
Roads and Maritime Services

F6 Extension Stage 1

New M5 Motorway at Arncliffe to
President Avenue at Kogarah

Environmental Impact Statement

Appendix I

Social and Economic Supporting Information

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1 Business impact survey

In order to identify the impacts associated with businesses in the study area, a survey of 37 businesses located in the study area was undertaken over three weeks in July and August 2018.

This appendix provides an overview of the core themes and responses to the business survey. The implications of the findings and how they relate to the project are discussed in **Chapter 15** (Social and economic).

1.1 Survey approach

A business impact survey was undertaken to gain a better understanding of the main issues, perceptions and concerns of local businesses in regard to construction and operation of the project. The surveys were conducted within 400 metres of the proposed Rockdale (C2) and President Avenue (C3) construction ancillary facilities. Specifically, the survey was offered to businesses located along:

- West Botany Street, between Bay Street and President Avenue, except the properties being acquired
- Bermill Street
- Lindsay Street
- French Street, between Cross Street and West Botany Street
- Beach Street, between Chandler Street and Kirby Industrial Estate
- President Avenue, between Crawford Road and Cross Street.

Thirty seven responses to the survey were received. It is assumed that each survey respondent represented their business as a whole. Some businesses that were offered the opportunity to complete the survey declined to take part.

The business impact survey was undertaken across a wide variety and representative sample of business types including businesses such as retail shops, auto service centres, manufacturers, wholesale centres and cafes.

The survey was not offered to businesses located on properties that would be directly acquired on behalf of the project¹.

All information gathered as part of the business surveys was collated into a database. Findings from this survey have been analysed and summarised in the following sections.

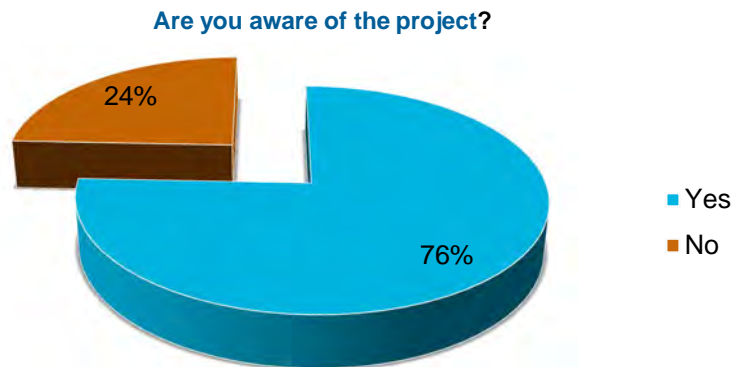
¹ Although not participants in the survey, businesses located on properties that are proposed to be acquired are still considered in the assessment in **Chapter 15** (Social and economic supporting information).

1.2 Survey results

1.2.1 Questions regarding knowledge and perception of the project

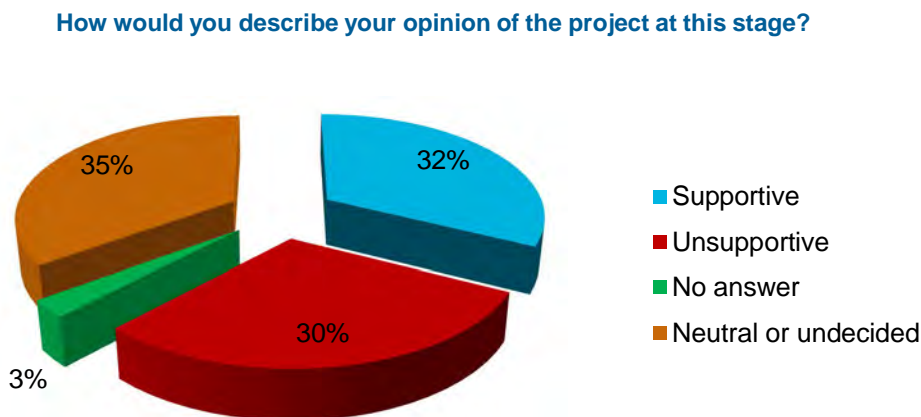
Are you aware of the project?

Of the businesses that participated in the survey, 76 per cent were aware of the project and 24 per cent had not heard of the project.



How would you describe your opinion of the project at this stage?

This question was open-ended when the survey was conducted. The following graph is a representation of the overall theme of the conversations conducted with business owners. Thirty-two per cent of the business owners surveyed were supportive of the project, 30 per cent were unsupportive, 35 per cent were undecided or neutral, and three per cent (one business) did not provide an answer.

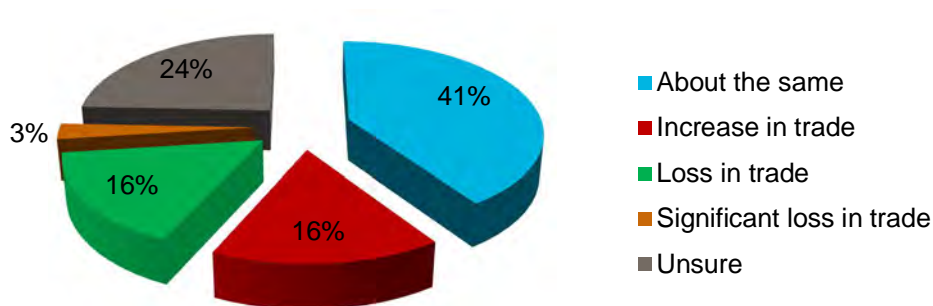


Once complete, would the project be positive for business within the area?

Of the businesses that participated in the survey, 16 per cent said they would expect an increase in trade with the project, whilst 41 per cent said it would be about the same.

Sixteen per cent said they expect a loss in trade as a result of the project, and three per cent (one business) said there they expect a significant loss in trade for businesses in the area.

Once complete, would the project be positive for businesses within the area?



What relevant factors about your business operations should we consider in our design?

Of the 37 businesses that participated in the survey, the most common recurring concern raised was traffic, access and parking impacts. Fifty-one per cent of the businesses raised these issues, and asked that they be managed or mitigated appropriately to minimise impacts on access for customers, staff and deliveries. One business owner requested that existing car parks (including the parking spaces available within Rockdale Bicentennial Park) not be affected.

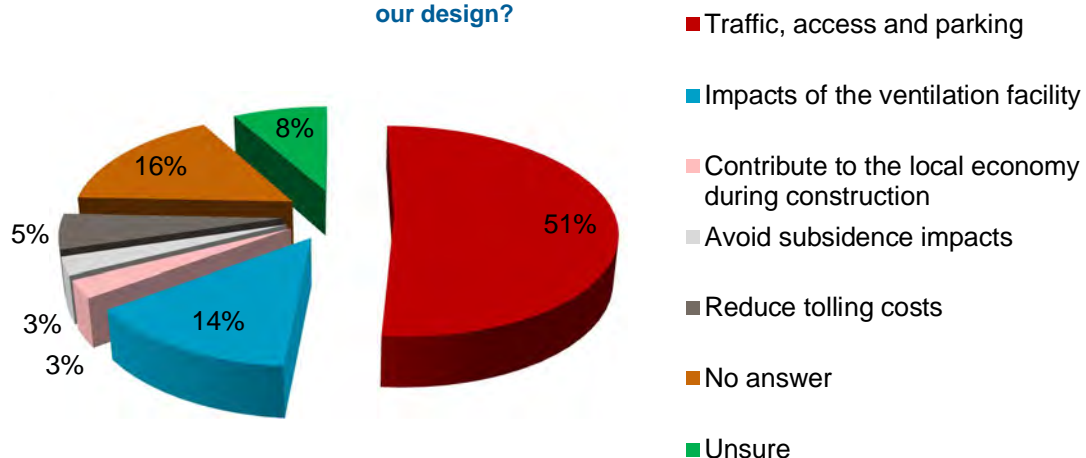
Fourteen per cent raised concern over the ventilation facility at the Rockdale Motorway Operations Complex (south) (MOC2), and the associated air quality impacts. Some of these businesses suggested the location of the ventilation facility should be moved away from their businesses.

Five per cent of the businesses surveyed indicated tolling would affect their operations, such as through an increase in the cost of deliveries.

Three per cent (one business) suggested that Roads and Maritime encourage workers to buy lunch locally during construction, in order to contribute to the local economy. One person asked that the project design ensures their floor doesn't collapse (i.e. assumed to be due to subsidence impacts).

Whilst this data presents the primary (first) concern raised by each business surveyed, they also commonly had secondary concerns such as a reduction in general amenity during construction. Businesses mentioned dust and air quality should be managed effectively.

What relevant factors about your business operations should we consider in our design?



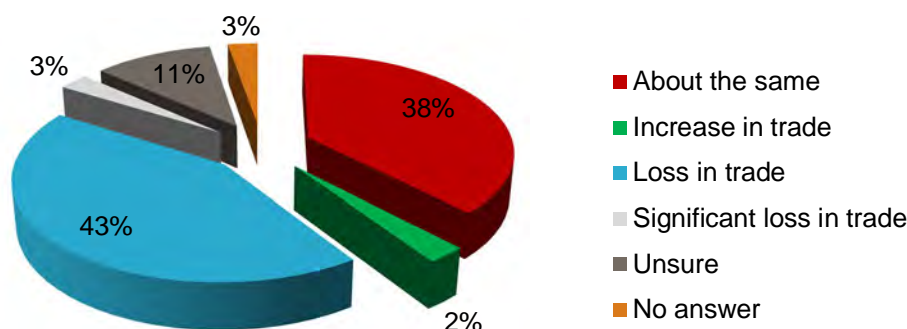
1.2.2 Questions regarding impacts on businesses during construction

How do you think your trade might be affected during the construction phase?

Of the businesses that participated in the survey, 43 per cent predicted that they would experience a loss in trade during the construction phase of the project, with three per cent (one business, an electrician) predicting a significant loss in trade. Thirty-eight per cent believed trade would be about the same.

There percent (one business) predicted construction would be positive for their business (a food and beverage business) and that they would experience an increase in trade.

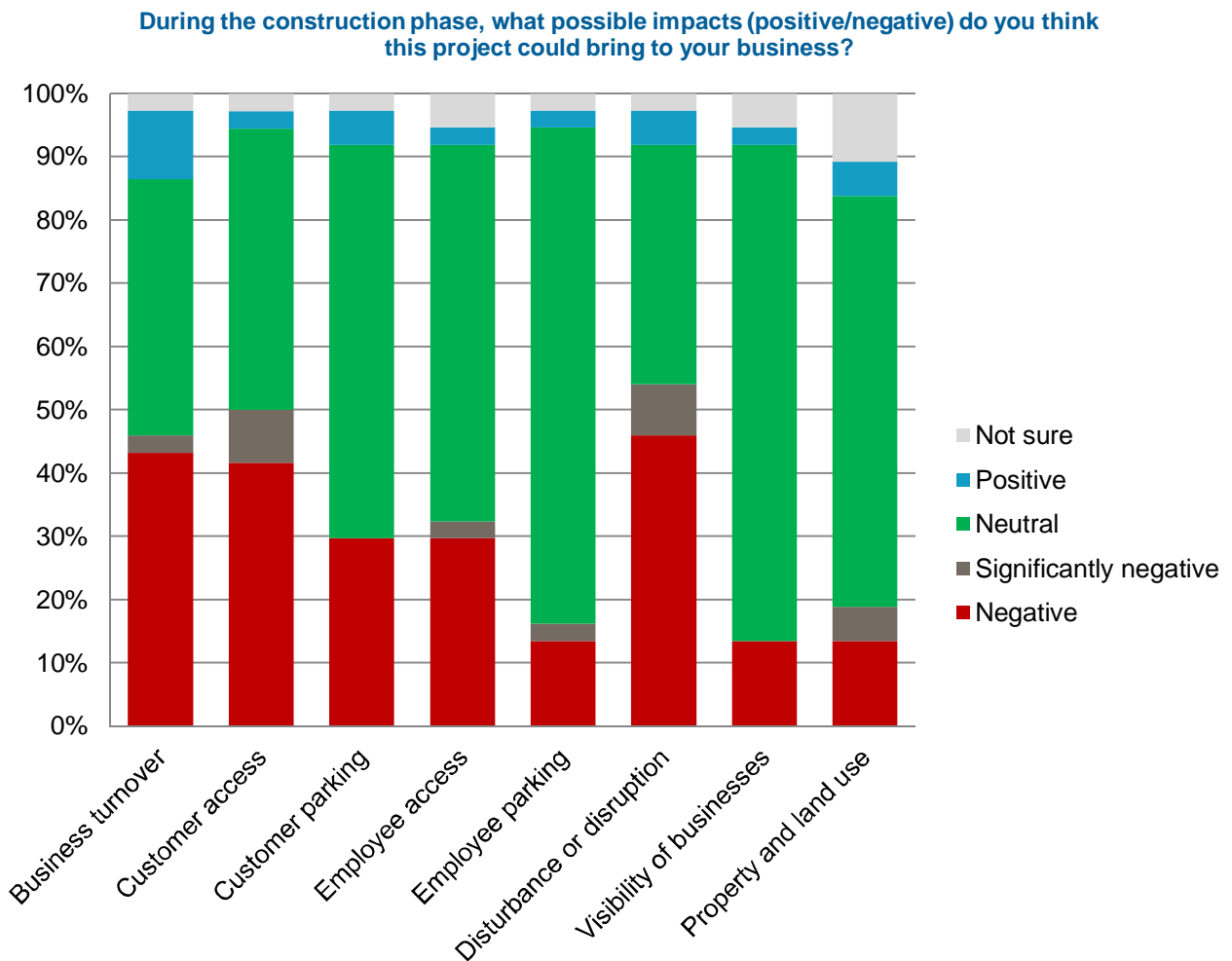
How do you think your trade might be affected during the construction phase?



During the construction phase, what possible impacts (positive/negative) do you think this project could bring to your business?

Of the 37 businesses that participated in the survey, 67 per cent stated that they would be somewhat negatively impacted by the project. 11 per cent said that construction would be positive for their business and 11 per cent said construction would have a neutral/no effect on their business operations. Eight per cent did not provide an answer and three per cent (one business) were unsure of the implications from construction.

Disturbance and disruption, such as traffic or amenity impacts, (seen as negative by 53 per cent of the businesses) and a reduction in business turnover (seen as negative by 46 per cent) were the most common negative impacts expected during construction. This included responses returned as 'negative' or 'significantly negative'.

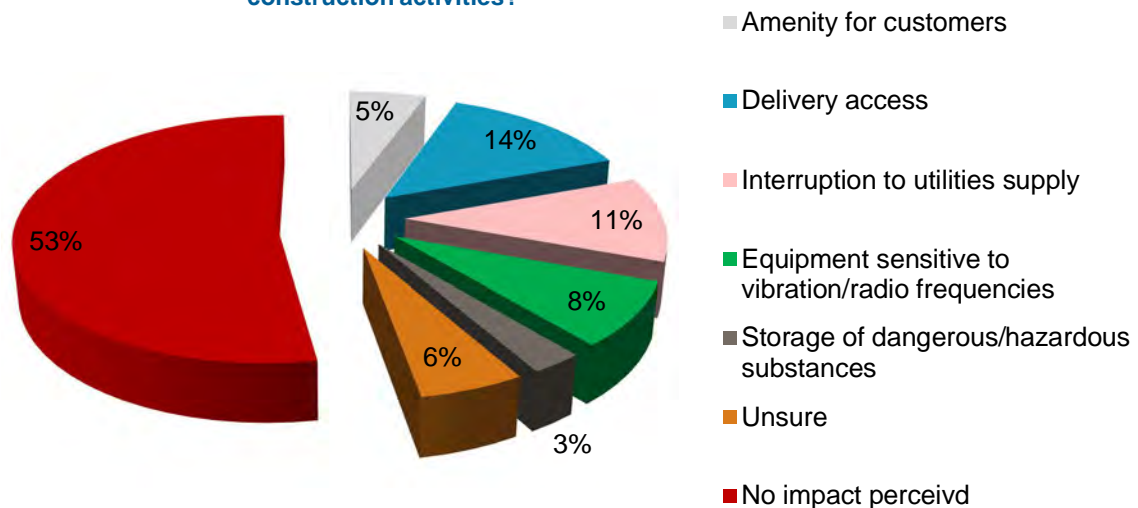


Is there any part of your business that you think might be affected by road construction activities?

Fifty-three per cent of the businesses that participated in the survey said that they don't expect their business to be affected by road construction activities. Fourteen per cent said that road construction activities would affect delivery access, and 11 per cent said that if construction interrupted the supply of utilities to their business (e.g. electricity) then there would be an impact on their business (e.g. for businesses relying on refrigeration).

Eight per cent said that their equipment is sensitive to vibration and/or radio frequencies. Six per cent were unsure of how road construction activities might affect their business.

Is there any part of your business that you think might be affected by road construction activities?



What could minimise the negative impacts and enhance the positives during the construction phase?

