Parramatta Road East civil site	• The Lotsearch (2017) 1970 UBD Business Directory search indicated the site was owned by Renno Motors Pty Ltd. A newsagency and television repairs and sales business was also present on the C3b site • A borehole BH1370 was drilled by GHD in 2014 on Alt Street adjacent the northern portion of the C3b site • A borehole BH1372 was drilled by GHD in 2014 on the western boundary of the southern portion of the C3b site adjacent Parramatta Road • No asbestos was detected at these locations and no exceedances of the ASC NEPM (NEPC 2013) health investigation levels for proposed recreational open space and commercial/industrial land uses and the management limits for residential/parkland were reported by GHD (2015) at these two boreholes • GHD (2015) classified the C3b site as moderate potential for contamination.
C1b Parramatta Road West civil and tunnel site (west of C3b on the opposite side of Parramatta Road)	• GHD (2015) noted that the site and surrounds comprised predominantly residential land use throughout 1930s to 1960s. In the 1970s, commercial buildings and car yards were visible on both sides of Parramatta Road between Alt Street and Bland Street. By 1990, commercial development had increased along Parramatta Road and development had further increased between 1990 and 2002 • GHD (2015) and Lotsearch (2017) noted that a search of the NSW EPA register did not identify any contaminated sites, any notified contaminated sites or any licensed activities within a 500 metre radius of the site, with the exception of CPB contractors for WestConnex M4 East construction works located 180 metres northwest of the site • The site appears to have been used as a car sales yard since the 1970s, confirmed by 1970 UBD Business Directory search provided by Lotsearch (2017) • The Lotsearch (2017) 1970 UBD Business Directory search also indicated that part of the site was owned by Muirs Motors Pty Ltd and part was owned by Palmers Car Sales • The Lotsearch (2017) 1950 UBD Business Directory search indicated the site was used by various commercial/industrial businesses including Purdle's Service Station at 252 Parramatta Road, Ashfield. 130 Bland Street, Ashfield was the only site in possession by Muirs Motors in 1950.
1 Former mechanical workshop and car saleyard (Parramatta Road, Ashfield)	• GHD (2015) identified a mechanical workshop and car saleyard located around 20 metres north of the C1b site which was classified by GHD as high potential for contamination. No detailed information on this property was noted in the GHD (2015) report • The Lotsearch (2017) report noted that the 1991 UBD Business Directory search indicated that a motor brake lining manufacturer and/or distributor was present at this site.

4.6.4 Soils and geology

According to the NSW Department of Industry, Resources and Energy (2017), 1:100,000 Sydney geology map sheet, the site geology consists of the following units:

- Triassic Ashfield Shale of the Wianamatta Group, characterised by black to dark grey shale and laminate
- According to information provided by OEH the soil landscape within the site consists mostly of Blacktown Residual Soils.

GHD (2015) noted that generalised stratigraphy within the vicinity of the C3b (M4 East EIS Section 6: Dobroyd Canal [Iron Cove Creek] to Bland Street [including Wattle Street]) comprised:

- Concrete or hardstand at ground level – thickness 0.1 to 0.13 metres
- Fill comprising gravelly and sandy clays from ground level to 0.13 metres – thickness 0.25 to 0.7 metres
- Residual clay with traces of gravels from 0.25 to 2.5 metres – thickness 1.1 to 1.9 metres
- Weathered shale from 1.5 to 2.5 metres – thickness not determined
- Sandstone from 2.3 metres – thickness not determined.

4.6.5 Hydrogeology

According to data provided by the (DPI-Water), Water Administration Ministerial Corporation and Commonwealth of Australia (Bureau of Meteorology) in the Lotsearch (2017) report, there are no registered groundwater wells located within the C1b site and six registered groundwater wells were within 500 metres of the C1b site. The purpose of all groundwater wells within 500 metres of the C1b site was for monitoring.

GHD (2015) noted that a groundwater monitoring well BH1369 was installed as part of the GHD 2014 investigation about 100 metres north of the C1b site on the western side of Parramatta Road. The screened stratum was noted to be weathered shale and the standing water level was noted to be 2.594 metres below top of casing. The depth of the monitoring well was 8.5 metres below ground level.

GHD (2015) also noted that a groundwater monitoring well BH1373 was installed as part of the GHD 2014 investigation about 40 metres south of the C1b and C3b sites on Bland Street. The screened stratum was noted to be weathered shale and the standing water level was noted to be 1.71 metres below top of casing. The depth of the monitoring well was 8.0 metres below ground level.

Deep groundwater is expected to be present as a porous and extensive productive aquifer in the underlying Hawkesbury Sandstone. GHD (2015) noted the hydrogeology is dominated by shale, siltstone and other sedimentary basins with low potential for groundwater movement and salinity levels greater than 14,000 milligrams per litre (NSW Department of Water Resources, 1987).

Groundwater is expected to be shallow and flow in a northerly direction towards Dobroyd Canal (Iron Cove Creek).

4.6.6 Acid sulfate soils

The site and surrounding areas are predominantly mapped with soil class 5 acid sulfate risk potential, see **Figure 4-12**. Soil class 5 indicates there is no known occurrence of acid sulfate soils. Works within 500 metres of adjacent Class 1, 2, 3 or 4 land that is below five metres AHD and by which the water table is likely to be lowered below one metre AHD on adjacent Class 1, 2, 3 or 4 land requires development consent and management procedures for acid sulfate soils. These conditions have not been mapped in the vicinity of the site.

GHD (2015) noted that no acid sulfate soil testing was undertaken as part of their assessment, as minimal construction disturbance was proposed as part of the M4 East works within the vicinity of disturbed terrain/reclaimed land.

4.6.7 Areas and contaminants of concern

The areas and contaminants of concern identified are outlined in **Table 4-14**.

Table 4-14 Activities and areas of potential concern – Parramatta Road East civil site, Haberfield (C3b)

Area	Potential contamination sources	Main PCoC
Previously identified contamination in soil and groundwater		
GHD undertook soil sampling works at two boreholes (BH1370 and BH1372) on the C3b site in 2014 and one groundwater monitoring well was installed within the project footprint	Data provided in GHD (2015) from boreholes sampled by GHD in 2014 indicated: • No visual or olfactory evidence of soil contamination was observed during sampling • From the soil samples collected and analysed at both boreholes (BH1370 and BH1372) no asbestos detected; no exceedances of the ASC NEPM (NEPC 2013) health investigation levels for proposed recreational open space and commercial/industrial land use; and no exceedances of the management limits for residential/parkland • Groundwater monitoring well BH1369 installed around 100 metres north of site C3b and BH1373 installed around 40 metres south of site C3b and site C1b, both screened in shale, detected concentrations of metals copper, nickel and zinc in exceedance of groundwater investigation levels • Waste classification assessment of soil samples collected and analysed at both boreholes (BH1370 and BH1372) indicated the material would be classified as general solid waste.	• Metals
Former and current car sales and servicing and former service station		
Within the C3b ancillary facility and project footprint	The C3b site and adjacent C1b site have been used for the purposes of car sales yards and servicing since the 1970s. In addition, historical land use surrounding the site has identified service stations, mechanics and garages. It's possible that former UPSS including USTs and pipelines may be present on the site to support these uses. There is also potential for soil and groundwater contamination from historical leaks from the former UPSS. Three properties within the site contained or likely contained mechanical workshops which may have historically stored and handled oils, fuels and solvents. The properties may have formally contained hoists, underground waste oil tanks, oil/water interceptor pits, inspection pits and drains which could leak into the subsurface.	• Metals (mainly lead) • Total recoverable hydrocarbons (TRH) • Benzene, toluene, ethylbenzene and xylene (BTEX) • Polycyclic aromatic hydrocarbons (PAHs) • Volatile organic compounds (VOCs)

Area	Potential contamination sources	Main PCoC
Hazardous building materials		
Numerous buildings within and surrounding the site were present on historical aerial photographs prior to 1970. In addition, the GHD (2015) report noted that the site and surrounding areas predominantly comprised residential land use up to 1970 when commercial/industrial development along Parramatta Road increased.	Potential that C3b site and adjacent areas within the Haberfield project footprint currently or formally contained buildings that are or were potentially constructed with ACM, lead paint or contained fittings with PCBs. Demolition or degradation of the buildings (paint flaking, ACM weathering) may have resulted in contamination of surface soils. GHD (2015) also noted that there are numerous buildings within the Haberfield project footprint which are being acquired as part of the M4 East works which have the potential to contain hazardous building materials.	• Lead • Asbestos • PCBs
Imported fill		
Areas of the site and immediate surrounds may have been filled using sources of uncontrolled and potentially contaminated fill.	Areas of the site and surrounding areas may have been filled using sources of uncontrolled and potentially contaminated fill.	• Metals • TRH • BTEX • PAHs • Phenols • OCPs • OPPs • PCBs • VOCs • Asbestos

Figure 4-12 Parramatta Road East civil site at Haberfield (C3b) - acid sulfate soils

4.7 C4 – Darley Road civil and tunnel site at Leichhardt

4.7.1 Site description and surrounding land use

The Darley Road civil and tunnel site (C4) is shown in **Figure 4-13** on land owned by Transport for NSW which is currently being leased and consists of a two storey brick building with a fibre cement roof which has been renovated and is now used as a commercial retail outlet. The land is enclosed by a security fence and the western portion of the land is paved with bitumen for use as a car park. The eastern portion of the Transport for NSW land consists of a paved area and landscaped area. The land is bound to the north by the North Leichhardt light rail stop and associated light rail line, to the south by Darley Road and Canal Road to the west.

The Darley Road tunnel site slopes to the west and is surrounded by the land uses listed in **Table 4-15**.

Table 4-15 Surrounding land use – Darley Road civil and tunnel site at Leichhardt (C4)

Direction	Description of surrounding land use and proximity to the site
North	• Sydney Light Rail line and Leichhardt North light rail stop • City West Link followed by low to medium density residential properties.
South	• Darley Road followed by low to medium density residential properties • An industrial building which operates as an antiques business fronting Darley Road • Monzo petrol station 100 metres southeast fronting Norton Street.
East	• Norton Street followed by low to medium density residential properties and some commercial/industrial properties along Norton Street.
West	• Charles Street and light rail followed by Blackmore Park • Hawthorne Canal 300 metres west of C4 adjacent to Blackmore Park and Canal Road.

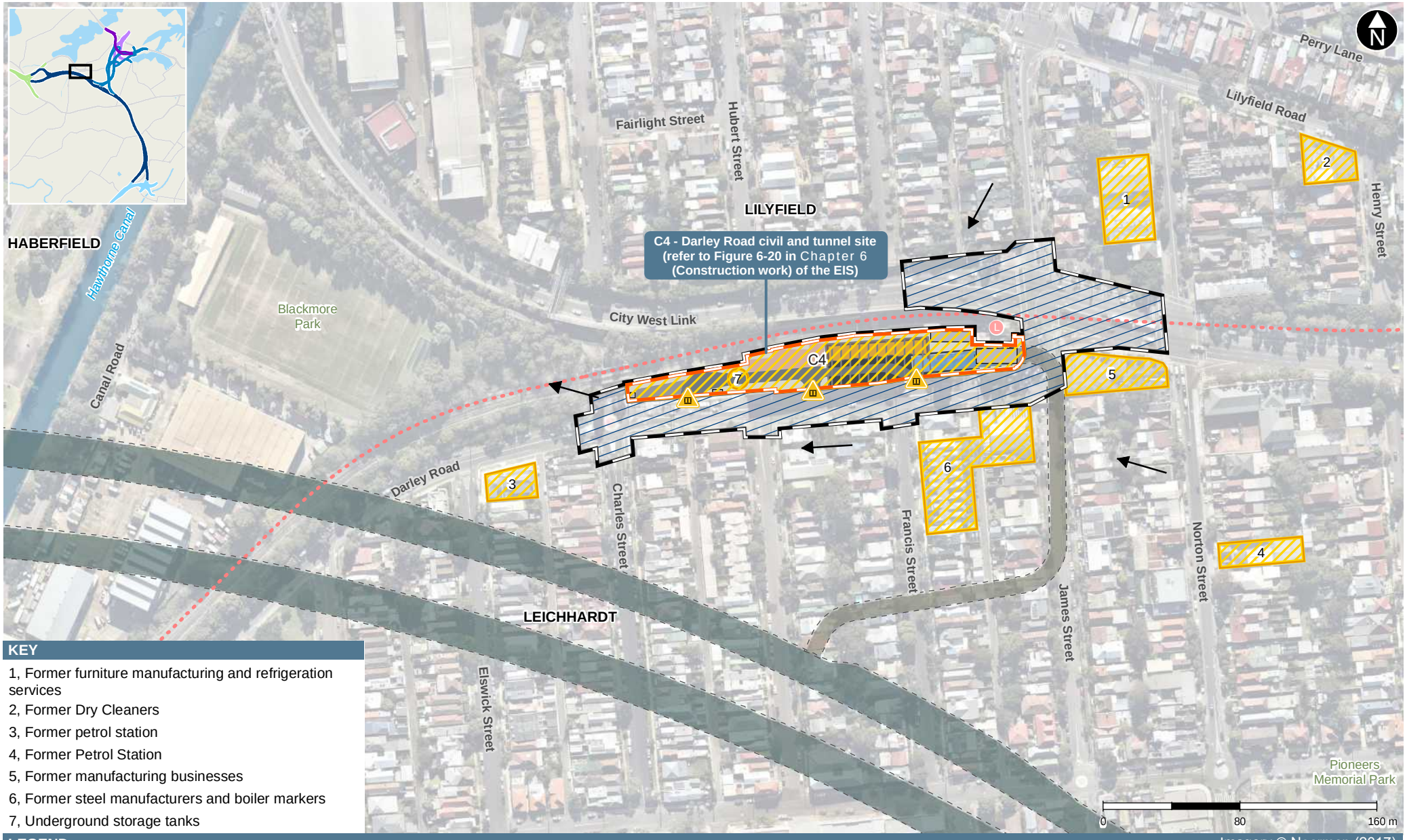


Figure 4-13 Darley Road civil and tunnel site at Leichhardt (C4)

4.7.2 Previous intrusive investigations

AECOM is aware of the previous soil and groundwater investigations undertaken within the Darley Road civil and tunnel site at Leichhardt (C4):

- Environmental Investigation Services, 2002. *Environmental Site Screening for Proposed Supermarket Development, 7 Darley Road, Leichhardt, NSW*
- HLA-Envirosciences Pty Ltd (HLA), 2007. *Additional Environmental Site Assessment, 7 Darley Road, Leichhardt, NSW.* December, 2007.

One borehole (HB_BH15) was completed to the east of the Darley Road civil and tunnel site (C4) site as part of the combined geotechnical and contamination investigations (AECOM 2016c).

4.7.3 Site history

The site history is detailed in the AECOM 2016a report and summarised in **Table 4-16**.

Table 4-16 Site history – Darley Road civil and tunnel site at Leichhardt (C4)

Property	Site history summary
C4 Transport for NSW land	• Based on historical aerial photographs, the land was mostly cleared and vacant with one small building near the centre-north part of the land prior to 1950 • C.A.M Pre Mixed Concrete Engineering Pty Ltd was located on the land in 1950 according to the UBD records. A loader, silo and several vehicles were visible on the land in the 1951 historical aerial photograph • The present day building was constructed prior to 1970 and was extended on the eastern side in 1986 along with an increase in sealed areas on the land • Land title information indicated that the land was formerly owned for the most part by the Commissioner for Railways and was also formerly used as a bakery, for rolled steel guttering production, for furniture and homewares retail, for the storage of cars and for the preparation and packaging of cakes • The presence of a possible underground storage tank (UST) was identified in the western car park. Dangerous Goods records from WorkCover NSW reviewed in the HLA (2007) report indicated that in 1974 there was an application to install a 2000 gallon UST to store mineral spirits. A letter to WorkCover from Fitform Holdings Pty Ltd dated 15 November 1996 stated that the tanks were filled with sand in November 1995 • The land was formally notified to the NSW EPA under section 60 of the CLM Act by RailCorp. The NSW EPA decided that regulation of the land was not required.

Property	Site history summary
Surrounding land	• Surrounding businesses within 150 metres and up-gradient of the Darley Road tunnel site in 1950 according to UBD records included: C.S Chadwick Pty Ltd (timber mill); K.L McNally (carriers and cartage); Roy Furniture Manufacturers Pty Ltd; Darkes Refrigeration Service; L Goldie & Sons (manufacturing) and Master Tile Co Pty Ltd Simpson; J.M & Co Pty Ltd (steel fabricators and manufacturers) located 40 metres south of the site and Barber Bros (motor garage and petrol station) • Surrounding businesses within 150 metres and up-gradient of the Darley Road tunnel site in 1970 according to UBD records included: Consolidated Gasket Company (gasket manufacturing); Kelso Manufacturing Co Pty Ltd; Mascox Pty Ltd (steel manufacturing and boiler makers); Simpson, J.M & Co Pty Ltd (steel fabricators and manufacturers); Lee Bagwell TV & Electrics (service and supplies); Martins Service Station; L Goldie & Sons (manufacturing); Master Tile Co Pty Ltd; Roy Furniture Manufacturers Pty Ltd ; United Display Pty Ltd (manufacturing); and C.S Chadwick Pty Ltd (timber mill) • Surrounding businesses in 1991 according to the UBD records included: Wawns Laboratories Pty Ltd; Wonder Pool Pty Ltd (Pharmaceuticals); Abbott Leichhardt Auto Electrical Service; Monza Smash Repairs • A search of the NSW EPA contaminated sites register identified that the Sydney Buses Leichhardt Depot located around 500 metres east and up-gradient of the Darley Road civil and tunnel site at Leichhardt has former notices under the CLM Act. Contaminants of concern at the Sydney Buses Leichhardt Depot were TPH, PAHs, phenols and metals in groundwater that had migrated off the depot to the west towards Hawthorne Canal. The notice was repealed in 2009 when the NSW EPA considered the site had been remediated to a level that no longer posed a significant risk of harm for the land use and state of the land at the time of determination.

4.7.4 Soil and geology

The Environmental Investigation Services 2002 site investigation scope included the drilling and sampling of 12 boreholes (BH1 to BH9 and BH101 to BH103) within the C4 site. The Environmental Investigation Services investigation identified fill to depths generally between 0.25 and 1.5 metres across the site. The fill was generally less than 0.5 metres deep and up to 1.5 metres deep at the western end of the site. The fill consisted of clay, sand and gravel with minor inclusions of brick and slag. Encountered fill material was underlain by medium plasticity sandy clay and weathered sandstone. The HLA (2007) report included the drilling of six boreholes (BH01 to BH06) to a maximum depth of 5.5 metres below ground level across the site and described the same conditions as Environmental Investigation Services 2002 report.

4.7.5 Hydrogeology

According to data provided by the (DPI-Water), Water Administration Ministerial Corporation and Commonwealth of Australia (Bureau of Meteorology) in December 2015, there were three registered groundwater wells within the Darley Road tunnel site and 21 registered groundwater wells within one kilometre. All wells were registered as groundwater monitoring wells. No hydrogeological information was recorded for these monitoring wells.

The HLA 2007 report included the installation of one groundwater monitoring well (MW01). The groundwater level was measured at 1.94 metres below top of the well casing (metres bTOC).

To the west of the C4 ancillary facility, a nested monitoring well was constructed within the alluvium of the Hawthorne Canal palaeochannel (HB_BH08s) and the underlying bedrock (HB_BH08d). The standing water level in the alluvium is shallow ranging from 0.3 to 0.6m during 2016 and 2017. Since the wells were constructed in May 2016 the groundwater in the sandstone has consistently been

artesian with a hydraulic head of about 1 to 2 metres. Groundwater flow in the alluvium and sandstone is towards Hawthorne Canal and Rozelle Bay.

4.7.6 Acid sulfate soils

According to information provided by DP&E (Acid Sulfate Data Source Accessed 03/06/2015: NSW Crown Copyright – Planning and Environment Creative Commons 3.0 © Commonwealth of Australia), the following acid sulfate soil classes were mapped within the site (see **Figure 4-14**):

- Soil Class 2: Works below the natural ground surface or works by which the water table is likely to be lowered requires development consent and management procedures for acid sulfate soils. The constructed wetland was within land mapped as Soil Class 2
- Soil Class 5: No known occurrence of acid sulfate soils. Works within 500 metres of adjacent Class 1, 2, 3 or 4 land that is below five metres AHD and by which the water table is likely to be lowered below one metre AHD requires development consent and management procedures for acid sulfate soils. The C4 compound was within land mapped as Soil Class 5.