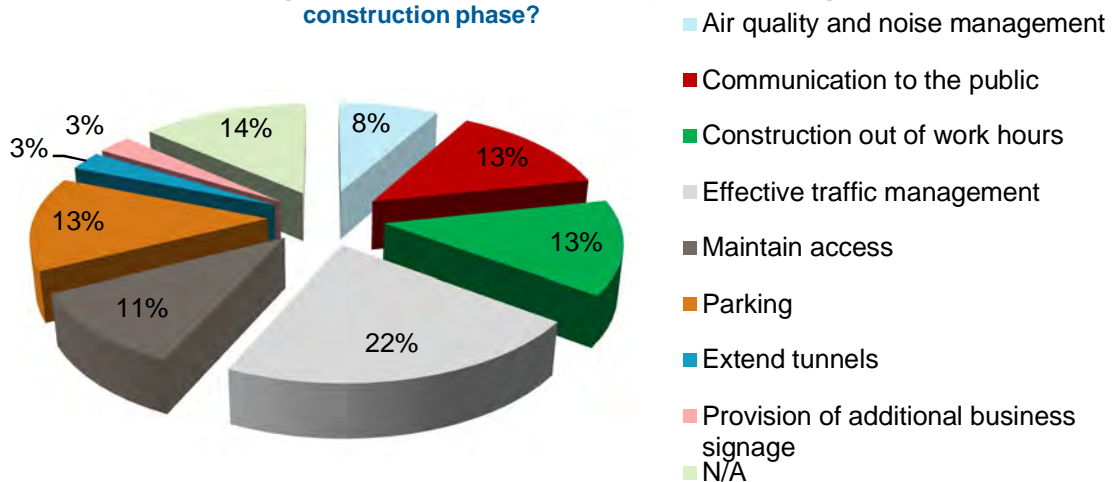
Twenty-two per cent of the businesses that participated in the survey said that the effective management of traffic and business access would minimise negative impacts during construction. Businesses specifically mentioned implementing effective wayfinding and signage.

Thirteen percent of the businesses that participated in the survey suggested that effective and timely communication to the public would assist in minimising construction impacts, and another 13 per cent suggested completing construction work outside of business hours.

Fourteen per cent provided suggestions in regards to parking, including provision of additional parking and ensuring construction workers park within construction ancillary facilities.

Other suggestions included the provision of additional signage for businesses and the effective management of dust and noise impacts during construction.

What could minimise the negative impacts and enhance the positives during the construction phase?



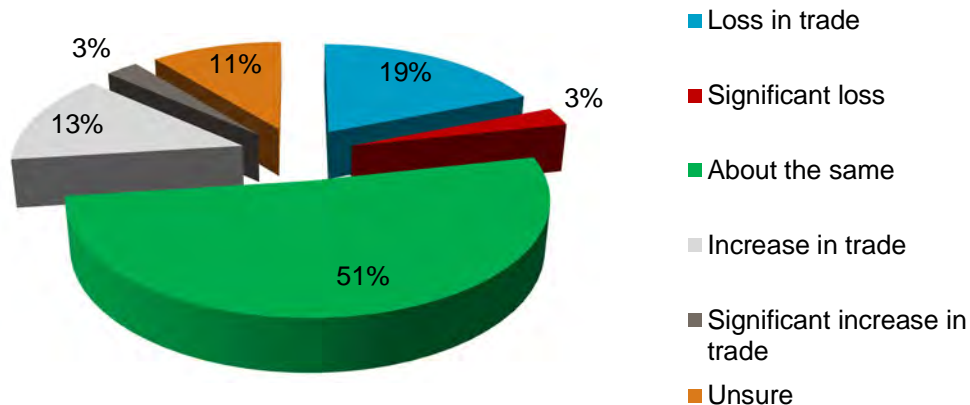
1.2.3 Questions regarding impacts on businesses during operation

How do you think your trade might be affected during operation?

Of the 37 businesses that participated in the survey, 19 per cent predicted that they would experience a loss in trade during the operation phase of the project, whilst 53 per cent believed trade would be about the same. Three per cent (one business) also believe it would result in a significant decrease in trade.

Thirteen per cent believe the project would result in an increase in trade, with three per cent (one business) believing it would result in a significant increase.

How do you think your trade might be affected during operation?



During the operation phase, what possible impacts (positive/negative) do you think this project could bring to your business?

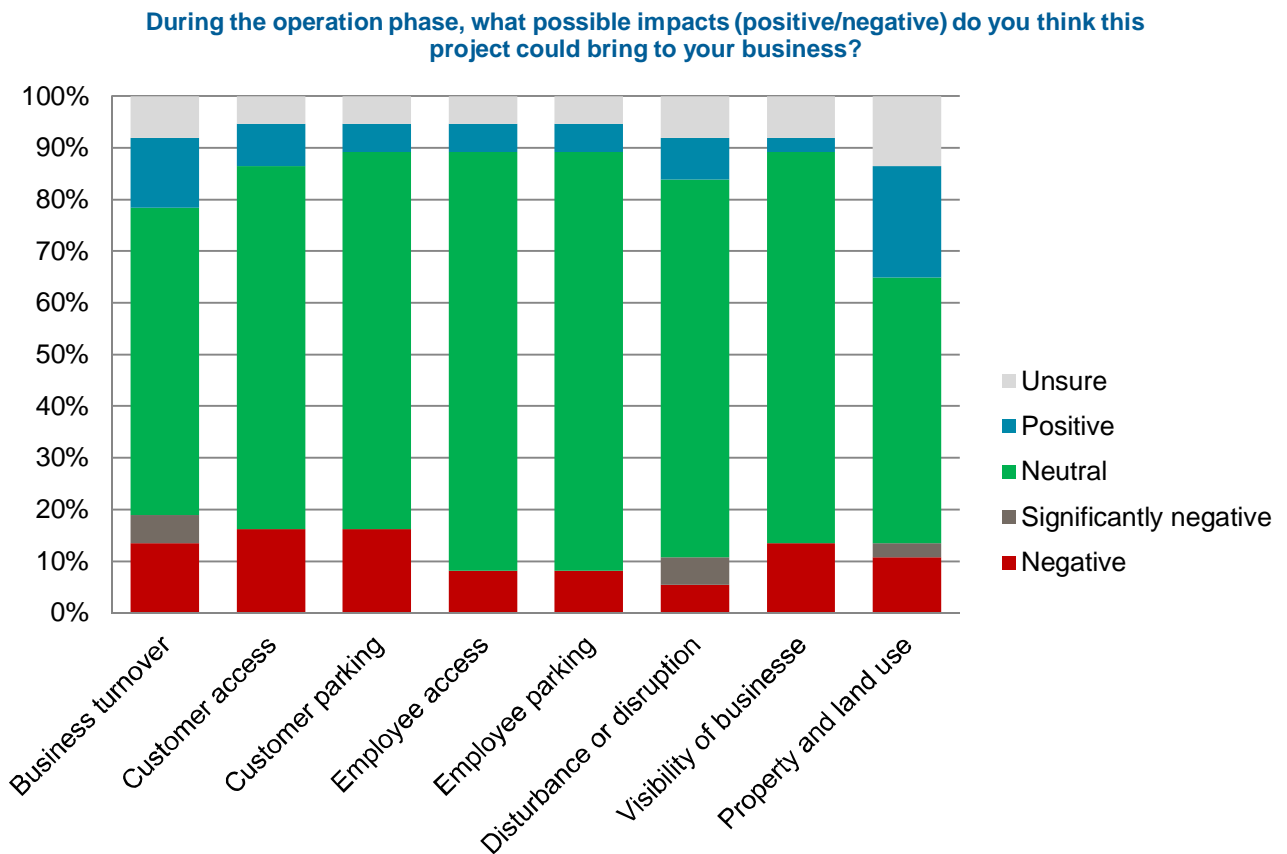
Overall, of the businesses that participated in the survey, 29 per cent stated that they would be somewhat negatively impacted by the operation of the project.

Twenty-four per cent said that operation of the project would be positive for their business and 27 per cent said the project would have a neutral/no effect on their business operations.

Six per cent did not provide an answer and 16 per cent were unsure of the implications from the project during the operation phase. Of those that were unsure, some were undecided as they weren't aware of the parking impacts.

A reduction in business turnover was the most common negative (or 'significantly negative') impact expected to occur during operation (seen as negative by 19 per cent of businesses who participated in the survey).

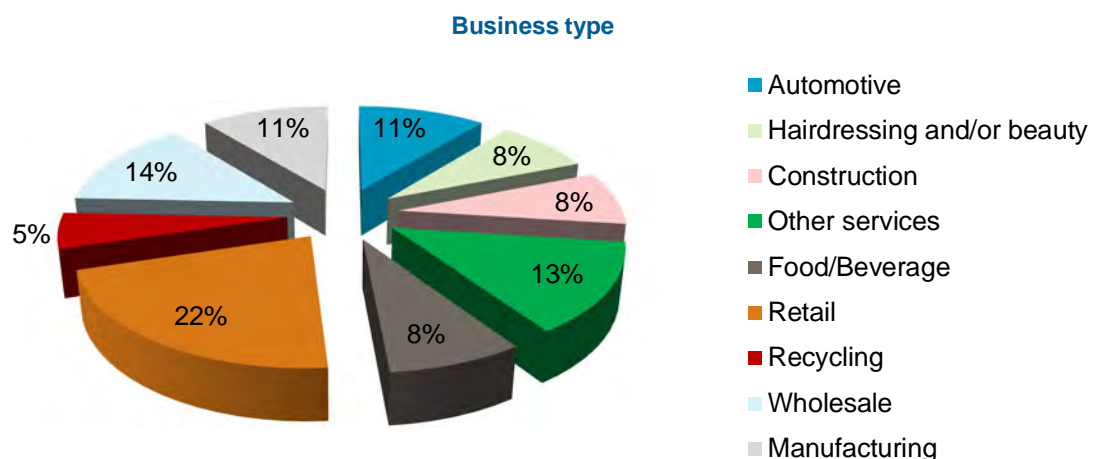
Customer parking (16 per cent) and customer access (16 per cent) were the second most common negative impacts expected to occur during operation.



1.2.4 Questions regarding the operation of each business

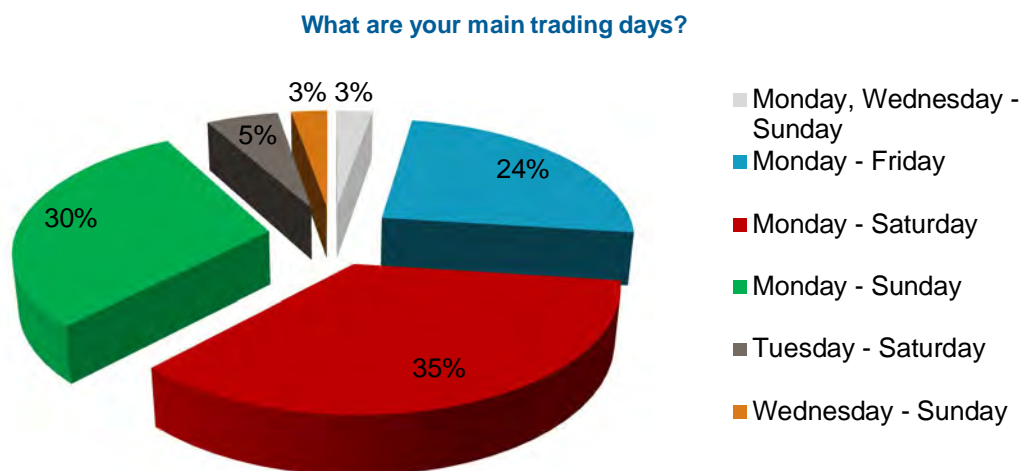
Business type

The participants of the survey included a diverse range of businesses across different industries. Twenty-two per cent were retail businesses, eight per cent were food/beverage, 11 per cent were automotive businesses and 11 per cent were wholesale businesses. 14 per cent were manufacturing businesses.



What are your main trading days?

Of the businesses that participated in the survey, 35 per cent are open Monday to Saturday and 30 per cent are open Monday to Sunday. Twenty-four per cent are open Monday to Friday.



What are your usual trading hours?

Three businesses did not provide their usual trading hours and have not been included in this discussion or the data represented in the graph.

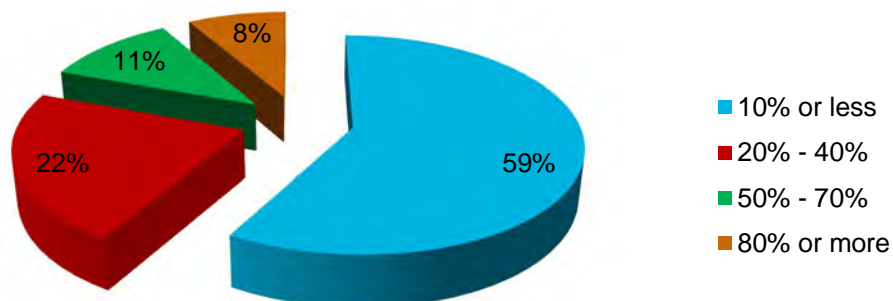
All the businesses that participated in the survey indicated that their business is open between 11:00am and 4:00pm (100 per cent), and up to around eight per cent are operational overnight between 11:00pm and 5:00am.



How much of your customer base is passing trade?

Fifty-nine per cent of the businesses that participated in the survey said that 10 per cent or less of their customer base is passing trade, whilst eight per cent said that 80 per cent or more of their customer base is passing trade.

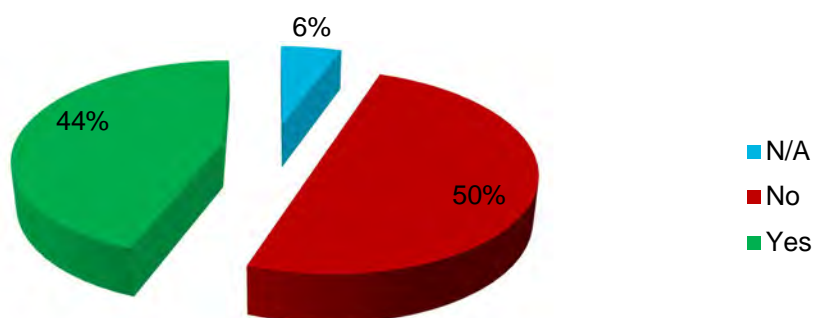
How much of your customer base is passing trade?



Does your business rely on prominent signage or visibility to passing customers?

Fifty per cent of the businesses that participated in the survey said that they do not rely on signage or visibility to passing customers, with some suggesting that reputation is more important. Forty-four per cent of businesses said that they do rely on prominent signage or visibility to passing customers.

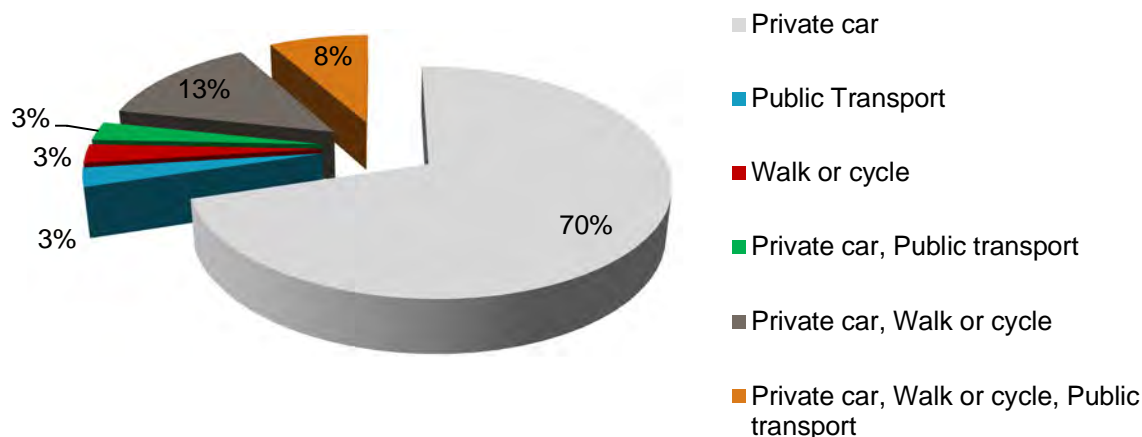
Does your business rely on prominent signage or visibility to passing customers?



How do customers/clients travel to your business?

Seventy per cent of the businesses that participated in the survey said that their customers travel by private car to their business. Thirteen per cent said that their customers travel by either private car, or they walk/cycle. A small proportion (14 per cent) of businesses said that public transport was one of the usual modes of transport for their customers.

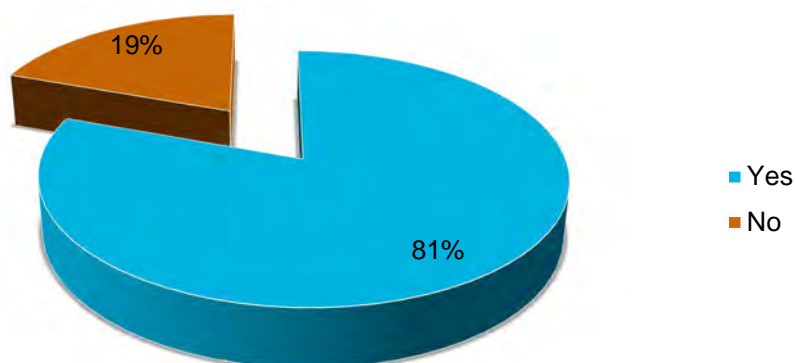
How do customers/clients usually travel to your business?



Do you have off-street parking?

Eighty-one per cent of the businesses that participated in the survey said they have off-street parking for their business. Nineteen per cent said that they did not have off-street parking.

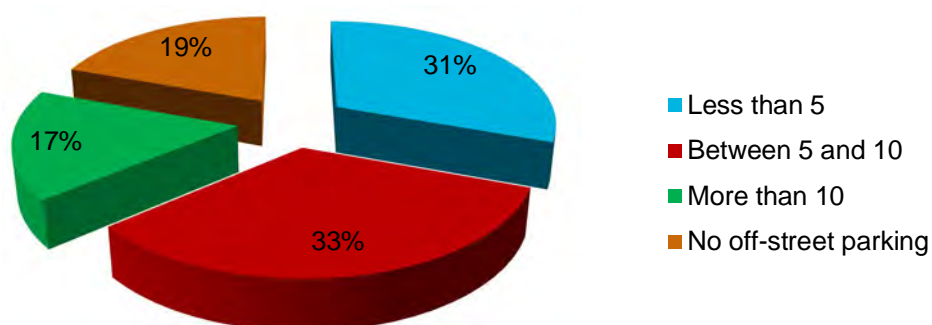
Do you have off-street parking?



How many parking spaces do you have?

Thirty per cent of the businesses that participated in the survey stated that they had less than five car spaces for off street parking, 16 per cent had more than 10 spaces and 32 per cent had between five to 10 car spaces. Twenty-two per cent did not have off-street parking.

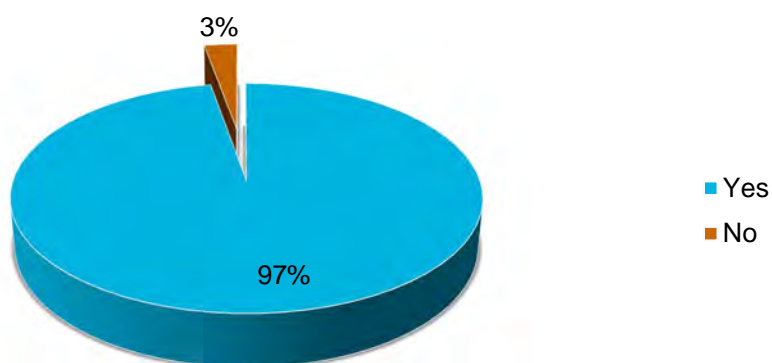
Number of parking spaces



Do you take or dispatch regular deliveries to/from these premises?

All but one business said that they take or dispatch regular deliveries to/from their premises.

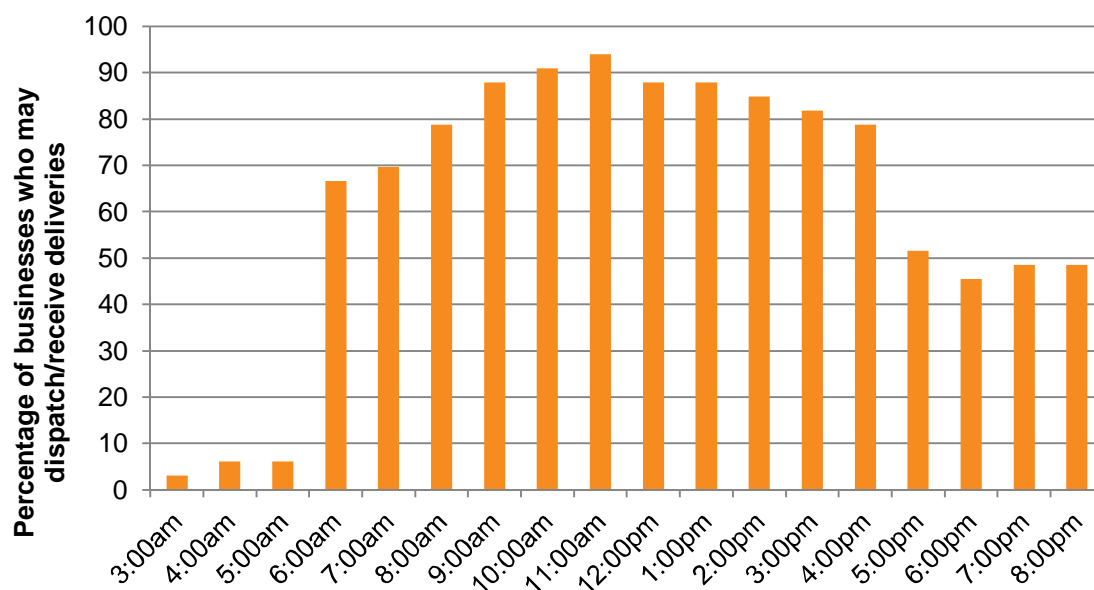
Do you take or dispatch regular deliveries to/from these premises?



What time of day do deliveries/dispatches usually occur?

The majority of businesses (at least 70 per cent) that participated in the survey said they would usually receive deliveries anytime between 7:00am and 5:00pm.

What time of day do deliveries/dispatches usually occur?



Roads and Maritime Services

F6 Extension Stage 1

New M5 Motorway at Arncliffe to
President Avenue at Kogarah

Environmental Impact Statement

Appendix J

Contamination Technical Report

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Glossary of terms and abbreviations

Term	Definition
ACM	Asbestos containing material
AEP	Annual exceedance probability
AHD	Australian height datum
ANEF	Annual noise exposure forecast
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ASC NEPM	National Environment Protection (Assessment of site Contamination) Measure 2013
ASS	Acid sulfate soil
ASSMAC	Acid Sulfate Soils Management Advisory Committee
bgl	Below ground level
BTEXN	Benzene, toluene, ethylbenzene, xylenes, naphthalene
CBD	Central business district
CEMP	Construction environment management plan
CGS	Characteristic gas situation
CLM Act	Contaminated Land Management Act 1997
CoPC	Contaminant of potential concern
CSM	Conceptual site model
CSWMP	Construction soil and water management plan
DP	Deposited plan
EHC Act	Environmentally Hazardous Chemicals Act 1985
EIS	Environmental impact statement
EP&A Act	Environment Planning and Assessment Act 1979
EPL	Environment protection licence
ERP	Environmental risk and planning
GIL	Groundwater investigation level
HIL	Health investigation level
HSL	Health screening level
LEP	Local environmental plan
LOR	Limit of reporting
ND	Not detected
NEPC	National Environment Protection Council
NOW	NSW office of water
NSW	New South Wales
NSW DEC	NSW Department of Environment and Conservation
NSW DPI	NSW Department of Primary Industries
NSW DUAP	NSW Department of Urban Affairs and Planning
NSW EPA	NSW Environment Protection Authority
NSW OEH	NSW Office of Environment and Heritage

Term	Definition
OCPs	Organochlorine pesticides
OPPs	Organophosphorus pesticides
PAHs	Polycyclic aromatic hydrocarbons
PCBs	Polychlorinated biphenyls
PFAS	Per- and poly- fluoralkyl substances
PID	Photoionisation detector
POEO Act	Protection of the Environment Operations Act 1997
RMS	Roads and Maritime Services
SEARs	Secretary's Environmental Assessment Requirements
SEPP 55	State Environment Planning Policy No 55 – Remediation of Land
SVOC	Semi-volatile organic compound
TKN	Total Kjeldahl Nitrogen
TRH	Total recoverable hydrocarbon
SWSOOS	Southern and Western Suburbs Ocean Outfall Sewer
VOC	Volatile organic compound
WTP	Water treatment plant

Executive summary

Introduction

Project Overview

The project would comprise twin motorway tunnels (around three kilometres in length) between the New M5 Motorway at Arncliffe and President Avenue, Kogarah. There would be a surface intersection at President Avenue, including on and off ramps connecting to the mainline tunnel. The project would include widening President Avenue at the location of the intersection, including slip lanes to provide a connection to the project. Intersection improvements at the President Avenue / Princes Highway intersection would also be undertaken.

Shared cycle and pedestrian pathways connecting Bestic Street to Civic Avenue, Kogarah via Rockdale Bicentennial Park would be constructed. Three Motorway Operation Complexes would be constructed at Arncliffe (Arncliffe Motorway Operations Complex (MOC1)), Rockdale North (current Roads and Maritime depot) (Rockdale Motorway Operations Complex (north) (MOC2)) and Rockdale South (Rockdale Motorway Operations Complex (south) (MOC3)). A Motorway Control Centre would be constructed at Rockdale Motorway Operations Complex (north) (MOC2).

The project would also include construction of permanent ancillary infrastructure and operational facilities for signage (including electronic signage), ventilation structures and systems at Rockdale, fire and safety systems, emergency evacuation and smoke extraction infrastructure and an operational water treatment facility at Arncliffe.

Temporary construction and ancillary facilities and temporary works to facilitate the construction of the project would be undertaken within the following five construction ancillary facilities:

- Arncliffe construction ancillary facility (C1) at Arncliffe, within the Kogarah Golf Course currently being used for the construction of the New M5 Motorway
- Rockdale construction ancillary facility (C2) at Rockdale, within a Roads and Maritime depot at West Botany Street
- President Avenue construction ancillary facility (C3) at Rockdale, north and south of President Avenue within Rockdale Bicentennial Park and part of Scarborough Park North, and a site west of West Botany Street
- Shared cycle and pedestrian pathways construction ancillary facilities (C4 and C5) at Brighton-le-Sands, within the recreation area between West Botany Street and Francis Avenue, near Muddy Creek
- Princes Highway construction ancillary facility (C6) at Kogarah, within the land currently occupied by the existing 7-Eleven service station on the north east corner of Princes Highway and President Avenue.

Purpose of this report

The purpose of this report is to:

- Assess the potential for soil, vapour, ground gas and groundwater contamination to be encountered within the project area
- Assess the potential contamination impacts of construction and operation of the project
- Identify mitigation measures to manage potential impacts from contamination during construction and operation of the project.

Methodology

The scope of work undertaken included:

- Review of available previous and relevant site contamination reports as provided, including soil, groundwater and landfill gas data collected as part of the targeted geotechnical investigations within the project alignment

- A desktop review of historical records (aerial photographs and historical business directory records) and NSW Environment Protection Authority (EPA) public registers of contaminated and licensed sites compiled in Environmental Risk and Planning (ERP) Reports prepared for the length of the project area by Lotsearch Pty Ltd (Lotsearch)
- Obtaining and reviewing historical titles and/or section 149 certificates for select Lot and Deposited Plan's (DP) within the following construction ancillary facilities and permanent operational infrastructure
- An inspection of project alignment and location of the construction ancillary facilities from publically accessible land
- A preliminary conceptual site model (CSM) was compiled for the impact assessment of the project construction and operation and qualitative risk ranking was completed.

Assessment of Impacts

Construction impacts

This technical working paper identified a number of areas of potential or known contamination which require management during the construction and operation of the project. Existing identified contamination issues are primarily related to historical land uses which have adversely impacted the quality of soil, fill, groundwater, ground gas and surface water within the project footprint.

Arncliffe construction ancillary facility (C1)

Arncliffe ancillary facility (C1) was assessed as having a potential risk of soil and groundwater contamination due to historical land uses, including uncontrolled filling and use of herbicides and pesticides for former use as market gardens and a golf course.

A Phase 2 Environmental Site Assessment (Golders 2016) completed for the New M5 Motorway Construction Compound, which has the same footprint as the Arncliffe construction ancillary facility (C1), identified asbestos in fill at one location which exceeded the adopted assessment criteria. There were no other soil exceedances of the adopted human health based criteria identified. Ammonia and dissolved methane concentrations in groundwater were identified as a potential concern during construction works, due to the potential for worker exposure to ammonia in groundwater during dewatering and excavation and the potential for methane to accumulate in subsurface structures. Management plans for mitigation measures for these issues were recommended during construction.

Due to known concentrations of ammonia and methane at concentrations above the adopted assessment criteria and pathways for exposure to human and ecological receptors during construction, the construction ancillary facility was assessed as a medium risk. It is noted that either further assessment and/or additional mitigation measures may need to be implemented beyond those carried out for the New M5 Motorway project at this construction ancillary facility.

Rockdale construction ancillary facility (C2)

Rockdale construction ancillary facility (C2) was historically used for market gardens and industrial activities and was formerly filled, therefore was assessed as having a potential for soil and groundwater contamination to be present. The construction works would include bulk excavation and dewatering for the construction of the cut and cover decline tunnel and construction of permanent operational facilities.

Limited previous soil and groundwater investigations have confirmed the presence of uncontrolled fill. Soil contamination was not detected above the adopted assessment criteria, however additional investigations would be required to characterise the site adequately. Based on the potential for contamination to potentially be present at concentrations above the adopted assessment criteria and pathways for exposure to human and ecological receptors the construction ancillary facility was assessed as a medium risk.

President Avenue construction ancillary facility (C3)

President Avenue construction ancillary facility (C3), includes parts of Rockdale Bicentennial Park, Rockdale Bicentennial Park East, President Avenue, West Botany Street and commercial/industrial properties at 427 to 441 West Botany Street, Rockdale. The construction works would include bulk excavation and dewatering for the construction of the cut and cover tunnel connection between President Avenue and the driven twin tunnels, construction of shared cycle and pedestrian pathways and bridge over President Avenue, as well as construction of permanent operational facilities on West Botany Street.

Rockdale Bicentennial Park and Rockdale Bicentennial Park East

Rockdale Bicentennial Park has historically been used as a council landfill and surrounding land including Rockdale Bicentennial Park East has been historically filled. The land is also mapped Class 2 for acid sulfate soil risk. Preliminary investigations within the construction ancillary facility have been completed and indicate that concentrations of PAHs, TRH, heavy metals, asbestos and acid sulfate soils are present in soil and fill materials above the assessment criteria.

Concentrations of landfill gases including methane, hydrogen sulphide, carbon dioxide and carbon monoxide were also detected within the subsurface in Rockdale Bicentennial Park. The results were interpreted as having a risk classification of Characteristic Gas Situation 2 (low risk) in accordance with NSW EPA (2012) guidelines. Sites classified as CGS 2 are recommended to have mitigation measures to address the risk of explosive conditions and/or health exposure risks. The concentrations of hydrogen sulphide also present a potential risk of nuisance odours and risk to health.

Concentrations of ammonia and nitrogen in groundwater were elevated, exceeding the assessment criteria and indicative of typical landfill leachate. Concentrations of heavy metals arsenic, lead and zinc were detected at concentrations slightly above the assessment criteria in groundwater within the fill. Based on the potential for contamination known to be present at concentrations above the adopted assessment criteria and pathways for exposure to human and ecological receptors the construction ancillary facility was assessed as a high risk.

Rockdale ventilation facility construction area (427 to 441 West Botany Street)

Works within the Rockdale ventilation facility footprint would include demolition of buildings and bulk excavation and construction of permanent operational facilities. The review of historical information indicated that properties at 427 to 441 West Botany Street, Rockdale have been used for potentially contaminating activities, are within land mapped as disturbed terrain and are mapped Class 3 for acid sulfate soil risk.

Based on the potential for contamination to be present at concentrations above the adopted assessment criteria and pathways for exposure to human and ecological receptors the construction ancillary facility was assessed as a medium risk.

Demolition of residential buildings

The demolition of several residential buildings, located along northern side of President Avenue and east of Rockdale Bicentennial Park East would be required. The buildings have the potential to contain hazardous materials such as asbestos and lead. Based on the potential for hazardous building materials and pathways for exposure to human receptors the construction ancillary facility was assessed as a medium risk.

West Botany Street trenching works

A trench for a temporary water pipeline from the Rockdale ancillary facility (C2) along West Botany Street to the Rockdale ventilation facility would be undertaken. Review of historical information indicated that West Botany Street is within land mapped as disturbed terrain, surrounded by historical industrial land use and mapped as Class 2 and 3 for acid sulfate soil risk.

Based on the potential for contamination to be present at concentrations above the adopted assessment criteria and pathways for exposure to human and ecological receptors the construction ancillary facility was assessed as a medium risk.

Shared cycle and pedestrian pathways south and north of President Avenue construction ancillary facility (C3)

Review of historical information indicated that land north and south of the President Avenue construction ancillary facility (C3) in Civic Avenue Reserve and land north of Rockdale Bicentennial Park is within land mapped as disturbed terrain and mapped as Class 2 and 3 for acid sulfate soil risk.

Based on the potential for contamination to potentially be present at concentrations above the adopted assessment criteria and pathways for exposure to human and ecological receptors the construction ancillary facility was assessed as a medium risk.

Shared cycle and pedestrian pathways construction ancillary facilities (C4 and C5)

Construction of the northern sections of the shared cycle and pedestrian pathways would include shallow earthworks. Review of historical information indicated that the shared cycle and pedestrian pathways is within land mapped as disturbed terrain, was formerly used as market gardens and mapped as Class 2 for acid sulfate soil risk.

Based on the potential for contamination to potentially be present at concentrations above the adopted assessment criteria and pathways for exposure to human and ecological receptors the construction ancillary facility was assessed as a medium risk.

Princes Highway construction ancillary facility (C6)

The 7-Eleven Service Station is currently under assessment by the NSW EPA for contamination. Petroleum soil and/or groundwater contamination is therefore known to be present at concentrations above the relevant assessment criteria. Based on the pathways for exposure to human and ecological receptors during construction the 7-Eleven Service Station has been assessed as a high risk.