4.7.7 Intrusive investigation results

The Environmental Investigation Services 2002 and HLA 2007 reports included the analysis of soil samples for metals, organochlorine pesticides, PCBs, polycyclic aromatic hydrocarbons, total petroleum hydrocarbons (TPH C6-C36) and BTEX within the C4 site. The results were all less than the current ASC NEPM Health Investigation Level (HIL) and Health Screening Levels (HSLs) for commercial/industrial land use. The results are summarised in **Table 4-17**.

Table 4-17 Summary of Environmental Investigation Services 2002 and HLA 2007 soil analytical results – Darley Road civil and tunnel site at Leichhardt (C4)

Contaminant	Soil concentration range (mg/kg)			
	EIS 2002 report		HLA 2007 report	
	Minimum	Maximum	Minimum	Maximum
Arsenic	4.7	48	<1	60
Cadmium	<0.5	2.8	<0.1	0.9
Chromium (total)	6.7	52	5	83
Copper	11	150	<2	93
Lead	42	1200	4	614
Mercury	0.05	0.56	<0.05	1.79
Nickel	5.1	64	<1	79
Zinc	57	1600	<5	509
Benzo(a)pyrene	<0.05	3.6	<0.5	2.3
Carcinogenic PAHs (CPAHs)	–	–	<Laboratory Limit of Report (LOR)	3.6
Total PAHs	<LOR	46	<LOR	33.6
TPH C_{10}-C_{36}	<LOR	670	<LOR	170

One groundwater sample was collected from MW01 within the site. Groundwater concentrations were less than the Australian and New Zealand Environment Conservation Council (ANZECC 2000) trigger values for 95 per cent marine ecosystems protection with the exception of the concentration of zinc (0.024 milligrams per litre), which exceeded the trigger value of 0.008 milligrams per litre (HLA 2007).

4.7.8 Areas and contaminants of concern

The key areas and contaminants of concern within the site are described in **Table 4-18**.

Table 4-18 Areas and contaminants of concern – Darley Road civil and tunnel site at Leichhardt (C4)

Area	Description	CoPC
C4 Transport for NSW land	A decommissioned UST is located to the west of the Transport for NSW site building. There could be localised petroleum contamination around the UST. Fill from an unknown source is present across the Transport for NSW land with slightly elevated concentrations of metals, PAHs and TPH previously identified. There is also potential for asbestos to be present in the fill from potential uncontrolled filling and demolition of former buildings. The property contains Class 2 mapped land (see **section 4.7.6**). As such works below the natural ground surface or works by which the water table is likely to be lowered requires management procedures for acid sulfate soils.	Metals, PAHs, TRH, asbestos
Off-site Sources	The closest known up-gradient source of potential contamination is the Sydney Buses Leichhardt Depot which was formerly regulated by the NSW EPA due to TPH, PAHs, phenols and metals in groundwater that had migrated off the depot to the west towards Hawthorne Canal. Up-gradient manufacturing sites were also located within 150 metres of the Darley Road civil and tunnel site.	TPH, PAHs, VOCs, SVOCs and metals

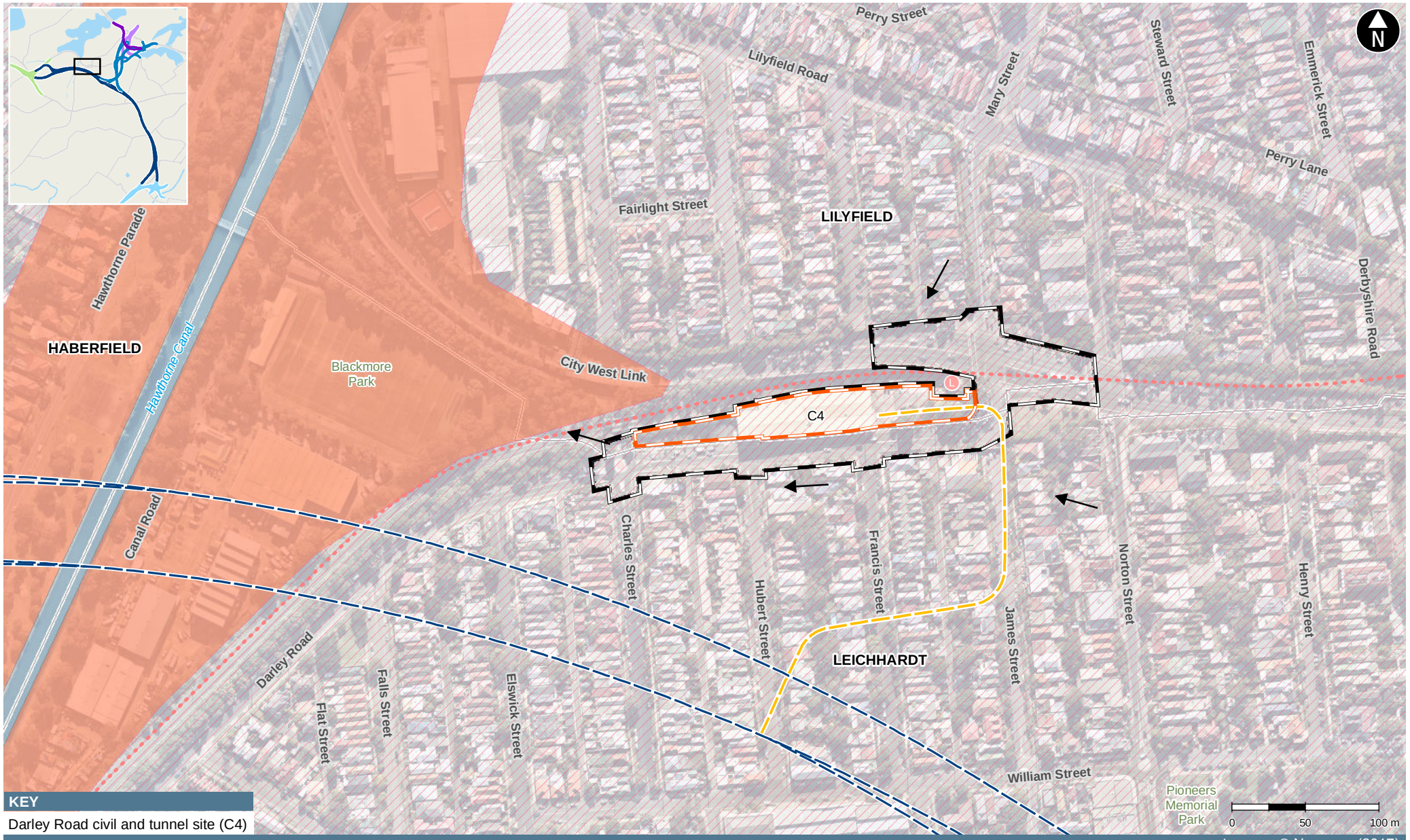


Figure 4-14 Darley Road civil and tunnel site at Leichhardt (C4) - acid sulfate soils

4.8 C5 – Rozelle civil and tunnel site at Rozelle

4.8.1 Site description and surrounding area

The Rozelle civil and tunnel site at Rozelle (C5) would be located in Lilyfield, within the Inner West Council LGA, primarily within the Rozelle Rail Yards and adjacent commercial and industrial lands to the north. The site is shown in **Figure 4-15**.

Existing railway tracks, rail related infrastructure (including rail ballast), surface wastes/stockpiles and vegetation are being removed from the Rozelle Rail Yards as part of site management works which were assessed separately in the *Rozelle Rail Yards site management works Review of Environmental Factors* (REF) (Roads and Maritime 2016). The site management works are not being assessed as part of the EIS and will be completed prior to construction of the M4-M5 Link project commencing. These works will be undertaken as a separate activity to the M4-M5 link project and will be undertaken in accordance with activity-specific environmental management measures required as part of that approval.

It is noted that the boundary of the site management works is smaller than the Rozelle civil and tunnel site boundary. The demolition of buildings north of the site management works boundary, south of Lilyfield Road within the Rozelle civil and tunnel site would be undertaken as part of the M4-M5 Link project. These activities and their associated construction impacts (refer **Table 5-1**) and management measures are discussed in **section 8**.

The Rozelle civil and tunnel site drains to Rozelle Bay and is surrounded by land uses as detailed in **Table 4-19**.

Table 4-19 Surrounding land use – C5 Rozelle civil and tunnel site at Rozelle

Direction	Description of surrounding land use and proximity to the site
North	• Low to medium density residential properties • Lilyfield Road • Easton Park.
South	• City West Link • Whites Creek followed by Brenan Street and then low to medium density residential properties • James Craig Drive and then wharves and Maritime NSW and Australian Superyacht Services Sydney • Rozelle Bay.
East	• Victoria Road bridge followed by the former White Bay Power Station.
West	• Construction site for the Sydney Light Rail maintenance depot • Low to high density residential properties (topographically up-gradient to the southwest and northwest)

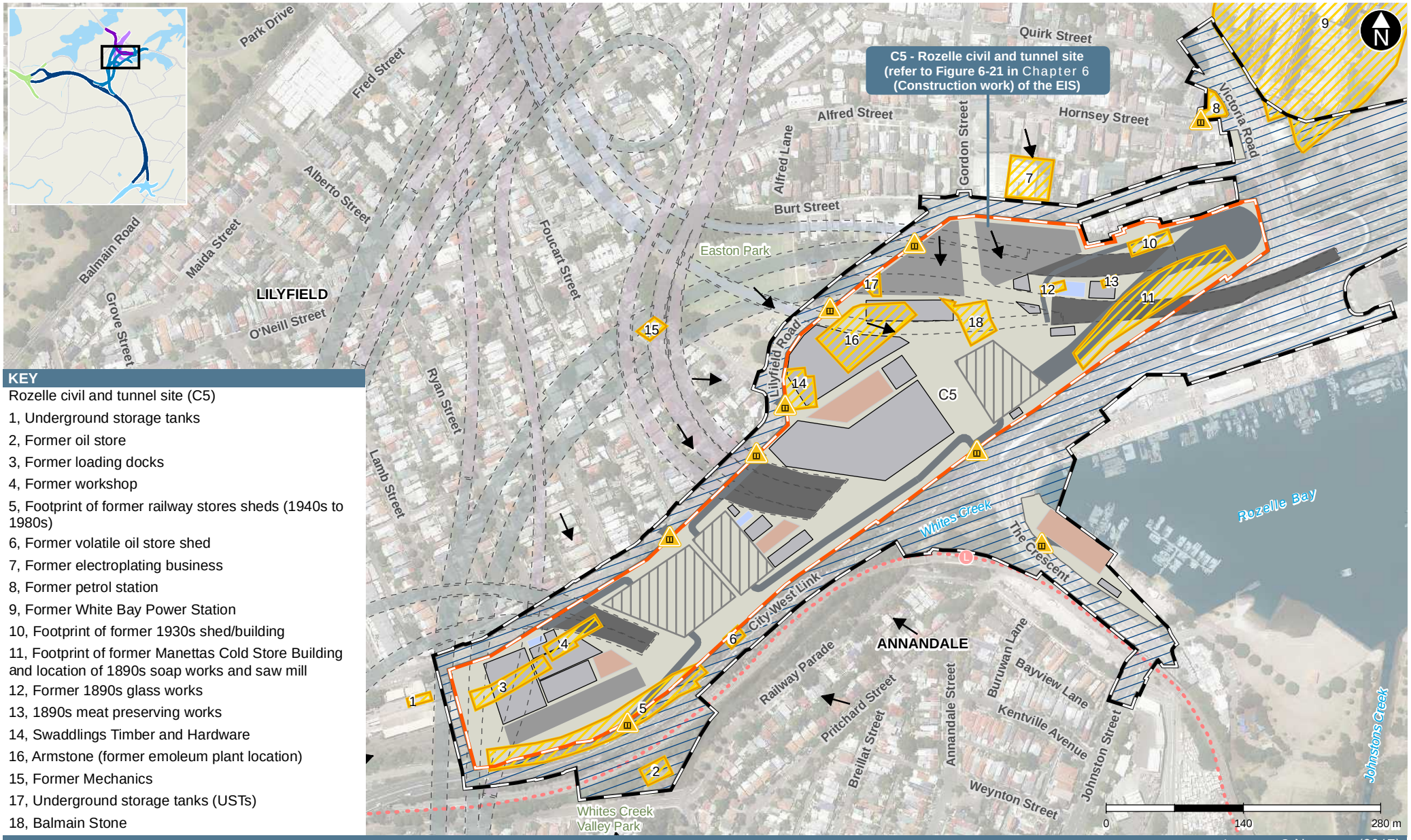


Figure 4-15 Rozelle civil and tunnel site at Rozelle (C5)

4.8.2 Previous intrusive investigations

The investigations detailed in **Table 4-20** have been undertaken within and surrounding the Rozelle civil and tunnel site (C5).

Table 4-20 Previous intrusive investigations – Rozelle civil and tunnel site at Rozelle (C5)

Report	Area	Overview
SKM, 1994	Leased properties	Soil sampling at 10 locations to a maximum depth of one metre and analysis for metals, PAHs, TPH and BTEX. Slightly elevated concentrations of PAHs and metals were detected in the shallow soils.
PB, 2003	Rozelle Rail Yards and leased properties	A total of 67 boreholes and three groundwater monitoring wells (MW1 to MW3) were sampled within the Rozelle Rail Yards, including the Rozelle civil and tunnel site area and the leased properties at 88–94 Lilyfield Road. Samples were analysed for metals (arsenic, copper, lead, mercury and zinc), TRP, BTEX, PAHs, OCPs, PCBs, asbestos, field acid sulfate test, suspension peroxide oxidation combined acidity and sulfur (SPOCAS) and toxicity characteristic leaching procedure (TCLP) for lead and PAHs. The investigation within the Rozelle Rail Yards reported elevated concentrations of lead, arsenic, TRH, benzene and CPAH concentrations. The concentrations were compared to the present day human health based NEPM (2013) guidelines for commercial land use in the AECOM 2016a report. With the exception of the concentration of benzene in one location, the concentrations did not exceed the present day human health based NEPM (2013) guidelines for commercial/industrial use. No light non-aqueous phase liquid (LNAPL) was detected in any of the wells gauged however oil sheen was noted in groundwater purged from MW2. The concentration of arsenic in MW2 and zinc in all wells exceeded the 95 per cent trigger value for marine water.
PB, 2011	Rozelle Rail Yards	The assessment was of a narrow single rail corridor (RailCorp site) within Rozelle Rail Yards. The objectives included determining whether ACM were present on the ground surface and within surface soils, assess and describe the nature, distribution and condition of ACM on the RailCorp site, assess the risk in context of the RailCorp site, document remediation requirements and prepare a remediation costing. The assessment identified asbestos containing train brakes, as well as ACM sheet fragments and conduit pipes within the area assessed.
AECOM, 2016c	Rozelle Rail Yards	A total of 51 boreholes (designated RZ_BH01 to RZ_BH53, excluding RZ_BH33 and BH34) were drilled and sampled within the Rozelle Rail Yards, as part of the combined geotechnical and contamination investigations for the project (see **Figure 4-15**). Twelve groundwater monitoring wells were installed across the Rozelle Rail Yards. The full results were reported in the AECOM 2016c report. The results are summarised in **sections 4.8.7** and **4.8.8**.

Report	Area	Overview
Roads and Maritime, 2017	Rozelle Rail Yards	As part of the site management works REF, contamination investigations and waste classification activities were carried out to inform the proposed site management work activities within Rozelle Rail Yards. The investigation included *in situ* assessment of soil and fill material, railway ballast, drums material and stockpiles which were present on the site at the time of sampling. The results are summarised in **section 4.8.9**.

4.8.3 Site history

The site history is detailed in AECOM (2016b) report and the GML (2017) Non-Aboriginal Heritage Impact Assessment. The relevant site history has been summarised in **Table 4-21**.

Table 4-21 Site History Summary – Rozelle civil and tunnel site at Rozelle (C5)

Area	Site history summary
C5 Rozelle Rail Yards	• Prior to 1900 the eastern third of the site was part of Rozelle Bay, which was reclaimed to build the Rozelle Rail Yards • From 1914 to 1930s the land was acquired by The Commissioner for Railways which became the Public Transport Commission of New South Wales (1970s) and then State Rail Authority of New South Wales (1980s) • The railyards were transferred to Sydney Harbour Foreshore Authority (SHFA) in 2000 (which was absorbed into Government Property NSW in 2015) • Other private businesses that operated in the Rozelle Rail Yards based on the UBD historical records and previous reports included: – Jefferies, Donald C (NSW) Pty Ltd (panel beaters supplies, 1970s) – Kircher, H.A (panel beaters, motor painter& electronics, 1970s) – Atlantic Union Oil Company (petroleum, 1932) – Thomas Nationwide Transport Ltd (logistics and transport, 1930s to 1961) – Metals Investigations Pty Ltd (1950s to 1960s) – Rudders Ltd (logistics, 1961) – Alltrans Pty Ltd (logistics, 1970) – Mayne Nickless Ltd (logistics, 1970s) – TNT Ltd (logistics, 1980 to 1984) – Rozelle Terminal Handling Pty Ltd (1984 to 2000s) – Red Funnel Trawlers (boat industry, 1986 to 1992) – Manettas & Co (seafood distributers, 1990s to 2000s) • Historical aerial photographs from 1930 to 2014 showed: – The site consisted mainly of train tracks (train marshalling yard) in 1930 to 1943 – Railway store sheds covering areas of 500 square metres and two hectares located along the southwest boundary were constructed between 1943 and 1951 – A 300 metre long loading dock had been constructed between 1951 and 1965 in the northern portion of the site – An additional building (mechanical workshop) was added to the train loading docks between 1965 and 1970 – The two hectare sized sheds were demolished between 1982 and 1991 – Train carriages were still visible on some of the rail tracks in 2007 – In 2014 vegetation was growing across the site • The rail yards completely ceased operation in 2007

Area	Site history summary
	• No information was found in a search of NSW EPA public records.
City West Link	• Historical aerial photographs showed City West Link was formerly part of the Rozelle Rail Yards until between 1982 and 1991. The construction of City West Link was visible in the 1991 photograph.
Surrounding land	• The Rozelle Rail Yards formerly extended to the south of City West Link to Whites Creek • According to online sources, noxious and offensive industry flourished to the south along the banks of Whites Creek in late 1800s. Bone boilers Peter Tancred, Thomas Elliott, Isaac Tester and Francis Hemming traded along the banks of the creek (http://dictionaryofsydney.org/entry/lilyfield) • Based on the aerials, other factories existed along the creek to the south from before 1930 until the mid to late 1980s. According to the 1950 UBD records, the businesses included Brenbar Manufacturing Co (sports goods manufacturing), Furniture Industries Pty Ltd (furniture manufacturing) and National Engineers Pty. Ltd (electrical engineers), Commonwealth Telegraph Supplies Ltd (nut and bolt manufacturing). In the 1970 UBD the businesses included P.G.H.Furniture Pty Ltd (furniture-tubular steel manufacturers), Audley Bros. Pty Ltd (wood moulding manufacturing) and Crampton's Garage (motor repairs and engineers).

4.8.4 Soil and geology

According to the NSW Department of Industry, Resources and Energy (2014), 1:100,000 geological units and structures, the Rozelle civil and tunnel site geology consists of the following units:

- 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. This layer extends across all low-lying areas
- Triassic sandstone consisting of medium to coarse grained quartz sandstone, very minor shale and laminate lenses
- A dyke runs in a northwest to southeast orientation beneath Victoria Road.

According to information provided by OEH, the soil landscapes consist of disturbed terrain and Gymea erosional soils. The disturbed terrain is present in low lying areas and the Gymea erosional soils are located above the Triassic sandstone.

In the AECOM 2016c investigation, anthropogenic fill was encountered in all boreholes to a maximum depth of 5.5 metres below ground level in the Rozelle civil and tunnel site. The greatest depth of fill was encountered along the southern half of the site. The fill primarily consisted of variable layers of sandy gravels, gravelly sands, silty sand, and sandstone cobbles and boulders. The fill contained minor layers of sand, clayey sands and sandy clay in some locations. The findings were similar the previous investigation within the Rozelle Rail Yards (PB 2003a).

Around half of the boreholes drilled in the Rozelle Rail Yards contained anthropogenic inclusions in the fill. Common inclusions were observed to include brick, slag and concrete. Less common inclusions in the fill included metal, timber, cloth, ash, netting, coal and porcelain. Fragments of asbestos cement sheeting were encountered in one borehole, to the east of Gordon Street.

Alluvial soils were encountered across most of the Rozelle Rail Yards. The alluvium extended to depths ranging from 0.6 to 20.1 metres below ground level within the Rozelle civil and tunnel site. The alluvium consisted of layers of sand, medium to high plasticity clay, high plasticity organic clay, peat, clayey sand. Traces of shell fragments and shell layers were also encountered in the alluvium. Groundwater is expected to be tidally influenced within filled areas of Rozelle Rail Yards site and surrounding areas close to the shore. Preferential pathways of groundwater flow are likely to exist in

variable fill types and the palaeochannel in the quaternary sediments identified to be present within the Rozelle civil and tunnel site.

Bedrock was encountered in the Rozelle Rail Yards at depths ranging from 0.55 to 20.4 metres belowground level within the Rozelle civil and tunnel site. The depth to bedrock was shallow in the northern half of the site and deep in the southern half of the site. Consistent with the regional geological maps, the bedrock was found to be Triassic Hawkesbury Sandstone, consisting of medium to coarse grained quartz sandstone and very minor shale and laminate lenses.

4.8.5 Hydrogeology

Groundwater flow is expected to be towards Rozelle Bay. Groundwater flow pathways are likely to exist in the various types of fill and the alluvium. A total of 11 groundwater monitoring wells were sampled within the Rozelle civil and tunnel site for groundwater contamination assessment purposes. Of the monitoring wells sampled:

- Five were screened in alluvium (including newly installed monitoring wells RZ_BH01S, RZ_BH44S, RZ_BH47S and RZ_BH49, and existing monitoring well BH57/MW2)
- One was screened across both fill and alluvium (existing monitoring well BH60/MW3)
- Five were screened in sandstone bedrock (newly installed monitoring wells RZ_BH16, RZ_BH19, RZ_BH26, RZ_BH47D and RZ_BH51).

The monitoring well construction and standing water levels are summarised in **Table 4-22**.

Groundwater is present within the alluvial aquifer and the underlying Hawkesbury Sandstone. Groundwater levels measured in nested monitoring wells have demonstrated that groundwater standing water levels in the alluvium are typically lower than those in the underlying Hawkesbury Sandstone. Hence, overall there is upward pressure from the Hawkesbury Sandstone to the alluvium where groundwater from the Hawkesbury Sandstone could be discharging into the alluvium if there is hydraulic connection. Within the alluvium, two sub aquifers separated by a clay horizon have been identified whereby the groundwater standing water levels in the deep palaeochannel are higher by about 0.5 metres than the shallow alluvium indicating there is upward pressure from the palaeochannel into the shallow alluvium, and groundwater from the palaeochannel may be discharging into the overlying shallow alluvium.

Monitored standing water levels ranged from 1.34–2.65 metres AHD. Groundwater is assumed to flow in a general south-easterly direction towards Whites Creek and Rozelle Bay.

Table 4-22 Hydrogeology – Rozelle civil and tunnel site at Rozelle (C5)

Monitoring well location	Screened interval (metres below ground level)	Screened geology	Standing water level (metres AHD)
BH57/MW2	1 to 5	Alluvium	1.82
BH60/MW3	1 to 4	Alluvium/fill	2.65
RZ_BH01(d)	22 to 25	Sandstone	1.56 to 2.47
RZ_BH01(s)	7 to 10	Alluvium	2.00 to 2.04
RZ_BH16(d)	17 to 22	Sandstone	1.56 to 1.71
RZ_BH19	19 to 22	Sandstone	1.46 to 2.46
RZ_BH38	28.25 to 31.25	Sandstone	1.72 to 2.27
RZ_BH44S	12 to15	Alluvium	1.11 to 2.25
RZ_BH44D	25 to 28	Sandstone	1.87 to 2.29
RZ_BH47D	27 to 30	Sandstone	1.55 to 2.3
RZ_BH49A	13.2 to 16.2	Alluvium	1.34 to 1.35

4.8.6 Acid sulfate soils

According to information provided by DP&E, the following acid sulfate soil classes are mapped within the Rozelle civil and tunnel site (see **Figure 4-17**):

- Soil Class 1: Any works require development consent and management procedures for acid sulfate soils. The majority of the site is mapped as Soil Class 1. A small area of the northeast corner of the Rozelle civil and tunnel site is mapped as Class 1
- Soil Class 3: Works more than one metre below the natural ground surface or works by which the water table is likely to be lowered requires development consent and management procedures for acid sulfate soils. Most of the Rozelle civil and tunnel site is mapped as Class 3
- Soil Class 5: No known occurrence of acid sulfate soils. Works within 500 metres of adjacent Class 1, 2, 3 or 4 land that is below five metres AHD and by which the water table is likely to be lowered below one metre AHD on adjacent Class 1, 2, 3 or 4 land requires development consent and management procedures for acid sulfate soils. A narrow strip of the northern boundary of the Rozelle civil and tunnel site, along the cliff line, is mapped as Class 5.

Intrusive investigation results identified potential acid sulfate soils (PASS), primarily in natural alluvium (AECOM 2016c).

4.8.7 Soil investigation results

The analytical results for fill and natural soil samples collected from within Rozelle Rail Yards, including the Rozelle civil and tunnel site, as part of the AECOM (2016c) investigation are summarised in **Table 4-23**. Borehole locations are shown in **Figure 4-16**.

Table 4-23 Summary of soil results (AECOM 2016c) – Rozelle Rail Yards

Analyte	Matrix	Results	Concentration (mg/kg)		
			Minimum	Maximum	Average
Arsenic	Fill	104	<3	1200	33
	Soil	36	<3	22	7.9
Cadmium	Fill	104	<0.3	1100	12
	Soil	36	<0.3	5.2	0.57
Chromium (III+VI)	Fill	104	0.5	79	11
	Soil	36	1.4	43	11
Copper	Fill	104	1.7	680	74
	Soil	36	1.2	150	19
Lead	Fill	104	3	6400	186
	Soil	36	3	320	45
Mercury	Fill	104	<0.01	10	0.27
	Soil	36	<0.01	0.8	0.1
Nickel	Fill	104	0.6	110	12
	Soil	36	<0.5	20	4.7
Zinc	Fill	104	5	250000	2812
	Soil	36	2.3	5900	269
Benzo(a)pyrene	Fill	99	<0.05	40	1.4

Analyte	Matrix	Results	Concentration (mg/kg)		
			Minimum	Maximum	Average
	Soil	36	<0.1	5.4	0.52
Carcinogenic PAHs	Fill	99	<0.2	59	2.1
	Soil	36	<0.2	7.8	0.82
Total PAHs	Fill	99	<0.8	680	16
	Soil	36	<0.8	60	5.8
Asbestos	Fill	53	Detected in three boreholes		
TRH C6-C10	Fill	101	<25	41	13
	Soil	36	<25	150	17
TRH C10-C16	Fill	101	<25	250	17
	Soil	36	<25	660	35
TRH C16-C34	Fill	101	<90	2600	146
	Soil	36	<90	820	87
TRH C34-C40	Fill	101	<100	550	73
	Soil	36	<100	<120	60
F1 (C6-C10 minus BTEX)	Fill	101	<25	38	13
	Soil	36	<25	150	17
F2 (C10-C16 minus naphthalene)	Fill	101	<25	220	17
	Soil	36	<25	660	35
Total BTEX	Fill	101	<0.6	9.1	0.42
	Soil	36	<0.6	0.8	0.32
OCPs	Fill	37	<LOR	<LOR	<LOR
	Soil	2	<LOR	<LOR	<LOR
OPPs	Fill	35	<LOR	<LOR	<LOR
	Soil	1	<LOR	<LOR	<LOR
Total PCBs	Fill	36	<LOR	<LOR	<LOR
	Soil	2	<LOR	<LOR	<LOR

Notes: LOR – limit of reporting

The following results exceeded the ASC NEPM (2013) HIL D criteria for commercial/industrial land use within the Rozelle civil and tunnel site (borehole locations are shown in **Figure 4-16**):

- Cadmium and lead in one sample (RZ_BH03_0.3-0.4)
- CPAHs in one sample (RZ_BH02_0.3-0.4).

The following results were greater than the ASC NEPM (2013) HIL C criteria for open space land use:

- Arsenic, cadmium, lead and zinc in one sample (RZ_BH02_0.3-0.4)
- Lead in two samples (RZ_BH02_0.1 and RZ_BH03_0.3-0.4)

- Carcinogenic PAHs in two samples (RZ_BH02_0.1 and RZ_BH03_0.3-0.4)
- Total PAHs in one sample (RZ_BH02_0.3-0.4).

Concentrations of copper, lead, nickel, zinc, benzo(a)pyrene, TRH C_{10}-C_{16} and TRH C_{16}-C_{34} also exceeded the ASC NEPM (2013) generic ecological investigation levels (EILs) and ecological screening levels (ESLs) for commercial/industrial and open space land uses in samples within the Rozelle civil and tunnel site.

All results were less than the ASC NEPM (2013) and CRC Care (32011) HSLs for open space (HSL C) and commercial land use (HSL D) for all soil types and depths.

4.8.8 Groundwater investigation results

The analytical results for groundwater samples collected from within the Rozelle Rail Yards, including the Rozelle civil and tunnel site as part of the AECOM (2016c) investigation are summarised in **Table 4-24**.

Table 4-24 Summary of groundwater results (AECOM, 2016c) – Rozelle Rail Yards

Analyte	Aquifer	Results	Concentration (mg/L)		
			Minimum	Maximum	Average
Arsenic	Alluvial	5	<0.001	0.002	0.0013
	Sandstone	5	<0.001	0.002	0.0008
Cadmium	Alluvial	5	<0.0001	<0.0001	<LOR
	Sandstone	5	<0.0001	<0.0001	<LOR
Chromium (III+VI)	Alluvial	5	<0.001	<0.001	<LOR
	Sandstone	5	<0.001	<0.001	<LOR
Copper	Alluvial	5	<0.001	<0.001	<LOR
	Sandstone	5	<0.001	0.019	0.0042
Lead	Alluvial	5	<0.001	<0.001	<LOR
	Sandstone	5	<0.001	<0.001	<LOR
Mercury	Alluvial	5	<0.0001	<0.0001	<LOR
	Sandstone		<0.0001	<0.0001	<LOR
Nickel	Alluvial	5	<0.001	0.002	0.008
	Sandstone	5	<0.001	0.01	0.0028
Zinc	Alluvial	5	<0.005	0.012	0.0081
	Sandstone	5	<0.005	0.06	0.0028
TRH C6-C10	Alluvial	5	<LOR	<LOR	<LOR
TRH C10-C40	Sandstone	5	<100	80	N/A
PAHs, SVOC and VOCs	Alluvial	5	<LOR	<LOR	<LOR
	Sandstone	5	<LOR	<LOR	<LOR

All groundwater results from the groundwater wells sampled and analysed within the Rozelle civil and tunnel site were less than the ANZECC (2000) 95 per cent marine trigger values, NHMRC (2015) ADWG and the ASC NEPM (2013) and CRC Care (32011) HSLs for open space (HSL C) and commercial land use (HSL D). Petroleum sourced light non aqueous phase liquid (LNAPL)/phase separated hydrocarbons (PSH) was detected at a single location (BH57/MW2) in a monitoring well installed during a previous (PB 2003) investigation.

4.8.9 Additional Rozelle Rail Yards investigation results

As part of the work undertaken for the Site Management Works REF (Roads and Maritime 2016) additional contamination investigations and waste classification activities were carried out to inform the proposed work activities within the Rozelle Rail Yards. The investigation included *in situ* assessment of soil and fill material, railway ballast, drums material and stockpiles which were present on the site at the time of sampling. Potential impacts of the site management works will be managed and mitigated on-site by the contractor. Management measures will include the preparation and carrying out of a CEMP, which will identify potential impacts, sensitive receivers and associated management measures. The CEMP will include measures for soil and water, contamination, including asbestos, resource use and waste, non-Aboriginal heritage, fauna and flora, traffic management and control, noise and vibration and air quality.

Potential impacts as a result of the finished site phase of the site management works will be minimal and will only occur if the surface cover and erosion and sediment controls are not maintained after completion of the site management works. These potential impacts include sediment and contamination leaving the site and entering the stormwater system. However, provided the site is maintained, the residual impacts of the finished site are not considered to be significant, particularly once appropriate management measures are put in place.

At the completion of the site management works contemplated in the Site Management Works REF (Roads and Maritime 2016), the majority of the Rozelle civil and tunnel site will be stabilised. The site will also contain areas of hardstand and new drainage channels and sediment basins to manage surface water flows. Over time, areas that had been seeded for erosion control will result in low growing vegetation.

4.8.10 Areas and contaminants of concern

The key areas and contaminants of concern within the site are summarised in**Table 4-25**.

Table 4-25 Areas and contaminants of concern – Rozelle civil and tunnel site at Rozelle (C5)

Area	Description	CoPC
C5 Rozelle Rail Yards	Investigations identified fill across the land. The fill contains elevated concentrations of metals, PAHs and TRH above applicable human health and ecological criteria. Asbestos was also identified in fill in several locations and also present as bonded asbestos fragments on the surface. The site is mapped as Class 1, 3 and 5 acid sulfate soil risk. Potential acid sulfate soils have been detected within the alluvial sediments across the Rozelle Rail Yards. LNAPL was identified in one groundwater monitoring well down-gradient of the commercial properties (Armstone, Swaddling's and Balmain Stone). Based on the findings of investigations undertaken to date, fill material present at the site is unlikely to be suitable for off-site reuse and would require disposal to a suitably licensed landfill. Fill material present at the site is heterogeneous and likely to be classified as a mix of general solid, restricted, hazardous and/or special waste in accordance with the criteria outlined in the NSW EPA (2014) Waste Classification Guidelines. Further information is required to refine the understanding of the vertical and lateral distribution of waste types at the site.	Metals, TRH, PAHs, and asbestos Acid sulfate soils
Timber Merchant	Historically used as a timber yard and formerly part of the Rozelle Rail Yards. The land was redeveloped in the late 1990s. The site is mapped as Class 1 and 5 acid sulfate soil risk. Potential acid sulfate soils have been detected within the alluvial sediments to the south of the property in the Rozelle Rail Yards. AECOM is not aware of previous intrusive investigations undertaken.	Metals, PAHs, OCPs, TRH, asbestos Acid sulfate soils
WHT – B Hotel and Crane Business	The land was formerly occupied by soap and candle manufacturers, followed by timber merchants and then Gillespie's Cranes. The land contains diesel USTs. The site is mapped as Soil Class 1 and 5 acid sulfate soil risk.	Metals, PAHs, OCPs, TRH, asbestos Acid sulfate soils
WHT – C Commercial Properties (, Swaddling's and Stonemason)	The land formerly contained an emoleum plant (bitumen manufacturing), timber yard, rail siding and boat repair yard. Limited previous shallow investigations (<1 metres) have been undertaken within the land that identified the presence of fill and slightly elevated PAHs and metals in shallow soils. The site is mapped as Soil Class 1 and 5 acid sulfate soil risk.	Metals, PAHs, TRH, SVOCs, VOCs, TBT, asbestos Acid sulfate soils
Off-site sources	Easton Park to the north of the site is filled with soil containing elevated concentrations of PAHs and metals from an unknown source.	Metals and PAHs

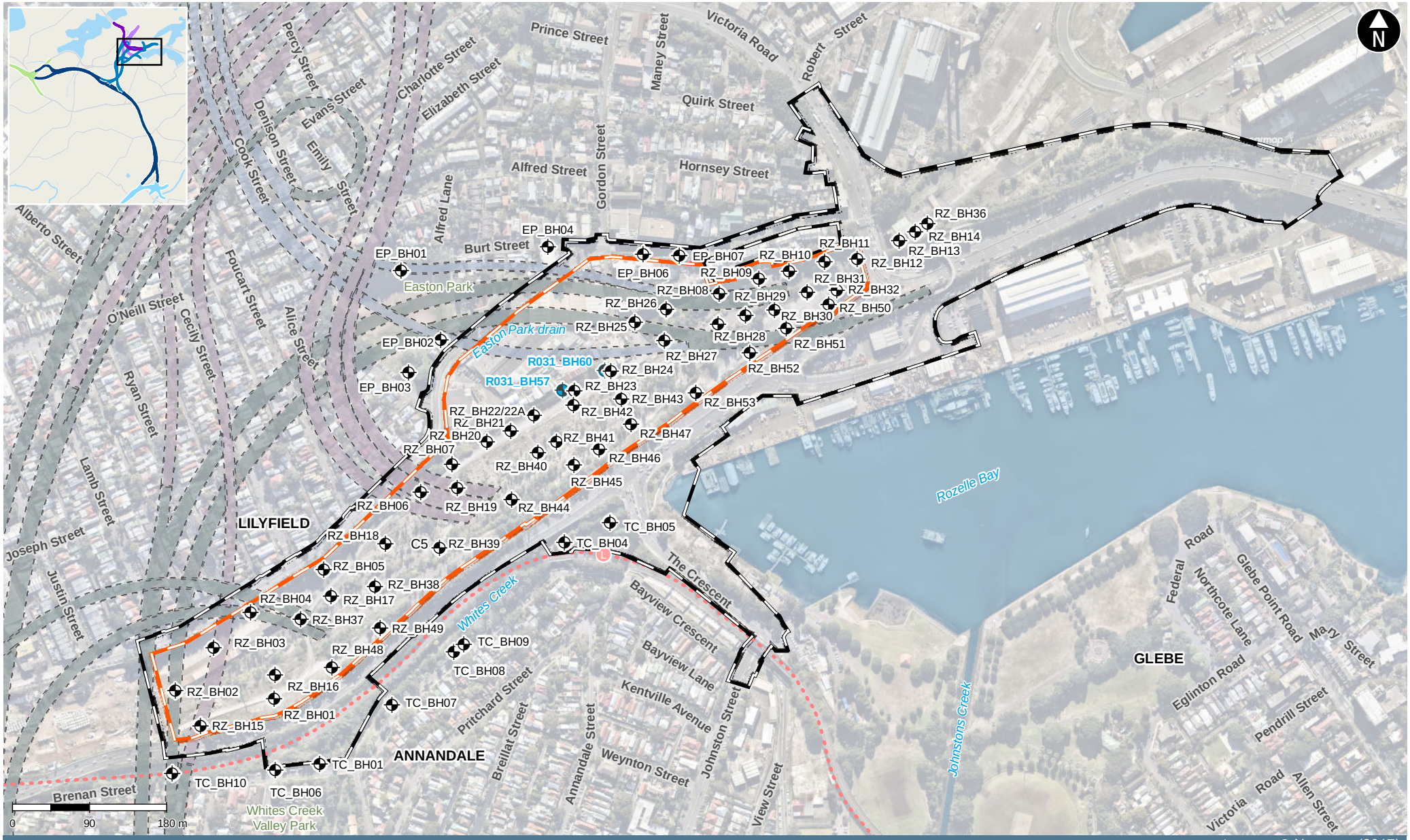
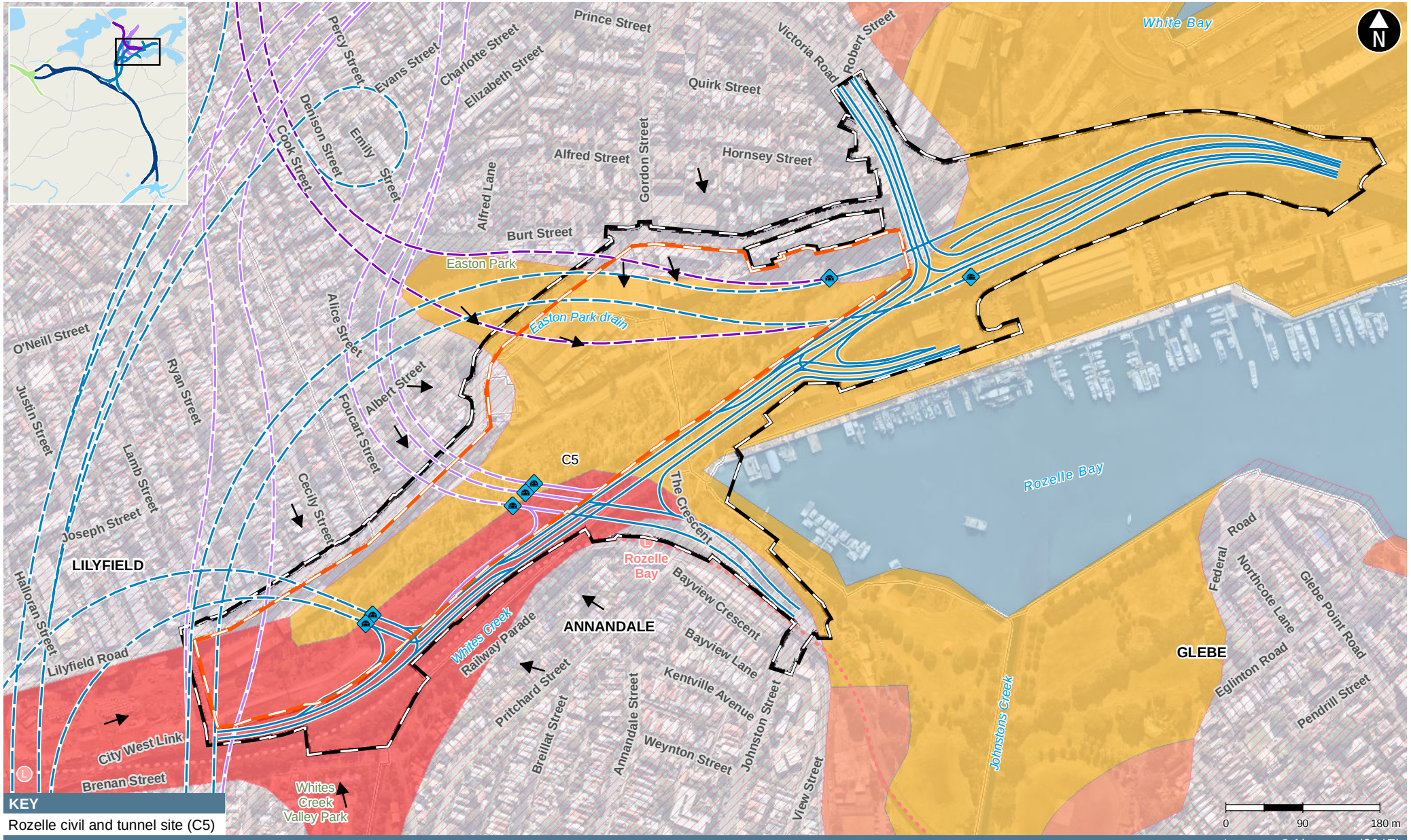


Figure 4-16 Rozelle civil and tunnel site at Rozelle (C5) – borehole and groundwater monitoring well locations



KEY

Rozelle civil and tunnel site (C5)

LEGEND

Existing features
- Suburb boundary
- Light rail
- Light rail stop

M4-M5 Link
Rozelle interchange
- Surface road
- Tunnel

Iron Cove Link
- Tunnel

M4-M5 Link
Iron Cove Link
- Tunnel

Proposed future WHTBL connections (civil construction only)
- Surface road
- Tunnel

Project features
- Tunnel portal
- Project footprint
- Ancillary facility

Slope direction
- Local slope

Acid sulfate soils
- Soil Class 1
- Soil Class 2
- Soil Class 3
- Soil Class 5

Figure 4-17 Rozelle civil and tunnel site at Rozelle (C5) - acid sulfate soils

4.9 C6 – The Crescent civil site at Annandale

4.9.1 Site description and surrounding area

The Crescent civil site at Annandale (C6) would be located within the Inner West LGA to the south of the Rozelle civil and tunnel site (C5) at Rozelle and City West Link.