Tunnel Alignment

Areas identified with a medium or high risk of groundwater contamination due to historical land uses, that could impact on groundwater quality along the tunnel alignment were:

- Kogarah Golf Course and surrounding filled land to the south
- Former Tempe Bus Depot in Arncliffe
- Up-gradient former and current commercial/ industrial properties (mainly mechanics and workshops) along Princes Highway, Arncliffe
- Former Goodfellow Dry Cleaners at 122 Cameron St, Rockdale
- Rockdale industrial area
- Rockdale Bicentennial Park and surrounding filled land.

Operational impacts

Motorway Operations Complexes (MOC1, MOC and MOC3)

Contamination impacts associated with the operation of the project would include leaks and spills on constructed roadways from vehicles and vehicle accidents. Minimal soil or groundwater contamination impacts would be expected from the operation of the MOCs. Sources of contamination could be from small volumes of oils, fuels, solvents and other chemicals used for operation and maintenance if not stored and handled in accordance with regulations.

Tunnel groundwater treatment and discharge

During operation, groundwater seepage, stormwater drainage at tunnel portals, tunnel wash-down water, fire suppressant deluge or fire main rupture and spillage of flammable and other hazardous materials would be captured by tunnel drainage. The captured water would be treated and discharged to the receiving water bodies. If the discharged water is not treated to the required standard there could be adverse impacts on water quality of the receiving environments.

Groundwater quality may be impacted along parts of the tunnel alignment due to overlying contamination sources impacting groundwater. As discussed in **Appendix K** of the EIS (Groundwater Technical Report), the mainline tunnels have been aligned to minimise intersecting highly permeable material that could result in high groundwater inflows into the tunnels. The proposed tunnel alignment avoids the underlying palaeochannels and unsuitable geology that lies to the east of the project alignment. The horizontal alignment maximises the extent of the project footprint within competent Hawkesbury Sandstone and minimises the alignment traversing immediately beneath sensitive environmental areas, creeks and wetlands to reduce the risk of surface water leakage.

The vertical tunnel alignment dives beneath palaeochannels where possible to reduce groundwater and surface water inflows into the tunnels. Where the project footprint intersects palaeochannels and alluvium, the tunnels would be tanked (undrained) to prevent groundwater inflow in these areas. As such, where present, contaminated groundwater would be unable to enter the tunnels at those locations due to tanked sections. In addition, the proposed depth of the tunnel alignment within the Hawkesbury Sandstone would increase the rock cover and reduce the risk of substantial groundwater inflows from potential hydraulic connections with the palaeochannels and surface water systems.

Assessment on the potential impacts to surface water receiving environments and proposed treatment and management is provided in **Appendix L** of the EIS (Surface Water Technical Report) and **Chapter 18** of the main EIS body (Surface water and flooding).

Management of impacts

Construction

The areas identified as medium and high risk within the construction footprint would be further investigated during detailed design and investigation sampling plans would be informed by existing data and project design. It is noted that that further investigations would not be required within the Arncliffe ancillary facility (C1), as they have been completed by the New M5 Motorway project.

All contamination investigations would be required to 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 investigations, Remediation Action Plans (RAPs) may be required and implemented in the event that site remediation is warranted prior to construction. An independent NSW EPA Accredited site Auditor would be engaged to review all contamination reports and evaluate the suitability of sites for a specified use as part of the project.

Following completion of project, construction ancillary facilities will be remediated in accordance with RAPs (where required), based on the findings of investigations and the intended land use or rehabilitation requirements. 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 sites for a specified use as part of the project.

A CEMP would also be prepared for the project. The CEMP would include management measures for areas within the project footprint identified as being potentially contaminated as well as areas within the project footprint that have been assessed as low risk and do not require further assessment or remediation and would be managed through the implementation of the CEMP.

The CEMP would incorporate the Roads and Maritime Unexpected Discovery of Contaminated Lands Procedure Roads and a Hazardous Building Materials Management Plan. The CEMP prepared for implementation during construction of the project should encompass all construction activities associated with the project. The plan should accurately reflect the existing conditions and potential contamination likely to be encountered during construction at various locations within the project footprint.

The CEMP would include CSWMP sub-plans to manage potentially contaminated soil and water for each construction ancillary facility. Sub-plans for President Avenue construction ancillary facility (C3), must have specific mitigation measures for leachate and landfill gas management for works within Rockdale Bicentennial Park, based on the findings of additional investigations.

Management procedures for acid sulfate soils as part of the CEMP would be prepared for implementation during the project, which should encompass the management of all potential or actual acid sulfate soils which may be disturbed as part of construction activities associated with the project. An Acid Sulfate Management Plan would be prepared for the construction ancillary facilities (C1 to C5).

Groundwater and surface water captured as a result of tunnelling activities may be contaminated with suspended solids and increased pH, in addition to existing groundwater contamination, due to tunnel grouting activities. Targeted groundwater investigations would continue to be undertaken along the tunnel alignment prior to construction, to obtain adequate data to estimate the concentrations of contamination to be treated during construction. Water would be captured during construction and treated on-site or at the Arncliffe water treatment plant and at the temporary construction water treatment plants and sedimentation ponds at the Rockdale construction ancillary facility (C2) and President Avenue construction ancillary facility (C3).

Operation

An Operational Environmental Management Plan (OEMP) would be prepared to manage potential impacts on groundwater and surface water during the operational phases of the project. Groundwater and surface water inflows drained from the tunnel will be treated at the Arncliffe water treatment plant to the required quality for discharge to the Cooks River.

Conclusion

Based on the findings of this technical working paper, AECOM concludes that there are areas of soil, vapour, ground gas, acid sulfate soil, surface water, fill and groundwater contamination associated with historical land uses to be encountered during construction, and further investigation and assessment is warranted.

Following adoption of the mitigation and management measures during the construction and operational phase of the project, the desired performance outcome could be achieved, which is to ensure that risks arising from the disturbance of soil and groundwater contamination and acid sulfate soils would be mitigated.

1 Introduction

The project would comprise a new multi-lane road between the New M5 Motorway at Arncliffe and President Avenue at Kogarah. The project would connect underground with the New M5 Motorway tunnel and to a new surface level intersection at President Avenue, Kogarah.

1.1 Overview of the project

Key components of the project would include:

- An underground connection to the existing stub tunnels at the New M5 Motorway at Arncliffe
- Twin motorway tunnels (around four kilometres in length) between the New M5 Motorway at Arncliffe and President Avenue, Kogarah
- A tunnel portal and entry and exit ramps connecting the tunnels to a surface intersection with President Avenue
- Intersection improvements at the President Avenue / Princes Highway intersection
- Mainline tunnel stubs to allow for connections to future stages of the F6 Extension
- Shared pedestrian and cycle pathways connecting Bestic Street, Rockdale to Civic Avenue, Kogarah via Rockdale Bicentennial Park (including an on-road cycleway)
- An Operational Motorway Control Centre to be located off West Botany Street, Rockdale
- Ancillary infrastructure and operational facilities for signage (including electronic signage), ventilation structures and systems at Rockdale, fire and safety systems, and emergency evacuation and smoke extraction infrastructure
- A proposed permanent power supply connection from the Ausgrid Canterbury sub-transmission substation
- Temporary construction ancillary facilities and temporary works to facilitate the construction of the project.

Once complete, the F6 Extension Stage 1 would improve connections and travel times between Sydney and the Princes Highway and enhance connections for residents and businesses within the broader regional area as well as promote and support economic development in areas to the south, such as Sutherland and the Illawarra.

Approval for the project is being sought under Part 5, Division 5.2 of the EP&A Act. Future stages of the F6 Extension would be subject to separate planning applications and assessments would be undertaken accordingly.

The configuration and design of the project will be further developed to take into consideration the outcomes of community and stakeholder engagement.

1.2 Project location

This project would be generally located within the Bayside local government area. The project commences about 8 kilometres south west of the Sydney central business district (CBD). The proposed President Avenue intersection would be located about 11 kilometres south east of the Sydney CBD.

1.3 Purpose of this report

The purpose of this report is to:

- Assess the potential for soil, vapour, ground gas and groundwater contamination to be encountered within the project area
- Assess the potential contamination impacts of construction and operation of the project

- Identify mitigation measures to manage potential impacts from contamination during construction and operation of the project.

1.4 SEARs and Agency comments

In preparing this Contamination Assessment Technical Report, the Secretary's Environmental Assessment Requirements (SEARs) issued for the project which are relevant to soil and groundwater contamination has been addressed. **Table 1-1** lists the applicable SEARs and where they have been addressed in this report. **Table 1-1** lists the applicable agency comments and where they have been addressed in the report.

Table 1-1 SEARs – Contamination Technical Report

Assessment requirements	Where addressed in this report
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.	The risk of encountering acid sulfate soils is assessed in section 4.1.4, section 4.2.6, section 4.3.6 and section 4.4.5
The Proponent must assess the impact of the project on acid sulfate soils (including impacts of acidic runoff offsite) in accordance with the current guidelines and detail the mitigation measures proposed to minimise potential impacts.	Assessment in section 4 and management in section 8
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 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 current guidelines.	Assessment in section 4 and section 5 and Management in section 8
A baseline contamination assessment must be undertaken for filled land in the vicinity of the proposed cut and cover works near President Avenue. The Proponent must provide details of contamination characteristics and measures to manage this spoil, including spoil stockpile management, transport and disposal to avoid adverse impacts to land, water quality and sensitive receivers	Tunnel Alignment section 4.1 , President Avenue construction ancillary facility section 4.4 , Assessment in section 5 and Management in section 8
The Proponent must assess the impact of any disturbance of contaminated groundwater and the tunnels should be carefully designed so as not to exacerbate mobilisation of contaminated groundwater and/or prevent contaminated groundwater flow	section 4.1.12, section 4.2.4, section 4.3.4, section 4.4.6, section 5.2 and section 6.2 and Appendix K (Groundwater Technical Report)
The Proponent must undertake a landfill gas assessment in the vicinity of the President Avenue intersection and provide details on proposed methods and options for managing and mitigating impacts during construction and operation.	Summary of landfill gas monitoring data in section 4.4.6 and management in section 8.1 .

1.5 Structure of this report

This report is structured as follows:

- **Chapter 1** – Introduction – This section provides a brief overview of the outlines the project and presents the purpose of this report
- **Chapter 2** – The project – This section provides an overview of the project
- **Chapter 3** – Assessment methodology – This section describes the methodology employed for this report
- **Chapter 4** – Existing environment – This section describes the study area and its existing environmental conditions by project area – tunnel alignment, Arncliffe construction ancillary facility (C1), Rockdale construction ancillary facility (C2), President Avenue construction ancillary facility (C3) and shared cycle and pedestrian pathways - North
- **Chapter 5** – Assessment of construction impacts – This section describes the potential contamination impacts resulting from the project during construction
- **Chapter 6** – Assessment of operational impacts – This section describes the potential contamination impacts resulting from the project during operation
- **Chapter 7** – Assessment of cumulative impacts – This section describes the potential cumulative contamination impacts resulting from the project and other key developments
- **Chapter 8** – Mitigation and management – This section provides a summary of environmental mitigation, management and monitoring responsibilities in relation management of potential contamination encountered during the construction and operation of the project.

2 The Project

2.1 Project features

The project would comprise a new multi-lane underground road link between the New M5 Motorway and a surface intersection at President Avenue, Kogarah.

Key components of the project would include:

- Twin mainline tunnels. Each mainline tunnel would be around 2.5 kilometres in length, sized for three lanes of traffic, and line marked for two lanes as part of the project
- A tunnel-to-tunnel connection to the New M5 Motorway southern extension stub tunnels, including line marking of the New M5 Motorway tunnels from St Peters interchange to the New M5 Motorway stub-tunnels
- Entry and exit ramp tunnels about 1.5 kilometres long (making the tunnel four kilometres in length overall) and a tunnel portal connecting the mainline tunnels to the President Avenue intersection
- An intersection with President Avenue including entry and exit ramps and the widening and raising of President Avenue
- Upgrade of the President Avenue / Princes Highway intersection to improve intersection capacity
- Shared cycle and pedestrian pathways connecting Bestic Street, Brighton-Le-Sands to Civic Avenue, Kogarah (including an on-road cycleways)
- Three motorway operation complexes:
 - Arncliffe, including a water treatment plant, substation and fitout (mechanical and electrical) of a ventilation facility currently being constructed as part of the New M5 Motorway project
 - Rockdale (north), including a motorway control centre, deluge tanks, a workshop and an office
 - Rockdale (south), including a ventilation facility, substation and power supply.
- Reinstatement of Rockdale Bicentennial Park and recreational facilities
- In-tunnel ventilation systems including jet fans and ventilation ducts connecting to the ventilation facilities
- Drainage infrastructure to collect surface water and groundwater inflows for treatment
- Ancillary infrastructure for electronic tolling, traffic control and signage (both static and electronic signage)
- Emergency access and evacuation facilities (including pedestrian and vehicular cross and long passages); and fire and life safety systems
- New service utilities, and modifications and connections to existing service utilities
- A proposed permanent power supply connection from the Ausgrid Canterbury sub-transmission substation, to Rockdale Motorway Operations Complex south.

The project does not include ongoing motorway maintenance activities during operation or future upgrades to other intersections in the vicinity during operation. These works are permitted under separate existing approvals and / or are subject to separate assessment and approval in accordance with the EP&A Act.

The key features of the project are shown on **Figure 2-1**.

2-2

2.2 Construction

2.2.1 Construction activities

The proposed construction activities for the project would include:

- Preparatory investigations
- Site establishment and enabling work
- Tunnelling
- Surface earthworks and structures
- Construction of motorway operations complexes
- Drainage and construction of operational water management infrastructure
- Construction of the permanent power supply connection
- Road pavement works
- Finishing works.

These activities would generally be undertaken within the following construction ancillary facilities:

- Arncliffe construction ancillary facility (C1) at Arncliffe, within the Kogarah Golf Course currently being used for the construction of the New M5 Motorway
- Rockdale construction ancillary facility (C2) at Rockdale, within a Roads and Maritime depot at West Botany Street
- President Avenue construction ancillary facility (C3) at Rockdale, north and south of President Avenue within Rockdale Bicentennial Park and part of Scarborough Park North, and a site west of West Botany Street
- Shared cycle and pedestrian pathways construction ancillary facilities (C4 and C5) at Brighton-le-Sands, within the recreation area between West Botany Street and Francis Avenue, near Muddy Creek
- Princes Highway construction ancillary facility (C6), on the north-east corner of the President Avenue and Princes Highway intersection.

2.2.2 Construction boundary

The area required for project construction is referred to as the 'construction boundary'. This comprises the surface construction works area, and construction ancillary facilities (refer to **Figure 2-2**). Utility works to support the project would occur within and outside the construction boundary (refer to **Chapter 7** (Construction) of the EIS).

In addition to these works, the underground construction boundary (including mainline tunnel construction and temporary access tunnels) is also shown on **Figure 2-2**.

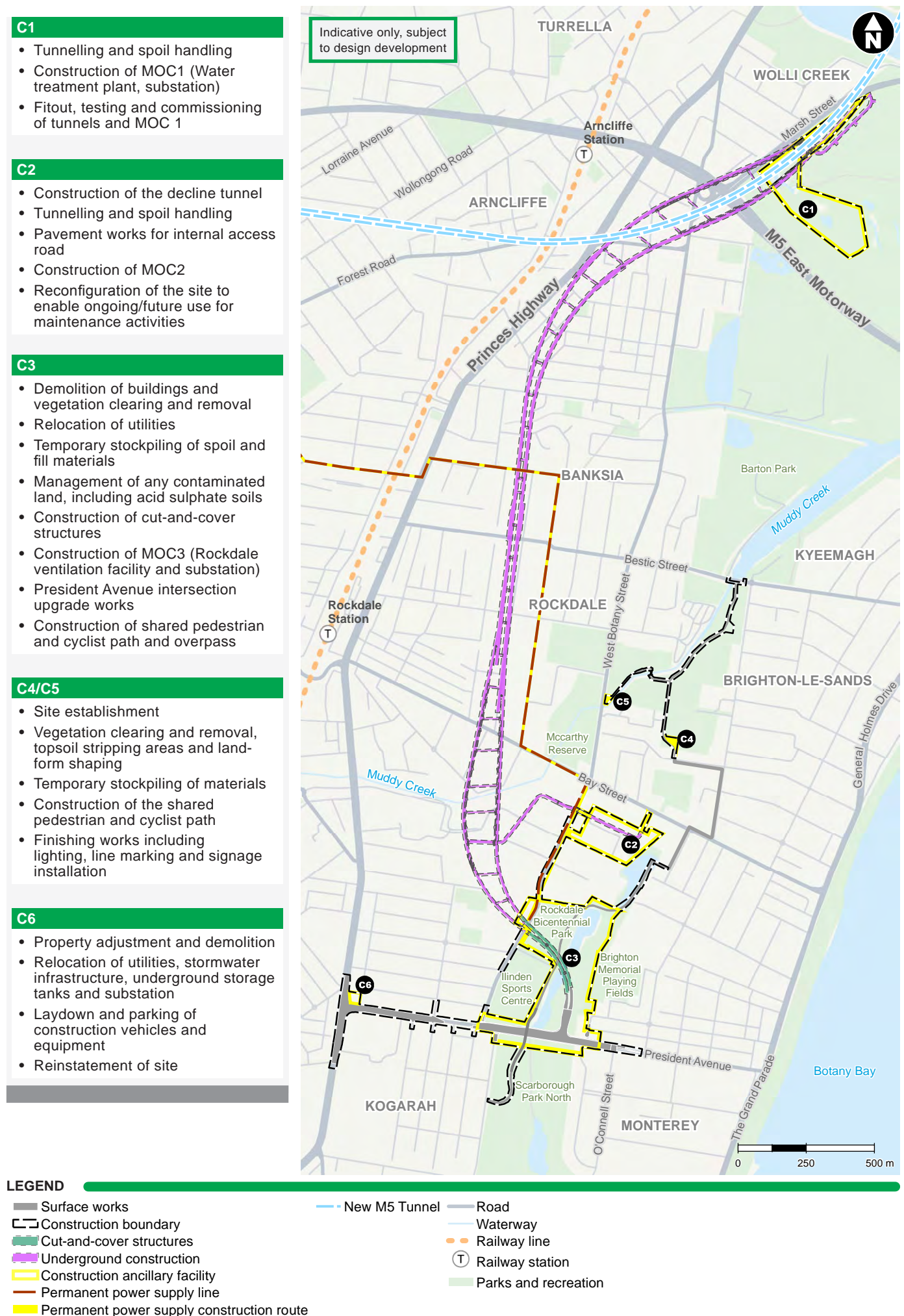


Figure 2-2 Construction boundary and construction ancillary facilities

2.3 Construction program

The project would be constructed over a period expected to be around four years, including commissioning which would occur concurrently with the final stages of construction (refer to **Figure 2-3**).