The site is shown in **Figure 4-18** and would be located on land that is currently vacant but has historically been used for boat, plant and machinery storage and maintenance. The site is currently owned by Roads and Maritime. Land at The Crescent civil site at Annandale (C6) drains in an easterly direction towards Rozelle Bay, which is located immediately to the east and is surrounded by land uses detailed in **Table 4-26**.

Table 4-26 Surrounding land use – The Crescent civil site at Annandale (C6)

Direction	Description of surrounding land use and proximity to the site
North	• Parkland, pedestrian and cycle pathways which collectively form part of the road verge above Whites Creek and Easton Park drainage into Rozelle Bay, immediately east of the intersection of The Crescent and City West Link roadways • Rozelle Rail Yards site.
South	• The Crescent Roadway and intersection with Johnston Street and Petersham TAFE College Annandale Campus. Above the intersection of these roadways are the light rail tracks • Southeast – Federal Park adjacent Rozelle Bay • Southwest residential land use.
East	• Rozelle Bay, jetties, pontoons and boats on the water.
West	• The Crescent roadway, further west residential land use, Buruwan Park adjacent to Whites Creek running west to east parallel to City West Link • Above Buruwan Park the Rozelle Bay light rail stop, tracks and associated infrastructure.

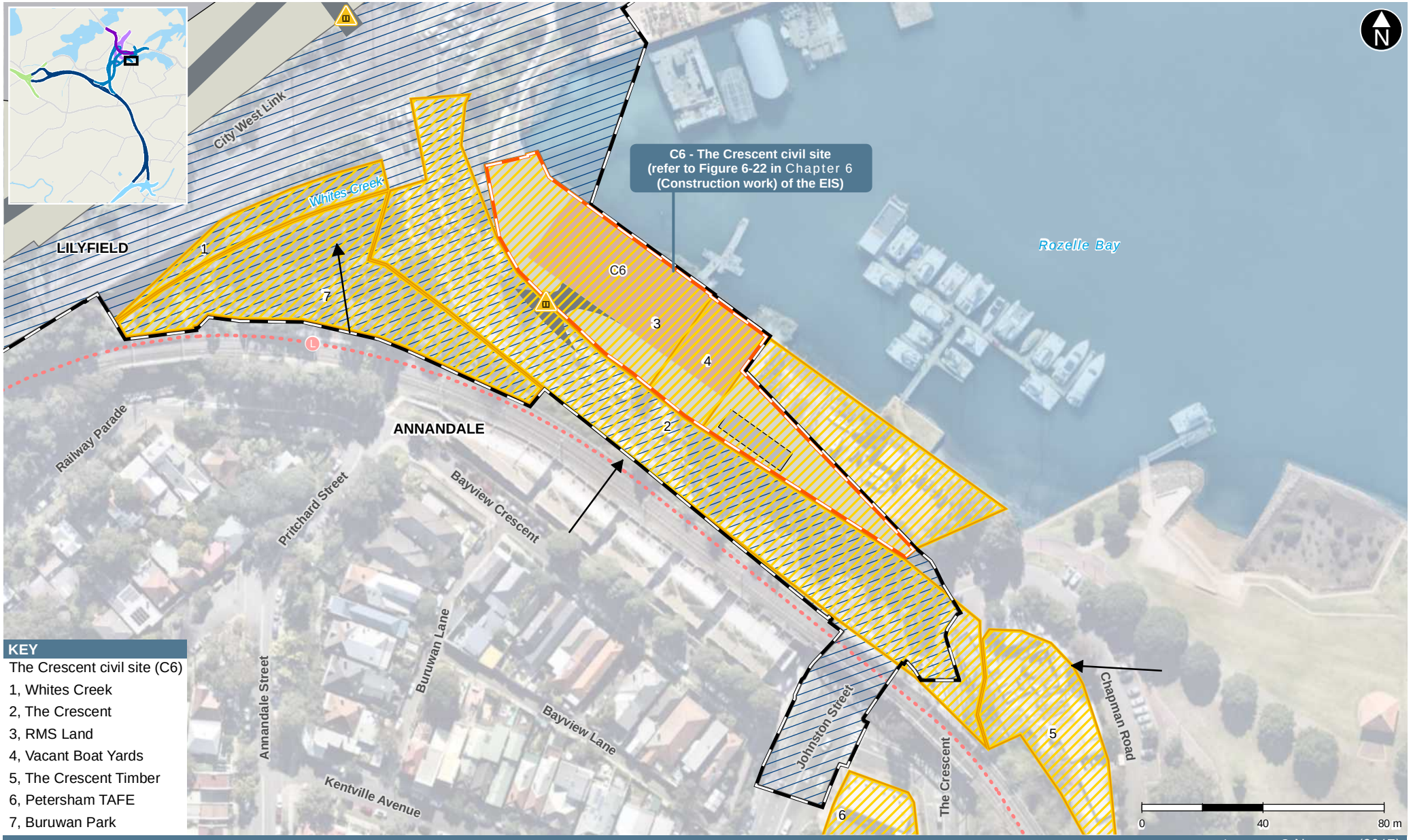


Figure 4-18 The Crescent civil site at Annandale (C6)

4.9.2 Previous reports

AECOM is aware of the previous investigations and management procedure relevant to The Crescent civil site at Annandale (C6):

- Jacobs (2015b) Lots 21/22, DP1151746 Rozelle Bay – NSW Roads & Maritime Services, Site Access and Management Procedures. Final, ExeC1a4/0341 17 June 2015
- AECOM (2016b) WestConnex M4-M5 Link Rozelle Interchange Phase 1 Environmental Site Assessment 4 March.

A summary of the information is provided in **Table 4-27**.

Table 4-27 Previous reports relevant to The Crescent civil site at Annandale (C6)

Report	Area	Overview
Jacobs, 2015	Part C6 – Lot 21 and Lot 22 DP 1151746	The Site Access and Management Procedures (SAMP) was produced by Jacobs using information sourced in the following investigation (not reviewed by AECOM): • Jacobs (2015a) Detailed Site Investigation Lots 21/22, DP1151746, The Crescent, Rozelle NSW. March 2015. The following primary hazards have been identified for the site in its current condition: • Exposure to asbestos (on ground surfaces and within soils) • Exposure to contaminated soil (including fill) and groundwater • Exposure to contaminated sediments along the site foreshore. Jacobs SAMP (2015b) noted that *'The source of contamination in soils was considered to be associated with historical fill and more recent industrial/commercial maritime operations, including the refurbishment of vessels and grit blasting activities, among others. Contamination includes asbestos in soil, heavy metals, polycyclic aromatic hydrocarbons (PAHs) and Tributyltin (TBT)*' Jacobs (2015b) considered the extent of impacted fill is likely to extend across the majority of filled areas from surface to depths of two metres below ground level. Figure 1 within the SAMP shows where concentrations of asbestos, lead, PAHs, and TBT exceeded the adopted assessment criteria used by Jacobs (2015b). Jacobs (2015b) also indicated an exclusion zone (no slashing or other ground surface disturbing works) was provided in Figure 2. AECOM notes that no Figure 2 is included in the SAMP (Jacobs, 2015b) and Figure 2 from Jacobs (2015a) does not show an exclusion zone. Jacobs (2015b) noted that groundwater at the site is likely to be contaminated by the leaching of identified contaminants in soils. Jacobs (2015b) noted that previous investigations undertaken across the foreshore in areas adjacent to the site have reported analytical results for PAH and metals in groundwater above the respective assessment criteria for the protection of drinking water, irrigation and aquatic ecosystems. Jacobs (2015b) noted that vapours (as volatile organic compound concentrations measured with a photoionisation detector) were not measured above the limit of reporting of the detector within test-pits or at ground surfaces of the site. The SAMP details the potential exposure pathways and recommended PPE requirements and recommended management measures for intrusive works undertaken within the site.

Report	Area	Overview
AECOM, 2016b	Surrounding area – including Rozelle project footprint	The Phase 1 ESA incorporated an area of 42 hectares, including land located in proximity to The Crescent civil site at Annandale (C6). Areas of identified potential contamination concern included: • Rozelle Rail Yards • Boat yards and maintenance facilities • Reclaimed land • The Crescent Timber Site. The Crescent Timber Site is located to the south of C6 and is currently used as a car park and commercial building for Crescent Timber and Hardware store. Previous investigations have identified fill materials containing elevated concentrations of lead and CPAH which exceeded the assessment criteria for open space. The site was also found to contain ACM and asbestos fibres in soil. Groundwater beneath the site was found to contain lead and cyanide concentrations greater than ecological assessment criteria and hexachlorobenzene was also detected at low concentrations in groundwater. PASS was also identified.

4.9.3 Site history

It is understood from Jacobs (2015b) that the site has been previously used for marine storage and maintenance purposes, has historically been reclaimed land and was previously part of Rozelle Bay.

Based on the results of the Phase 1 ESA (AECOM 2016b) the land forming part of the Rozelle civil and tunnel site incorporates the following historical land uses:

- Rozelle Rail Yards north and northwest of the site
- Timber yard south of the site
- Former mechanics further south of the site.

The surrounding historical land uses are unlikely to have impacted on the soil and groundwater quality of the C6 site due to being either down-gradient or located greater than 100 metres from the C6 site. However, the long commercial/industrial land use indicates there is a high potential for contaminated soil, fill, sediment and groundwater to be present at this location.

4.9.4 Soils and geology

According to the NSW Department of Industry, Resources and Energy (2017), 1:100,000 Sydney geology map sheet, the site geology consists of the following units:

- Triassic Ashfield Shale of the Wianamatta Group, characterised by black to dark grey shale and laminate
- According to information provided by OEH the soil landscape within the site consists mostly of Blacktown Residual Soils.

4.9.5 Hydrogeology

Groundwater is expected to be shallow and tidally influenced in a northerly (towards Whites Creek) and easterly (towards Rozelle Bay) direction. The expected groundwater flow direction within the project is anticipated to be radial in a predominantly easterly, westerly and northerly direction. Eight groundwater monitoring wells have been constructed within the alluvium and Hawkesbury Sandstone at The Crescent (AECOM 2017a). Groundwater levels are typically shallow with levels in the sandstone being less than one metre below ground level. As at Rozelle, the groundwater standing

water levels within the alluvium are lower by up to a metre indicating there is likely to be upward pressure from the groundwater within the sandstone.

4.9.6 Acid sulfate soils

The Crescent civil site at Annandale (C6) and surrounding areas are predominantly mapped with Class 1 acid sulfate risk potential which means any works that disturb more than one tonne of soil, or lower the water table would trigger the requirement for assessment and may require management (see **Figure 4-20**).

4.9.7 Rozelle Bay

As noted in the in the site management works REF (Roads and Maritime 2016) Rozelle Bay is a tidal harbour embayment located immediately adjacent – north and east of The Crescent civil site at Annandale. The morphology and shoreline of the bay have been substantially modified by land reclamation activities. Rozelle Bay receives urban runoff from the suburbs of Rozelle, Lilyfield, Annandale and Forest Lodge.

The site management works REF (Roads and Maritime 2016) noted that historic reports indicate Rozelle Bay is one of the most heavily polluted areas of Sydney Harbour. AECOM notes that under the ANZECC (2000) guidelines for fresh and marine water quality, the condition of the ecosystem in Rozelle Bay within the project footprint would be characterised as highly disturbed. The portion of Rozelle Bay immediately adjacent The Crescent civil site at Annandale which is included in the project footprint receives stormwater outfall from Easton Park drain and Whites Creek.

As noted in the in the site management works REF (Roads and Maritime 2016) Easton Park drain collects stormwater from a heavily urbanised catchment of about 55 hectares to the north and west of the project footprint, and discharges into Rozelle Bay through a combination of stormwater pipes, lined open channel and culverted reaches and is tidally influenced.

Whites Creek is located close to the corner of City West Link and The Crescent at Ananndale. The watercourse drains a dense urban catchment area of about 262 hectares originating approximately 1.5 kilometres southwest of The Crescent civil site. Whites Creek is a concrete lined open channel spanned by a number of road and rail crossings. The creek discharges into Rozelle Bay immediately east of The Crescent and is tidally influenced.

4.9.8 The Crescent soil investigation results

As part of the preparation of this technical working paper, AECOM collected soil samples at one metre intervals to a maximum depth of four metres below ground level from two boreholes excavated within part of the proposed Crescent civil site at Annandale C6 ancillary facility and The Crescent roadway widening works. AECOM collected soil samples at one metre intervals to a maximum depth of four metres below ground level from four boreholes excavated on the grass verge north of Whites Creek and east of the intersection of The Crescent and City West Link adjacent Rozelle Bay (ie north of the proposed ancillary facility). A further three boreholes were excavated and sampled within Buruwan Park, the site of the proposed Whites Creek widening and footbridge.

All boreholes were located within the vicinity of proposed intrusive works either for the purpose of a construction ancillary facility, piling works for overhead structures and/or cut and cover works as part of road realignment works for the project.

An assessment of the soil analytical results from the samples collected by AECOM adjacent to Rozelle Bay against waste classification criteria indicated that the material is classified as General Solid Waste. However, it is noted that based on the results provided in the Jacobs (2015) SAMP, asbestos containing materials and fines have been identified in soil. Therefore it is recommended that ex-situ sampling occur prior to disposal to confirm the waste classification.

An assessment of the soil analytical results against potential site suitability criteria commercial/industrial – road and open space indicated:

- Selected soil samples exceeded the human health USEPA (2018) residential regional screening levels (RSLs). These criteria were selected as part of the soil human health assessment criteria for proposed recreational open space in the absence of criteria for particular analytes specific to exposure scenarios during proposed recreational open space land use and are therefore considered to be conservative for the proposed land uses (commercial/industrial – road and open space)
- Selected soil samples exceeded the NEPC (2013) NEPM ecological screening level (ESL) for urban residential and public open space for benzo(a)pyrene toxic equivalence quotient (TEQ).

Potential acid sulfate soils were detected in one sample RZ_BH79_2.7. Sample locations are shown in **Figure 4-19**.

4.9.9 Rozelle Bay sediment investigation results

As part of the preparation of this technical working paper, AECOM collected four composite sediment samples from Rozelle Bay immediately adjacent to the existing Whites Creek outlet and four composite sediment samples from Rozelle Bay immediately adjacent to the two existing Easton Park drain outlets. Construction works proposed include placement of two coffer dams in Rozelle Bay adjacent to both drainage outlets to assist with dewatering and expansion of both Easton Park drain and Whites Creek.

An assessment of the sediment analytical results against waste classification criteria indicated exceedances of benzo(a)pyrene and lead in the majority of samples and detections of asbestos. TCLP analysis for lead and benzo(a)pyrene was undertaken on selected samples to confirm the secondary chemical waste classifications. The reported results indicated that the material would be classified as Special Waste (Asbestos) secondary chemical classification Restricted Solid Waste for offsite disposal to landfill.

An assessment of the sediment analytical results against the selected ecological criteria for site reuse indicated the following contaminants of potential concern were detected and/or exceeded the selected ecological assessment criteria:

- Asbestos: Asbestos fines and asbestos containing material were detected in five of eight primary samples analysed
- Perfluroalkylated Substances (PFAS): PFAS compounds Perfluorooctanesulfonic acid (PFOS) and Perfluorohexane sulfonate (PFHxS) were detected in six of eight primary samples analysed
- Metals: Selected sediment samples exceeded the adopted ecological sediment assessment criteria for copper, lead, nickel and zinc
- PAHs: Selected sediment samples exceeded the adopted ecological assessment criteria for benz(a)anthracene, benzo(a)pyrene, phenanthrene and pyrene
- Phathalates: One sample exceeded the adopted ecological assessment criteria for Bis(2-ethyhexyl)phathalate.

An assessment of sediment analytical results against the ASSMAC (1998) guidelines indicated that potential acid sulfate soils were detected in two of eight samples analysed and actual acid sulfate soils were detected in six of eight samples analysed. Management procedures for acid sulfate soils would be adopted as part of the Construction Soil and Water Management Plan (CSWMP) prepared for implementation prior to intrusive works commencing.

4.9.10 Areas and contaminants of concern

The following areas and contaminants of concern were identified.

Table 4-28 Activities and areas of concern – The Crescent civil site at Annandale (C6)

Area	Potential contamination sources	Main PCoC
Previously identified contamination in soil, sediment and groundwater		
Part C6 – North-eastern boundary of Lot 22 DP 1151746 adjacent Rozelle Bay Exceedances not detected at sample locations in the southern portion adjacent The Crescent Part C6 – Lot 21 DP 1151746	Figure 1 in Jacobs SAMP (2015b) indicated exceedances of the adopted assessment criteria at selected locations. Use of the site for marine, plant and machinery storage and maintenance. Reclaimed land. Imported fill of unknown origin. Migration of potentially contaminated groundwater onto the site and from the site. Samples collected by Cardno (2010), SKM (1998) and Jacobs (2014).	• Lead • PAHs • Tributyltin • Asbestos
Analytical results for soil samples collected by AECOM 2017		
C6 – Lot 22 DP 1151746 Lot 21 DP 1151746 Lot 20 DP 1151746	Reclaimed land. Imported fill of unknown origin.	• Benzo(a)pyrene • Selected PAHs • Benzo(a)pyrene • Selected PAHs
Analytical results for sediment samples collected by AECOM 2017		
Within project footprint at Whites Creek outlet and Easton Creek drain outlet at Rozelle Bay (sediment)	Based on analytical results detections and exceedances of the ecological assessment criteria.	• Asbestos • PFAS – PFOS and PFHxS • Metals (copper, lead, nickel and zinc) • PAHs (benz[a]anthracene, benzo[a]pyrene, phenanthrene, pyrene) • Phathalates (Bis[2-ethyhexyl]phathalate)
Acid sulfate soils		
C6 site is predominantly mapped Class 5 (no known occurrence of acid sulfate soils)	Class 1 mapped land is located within proximity to the site. Soil analytical results indicated potential acid sulfate soils present on site.	• PASS/actual acid sulfate soils
Within project footprint at Whites Creek and Easton Creek drain outlet at Rozelle Bay (sediment)	Based on analytical results PASS/AASS are present.	• PASS/actual acid sulfate soils

Area	Potential contamination sources	Main PCoC
Surrounding areas within the Rozelle civil and tunnel site	Potential for up-gradient contaminants to be mobilised via sediment and stormwater flowing into Whites Creek and Easton Park drain into Rozelle Bay. Former timber yard southeast of the C6 site. Rozelle Rail Yards north and northwest of the C6 site within the Rozelle civil and tunnel site. Former mechanics further south of the Rozelle civil and tunnel site, immediately adjacent to the project footprint. Historical filling activities within the project footprint land surrounding Rozelle Bay. Boat maintenance activities and wharfing facilities within and adjacent to Rozelle Bay within the C6 site.	• Metals • Tributyltin • SVOCs • VOCs • TRH • BTEXN • PAHs • PASS/actual acid sulfate soils

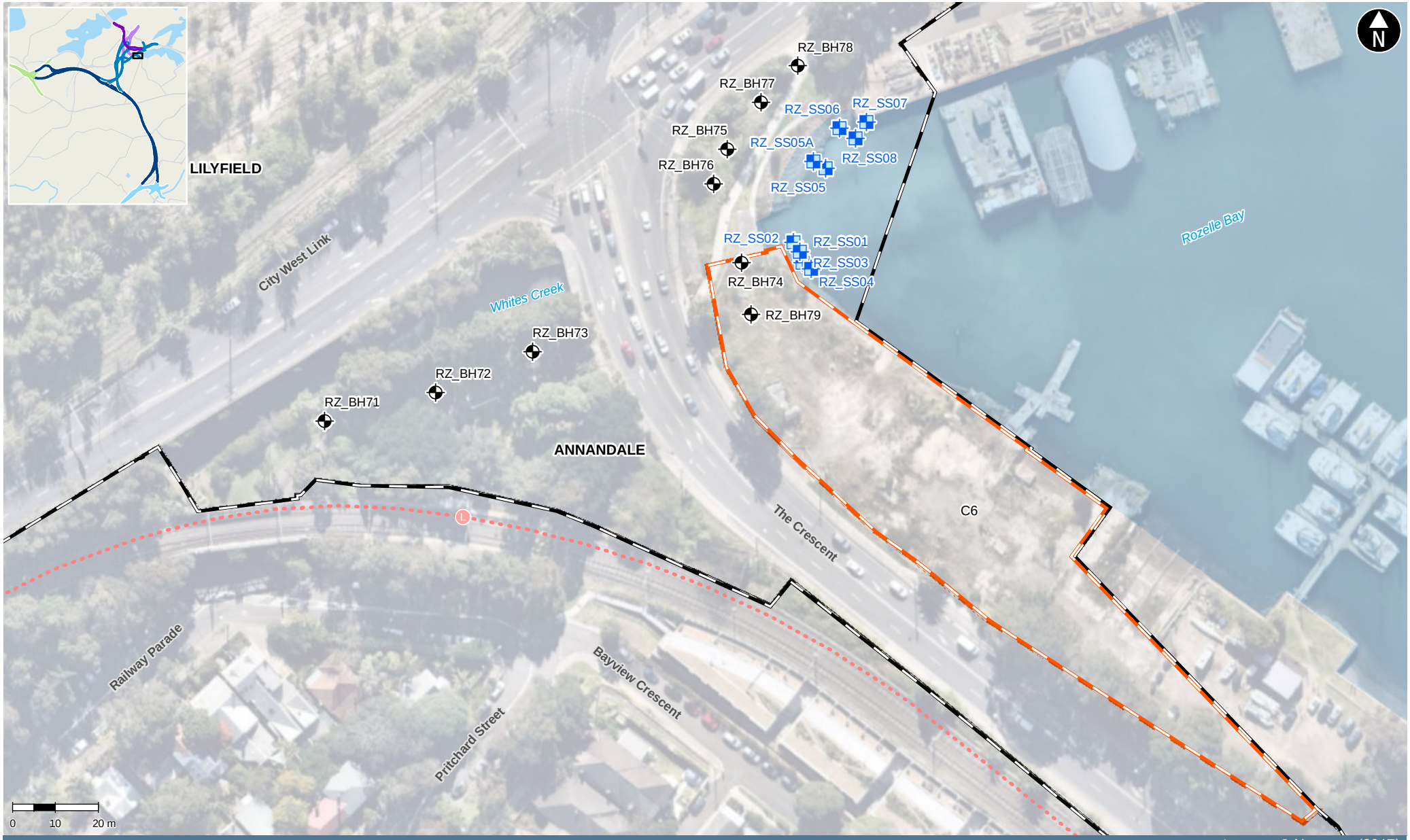


Figure 4-19 The Crescent civil site at Annandale (C6) - Borehole and sediment sample locations

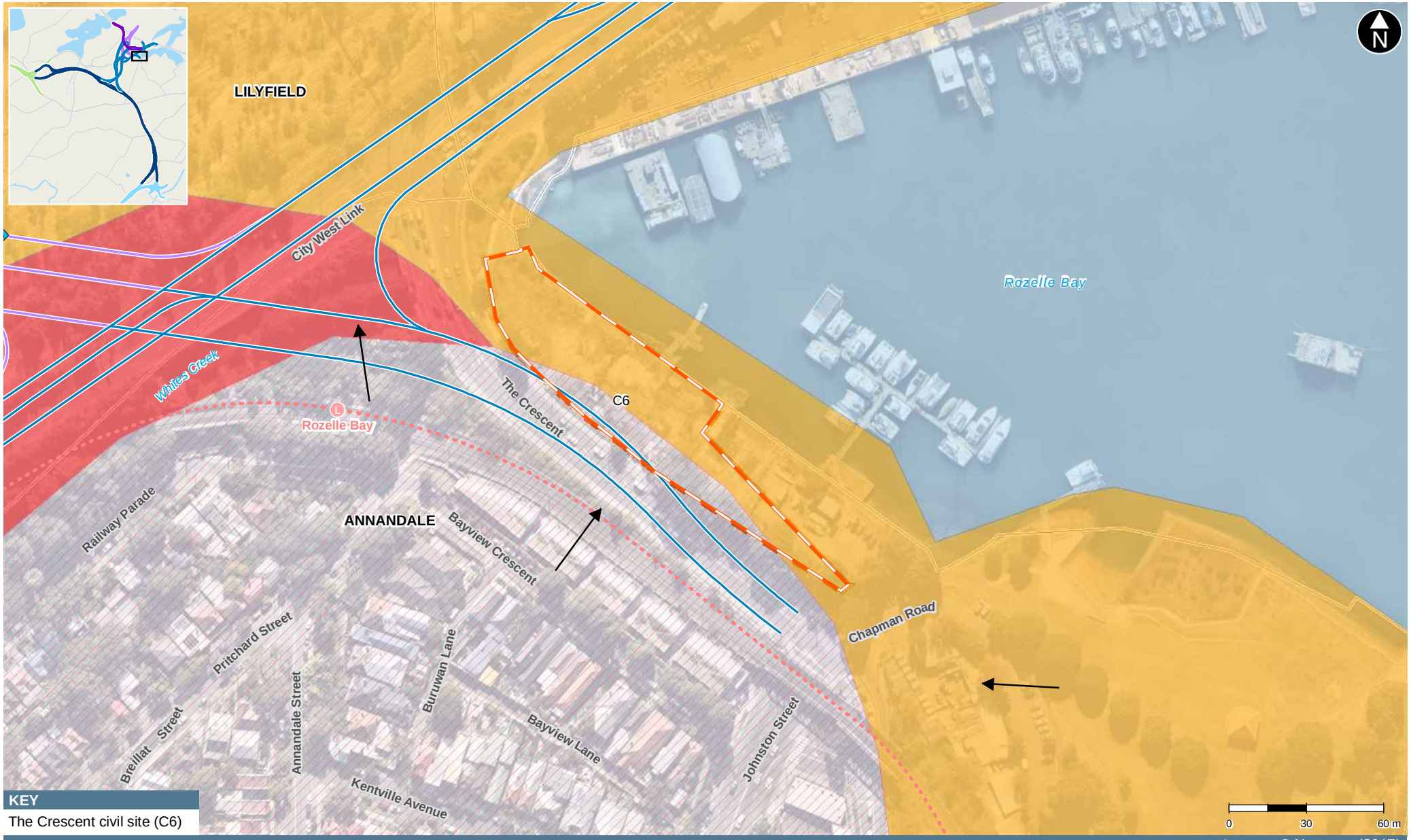


Figure 4-20 The Crescent civil site at Annandale (C6) - acid sulfate soils

4.10 C7 – Victoria Road civil site at Rozelle

4.10.1 Site description and surrounding area

The Victoria Road civil site is located within the suburb of Rozelle and within the Inner West Council LGA. The site is shown in **Figure 4-21** and would be located in an area currently comprising residential and commercial properties. The Victoria Road civil site slopes to the east and southeast and is surrounded by the land uses listed in **Table 4-29**.

Table 4-29 Surrounding land use – Victoria Road civil site at Rozelle (C7)

Direction	Description of surrounding land use and proximity to the site
North	• Quirk Street and Victoria Road, with medium density residential properties to the northwest and commercial properties about 100 metres to the north • Rosebud Cottage Child Care Centre about 75 metres topographically up-gradient.
South	• Lilyfield Road followed by medium density residential properties and then the Rozelle Rail Yards, City West Link and then Rozelle Bay wharves • Rozelle Bay about 300 metres to the south.
East	• Victoria Road followed by the White Bay Power Station and Glebe Island Container Terminal and White Bay.
West	• Medium and low density residential properties.

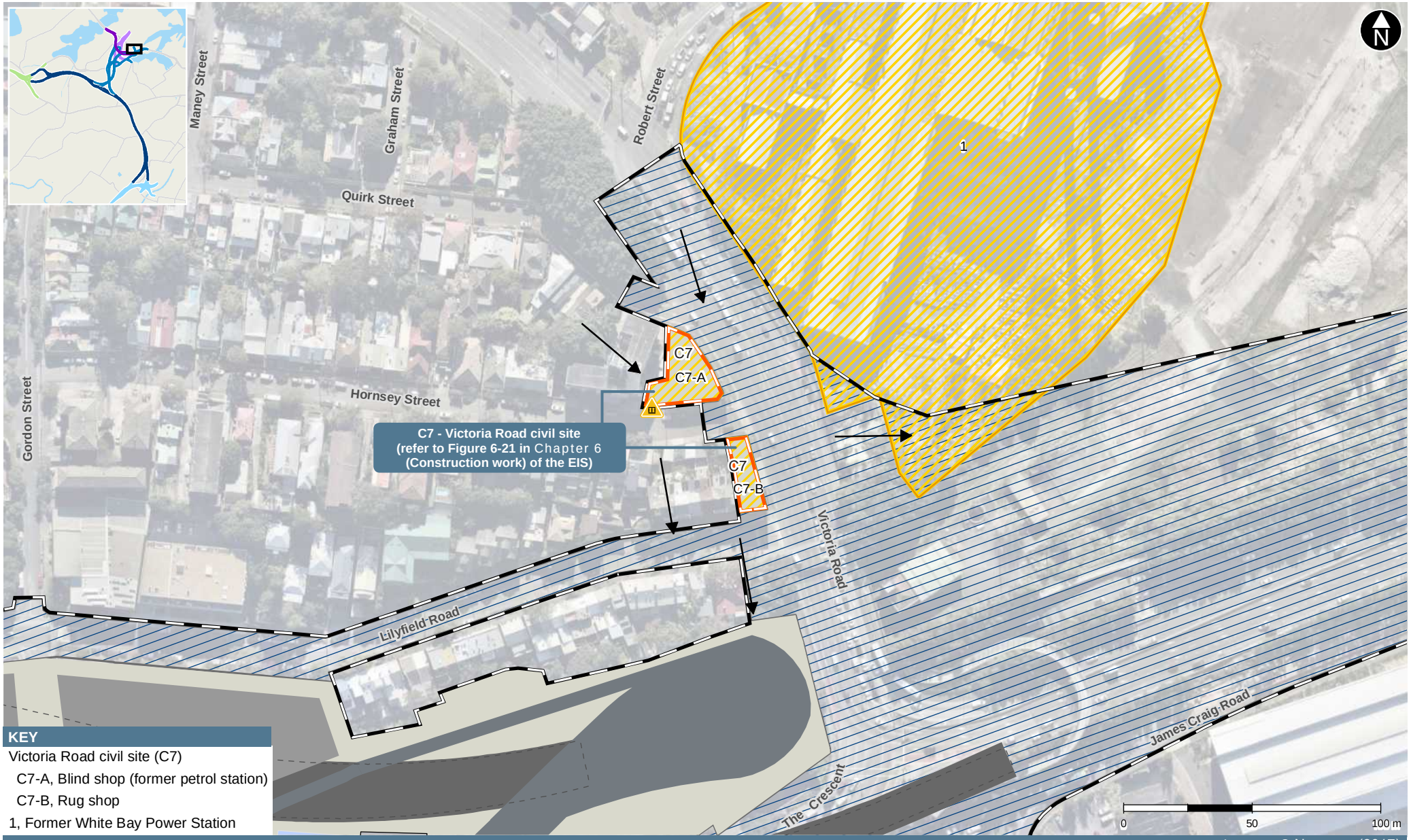


Figure 4-21 Victoria Road civil site at Rozelle (C7)

4.10.2 Previous investigations

AECOM is not aware of soil or groundwater investigations previously completed within the Victoria Road civil site in Rozelle.

4.10.3 Site history

A review of historical aerial photographs, historical UBD business directories and NSW EPA records were undertaken for the AECOM 2016b report. The information is summarised in **Table 4-30**.

Table 4-30 Site History Summary – Victoria Road civil site at Rozelle (C7)

Property	Site history summary
C7-A Blinds Business and residential properties	• In the historical aerial photographs, a small building was located on the land and was present from 1931 to 1951. The building changed in the 1961 aerial photograph and remained the same until after the 2009 aerial when the land appeared redeveloped • According to the UBD business directory data, the land was listed as Ampol Rozelle Service Station in 1991 and White Bay Filling & Service Station Pty Ltd in 1970 • Google Maps Street View© shows that a service station was still in place in December 2009 and appeared to contain seven fuel pumps, six vent pipes and a motor repair garage • In July 2013 a new commercial and residential building had been constructed over the land • No information was found in a search of NSW EPA public records • The land contained a two-storey relatively new commercial and residential building during the site inspection in January 2016.
C7-B Rug Business	• In the historical aerial photographs the land appeared to contain a terrace house up until and including 1951. The present day building was visible in 1961. • No information was found in a search of NSW EPA public records. • The land comprised an old two-storey commercial brick building during the site inspection in January 2016.

4.10.4 Soil and geology

According to the NSW Department of Industry, Resources and Energy (2014), 1:100,000 geological units and structures, the site is underlain by Triassic sandstone consisting of medium to coarse grained quartz sandstone, very minor shale and laminate lenses.

4.10.5 Hydrogeology

According to data provided by the (DPI-Water), Water Administration Ministerial Corporation and Commonwealth of Australia (Bureau of Meteorology) in December 2015, there were no registered groundwater wells within the site and two registered groundwater wells within one kilometre of the site. The wells were registered as groundwater monitoring wells and located 650 metres northeast of the site. The standing water level in the wells was 0.4 metres below ground level. Groundwater was monitored in a number of monitoring wells intersecting the sandstone including RZ_BH50, RZ_BH51, RZ_BH52 and RZ_BH30. The C7 ancillary facility is proposed to be located to the north of the Rozelle Rail Yards on sandstone and consequently is not underlain by alluvium.

The groundwater flow direction is expected to be predominantly towards Rozelle Bay to the south or White Bay to the east. Groundwater is expected to be present beneath the site as either shallow or

perched groundwater in residual soils or fill and as deeper groundwater semi-confined or confined within the underlying bedrock.

4.10.6 Acid sulfate soils

According to information provided by DP&E, the site is within land mapped as Soil Class 5 (no known occurrence of acid sulfate soils) and is adjacent to Class 2 mapped land (see **Figure 4-22**). Works within 500 metres of adjacent Class 1, 2, 3 or 4 land that is below five metres AHD and by which the water table is likely to be lowered below one metre AHD on adjacent Class 1, 2, 3 or 4 land requires development consent and development of management procedures for acid sulfate soils.

4.10.7 Areas and contaminant of concern

The key areas and contaminants of concern within the site are summarised in **Table 4-31**.

Table 4-31 Areas and Contaminants of Concern – Victoria Road civil site at Rozelle (C7)

Property	Description	CoPC
C7-A Blinds business and residential properties	A petrol station was located within the land prior to redevelopment as a commercial property. The former underground petroleum storage systems (UPSS) could have caused soil or groundwater contamination.	TRH, BTEXN, PAHs, lead and asbestos
C7-B Rug business	Demolition of former residential building, potential hazardous building materials. The historical use of commercial building prior to use as a retail store is unknown but unlikely to be have used for an activity that could have caused contamination.	Lead and asbestos

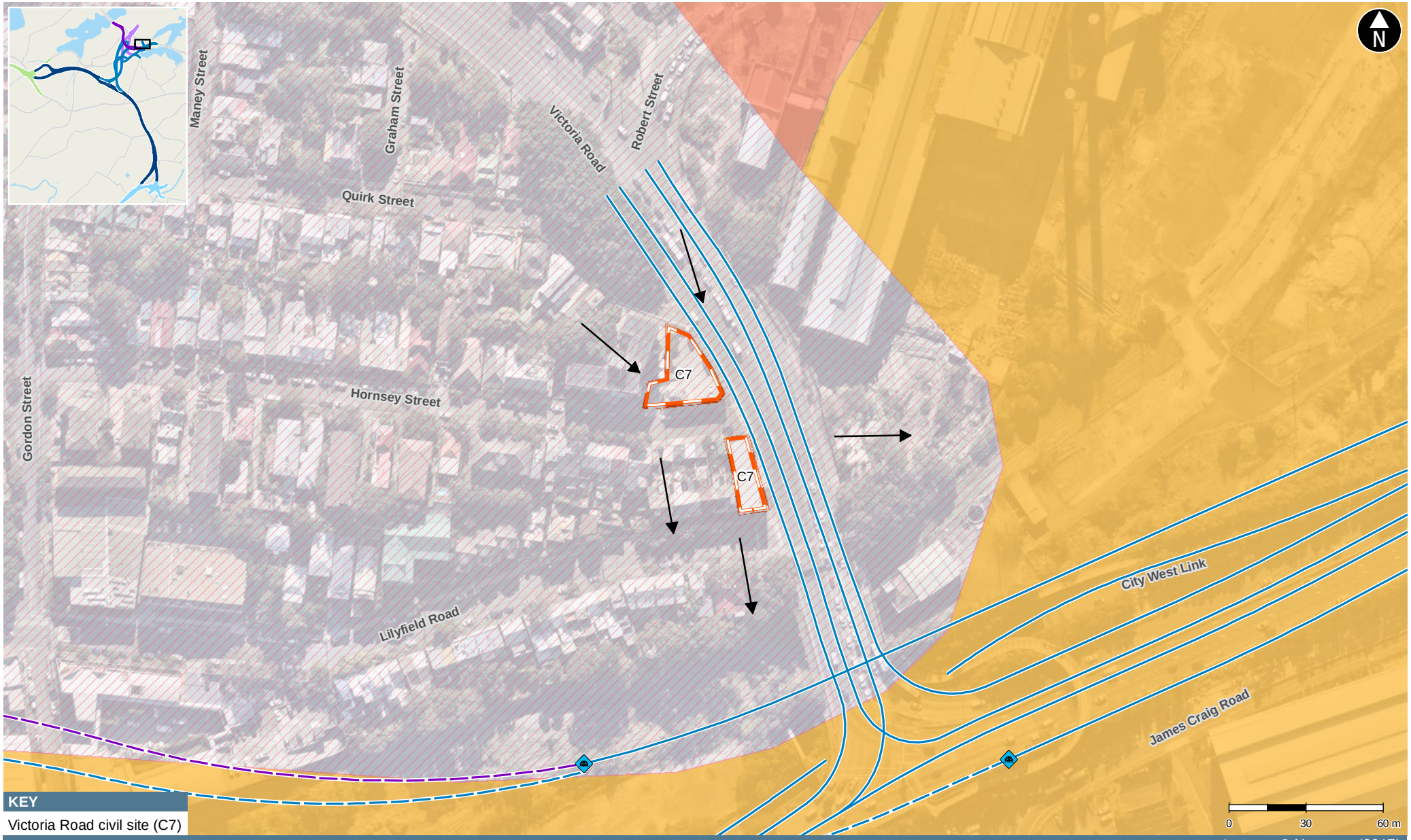


Figure 4-22 Victoria Road civil site at Rozelle (C7) - acid sulfate soils

4.11 C8 – Iron Cove Link civil site at Rozelle

4.11.1 Site description and surrounding area

The Iron Cove Link civil site (C8) is located within Rozelle and the Inner West Council LGA. The site is shown in **Figure 4-23** and would be located in an area currently comprising residential, commercial and industrial properties and road corridor and open space. The surrounding land use is summarised in **Table 4-32**.