The project is expected to be completed towards the end of 2024.

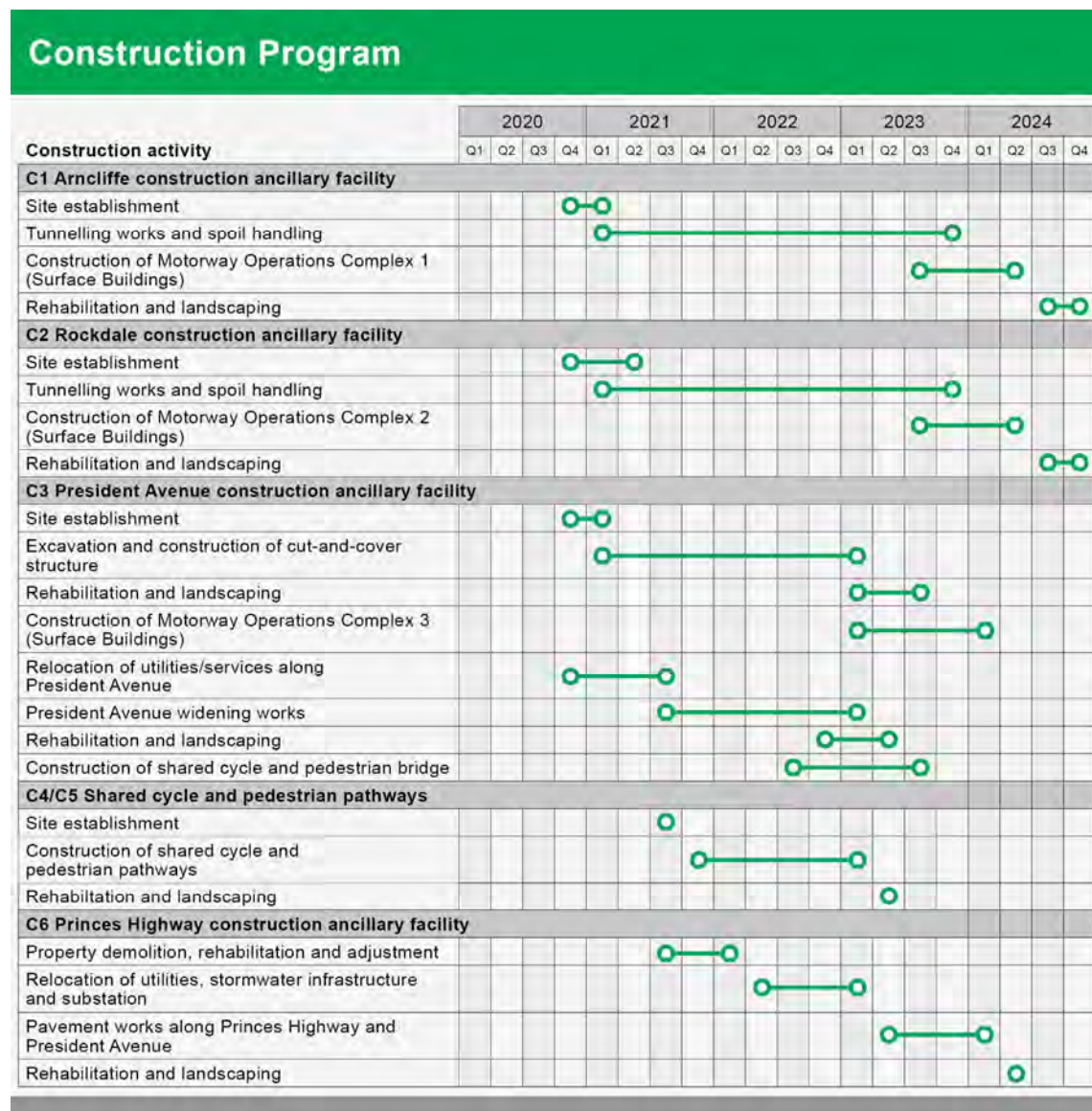


Figure 2-3 Indicative construction program

3 Assessment methodology

3.1 Relevant 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 EPA 2017. *Guidelines for the NSW Site Auditor Scheme* (3rd edition). October.
- NSW Department of Urban Affairs and Planning (DUAP) and NSW EPA, 1998. *Managing Land Contamination*, Planning Guidelines SEPP 55-Remediation of Land
- NSW Department of Environment and Conservation (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
- Department of Planning (DoP) 2008. *Acid Sulfate Soils Assessment Guidelines*.

3.2 Key assumptions

The contamination assessment was undertaken based on the following key assumptions:

- This report relies on soil, groundwater and ground gas monitoring data provided by Roads and Maritime. It is assumed this data is accurate
- The Arncliffe ancillary construction facility will have been investigated and interim advice provided by the appointed NSW EPA Site Auditor on the appropriateness of mitigation and management measures proposed by the New M5 Motorway contractor prior to hand over to the project
- The parts of Arncliffe and President Avenue construction ancillary facilities that will not be part of the operational footprint, will be returned to the previous land use and/or made suitable for ongoing land use, and pre-existing contamination will not be required to be remediated as part of the project.

3.3 Methodology

The following scope of work was undertaken in the desktop review:

- Review of available previous and relevant site contamination reports as provided
- Review of soil, groundwater and gas data collected as part of the targeted geotechnical investigations within the project alignment
- Review of Environmental Risk and Planning (ERP) Reports prepared for the length of the mainline tunnel alignment by Lotsearch Pty Ltd (Lotsearch) (Lotsearch 2017a, 2017b, 2017c, 2017d and 2017e) which included:
 - NSW EPA records of:
 - Contaminated sites notified to the NSW EPA under Section 60 of the CLM Act 1997
 - Contaminated sites currently or formerly regulated by the NSW EPA (Record of Notices)
 - Former gasworks sites
 - EPA Per- and Poly-Fluoralkyl Substances (PFAS) investigation program
 - Other sites with known contamination issues
 - Sites listed on the National Waste Management site database
 - Historical business activities from Universal Business Directories (UBD) Business to Business Directory including dry cleaners, motor garages and service stations (for the years 1991, 1986, 1982, 1978, 1975, 1970, 1965, 1961, 1950)
 - Historical aerial photographs for the years (2015, 2009, 2003, 1991, 1982, 1970, 1965, 1961, 1955, 1943)
 - Historical topographic and parish survey maps
 - Registered groundwater wells
 - Geology, soils, acid sulfate soil risk, dryland salinity potential
 - Local Environmental Plan (LEP) zones
- Obtaining and reviewing historical titles and/or section 149 certificates for select Lot and DP's within the following construction ancillary facilities and permanent operational infrastructure:
 - Rockdale construction ancillary facility site (C2) Roads and Maritime Services (RMS) Depot – 400 West Botany Street, Rockdale (Lot 1 Deposited Plan (DP)_ 655257 and Lot 1 DP950820)
 - President Avenue construction ancillary facility (C3) including Rockdale ventilation facility – Illinden Sports Centre (Lot 1 DP 535905), 112-132 President Avenue, Brighton Le Sands (Lot 73 DP746043 and Lot 72 DP746043) and 427-441 West Botany Street, Rockdale (Lot 7 DP381773, Lot 6 DP 22338, Lot 5 DP 22338, Lot 1 DP 100164, Lot 4 DP 22338, Lot 3 DP22338 and Lot 2 DP100164)
- An inspection of project alignment and location of the construction ancillary facilities from publically accessible land was undertaken by AECOM environmental scientists on 11 December 2017 to assist in the description of the existing environment

- A preliminary conceptual site model (CSM) was compiled for the impact assessment of the project construction and operation. A CSM identifies potential contamination sources, receptors and exposure pathways between the sources and receptors. As detailed in the ASC NEPM 2013, the development of a CSM is a key component of contaminated site assessments and provides the framework for identifying how potential receptors may be exposed to contamination from previous or current site sources. The sources, pathways and receptors were identified by information obtained in the desktop review and site inspection. The qualitative risk ranking was completed in **section 5 (Table 5.1)** and **section 6 (Table 6.1)** by identifying and assessing the pollutant linkages in the CSM and assigning the following risk:
 - low risk: based on the available information, a complete pollutant linkage is considered to be unlikely
 - medium risk: based on the available information, a complete pollutant linkage may potentially be present, however the likelihood and consequence is considered to be medium
 - high risk: based on the available information, a complete pollutant linkage is considered to be likely.

4 Existing Environment

4.1 Tunnel alignment

4.1.1 Location description

The F6 Extension Stage 1 mainline tunnel alignment runs from below the Kogarah Golf Course in Arncliffe where it connects to the New M5 Motorway tunnel stubs. It then travels south, to the east of the Princes Highway beneath the suburbs of Arncliffe, Banksia and Rockdale until it emerges in the location of Rockdale Bicentennial Park. Tunnel stubs for the continuation for the future stages of the F6 Extension are located north of Bay Street in Rockdale. The tunnel alignment comprises 3 kilometres of three lane multiline tunnel and 2.9 kilometres of two lane north facing ramps from President Avenue.

4.1.2 Topography and drainage

Lands around the tunnel alignment are relatively flat and low lying with gentle undulating hills ranging from around two metres Australian height datum (AHD) to around 16 metres AHD. The lands closest to the northern and southern end of the tunnel alignment are the lowest and flattest and the land with greatest elevation, around 36 metres AHD, is located in Arncliffe near the Princes Highway.

Muddy Creek traverses the tunnel alignment in a north-easterly direction draining stormwater run-off from the suburbs of Carlton, Kogarah, Rockdale, Banksia, Brighton-Le-Sands and Kyeemagh. It consists predominately of a brick and concrete-lined channel owned by Sydney Water. Its sub-catchment is around 5.7 square kilometres and mainly takes runoff from residential areas, with small pockets of commercial areas, parklands and a Chinese market garden. Muddy Creek connects to the Cooks River near Sydney Airport.

Rockdale wetland re located within an area of extensive low lying, flood prone land that is also influenced by tidal/storm conditions in Botany Bay. Piped drainage systems connect into the watercourses along the length, draining the surrounding built up areas of Brighton-Le-Sands, Rockdale, Kogarah, Monterey, Ramsgate, Sans Souci and Sandringham.

Rockdale wetland drain generally southwards from around Bay Street, Rockdale in the north, and comprises a series of large ponds linked by culverts passing under road crossings at President Avenue, Rockdale and Barton Street, Monterey. The chain of ponds is located within several reserves, and discharges to Botany Bay in the vicinity of Florence Street, Ramsgate Beach via a piped drainage line. Topography and drainage features are shown on **Figure 4-1**. An assessment of surface water impacts has been undertaken in **Appendix L** of the EIS (Surface water technical report).

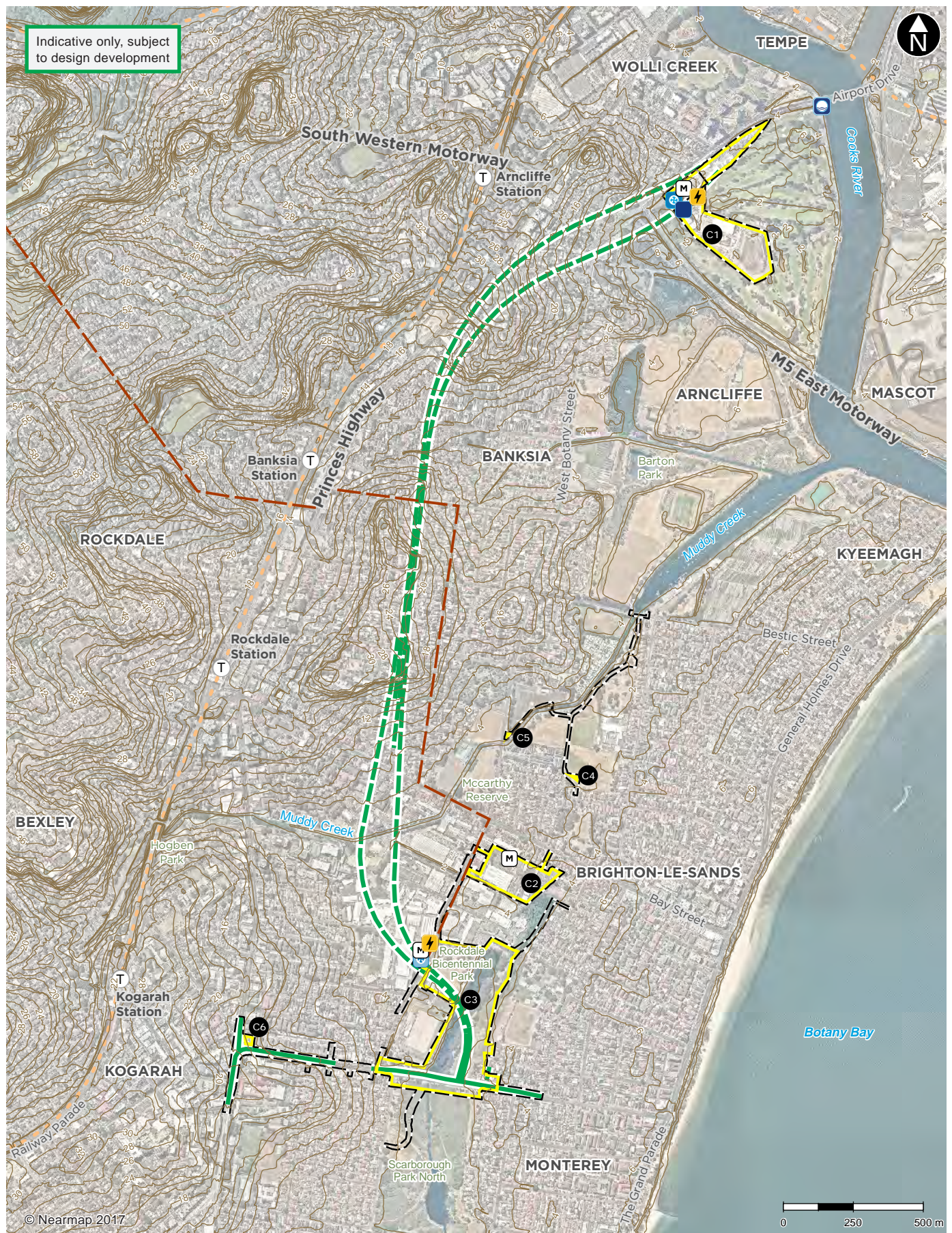


Figure 4-1 Topography and drainage

4.1.3 Soils

Soil landscape types along the tunnel alignment and surrounding area is shown on **Figure 4-2**. The soils above the alignment consist of Hawkesbury colluvial, Lambert erosional, Newport aeolian and GyMEA erosional soils in higher elevated areas. Warriewood swamp soil landscapes occur in the low lying areas.

Areas of disturbed terrain are mapped in the following locations along the tunnel alignment:

- Kogarah Golf Course (extending to the north and east to the Cooks River at the northern most extent of the tunnel)
- The low lying areas along Muddy Creek, the industrial area in Rockdale and Rockdale Bicentennial Park.

4.1.4 Acid sulfate soils

Acid sulfate soils risk above and around the tunnel alignment are shown on **Figure 4-3**. Areas of a high risk of acid sulfate soil occurrence are located in the following areas:

- An area surrounding the drainage line running south and perpendicular to Spring Street (Soil Class 3) into Muddy Creek (between chainage 1700 and 1900)
- The low lying areas along Muddy Creek and in the industrial area in Rockdale (Soil Class 3)
- The low lying areas surrounding Rockdale wetland including Rockdale Bicentennial Park and Rockdale Bicentennial Park East (Soil Class 2) and further east (Soil Class 3 and Class 4).