Table 4-32 Surrounding land use – Iron Cove Link civil site at Rozelle (C8)

Direction	Description of surrounding land use and proximity to the Iron Cove Link civil site
North	• Bridgewater Park adjacent to Byrnes Street and residential apartments located directly to the north and topographically down-gradient • United 24 service station, Andrew Lyall car dealership and Caltex service station, VRS prestige (mechanics) and a substation are located directly adjacent and topographically up-gradient of the site • Iron Cove Bridge located immediately west and topographically down-gradient of the site.
South	• 7 Eleven service station is located adjacent and topographically up-gradient • Low density residential properties are located adjacent and topographically up-gradient.
East	• Rozelle Primary School is located 200 metres topographically up-gradient • Further east are Rozelle shops and low to medium density residential.
West	• King George Park adjacent and topographically down-gradient • Iron Cove (Parramatta River) located 50 metres and topographically down-gradient.

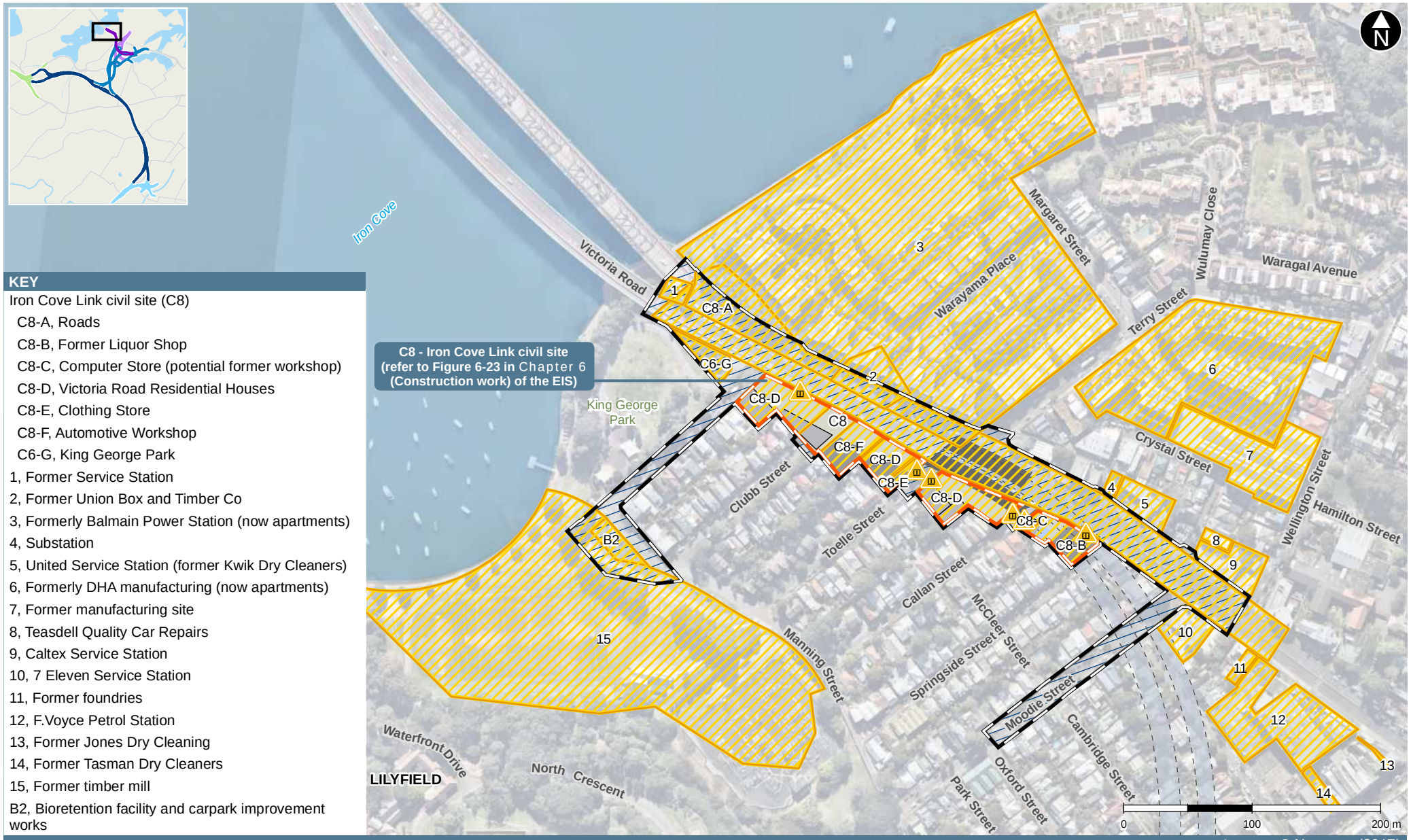


Figure 4-23 Iron Cove civil site at Rozelle (C8)

4.11.2 Previous investigations

An investigation was performed by Golder Associates in 2009 (Golder 2009) to inform the design of foundations for changeable message sign mast arms in the Rozelle area. The report identified that the top of the rock (sandstone) was encountered at depths of between 1.2 and two metres below ground level. There was no contamination investigation undertaken as part of the investigation.

AECOM is not aware of other soil or groundwater investigations previously completed within the Iron Cove Link civil site at Rozelle.

4.11.3 Site history

A review of historical aerial photographs, historical UBD business directories, historical titles, section 149 certificates and NSW EPA records was undertaken for the AECOM 2016c report. The information is summarised in **Table 4-33**.

Table 4-33 Site history summary – Iron Cove Link civil site (C8)

Property	Site history summary
C8-A Roads	• The historical aerial photographs showed that Victoria Road was realigned between 1943 and 1955. Prior to 1955 there were businesses located on Victoria Road west of Toelle Street, which were later demolished to make way for the new road alignment. An additional bridge was constructed on the south side of Iron Cove Bridge between 2007 and 2014; this work included the widening of the road leading to both bridges • The former Balmain Power Station was located directly north and adjacent to the site and was previously regulated by the NSW EPA due to the presence of a range of contaminants including polychlorinated biphenyl (PCBs) and asbestos. The NSW EPA notices were revoked in August 1997 following remediation of the site and the site was developed for high density residential and recreational open space land use • According to historical UBD records, there were timber merchants, motor garages, petrol stations, metal founders, laundries and copper and vat maker businesses along Victoria Road in 1950 and 1970.
C8-B Liquor store	• According to historical UBD records, Door and Joinery Pty Ltd (carpenters) and Cavanagh Brothers (carpenters) in 1950, Springside service station was located at the site in 1970 and an Ampol service station was located on the land in 1991 and N.S.W. Sash • The historical aerial photographs showed that there were buildings constructed and demolished between 1930 and 1961. The present day layout appeared the same in 1961 • During the site inspection in September 2016, the land appeared to be a former petrol station, with the original sales building converted into a Liquorland store and the former forecourt into a car park. There was an area of patched bitumen in the concrete in the northern car park which appeared to be the likely location of decommissioned USTs. No vent pipes or evidence of the location of the former fuel dispensing infrastructure was observed.
C8-C Computer and equipment store	• Historical titles records indicated 10 different owners between 1898 and 2016. The property was formerly owned by a joiner from 1918 to 1978. Various private owners held the site until 1991 • There were no historical UBD records for the property • During the site inspection in September 2016, the building had two windows on the building fronting Victoria Road which appeared to be former garage entries. The building also had two garages at the rear of the building off Callan Street. The building age appeared to be pre-1940s.

Property	Site history summary
C8-D Victoria Road residential houses	• Based on the historical aerial photographs it appears the properties have been used for residential properties since at least 1930 • During the site inspection in September 2016, all properties appeared to be used for residential purposes.
C8-E Clothing store	• Historical aerial photographs showed that since 1930 the property has been occupied by a building with only minor changes evident through to 2014 • According to UBD records the property was occupied by Iron Cove Bridge Sandwiches & Pies and Mrs Reid (mixed business) in 1970 and Mrs M White (mixed business and general store) in 1950 • During the site inspection in September 2016, the property appeared to be used as a clothing store.
C8-F Car dealership	• Historical aerial photographs showed that there were changes to the buildings on the property between 1930 and 1961 • According to the Gabriel Motors website (http://www.gabrielmotors.com.au) the mechanics workshop opened on the property in 1977 • There are no historical UBD records for the property and no NSW EPA records.
C8-G King George Park	• Historical aerial photographs showed that there were changes to the park in the form of earthworks between 1930 and 2014.
C8-B2 Car park	• Historical aerial photographs showed that the site was a park in 1930 and then a timber mill which was constructed between 1930 and 1943 and demolished between 1955 and 1961. From 1965 the site appeared to be a grassed area now used for car parking • There were no distinguishable features within the site when the timber mill was present and the operations and buildings of the timber mill appeared to be down topographic gradient of the site.
Up-gradient land	• Commercial and industrial businesses were formally located up-gradient (south) of the property along Victoria Road including the following: – Kwik Dry Cleaners (near the northern boundary) – Mars Steel Products and Winnertons Pty Ltd (metal foundries) and Motorcycle workshop (near the southern boundary) – Speedy Steering Service and Atlanta Spares (mechanics) (20 metres south) – F.Voyce Petrol Station and Space Motors (40 metres southeast) – Traynor Dry Cleaners, Superb Dry Cleaners, Jones Dry Cleaning and Tasman Dry Cleaning (100 to 170 metres southeast) – Unknown manufacturing business (formerly notified to the NSW EPA – regulation not required) (70 metres north).

4.11.4 Soil and geology

According to the NSW Department of Industry, Resources and Energy (2014), 1:100,000 Sydney geology map sheet the Iron Cove civil site geology consists of Triassic sandstone consisting of medium to coarse grained quartz sandstone, very minor shale and laminate lenses.

According to information provided by OEH the soil landscape consists mostly of Gymea Erosional soils and Hawkesbury Colluvial soils.

4.11.5 Hydrogeology

According to data provided by the (DPI-Water), Water Administration Ministerial Corporation and Commonwealth of Australia (Bureau of Meteorology) in December 2015, no registered groundwater wells were located within the proposed Iron Cove civil site and one registered groundwater well was within one kilometre of the Iron Cove civil site. Groundwater is measured alongside Victoria Road within the sandstone in two monitoring wells BH_IC01 and BH_IC02. Groundwater levels within the sandstone are relatively deep at between 4 and 8 metres below ground level, the water table becoming deeper further away from Iron Cove. There is no alluvium containing groundwater at the Iron Cove site.

The closest groundwater well was a monitoring well located 21 metres west in King George Park, with a recorded well depth of 25 metres. The geology of this well was logged as clay to seven metres and siltstone to 25 metres.

The groundwater flow direction at the site is towards the northwest, towards Iron Cove. Deep groundwater is present within porous productive aquifer in the underlying Hawkesbury Sandstone.

4.11.6 Acid sulfate soils

According to information provided by DP&E, the majority of the site is mapped as the following (see **Figure 4-24**):

- Soil Class 2: Works below natural ground surface or works by which the water table is likely to be lowered present an environment risk and require development consent and management procedures for acid sulfate soils. A small area of the northeast corner of the site and the western half of W2 is mapped as Soil Class 2.
- Soil Class 5: No known occurrence of acid sulfate soils. Works within 500 metres of adjacent Class 1, 2, 3 or 4 land that is below five metres AHD and by which the water table is likely to be lowered below one metre AHD on adjacent Class 1, 2, 3 or 4 land requires development consent and management procedures for acid sulfate soils. The whole of the site is mapped as Soil Class 5 with the exception of the areas mapped as Soil Class 2.

4.11.7 Areas and contaminants of concern

The key areas and contaminants of concern within the Iron Cove civil site are summarised in **Table 4-34**.

Table 4-34 Areas and contaminants of concern – Iron Cove Link civil site at Rozelle (C8)

Property	Description	CoPC
C8-A Roads	Former petrol stations, manufacturing and timber industries located at the northwest end of Victoria Road. Imported fill from an unknown source potentially used to raise the level of the road near Iron Cove Bridge. The northeast corner of the area is mapped as Soil Class 1 for acid sulfate soils.	Metals, TRH, VOCs, SVOCs, asbestos Acid sulfate soils
C8-B Liquor store	Former petrol station and carpenters. Former UPSS is a potential source of soil and groundwater contamination. Imported fill from an unknown source potentially used to raise and level the site.	Metals, TRH, BTEX, PAHs, OCPs, PCBs, asbestos
C8-C Computer store	Potentially a former workshop, which may have historically stored and handled oils, fuels and solvents.	Lead, TRH, PAHs and VOCs

Property	Description	CoPC
C8-D Victoria Road residential houses	No areas of concern expected with the exception of the demolition/construction of buildings and use of lead paint which may have resulted in localised areas of ACM fragments and lead paint flakes in soil.	Lead, asbestos
C8-E Clothing store	No known former contaminating land uses.	Nil
C8-F Car dealership	Currently a mechanical workshop which would have historically stored and handled oils, fuels and solvents.	Lead, TRH, PAHs and VOCs
C8-G King George Park	Imported fill from an unknown source potentially used. Other unknown site activities appeared to have occurred on the site based on the historical aerial photographs.	Metals, TRH, BTEX, PAHs, OCPs, PCBs, asbestos
C8-B2 Car park	Imported fill from an unknown source potentially used. Operation of a timber mill on adjacent land in the 1940s and 1950s.	Metals, OCPs, PAHs, asbestos
Up-gradient land	Current and former petrol stations, mechanics, dry cleaners, manufacturing businesses and substation located adjacent and topographically up-gradient of the site.	Metals, TRH, VOCs, SVOCs, PCBs

Figure 4-24 Iron Cove civil site at Rozelle (C8) - acid sulfate soils

4.12 C9 – Pyrmont Bridge Road tunnel site at Annandale

4.12.1 Site description and surrounding area

The Pyrmont Bridge Road tunnel site is located within Annandale in the Inner West Council LGA. The site is shown in **Figure 4-25** and would be located in area currently comprising various commercial properties. The Pyrmont Bridge Road tunnel site at Annandale slopes to the northwest and is surrounded by the land uses listed in **Table 4-35**.

Table 4-35 Surrounding land use – Pyrmont Bridge Road tunnel site at Annandale (C9)

Direction	Description of surrounding land use and proximity to the site
North	• Pyrmont Bridge Road, followed by commercial/industrial and residential properties (topographically down-gradient) and then Johnstons Creek 150 metres northwest and 280 metres north.
South	• Parramatta Road followed by the Bridge Road School and mixed use commercial and medium to high density residential properties • Alfred's Dry Cleaning located 314 metres topographically up-gradient • Johnstons Creek is also located 150 metres northwest up-gradient.
East	• Booth Street followed by commercial and medium to high density residential properties • Grace Dry Cleaning and Laundry located around 95 metres topographically up-gradient • BP Connect Camperdown service station located around 270 metres topographically up-gradient.
West	• Camperdown Service Centre located around 50 metres topographically down-gradient • James Squires Brewery located adjacent and topographically down-gradient • 7 Eleven service station located 65 metres topographically down-gradient.

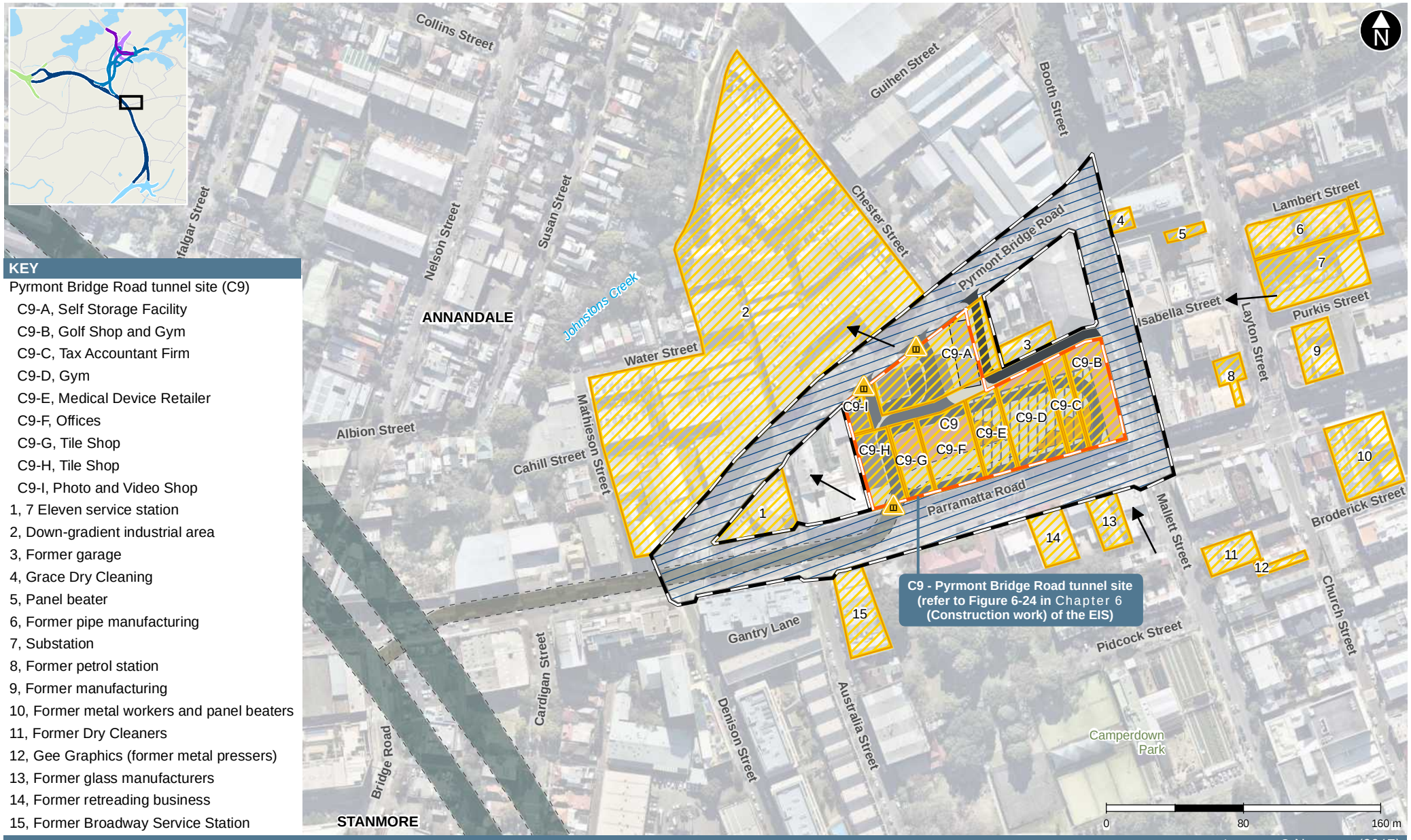


Figure 4-25 Pyrmont Bridge Road tunnel site at Annandale (C9)

4.12.2 Previous investigations

AECOM is not aware of soil or groundwater investigations previously completed within the Pyrmont Bridge Road tunnel site at Annandale.

4.12.3 Site history

A review of historical aerial photographs, historical UBD business directories and NSW EPA records were undertaken for the AECOM 2016d report. The information is summarised in **Table 4-36**.