An Acid Sulfate Management Plan is required for the following circumstances for each classification:

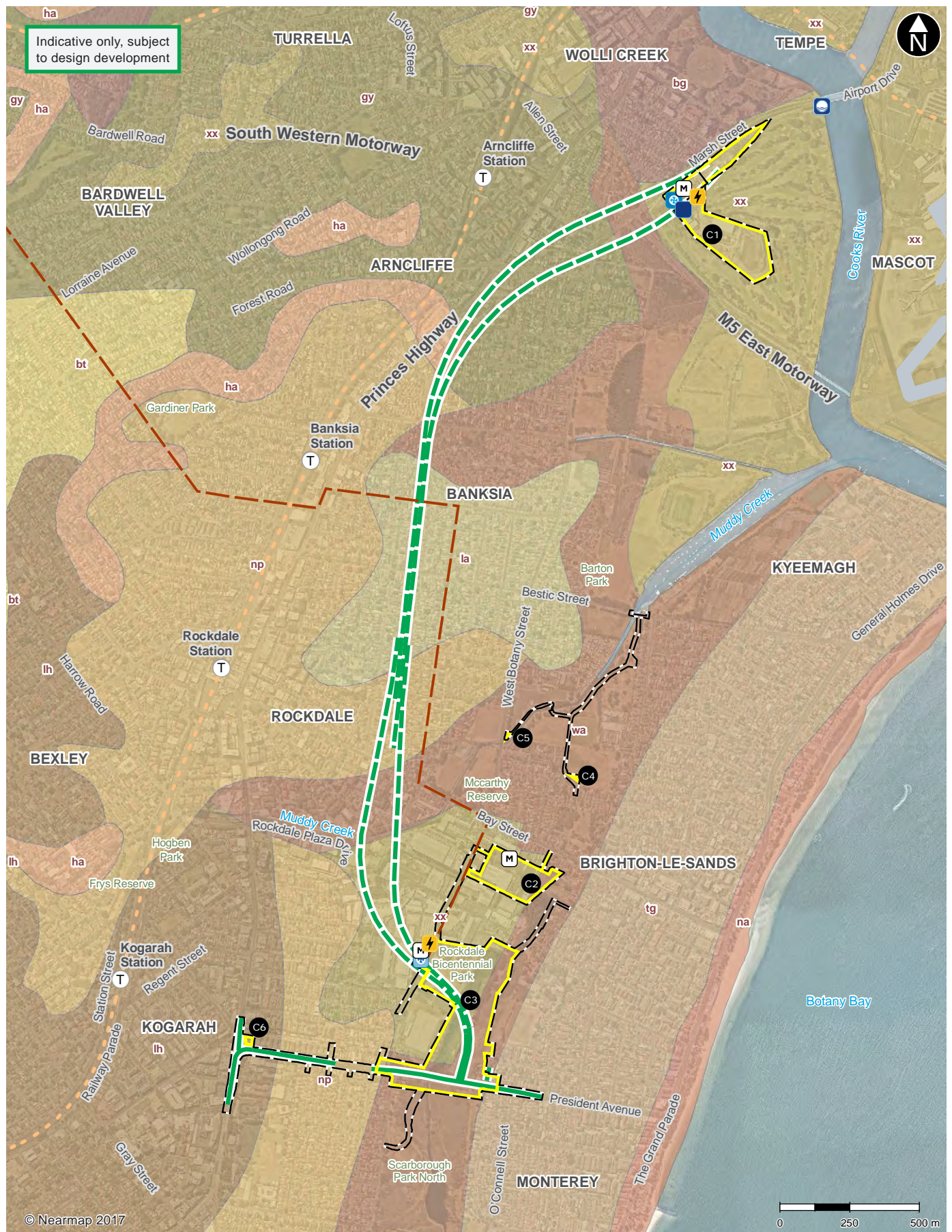
- Class 2: Works below the natural ground surface. Works by which the water table is likely to be lowered
- Class 3: Works more than 1 metre below the natural ground surface. Works by which the water table is likely to be lowered more than 1 metre below the natural ground surface
- Class 4: Works more than 2 metres below the natural ground surface. Works by which the water table is likely to be lowered more than 2 metres below the natural ground surface

4.1.5 Geology

Geology along the tunnel alignment and surrounding area is shown on **Figure 4-4**. The low elevation areas along the tunnel alignment consist of Quaternary alluvium with areas of former swamps consisting of man-made fill. Areas of higher elevation and westerly sections along the tunnel alignment consist of Triassic aged Hawkesbury Sandstone. The Hawkesbury Sandstone also underlays the alluvium.

The alluvium extends further west in the location of a drainage line that runs east to Muddy Creek from the western side of Banksia and also west of Rockdale Industrial area along Muddy Creek, where it extends west of the Princes Highway in Kogarah. The alluvium is deepest in the location of palaeochannels. The alluvium usually consists of a mixture of peat, sandy peat, and mud; coarse quartz sand with varying amounts of shell fragments; and medium to fine grained marine sand with podsols. The man-made fill often contains dredged estuarine sand and mud, demolition rubble and industrial and domestic waste.

Further detail on the geology in the location of the project, including cross sections is presented in **Appendix K** of the EIS (Groundwater technical report).

**LEGEND**

- | | | | | |
|--|--|---|--|--|
| — The project in tunnel | Substation | bg - Birrong | np - Newport | Railway station |
| — The project on surface | Water treatment facility | bt - Blacktown | na - Narrabeen | — Railway line |
| Construction boundary | Rockdale ventilation facility | gy - Gynea | tg - Tuggerah | |
| Construction ancillary facility | Arnccliffe ventilation facility* | ha - Hawkesbury | wa - Warriewood | |
| — Permanent power supply line | <small>* Under construction as part of the New M5 Motorway project</small> | la - Lambert | xx - Disturbed | |
| Motorway operations complex | | lh - Lucas heights | | |
| Operational discharge location | | | | |

Figure 4-2 Soil landscapes

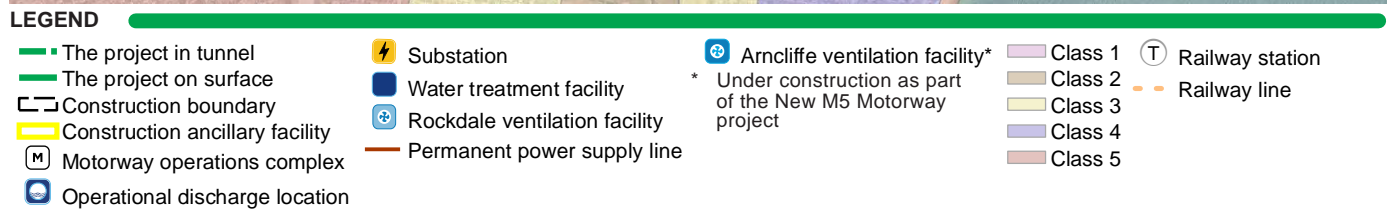
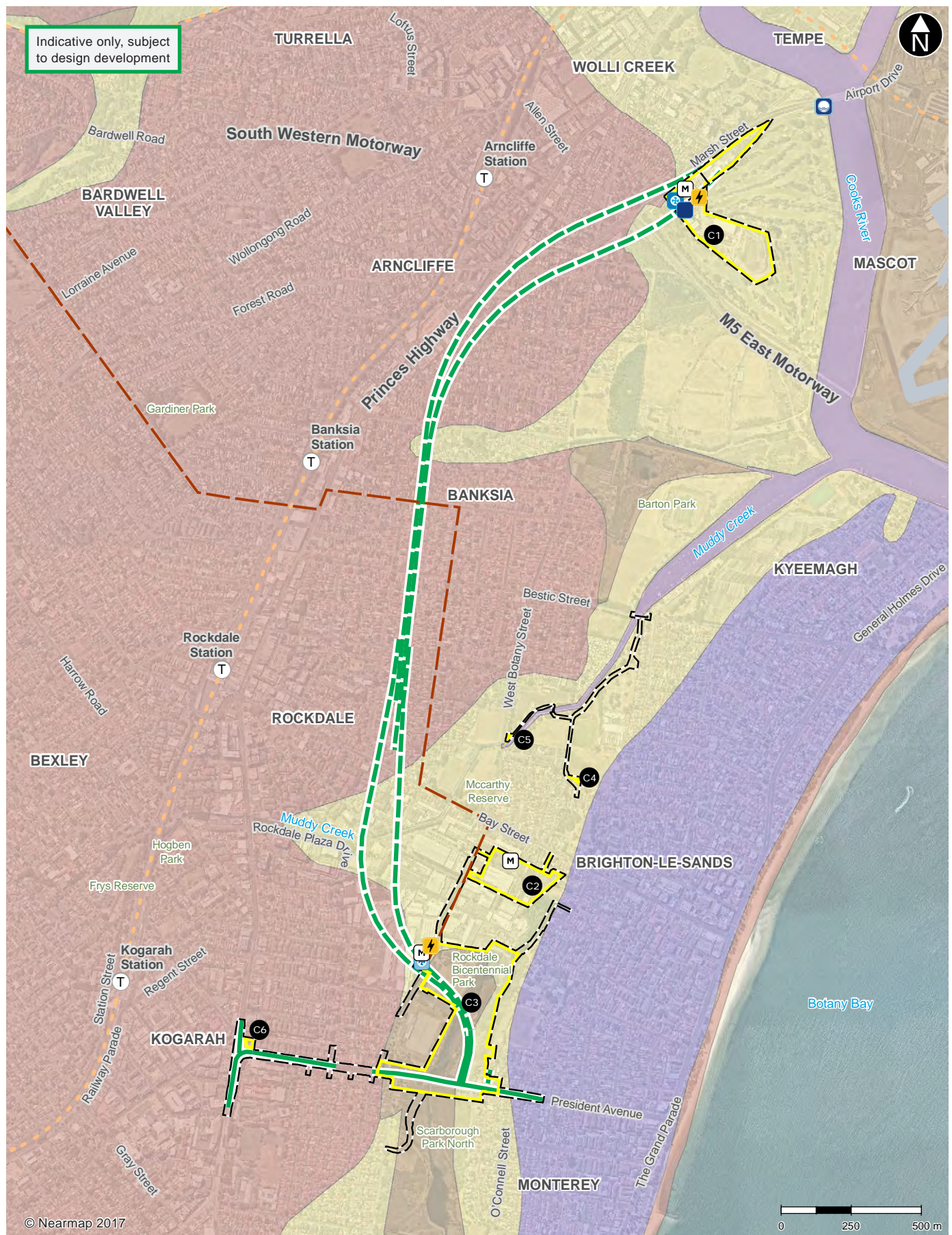


Figure 4-3 Acid sulfate soils

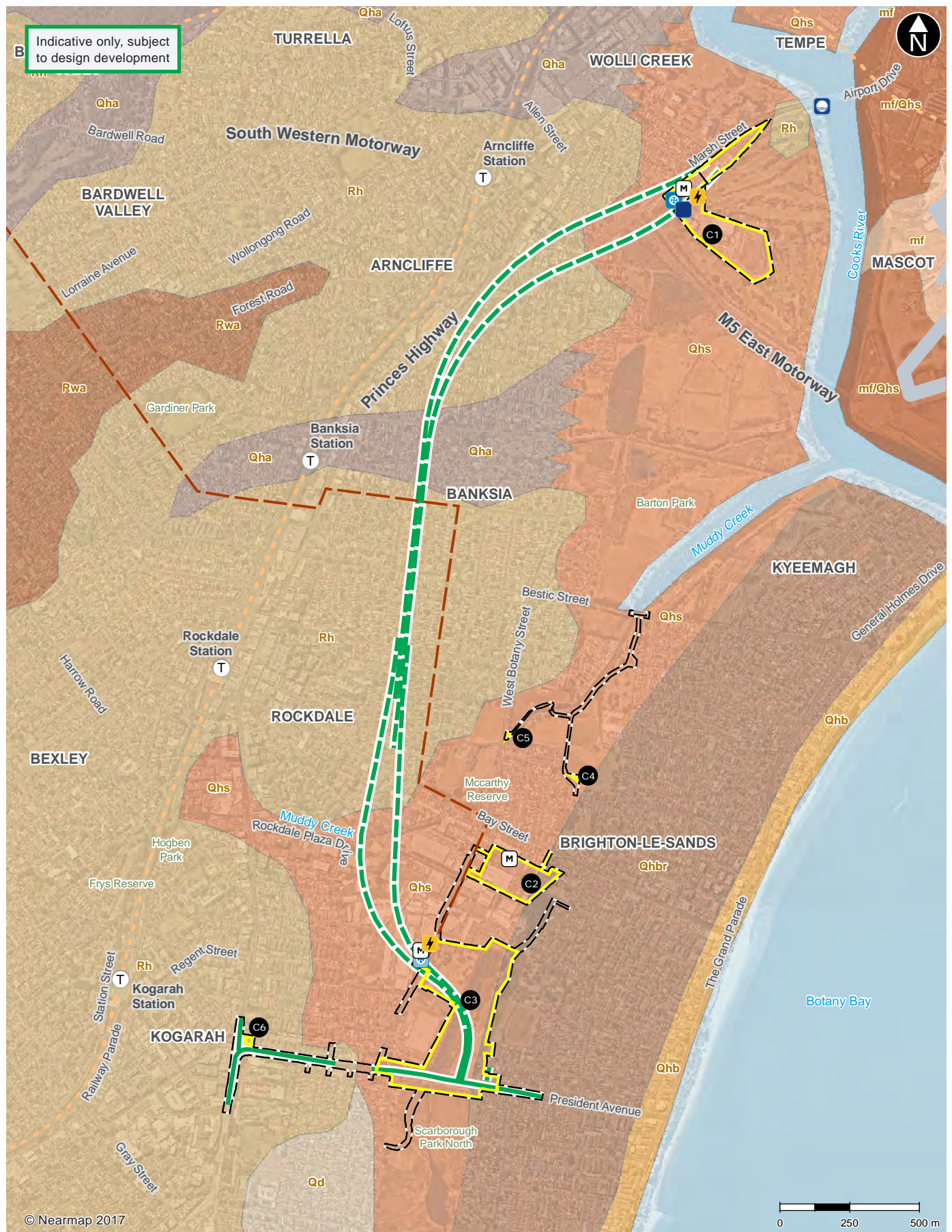


Figure 4-4 Geology

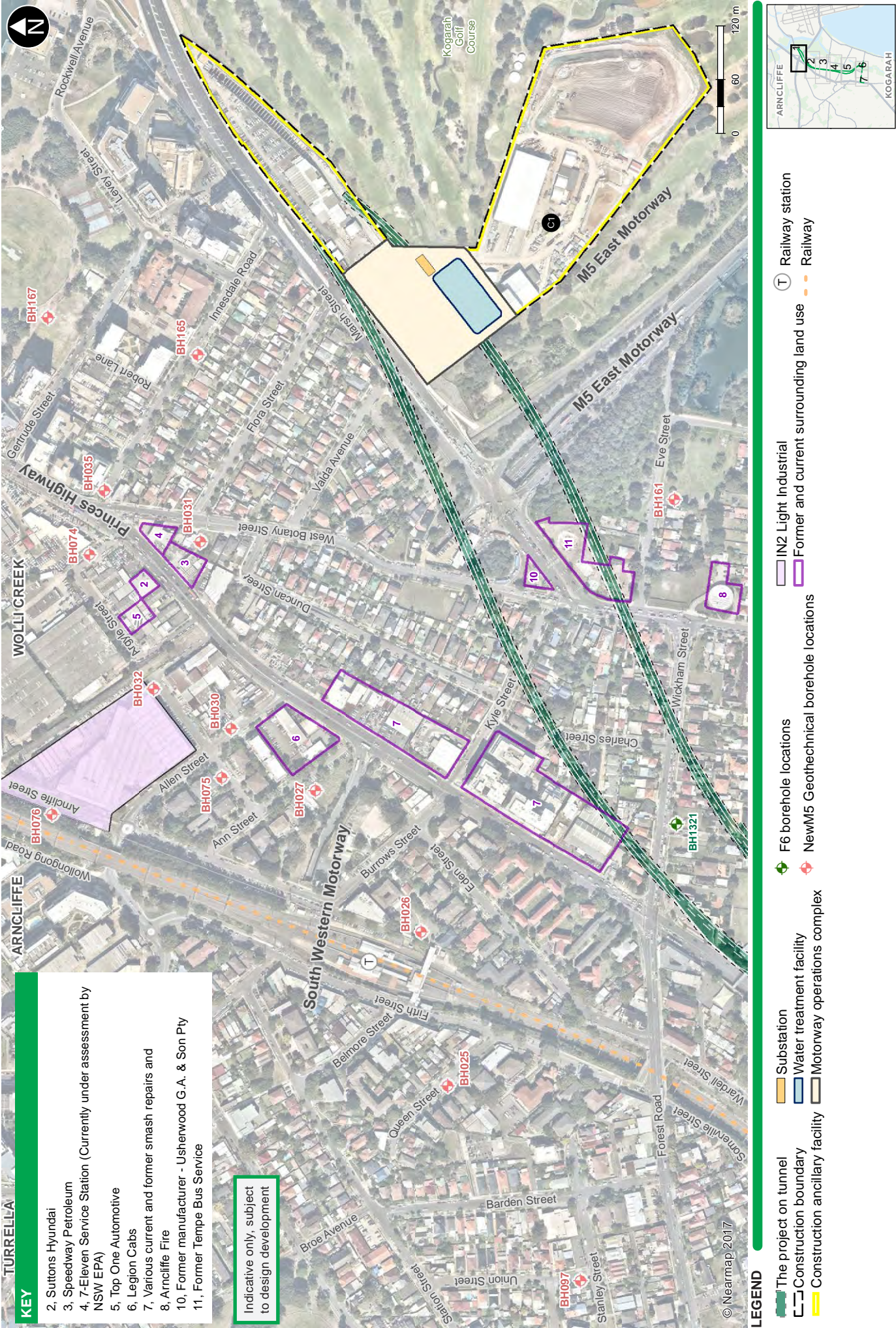


Figure 4-5 New M5 Motorway to Forest Road, Arncliffe

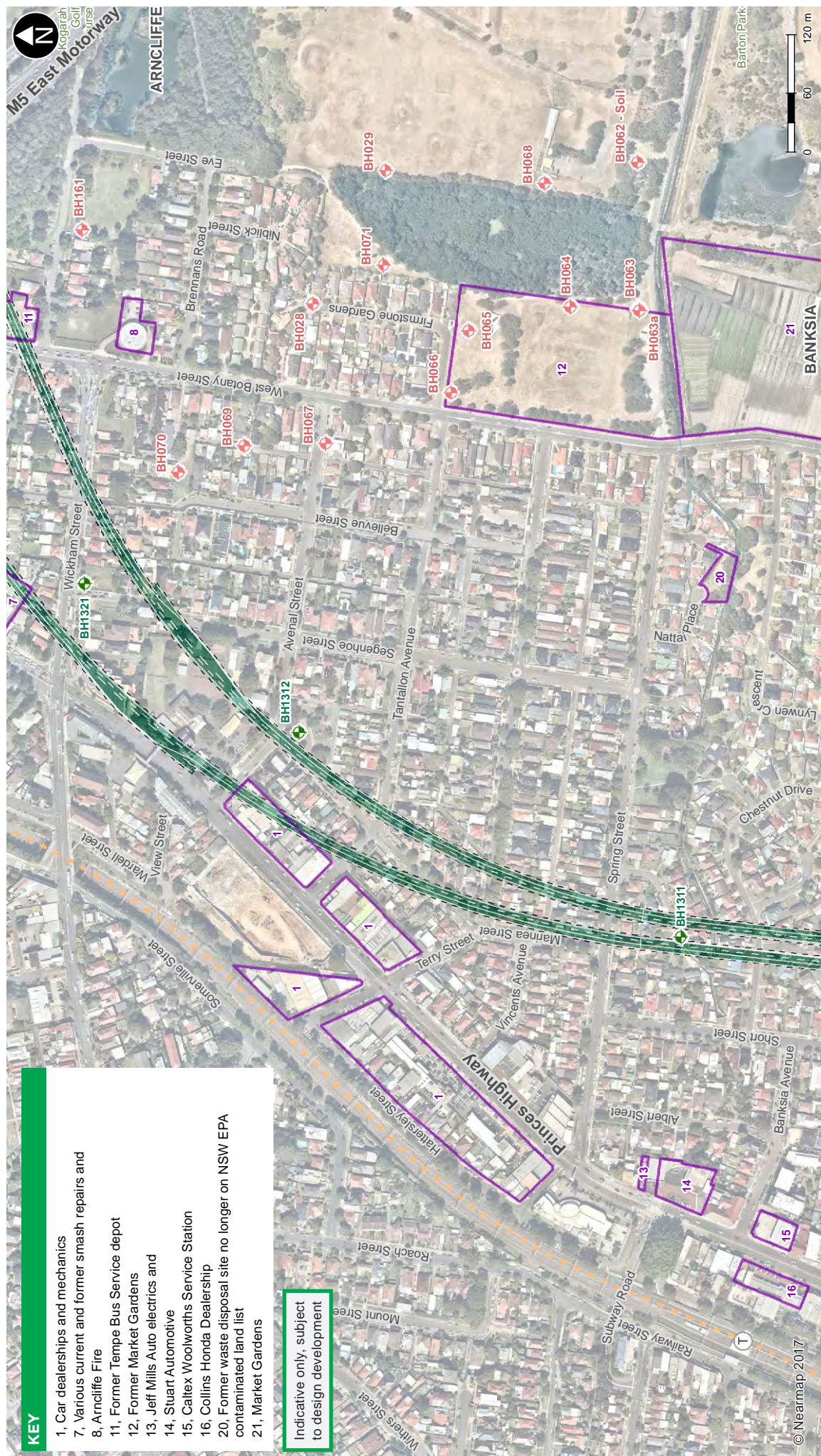


Figure 4-6 Forest Road to Spring Street, Arncliffe

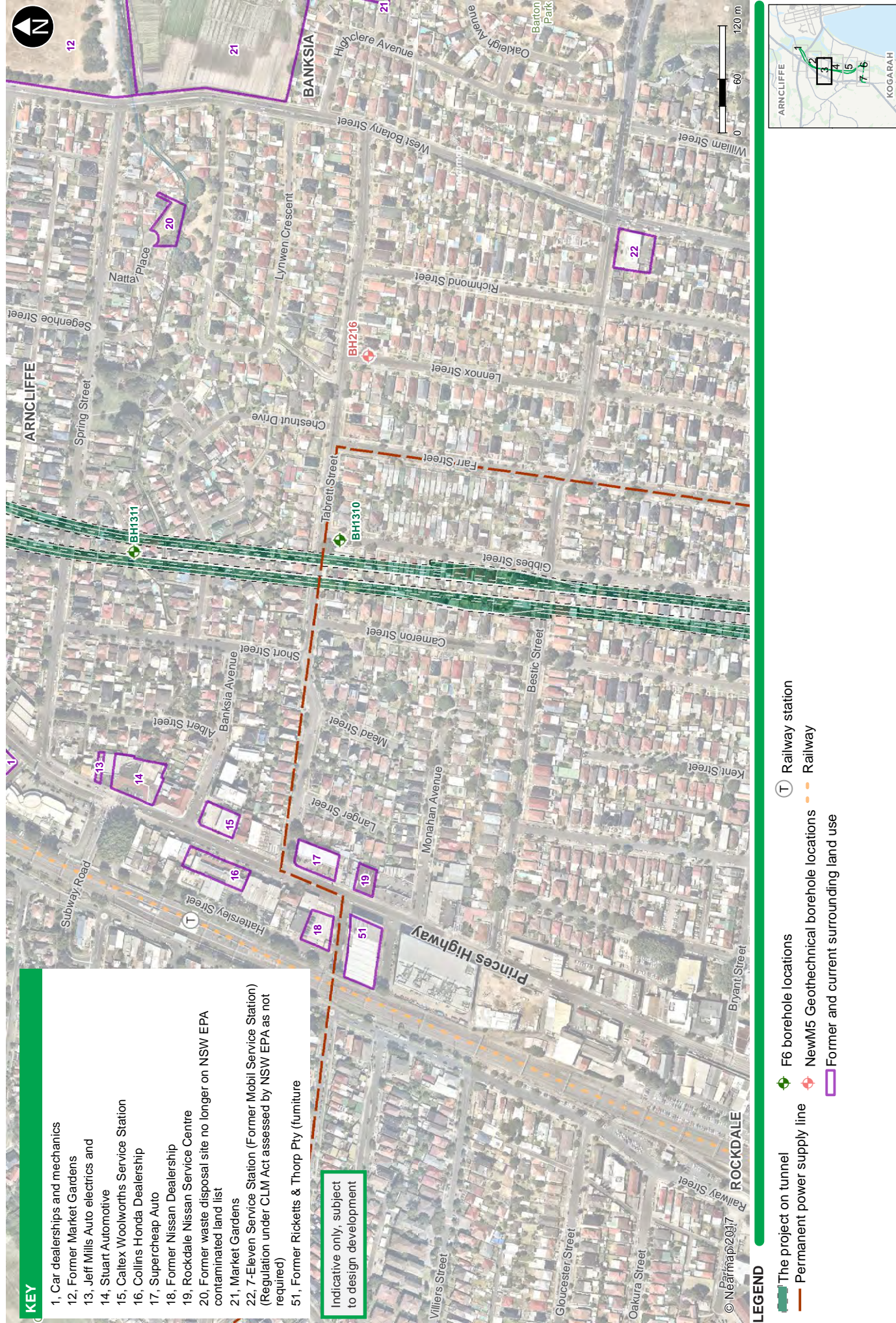


Figure 4-7 Spring Street to Bestic Street, Arncliffe



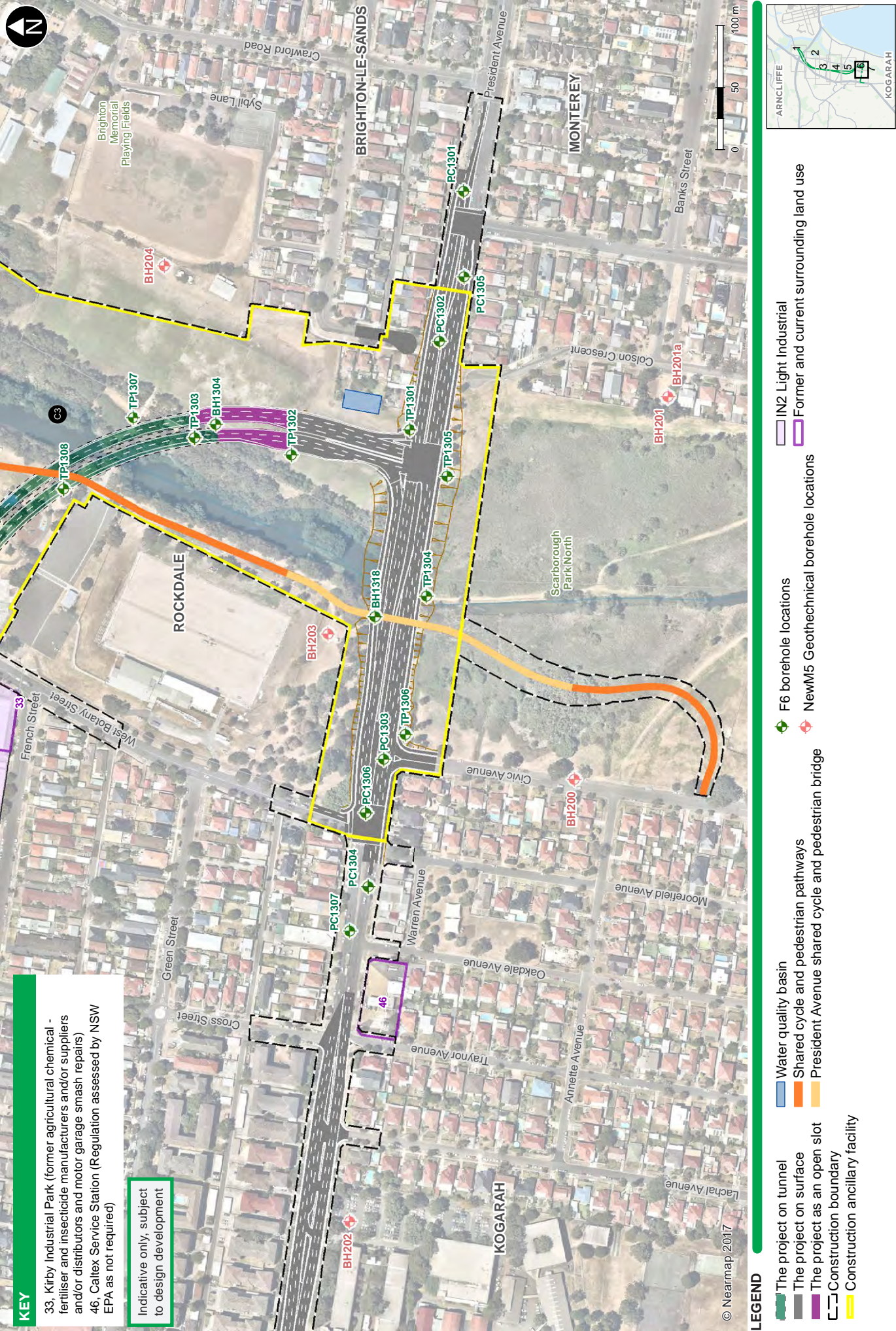
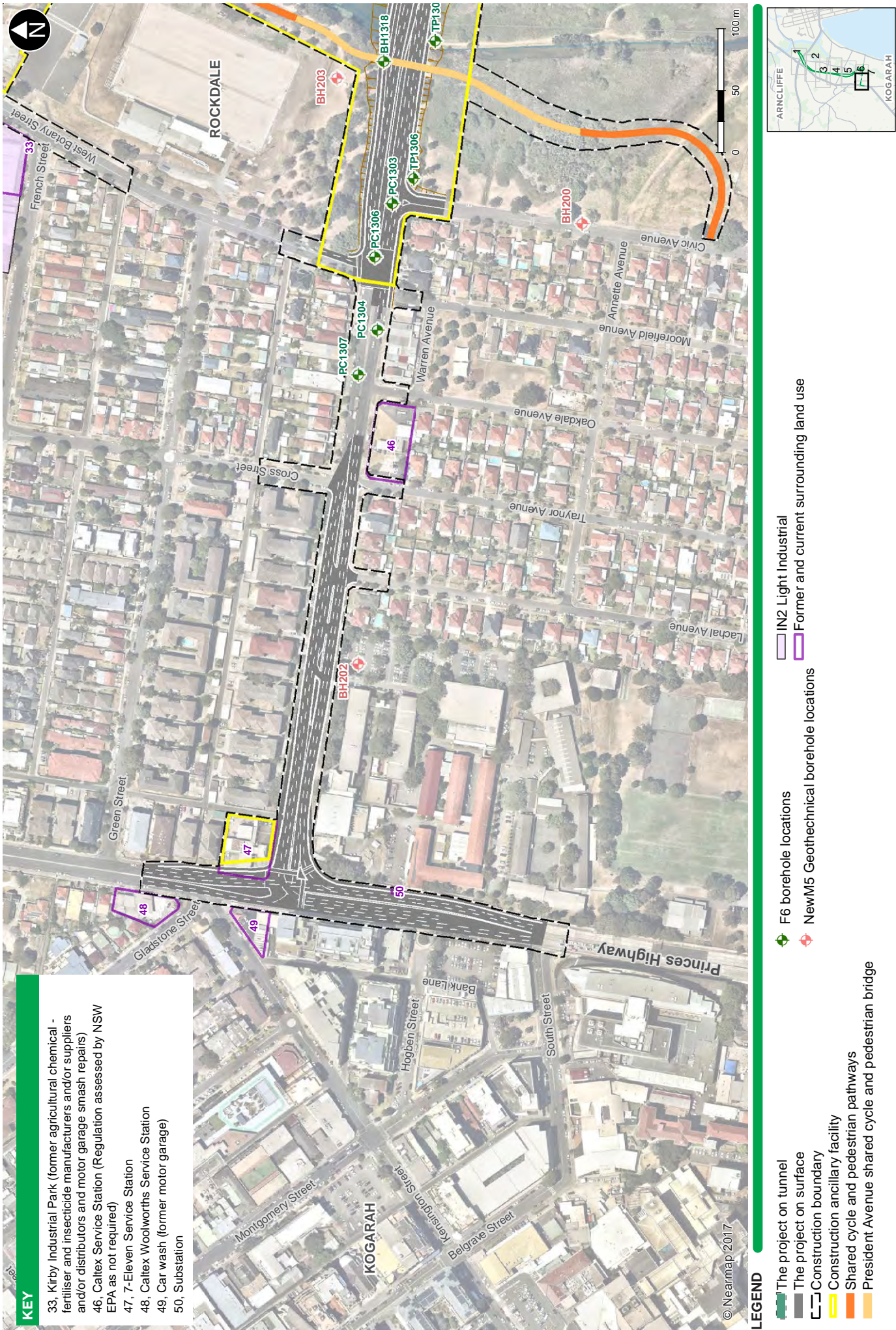


Figure 4-10 President Avenue intersection, Kogarah



4.1.6 Hydrogeology

Shallow groundwater is generally present within alluvial materials (Botany Sands) and deeper groundwater within bedrock (generally Hawkesbury Sandstone). It is noted that there is potential for discontinuous shallow perched groundwater to be present in fill materials overlying alluvial materials in certain areas.

Aquifers within the area of the tunnel alignment are described as porous and extensive low to moderate and high productivity. Groundwater elevations vary depending on the topography and geology along the tunnel alignment. The tunnel alignment is located partially within land regulated by the Botany Sands Water Sharing Plan (within Botany Management Zone 2) to the north east surrounding Botany Bay and the remaining areas are regulated by the Greater Metropolitan Region Groundwater Sources Water Sharing Plan.

To the northeast of the tunnel alignment, to the north of Botany Bay, is the Botany Sand Beds aquifer which is a large volume of groundwater present in the sandy ground to the north of Botany Bay. The aquifer is highly vulnerable to contamination due to the permeability of the sands and the generally shallow water table. There is an embargo on the domestic use of groundwater in this area due to historic contamination.