Table 4-36 Site History Summary – Pyrmont Bridge Road tunnel site at Annandale (C9)

Property	Site history summary
C9-A Self-storage Facility	• The 1948 and 1956 historical survey map showed the property was occupied by Hastings Deering Limited (earth moving equipment manufacturers) • No businesses were identified within the property from the 1950 UBD business directory records. In 1970 Rowell Thiele Ford Pty Ltd (Motor car/truck dealers and spare parts) was located within the property and Millers Self Storage was located on the site in 1991 • The building configuration appeared the same as the present day in all historical aerial photographs between 1930 and 2014 (present day warehouse building) • The property is currently being used as a self-storage facility • The property was not listed on the NSW EPA record of notices or sites notified to the NSW EPA.
C9-B Golf shop and Gym	• The 1948 historical survey map showed the property was occupied by Bedford Trucks Sales and Service • The Australian Incandescent Co (electrical suppliers) was located on the site in 1950 according to the UBD business directory records. W.T Coggins Pty Ltd; a motor accessories wholesaler/car dealership was located at the site in 1950 and 1970 • There were no records available for a business at the property in 1991 • The building configuration appeared the same as the present day in all aerial photographs between 1930 and 2014 • The property is currently being used for a Golf retail store and gym.
C9-C Tax accountant firm	• The property was occupied by the Bank of NSW in the 1948 and 1956 historical survey maps • No UBD business records were available for the property in 1970 or 1991 • The historical aerial photographs showed that prior to 1970 there were previously small buildings or sheds in what is now the rear car park accessed by Bignell Lane. In 1982 there also appeared to be some small sheds along the western boundary of the car park and the ground in the car park appeared disturbed • The property is currently being used as a tax accounting firm • The property was not listed on the NSW EPA record of notices or sites notified to the NSW EPA.

Property	Site history summary
C9-D Gym	• The UBD business directory records showed J.T.A Pryer & Son (blacksmiths and welders), Ferrier, Dickinson and Weir Drysdale Ltd (motor garage/engineers) and J.W. Rigden & Son Pty Ltd (a motor parts and accessories dealer) were located within the site in 1950 • According to the 1956 historical survey map the property was occupied by Pioneer Spring Co Ltd (spring manufacturers) • In 1970 J.W. Rigden & Son Pty Ltd, Australian Brake Lining Co Pty. Ltd (motor brakes manufacture and wholesaler) and Speedy Spring Service Pty Ltd (spring manufacturers) were located within the property. In 1991 the site contained Jay-Jay Jeans Warehouse, a clothing manufacture and wholesaler • Between 1943 and 1970 the site appeared to consist of two long narrow buildings with a driveway between them, and appeared to be part of the building adjacent to the west. The western building had been demolished and replaced with a car park in 1982. A new building had been constructed across the entire property by the 1991 aerial photograph • The property is currently being used by Camperdown Fitness, a gym and personal training facility • The property was not listed on the NSW EPA record of notices or sites notified to the NSW EPA.
C9-E Medical device retailer	• According to the 1956 historical survey map the property was occupied by F.R.S Springs (spring manufacturing) • Spray King Auto Painting International Inc., a motor body repair and accessory wholesaler was located within the property in 1970 according to the UBD business directory records • The building configuration appeared the same in all historical aerial photographs between 1930 and 2014, with the exception of the connection to the adjoining former warehouse between 1943 and 1970 • The property is currently being used as medical device retailer • The property was not listed on the NSW EPA record of notices or sites notified to the NSW EPA.
C9-F Offices	• According to the 1956 historical survey map the property was occupied by the Australian Incandescent Co (electrical supplies/manufacturing) • Thorn Electrical Industries (Aust.) Pty Ltd, a refrigerator wholesaler was located at the property in 1970 • Starkey Laboratories Australia Pty Ltd (hearing aids), James Creative Services Pty Ltd (advertising agency) and Reproduction Tiles (tile merchants) were located within the property in 1991 • The building configuration appeared the same as the present day in all historical aerial photographs between 1943 and 2014. The building was not distinguishable in the 1930 aerial photograph • At the time of the site inspection the property was an office building occupied by a number of businesses • The property was not listed on the NSW EPA record of notices or sites notified to the NSW EPA.

Property	Site history summary
C9-G Tile shop	• According to the 1956 historical survey map the property was occupied by W.R Carpenter & Co Ltd (mechanics and part dealers) • U.R.I. Printing Industries Pty Ltd, a printer lithographic was located at the property in 1991 according to the UBD records. There were no UBD records for 1950 and 1970 • The building configuration appeared the same in all historical aerial photographs between 1930 and 2014 • The location is currently being used as a tile store • The property was not listed on the NSW EPA record of notices or sites notified to the NSW EPA.
C9-H Tile shop	• Bass Products (light fitting manufacturers) and Novelta Textiles Pty Ltd (textile manufacturers) and C.H, Robertson (gasket manufacturers) in 1950 according to UBD business directories • According to the 1956 historical survey map the property was occupied by Consolidated Neon Ltd (light fitting manufacturers) in 1956 • The property was not listed on the NSW EPA record of notices or sites notified to the NSW EPA • The property is currently being used as a tile retail store.
C9-I Photo and Video shop	• Burrows Plating Works Pty Ltd (annunciators and electroplaters) was located within the property in 1950 and 1970 according to the UBD business directory records • The property was not listed on the NSW EPA record of notices or sites notified to the NSW EPA • The property is currently being used as a photography studio.
Surrounding land	• Motor garages, petrol stations, dry cleaners, metal platers and manufacturing businesses were all located topographically up-gradient and within 150 metres of the Pyrmont Bridge Road tunnel site according to the UBD business directory records between 1950 and 1991 • Sites notified to the NSW EPA under section 60 of the CLM Act and topographically up-gradient of the Pyrmont Bridge Road tunnel site: – Former Gee Graphics (27 Church Street, Camperdown), regulation under CLM Act not required (around 100 metres southeast) – Shell Coles Express service station, 124–126 Johnston Street. Annandale, regulation under CLM Act not required (around 700 metres northwest) • O'Dea Reserve, Salisbury Lane, Camperdown (340 metres south), a former uncontrolled landfill in a former brick pit, was formerly regulated by the NSW EPA under the CLM Act 1997 for PAH, lead and TPH contamination, which suggests this location has historically been remediated.

4.12.4 Soil and geology

According to the NSW Department of Industry, Resources and Energy (2016), 1:100,000 scale geological units and structures, the geology of the Pyrmont Bridge Road tunnel site at Annandale consists of the Triassic Ashfield Shale from the Wianamatta Group, which is described as black to dark grey shale and laminate.

4.12.5 Hydrogeology

According to data provided by the (DPI-Water), Water Administration Ministerial Corporation and Commonwealth of Australia (Bureau of Meteorology) in August 2016, there are no registered groundwater wells within the Pyrmont Bridge Road tunnel site at Annandale and 10 registered groundwater wells within one kilometre. All 10 wells were registered as monitoring wells. Further details are listed as follows:

- Four monitoring wells were located in O'Dea Reserve, 423 metres south of the site. The wells were installed to depths of 2.5 to 10.7 metres below ground level
- Two private monitoring wells were registered at 80 Parramatta Road Camperdown, 450 metres east of the site. The wells were installed to depths of 1.8 and 3.2 metres below ground level
- Three private monitoring wells were registered at the Shell Coles Express Annandale, 710–740 metres northwest of the Pyrmont Bridge Road tunnel site. The wells were installed to depths of four metres below ground level. Standing water level in these wells has been registered as 1.75 and 2.4 metres below top of casing
- One private well was registered at a car dealership located at 36–38 Parramatta Road Glebe, 739 metres east of the Pyrmont Bridge Road tunnel site. The well was installed to a depth of 4.4 metres below ground surface, with standing water level of 2.07 metres below top of casing.

Camperdown is underlain by Ashfield Shale which typically displays a weathered profile consisting of clay. At Camperdown five monitoring wells were constructed (AECOM 2017a) that intersected Ashfield Shale and the underlying Hawkesbury Sandstone. The area has a relatively high topography and consequently groundwater level depths range between two and nine metres below ground level and reflect the elevated topography.

Aquifers within one kilometre of the Pyrmont Bridge Road tunnel site at Annandale are described as being porous, extensive and highly productive in the Hawkesbury Sandstone.

Groundwater is expected to flow to the northwest towards Johnstons Creek and Rozelle Bay.

4.12.6 Acid sulfate soils

According to information provided by DP&E, the site is mapped as Soil Class 5: No known occurrence of acid sulfate soils. Works within 500 metres of adjacent Class 1, 2, 3 or 4 land that is below five metres AHD and by which the water table is likely to be lowered below one metre AHD on adjacent Class 1, 2, 3 or 4 land requires development consent and management procedures for acid sulfate soils. Land mapped as Soil Class 3 is located 110 metres northwest of the site (see **Figure 4-26**).

4.12.7 Areas and contaminants of concern

The key areas and contaminants of concern within the Pyrmont Bridge Road tunnel site are summarised in **Table 4-37**.

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Table 4-37 Areas and contaminants of concern – C9 Pyrmont Bridge Road tunnel site at Annandale

Property	Description	CoPC
C9-A Self-storage Facility	Former earth moving machinery manufacturing	Metals, TRH, BTEXN, PAHs, VOCs
C9-B Golf shop and Gym	Potential former workshops and mechanics	Metals, TRH, BTEXN, PAHs, VOCs
C9-C Tax accountant firm	Former carpenters and demolition of former structures at rear of the property	Lead, asbestos and PCBs
C9-D Gym	Former manufacturing and workshops and demolition of former building	Metals, TRH, BTEXN, PAHs, VOCs, asbestos, PCBs
C9-E Medical device retailer	Former manufacturing and workshops	Metals, TRH, BTEXN, PAHs, VOCs
C9-F Offices	Former manufacturing	Metals, TRH, BTEXN, PAHs, VOCs
C9-G Tile shop	Former mechanics workshops	Metals, TRH, BTEXN, PAHs, VOCs
C9-H Tile shop	Former fluorescent light manufacturing	Metals, PCBs
C9-I Photo and Video shop	Former electroplaters	Metals, TRH, cyanide
Off-site sources	Former motor garages, petrol stations, dry cleaners, metal platers and manufacturing businesses had the potential to cause contamination.	Metals, TRH, BTEXN, PAHs, VOCs, SVOCs, cyanide

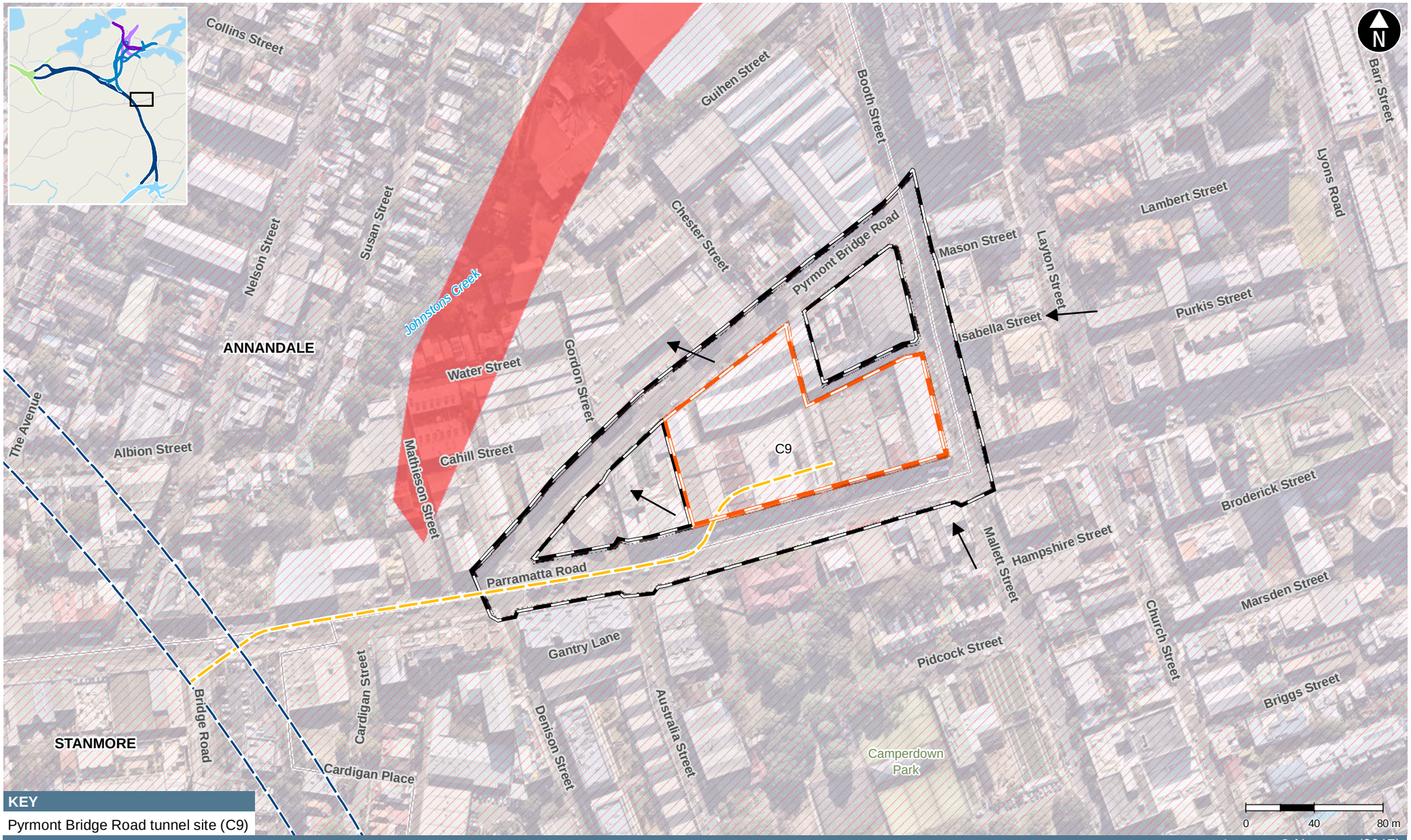

Figure 4-26 Pyrmont Bridge Road tunnel site at Annandale (C9) - acid sulfate soils

4.13 C10 – Campbell Road civil and tunnel site at St Peters

4.13.1 Site description

The Campbell Road civil and tunnel site is located at St Peters within the Inner West Council and City of Sydney LGAs. The site is shown in **Figure 4-27** and would be located on land currently being used as a construction site for the New M5 project**.** The findings of contamination investigations previously undertaken for the New M5 project are summarised in **Table 4-41**.

Following approval of the New M5 project, the Campbell Road civil and tunnel site has undergone significant clearance and construction work. It is understood that these works are being managed under the WestConnex New M5 *Construction Contaminated Management Plan* (Document: M5N-ES-PLN-PWD-0033), 17 November 2016.

The Campbell Road civil and tunnel site at St Peters slopes to the southeast and is surrounded by the land uses listed in **Table 4-38.**

Table 4-38 Surrounding land use – Campbell Road civil and tunnel site at St Peters (C10)

Direction	Description of surrounding land use and proximity to the site
North	• Medium to high density residential properties • Commercial properties including Barbara's Prestige Smash Repairs and Australian Refined Alloys • Campbell Road • Sydney Park.
South	• Former Alexandria Landfill/St Peters interchange construction site (part of the New M5 project).
East	• Commercial/industrial properties including Real Foods, former smash repairs and taxi base, and former Sims Metal Management scrap metal depot.
West	• Former Alexandria Landfill/St Peters interchange construction site (part of the New M5 project) • Retail and warehouse commercial businesses • Princes Highway • Medium to high density residential properties.

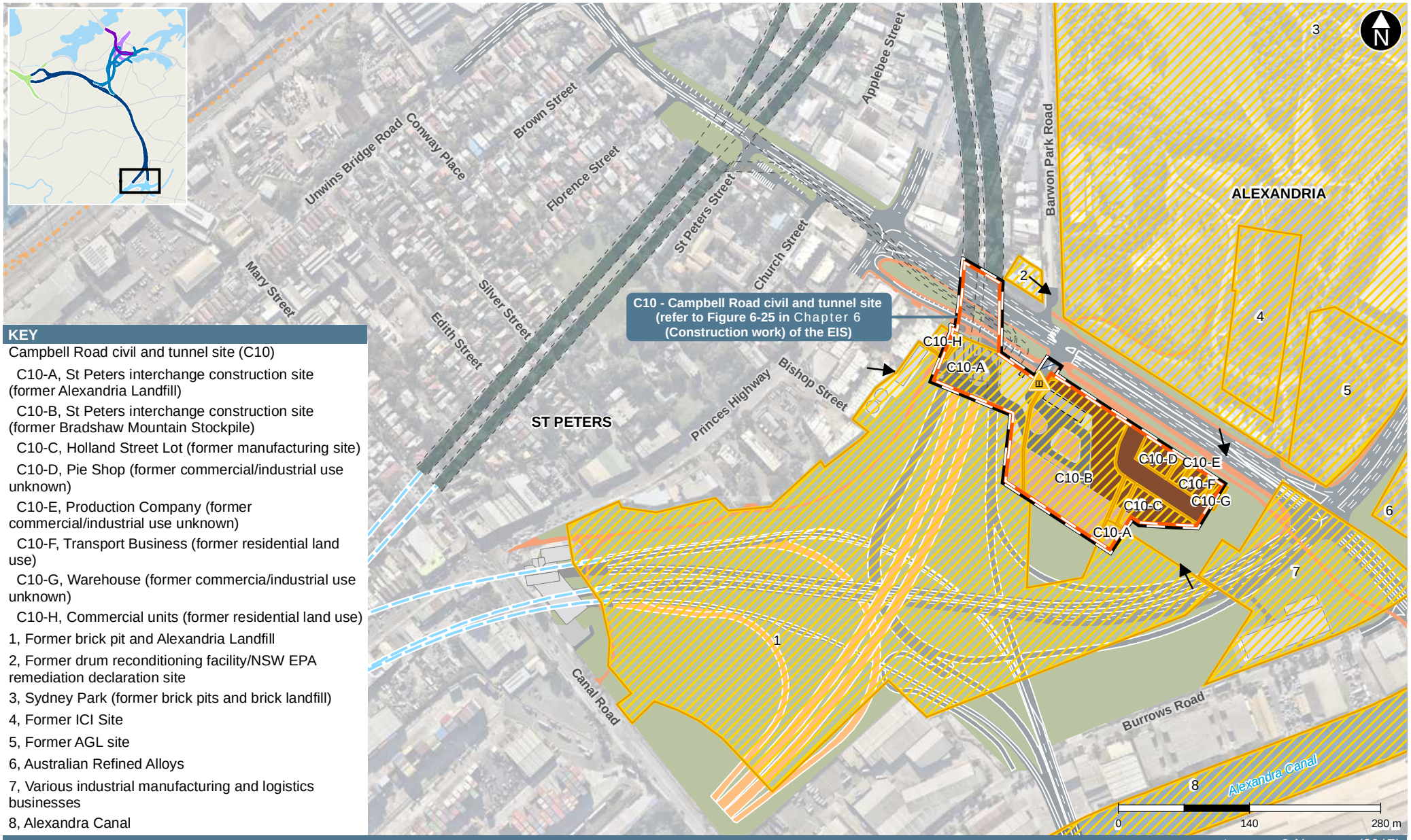

Figure 4-27 Campbell Road civil and tunnel site at St Peters (C10)

4.13.2 Previous intrusive investigations

The following soil, groundwater and landfill gas investigations have been undertaken that are relevant to the Campbell Road civil and tunnel site:

- AECOM, 2015b. WestConnex Stage 2: M5 Factual Contamination Assessment. 60327128_CI_RPT03_Draft_20150422. 22 April 2015
- AECOM, 2015c. Characterisation of the Bradshaw Mountain Stockpile – Resource Recovery Order for Potential Excavated Natural Material Exemption (Draft). 24 April 2015
- AECOM, 2015d. Phase 2 Environmental Site Assessment Alexandria Landfill, 10-16 Albert Street, NSW. 60327128_Draft Phase 2 ESA_20150506_A. 6 May 2015.

4.13.3 Site history

Key historical information for the Campbell Road civil and tunnel site has been summarised from the previous reports in **Table 4-39**.

Table 4-39 Site History Summary pre-New M5 – Campbell Road civil and tunnel site at St Peters (C10)

Property	Site history summary
C10-A St Peters interchange construction site (former Alexandria Landfill)	• The property was a mixture of unknown commercial/industrial land use and agricultural land use prior to 1908. The property was then a Ralford pit quarry and brick works operated by the Austral Brick Company until 1962 • The City of Sydney operated a solid waste 'inert/non-putrescible' landfill (Alexandria Landfill) within the former quarry from 1988 until 2002 when the landfill was purchased and operated by Dial-A-Dump Industries (AECOM, 2014) • The property was then acquired by the NSW Government in 2015 • AECOM undertook soil, groundwater, leachate and landfill gas investigations and assessments in 2014 and 2015 (AECOM 2015d) and prepared a Landfill Closure Management Plan (AECOM 2015f) for the property • The property is currently operated by the CPB Contractors, Dragados, Samsung Joint Venture for the construction of the St Peters interchange as part of the New M5 project and is being managed under the WestConnex New M5 Construction Contaminated Management Plan (Document: M5N-ES-PLN-PWD-0033), 17 November 2016 and the Golder Associates (2016). Design Report – Alexandria Landfill & Bradshaw Mountain Remediation Action Plan (RAP). St Peters Interchange – Alexandria Landfill and Bradshaw Mountain Sites (Document: M5N-GOL-MNP-900-300-WT-9401-D), 12 April 2016 • The premises is licensed for road construction under EPL 4627. The Licensee for the site is the CPB Contractors, Dragados, Samsung Joint Venture. The EPL includes requirements for closure of the landfill, including leachate and landfill gas management measures, which must be undertaken in accordance with the landfill closure plan.

Property	Site history summary
C10-B St Peters interchange construction site (former Bradshaw Mountain Stockpile)	• The property was occupied by market gardens prior to 1923. After 1923 the brick works infrastructure (buildings, furnaces and chimneys) was constructed on the site • The brick works was demolished in 1970 and then the property was used for storing crushed sandstone. The crushed sandstone stockpile (known as Bradshaw Mountain) was unused and became vegetated after 2004 (AECOM, 2014) • AECOM completed an assessment of the stockpiled sandstone against the *Excavated Natural Material Exemption Order* 2014 in 2015 (AECOM 2015c) • The property is currently operated by the CPB Contractors, Dragados, Samsung Joint Venture for the construction of the St Peters interchange as part of the New M5 project and is being managed under the WestConnex New M5 Construction Contaminated Management Plan (Document: M5N-ES-PLN-PWD-0033), 17 November 2016.
C10-C Holland Street Lot	• According to the historical certificates of titles the property was previously occupied by Francis Holbeach (fishing line manufacturing) from 1926 to 1947, Ralph Symonds Pty Ltd (laminated timber veneer manufacturers) from until 1970, Alltrans Storage (S.A) Pty Ltd until 1995, Brambles Australia Ltd until 1999 and then Glenridge Holdings (AECOM 2014) • Based on the historical aerial photographs a factory was constructed on the property in the early 1950s. The factory continued to the east on the adjacent lot. The factory roof on the property was demolished between 1999 and 2004 • The walls of the original factory remained and the property was leased to various businesses as a yard for equipment and stockpiling until acquisition for the New M5 project in 2016 • The property is currently operated by the CPB Contractors, Dragados, Samsung Joint Venture for the construction of the St Peters interchange as part of the New M5 project and is being managed under the WestConnex New M5 Construction Contaminated Management Plan (Document: M5N-ES-PLN-PWD-0033), 17 November 2016.
C10-D Pie shop	• Based on the historical aerial photographs the present day factory building has been present since at least 1978. Prior to 1978 the property contained several smaller commercial or industrial buildings • A pre-1970s survey map showed that the property site was occupied by Helicon Pty Ltd (business type unknown) • The site was most recently used as a pie shop until acquisition for the New M5 project in 2016 • The property is currently occupied by the CPB Contractors, Dragados, Samsung Joint Venture for the construction of the St Peters interchange as part of the New M5 project and is being managed under the WestConnex New M5 *Construction Contaminated Management Plan* (Document: M5N-ES-PLN-PWD-0033), 17 November 2016.

Property	Site history summary
C10-E Production Company	• Based on the historical aerial photographs the current workshop building has been present since the 1960s. Prior to 1960 the property appeared to contain a number of small sheds • The site was most recently used by a production company as a workshop until acquisition for the New M5 project in 2016 • The property is currently occupied by the CPB Contractors, Dragados, Samsung Joint Venture for the construction of the St Peters interchange as part of the New M5 project and is being managed under the WestConnex New M5 Construction Contaminated Management Plan (Document: M5N-ES-PLN-PWD-0033), 17 November 2016.
C10-F Transport Business	• The property contained residential houses from pre 1930 until between 1960 and 1978 when the houses were demolished and a warehouse was constructed on the eastern side of the property. The property appeared undeveloped since • The property was most recently used as a yard for Brownways Transport until acquisition for the New M5 project in 2016 • The property is currently occupied by the CPB Contractors, Dragados, Samsung Joint Venture for the construction of the St Peters interchange as part of the New M5 project and is being managed under the WestConnex New M5 Construction Contaminated Management Plan (Document: M5N-ES-PLN-PWD-0033), 17 November 2016.
C10-G Warehouse	• The property contained residential houses from pre-1930 until between 1961 and 1978 when the present day warehouse building was constructed • The use of the site was unknown at the time of acquisition for the New M5 project in 2016 • The property is currently occupied by the CPB Contractors, Dragados, Samsung Joint Venture for the construction of the St Peters interchange as part of the New M5 project and is being managed under the WestConnex New M5 *Construction Contaminated Management Plan* (Document: M5N-ES-PLN-PWD-0033), 17 November 2016.
C10-H Commercial units	• The property contained residential houses from pre-1930 until the 1990s based on historical aerials. The property was then redeveloped into commercial units • The site was used by various commercial businesses at the time of acquisition for the New M5 project in 2016 • The property is currently occupied by CPB Contractors, Dragados, Samsung Joint Venture for the construction of the St Peters interchange as part of the New M5 project.

Property	Site history summary
Surrounding land	• The St Peters brick pits and brick works were located to the north of Campbell Road. The brick pit quarries were converted into council solid waste landfills and then redeveloped into Sydney Park • There were various industrial properties north of the site area including Hibbards Meters Pty Ltd, Imperial Chemical Industries (ICI), Australian Gas and Light Company (AGL) gasholders, R Clifford and Son Transport, Endochrome Pty Ltd and Universal Constructions • Industrial properties were also located to the east of the site, including F.A Harper and Sons Pty Ltd (unknown business type) and Rudders Ltd (logistics) • A former drum reconditioning facility located on the corner of Barwon Park Road and Campbell Road and topographically up-gradient of the C9 site was formerly declared a remediation site by the NSW in 2006. The declaration was for soil contaminated with PAHs, TPH and BTEXN and groundwater contaminated with naphthalene and TPH migrating off-site.

4.13.4 Soil and geology

AECOM completed intrusive investigations within the Campbell Road civil and tunnel site within the former Alexandria Landfill (C10/1) (AECOM 2015d) and Bradshaw Mountain (C10/2) (AECOM 2015c). The investigations included eight boreholes in the former Alexandria Landfill part of the site and eight boreholes in the Bradshaw Mountain part of the site.

The investigations showed that landfill extends to depths of up to 33.5 metres below ground surface in the portion of the Campbell Road civil and tunnel site within the former Alexandria Landfill. Closer to Albert Street the depth of the fill is less than 2.5 metres below ground surface. The landfill was directly underlain by bedrock.

Prior to reuse, Bradshaw Mountain consisted of crushed sandstone until the depth of the surrounding ground level and then three to 10 metres of underlying fill (non-landfill waste), followed by alluvial sediments consisting of silty sand and clay (Botany Sands) and then bedrock.

AECOM completed geotechnical investigations within and surrounding the Campbell Road civil and tunnel site to inform the WestConnex project (AECOM 2015b). The works included coring 13 boreholes (WXCBH045 to WCXBH60) to a maximum depth of 51 metres below ground surface (-44.26 metres AHD). The investigation found that the landfill overlays laminite and siltstone of the Ashfield Shale group and then Hawkesbury Sandstone.

Much of the soil and fill material (including the Bradshaw Mountain stockpile) identified during previous investigations completed for the New M5 project has been excavated or removed as part of the bulk earthworks required for construction of the St Peters interchange. Any residual landfill waste would be managed in accordance with the Golder Associates (2016) RAP prepared for the St Peters interchange as part of the New M5 project.

4.13.5 Acid sulfate soils

Based on review of the previous Marrickville Council and City of Sydney Acid Sulfate Soil Risk Map Sheets and the presence of Holocene estuarine sediments, there is potential for acid sulfate soils to be present within the site. The north-western half of the site is indicated as Class 2 acid sulfate soils and the south-eastern half as Class 3 acid sulfate soils under the classification scheme (see **Figure 4-28**). Class 2 means that any works below the natural ground surface or works where the groundwater table would be lowered would require development consent. Class 3 means that any work greater than one metre below ground surface or any works that would lower the water table by greater than one metre bgs would require development consent.

4.13.6 Hydrogeology

Four groundwater monitoring wells were previously installed within the Campbell Road civil and tunnel site within the former Alexandria Landfill (C10/1) (AECOM 2015d). The construction details are summarised in **Table 4-40**.

Table 4-40 Groundwater monitoring wells – Campbell Road civil and tunnel site at St Peters (C10)

Well ID	Screened interval (metres btoc)	Screened lithology	Standing water level (metres btoc)	Standing water level (metres AHD)
MW308	30.5 to 33.5	Landfill	21.985	-12.515
MW309	6.2 to 9.8	Botany Sands	4.480	-1.53
MW310	4.7 to 5.1	Botany Sands	4.330	1.14
MW311	9.9 to 12.9	Landfill	12.965	-4.865

The AECOM 2015d report found that the groundwater flow in the Botany Sands, landfill and bedrock was towards the main leachate extraction sump located around 300 metres southwest of the Campbell Road civil and tunnel site in the former Alexandria Landfill. A new leachate extraction system has been installed as part of the landfill closure plan developed for the St Peters interchange, for the New M5 project.

Groundwater is present within the Ashfield Shale and the Botany Sands to the south east. Groundwater levels are influenced by the leachate pumping from the former landfill locally causing groundwater flow to be artificially centred on the landfill. Groundwater quality immediately around the landfill may be influenced by the landfill with both elevated ammonia and nutrients among the contaminants of concern. Groundwater levels monitored in wells SP_BH04, SP_BH09, SP_BH06 (AECOM 2017a) range between 4 and 16 m below ground level and are depressed due to the leachate pumping.

4.13.7 Intrusive investigation results

The findings from the previous investigations (AECOM 2015b, 2015c and 2015d) are summarised in **Table 4-41**.

Table 4-41 Intrusive Investigation Results – Campbell Road civil and tunnel site at St Peters (C10)

Property	Description
C10-A St Peters interchange construction site (former Alexandria Landfill)	• Ten boreholes (BH351, BH353, BH361, BH362, BH364, BH356, BH357, BH407, BH408 and WCX_BH_059) were sampled in the C10-A area. A further 74 boreholes were sampled within the surrounding St Peters interchange construction site/former Alexandria Landfill to the south • Four groundwater monitoring wells (MW1, MW311, MW309 and MW310) were sampled in the C10-A area. A further 13 monitoring wells were sampled within the surrounding St Peters interchange construction site/former Alexandria Landfill to the south • Three landfill gas monitoring wells (LG308, LG310 and LG309) were sampled in the C10-A area. A further 10 monitoring wells were sampled within the surrounding St Peters interchange construction site/former Alexandria Landfill to the south • Concentrations of metals, TRH, CPAHs, PAHs, PCBs, dioxins and asbestos within subsurface soil variably exceeded the adopted human-health based assessment criteria for both the open space and commercial/industrial land use scenarios (ASC NEPM (2013) HIL C and HIL D). Contamination was mainly confined to the fill and randomly distributed both laterally and throughout the full depth of the landfill • Friable asbestos was detected in surface soils at concentration's greater than the assessment criteria for both the open space and commercial/industrial land use scenarios and was widespread across the site • Concentrations of CoPC in natural soils underlying the fill were less than the adopted human-health and ecological based assessment criteria. Analytical results indicated PASS was present in natural soils • Based on the concentrations of methane and flow rates measured, the site was classified as Characteristic Gas Situation 4 (moderate to high risk) definition based on the MWCC (NSW EPA 2012) • Landfill gases carbon dioxide and carbon monoxide were detected at high concentrations with concentrations of hydrogen sulfide exceeding the adopted site assessment criteria • Concentrations of TRH >C10-C34 fractions, benzene, manganese, nickel, sodium, chloride and TDS exceeded the human health based criteria in groundwater. TRH >C10-C34 fractions and benzene were detected in the leachate and not in the Botany Sands or bedrock aquifer • Concentrations of cobalt, cadmium, copper, nickel and zinc exceeded the ecological based assessment criteria in leachate and the bedrock aquifer. Concentrations of metals were highest in the leachate and the bedrock aquifer • Concentrations of ammonia exceeded the adopted groundwater ecological based assessment criteria in leachate and slightly exceeded the criteria in the Botany Sands and bedrock aquifers.

Property	Description
C10-B St Peters interchange construction site (former Bradshaw Mountain Stockpile)	• Nine boreholes (BH398 to BH404) were drilled through the Bradshaw Mountain stockpile and into the underlying fill and Botany Sands within the C10-B area • The stockpile of crushed sandstone was assessed against the excavated natural material (ENM) exemption 2014. With the exception of the base of the stockpile interface with underlying fill, the material met the ENM exemption 2014 criteria • The underlying fill and natural soils were analysed for metals, TRH, BTEXN, PAHs, phenols, OCPs, OPPs, PCBs, SVOCs, VOCs and asbestos and assessed against the ASC NEPM 2013 guidelines for commercial/industrial and open space land use • One exceedance of the ASC NEPM (2013) HIL C for CPAHs was detected within the fill underlying the Bradshaw Mountain stockpile and friable ACM was detected in one sample from the fill underlying the Bradshaw Mountain stockpile • The main inclusions in the fill were observed to be brick and ceramic materials and some ash layers, which is consistent with the historical brickworks use of the site. No landfill waste was identified within the footprint of Bradshaw Mountain at the locations sampled • No observations of contamination were observed in the underlying natural soil • The 95 per cent UCL for all CoPC met the adopted assessment criteria in the samples analysed • Acid sulfate field tests and SPOCAS analysis was also completed for samples collected from the Botany Sands • Based on the field acid sulfate soils tests completed and observations of marine sediments, there is potential for acid sulfate soils to be present within the natural soils in the site. The sulfur trail results from samples analysed for SPOCAS exceeded the ASSMAC (1998) assessment criteria, indicating that management procedures for acid sulfate soils should be prepared as part of the CSWMP and implemented if future disturbance of the underlying natural soil or lowering of the water table is anticipated as part of future works.

4.13.8 Areas and contaminants of concern

The key areas and contaminants of concern within the Campbell Road civil and tunnel site are summarised in **Table 4-42**. Some areas of concern such as the former Alexandria Landfill (located immediately to the south) are currently being remediated/managed as part of the New M5 project in accordance with the following documents:

- Golder Associates (2016). Design Report – Alexandria Landfill & Bradshaw Mountain Remediation Action Plan (RAP). St Peters Interchange – Alexandria Landfill and Bradshaw Mountain Sites (Document: M5N-GOL-MNP-900-300-WT-9401-D), 12 April 2016
- WestConnex New M5 Construction Contaminated Management Plan (Document: M5N-ES-PLN-PWD-0033), 17 November 2016.

As such, the potential contamination risk posed by the presence of contamination following the implementation of remediation and landfill closure works at these locations is considered to be low.

Table 4-42 Areas and Contaminants of Concern – Campbell Road civil and tunnel site at St Peters (C10)

Property	Description	Contaminants of Potential Concern
C10-A St Peters interchange construction site (former Alexandria Landfill)	Former solid waste (non-putrescible) landfill and recycling facility.	Landfill gases (methane, hydrogen sulphide, carbon dioxide and carbon monoxide), leachate (particularly ammonia), metals, PAHs, SVOCS, VOCs and asbestos.
C10-B St Peters interchange construction site (former Bradshaw Mountain Stockpile). Note: The material comprising Bradshaw Mountain has been removed as part of the St Peters interchange construction works program.	Historical uncontrolled filling (non-landfill). A stockpile of ENM is located on the site.	Landfill gases (from adjacent landfill), metals, PAHs and asbestos.
C10-C Holland Street Lot	Historical uncontrolled filling.	Landfill gases (from adjacent landfill), metals, SVOCs, VOCs and asbestos.
C10-D Pie shop	Unknown former commercial/industrial purposes.	Landfill gases (from adjacent landfill), metals, SVOCs, VOCs and asbestos.
C10-E Production Company	Unknown former commercial/industrial purposes.	Landfill gases (from adjacent landfill), metals, TRH, SVOCs, VOCs and asbestos.
C10-F Transport Business	Demolition of former structures and storage/maintenance of trucks.	Lead, TRH, BTEXN, asbestos.
C10-G Warehouse	Demolition of former structures and warehouse.	Lead, TRH, BTEXN, asbestos.
Off-site sources	Sydney Park (former landfill) and former surrounding industrial land use.	Landfill gases (from adjacent landfill), metals, TRH, SVOCs, VOCs.

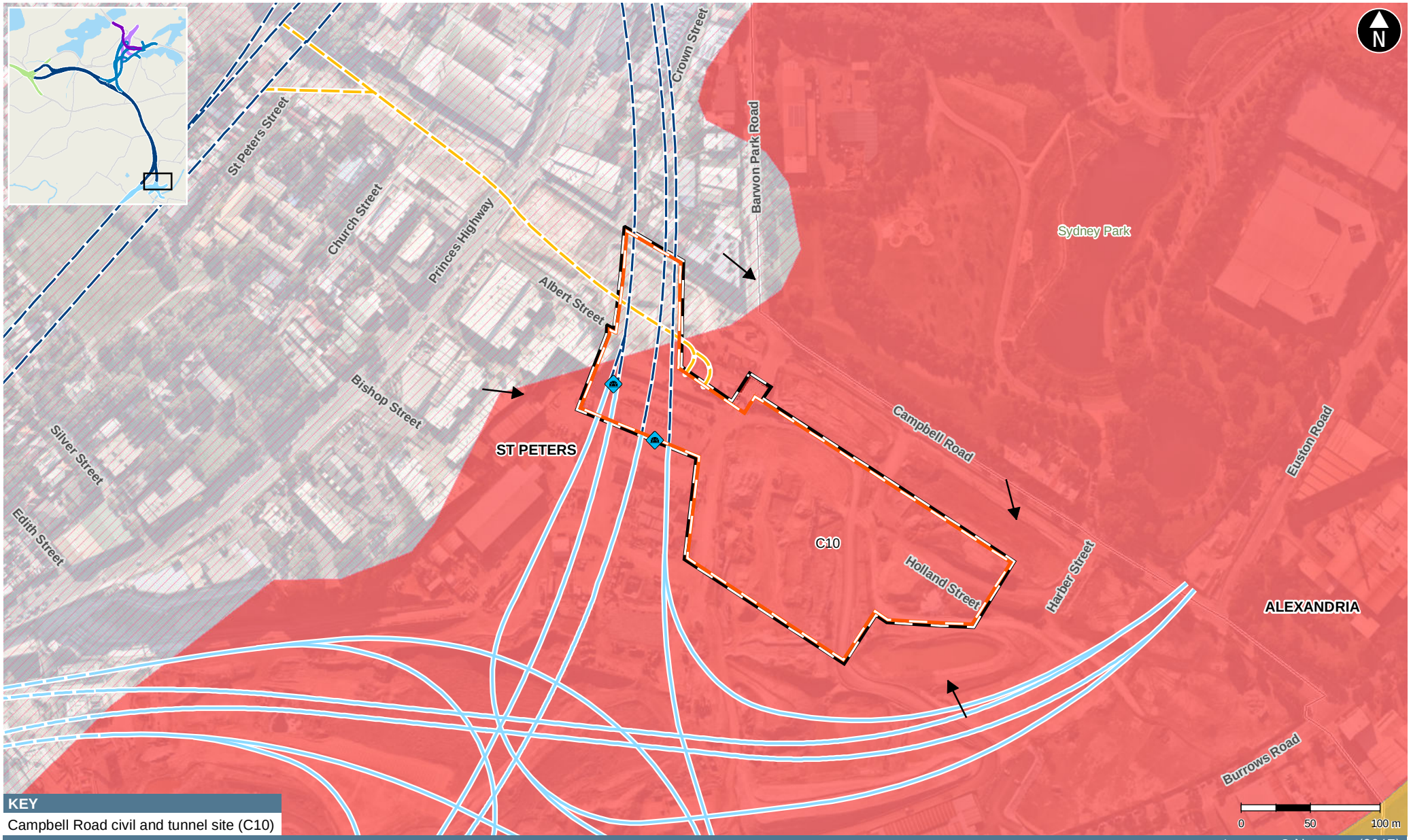

Figure 4-28 Campbell Road civil and tunnel site at St Peters (C10) - acid sulfate soils