A summary of existing registered groundwater wells (NSW Department of Primary Industries (DPI) – NSW Office of Water (NOW) within 50 metres of the tunnel alignment is provided in **Table 4-1**.

Table 4-1 Summary of registered groundwater bores (north to south)

Bore ID	Purpose	Final depth (metres)	Screened lithology	Standing water level (metres)	Distance and direction
Kogarah Golf Club to Bestic Street, Arncliffe					
GW027664	Irrigation	6.00	Sand	Not recorded	19 metres north-east
GW114745	Monitoring bore	13.95	Sandstone	Not recorded	28 metres west
GW114744	Monitoring Bore	17.00	Sandstone	Not recorded	32 metres west
GW109963	Domestic	8.00	Sand	Not recorded	45 metres north-east
GW072161	Recreation	90.50	Sandstone	14.0	53 metres north-east
Bestic Street, Arncliffe to Bay Street, Banksia					
Nil records within 50 metres of the project area					
Bay Street, Banksia to Industrial Area Rockdale					
GW026651	General Use	3.60	Black Mud (Clay)	Not recorded	27 metres south
GW026648	General Use	6.00	Sand	Not recorded	35 metres south
Industrial Area Rockdale/Brighton Le Sands					
GW107531	Industrial	14.00	Sand	2.00	Within the project area
GW105158	Domestic/ Industrial	4.58	Sand	1.83	3 metres north-west
President Avenue, Rockdale Bicentennial Park and Rockdale Bicentennial Park East Kogarah, Rockdale & Brighton Le Sands					
GW026647	General Use	10.30	Not recorded	Not recorded	Within the project area
GW013930	General Use	7.60	Sand	Not recorded	Within the project area
GW027055	General Use	9.10	Sand	Not recorded	Within the project area
GW025719	General Use	5.40	Not recorded	Not recorded	1 metres south-east

Bore ID	Purpose	Final depth (metres)	Screened lithology	Standing water level (metres)	Distance and direction
GW107423	Domestic	5.80	Sand	2.75	14 metres south-east
GW106672	Domestic	5.49	Sand	3.05	17 metres south-east
GW026651	General Use	3.60	Black Mud (Clay)	Not recorded	22 metres north
GW113047	Domestic	6.71	Not recorded	3.05	29 metres south-east
GW026648	General Use	6.00	Not recorded	Not recorded	48 metres north

Groundwater modelling and a detailed assessment of hydrogeology for the project has been undertaken in **Appendix K** of the EIS (Groundwater technical report). Investigations of the hydrogeological, geochemical and chemical contamination conditions of groundwater along the project alignment have been undertaken by SMEC. The results of the groundwater investigations relevant to the contamination assessment are described in **section 4.1.12**.

Potential impacts to groundwater dependent ecosystems has been assessed in **Appendix H** of the EIS (Biodiversity Development Assessment).

4.1.7 Current land use

The land use above and surrounding the tunnel alignment is predominantly zoned low and medium density residential (R2 and R3) and public recreation (RE1) with the exception of the following areas:

- Enterprise corridor (B6) and mixed use (B4) along the Princes Highway above and directly to the west of the alignment
- High density residential (R4), industrial (IN2), private recreation (RE2) and infrastructure (SP2) between Bay Street, Rockdale and President Avenue, Rockdale.

Current commercial and industrial land uses within 250 metres of the tunnel alignment that could contain potential contaminating activities are listed in **Table 4-2** and shown on **Figure 4-5** to **Figure 4-11**. The currently industrial (IN2) zoned land is shown on **Figure 4-9**.

Table 4-2 Current commercial and industrial land uses

Property identification	Proximity to tunnel alignment	Activity
Arncliffe to Rockdale Industrial Area		
7-Eleven Service Station 28 Princes Highway, Arncliffe	250 metres north west	Underground fuel storage
Speedway Service Station 12 Arncliffe Street, Wolli Creek	250 metres north west	Underground fuel storage
Arncliffe Fire Station 100 – 106 West Botany Street, Arncliffe	65 metres south east	Fire Fighting Foam residues
Smash repairs and mechanics between 62 and 96 Princes Highway, Arncliffe	150 metres west	Use of oils and solvents
Caltex Woolworths 314 Princes Highway, Banksia	250 metres west	Underground fuel storage

Property identification	Proximity to tunnel alignment	Activity
Numerous individual mechanical workshops and car dealerships with workshops Located between 172 and 286 Princes Highway, Arncliffe	Above alignment to 250 metres west	Use of oils, solvents and underground fuel storage
Rockdale industrial area		
23 Field Regiment Royal Australian Artillery 40 Beach Street, Rockdale	Above alignment	Potential oils, solvents and underground fuel storage
Suez Waste Transfer Station 5 Lindsay Street Rockdale	Above alignment	Waste management
R.E. Davidson Pty Ltd (RED Composite) 7 Lindsay Street, Rockdale	Above alignment	Manufacturing
Rockdale Radiator Specialist Co 13/380 West Botany Street Rockdale	40 metres north of the ventilation tunnel	Storage and use of solvents and oils
Rockdale Mechanical Repairs 371 West Botany Street Rockdale	12 metres north of the ventilation tunnel	Storage and use of solvents and oils
400 West Botany Street Rockdale	Refer to section 4.3	Refer to section 4.3
Sydney Collision Repairs 410 West Botany Street Rockdale	25 metres south of ventilation tunnel	Storage and use of solvents and oils
Ralphs Smash Repairs 412 West Botany Street Rockdale	40 metres south of ventilation tunnel	Storage and use of solvents and oils
Petrol station (under construction) 444 West Botany Street Rockdale	160 metres northeast of tunnel	Underground fuel storage
AFCO All Metal Work 2-6 Bermill Street Rockdale	185 metres south of the ventilation tunnel	Manufacturing/storage and use of solvents
CT Automotive 5 Bermill Street Rockdale	110 metres north west of the ventilation tunnel	Storage and use of solvents and oils
IS Motor Racing 5/5-7 Bermill Street Rockdale	60 metres north west of the ventilation tunnel	Storage and use of solvents and oils
Crystalite Plastics Pty Ltd 8-14 Bermill Street Rockdale	140 metres west of the ventilation tunnel	Plastics manufacturing
Motorcycle Service and Repair Centre and Mechanics 4u 9 Bermill Street Rockdale	Adjacent to alignment of ventilation tunnel	Storage and use of solvents and oils
St George Metal Recovery 17 Bermill Street Rockdale	40 metres north of ventilation tunnel	Storage of waste oils

Property identification	Proximity to tunnel alignment	Activity
Tyrepower 433 West Botany Street Rockdale	100 metres north east of the tunnel	Storage and use of solvents and oils
NRMA Car Servicing Rockdale 443 West Botany Street Rockdale	100 metres north east of the tunnel	Storage and use of solvents and oils
Botany Car Detailing 427 West Botany Street Rockdale	70 metres north of tunnel	Storage of waste oils

4.1.8 Historical aerial photographs

Historical aerial photographs were reviewed for the tunnel alignment and surrounding land. A summary of the review is provided in the **Table 4-3**.

Table 4-3 Tunnel alignment – historical aerals

Area	Summary
New M5 Motorway to Bestic Street, Arncliffe	<ul style="list-style-type: none"> Historical aerals show that market gardens were located at the northern end of the tunnel alignment on either side of the SWSOOS since prior to 1943. By 1982 the market garden on the south side of the SWSOOS had been covered by a large stockpile and Kogarah Golf Course covered the former northern market garden. Factories were located on the Princes Highway between Forest Road and Kyle Street on the west side of the tunnel alignment from prior to 1943 until 2015. Commercial buildings were located along the Princes Highway between Avenal Street and Bestic Street (to the west of the tunnel alignment) from prior to 1943 and 1915. The remainder of the land above and on either side of the tunnel alignment was residential with the exception of market gardens between Spring Street and Bestic Street in Banksia which developed into residential between 1955 and 1982. Substantial land filling occurred across the land to the east of the tunnel alignment between West Botany Street and Muddy Creek in Banksia and Arncliffe (Riverine Reserve and Barton Park) and parts of Kogarah Golf Course in the 1960s and 1970s.
Bestic Street, Arncliffe to Bay Street, Banksia	<ul style="list-style-type: none"> The land use above and within 150 metres of the tunnel alignment within this area appeared to be residential since prior to 1945. There appeared to be shallow filling occurring along the banks of Muddy Creek 100 metres to the east of the alignment since prior to 1945 until the development of the sports fields (McCarthy Reserve and Ador Reserve) between 1965 and 1970.

Area	Summary
Rockdale industrial area	<ul style="list-style-type: none"> In 1943 the majority of the Rockdale industrial area appeared to be a mixture of low-lying swamp land with market gardens and residential development around the fringes. There appeared to be an isolated cluster of industrial buildings at 450 West Botany Street. Industrial development occurred after 1945, firstly along West Botany Street, Bermill Street and then infilled towards Muddy Creek and was mostly developed between the mid-1950s and 1970s. There were numerous large factories across the area. A lot of the factories were redeveloped into industrial parks and units in the 1990s and 2000s, with pockets of smaller factories remaining along West Botany Street and Bermill Street. The remainder of the area to the west was largely residential since prior to the 1950s.
Rockdale Bicentennial Park and Rockdale Bicentennial Park East	<ul style="list-style-type: none"> The 1943 aerial photograph showed a narrow strip of market gardens along the eastern side of West Botany Street. The remainder of the land appeared uncultivated and undeveloped. Rockdale Bicentennial parklands on the west side of Rockdale wetland appeared to be infilled in the 1960s and 1970s and then developed into the parklands and sports field in the 1980s. The Rockdale Bicentennial Park East on the east side of Rockdale wetland appeared to undergo filling in the 1980s. Prior to the 1980s the land appeared to be swamp. Further filling and redevelopment into sports fields occurred between 2003 and 2009.

4.1.9 NSW EPA records

A search of the NSW EPA records indicated that there were no sites currently regulated by the NSW EPA under Section 60 of the CLM Act 1997 within 500 metres of the tunnel alignment. Sites that have been notified to the NSW EPA within 500 metres of the tunnel alignment are listed in the **Table 4-4** and shown on **Figure 4-5** to **Figure 4-11**.

Table 4-4 Tunnel alignment – sites within 500 m notified to the NSW EPA.

Property and address	Proximity to tunnel alignment	Summary
7-Eleven Arncliffe 28 Princes Highway	273 metres north	Currently under assessment by the NSW EPA
Former Ausgrid Substation 10061 13 Gertrude Street	278 metres north	Regulation under the CLM Act was assessed by the NSW EPA as not being required
Former waste disposal site and properties around Lynwen Crescent, Banksia	388 metres south east	Site no longer on EPA contaminated land list
7-Eleven (former Mobil) Service Station 293 West Botany Street, Rockdale	342 metres south east	Regulation under the CLM Act was assessed by the NSW EPA as not being required
Caltex Service Station, 29 President Avenue, Kogarah	451 metres south	Regulation under the CLM Act was assessed by the NSW EPA as not being required

4.1.10 Waste management sites and NSW EPA licensed activities

Currently and formerly licensed and delicensed sites within 500 metres of the tunnel alignment are listed in **Table 4-5**.

Table 4-5 Tunnel alignment – national waste management sites and NSW EPA licensed activities

Property and address	Proximity to alignment	Summary
WestConnex New M5 Motorway tunnels, between Beverly Hills and St Peters, Beverly Hills	Above alignment	Currently licensed under the POEO Act 1997
Sydney Trains, Illawarra railway	124 metres north west	Currently licensed under the POEO Act 1997
Morris, McMahon & Co Pty Ltd, 34 Arncliffe Street, Arncliffe	381 metres north	Delicensed activity for Hazardous, Industrial or Group A Waste Generation or Storage
Bilfinger Berger Project Investments Pty Ltd, M5 East Between Kings Georges Rd, Beverly Hills & General Holmes Drive, Kyeemagh	Above alignment	Former license for road construction
Luhmann Environment Management Pty Ltd, Robert Orchard and Sydney Weed and Pest Management Pty Ltd, Waterways Throughout NSW	Above alignment (including Muddy Creek and Cooks River)	Former license for Other Activities / Non Scheduled Activity - Application of Herbicides
McConnell Dowell Constructor S (Aust.) Pty Ltd	365 metres south east (Cooks River)	Former license for water-based extractive activity, miscellaneous licensed discharge to waters (at any time)
SUEZ Recycling and Recovery Pty Ltd Rockdale Waste and Recycling Centre Lindsay Street Rockdale	Above alignment	Non-thermal treatment and recovery of general waste, as well as storage of all types of waste including hazardous waste (including asbestos).
Jacron Pty Ltd/Vulkan Industries 3 Garnet Street, Rockdale	25 metres east	Delicensed activity for Hazardous, Industrial or Group A Waste Generation or Storage
Roads and Traffic Authority of New South Wales, 422 West Botany Street	Above alignment	Delicensed activity for Hazardous, Industrial or Group A Waste Generation or Storage

4.1.11 Historical businesses

A summary of historical businesses within 100 metres of the tunnel alignment from UBD business directory records are summarised in **Table 4-6** and shown on **Figure 4-5** to **Figure 4-11**.

Table 4-6 Tunnel alignment – historical businesses

Property address	Proximity to tunnel alignment	Businesses (potentially contaminating)
St. George Motors Pty. Ltd., 132 Princes Highway, Arncliffe	11 metres west	Motor garage/service station (1950 to 1970)
Watson, A, 150 Princes Highway	20 metres west	Motor garage/service station (1965)
Leach, C., 14 Terry St. Arncliffe	88 metres west	Motor garage/service station (1950 to 1965)
Goodfellows Dry Cleaners & Launderers, 122 Cameron St, Rockdale	Above alignment	Dry cleaners (1965 to 1982)
Numerous properties Aboukir and Garnet Street Rockdale	Above alignment	Chemical manufacturing, electroplaters, plastic manufacturing, tool manufacturing, firefighting equipment manufacture/distribution
3 West Botany Street, Rockdale	Above alignment	Steel fabricators, boilermakers, production engineers, chemical and structural engineers, metal pressers/stampers
365 to 387 West Botany Street (including Bunnings property) Rockdale	Above ventilation tunnel	The Rockdale Centre comprising various businesses – cleaning, joinery, refrigeration, wedding cars, blinds, eco appliances, shop fitting services Rockdale mechanical repairs Various businesses – motor accessories, kitchen manufacturers, electrical contractors, transport company (1986) Agricultural chemical, fertiliser and insecticide manufacturers and/or suppliers and/or distributors (1978 to 1986)
380 to 446 West Botany Street (east side of street north of Rockdale Bicentennial Park) Rockdale	Above alignment	Veneer manufacturers, fibrous plaster manufacturers, sheet metal workers, air conditioner and fridge manufacturers, fibreglass manufacturers, plastic manufacturers
427 to 493 West Botany Street Rockdale	Above alignment	Motor garages and various businesses – manufacturers, wholesalers, retailers – fireworks, kitchen components, toy sales, electrical engineers (1978 to 1986)
443 West Botany Street Rockdale (now Kirby Industrial Park)	Above alignment	Agricultural chemical, fertiliser and insecticide manufacturers and/or suppliers and/or distributors (1978 to 1986) Motor garage/smash repairs (1978 to 1986)
40 to 56 Beach Street Rockdale	Above alignment	Business park – various businesses: telecom services group, snap printing, limousines, security, cake decorations Sawmillers/timber merchants (1961 to 1986) Building contractors (1970 to 1978)
Bermill Street Rockdale	Adjacent to west side of ventilation tunnel	Various businesses – engineers, Downing enterprises – goods manufacturers and distributors, Crystalite Plastics Cement, resin and fibreglass manufacturers (1986)

Property address	Proximity to tunnel alignment	Businesses (potentially contaminating)
Lindsay Street Rockdale	Above and east of alignment	Plastic manufacturing, Rockdale City Council (Suez recycling and recovery) waste and recycling centre Industrial manufacturers, rubber goods and manufacturers (1978 to 1986)

4.1.12 Groundwater quality

Previous investigations

Groundwater monitoring wells were installed by SMEC as part of the geotechnical and contamination investigations:

- F6 Northern Geotechnical Investigations (SMEC 2016): monitoring wells BH1100, BH002, BH1102, BH005, BH1143, BH014a, BH1121A and BH020a were installed and selected wells were sampled
- F6 Northern SEA Geotechnical Investigations (SMEC 2017a): monitoring wells BH1212 and BH1214 installed
- EIS Section A Phase 1 Geotechnical Investigations (SMEC, 2017b): monitoring wells BH1300, BH1303, BH1314, BH1315 and BH1316
- F6 Stage 1 Extension Phase 2 Geotechnical Site Investigations (SMEC, 2018): monitoring wells BH1313, BH1318, TP1303, TP1307, TP1308, TP1309 and TP1310.

The groundwater monitoring wells were installed in the fill, alluvium and sandstone as listed in **Table 4-7**.

Table 4-7 Summary of groundwater monitoring wells installed along the alignment from north to south

Monitoring well ID (figure reference)	Location	Ground surface (GS) and screened interval (SI) and RL (metres AHD)	Screened lithology	Groundwater elevation (metres AHD)	Sampled for contaminants
BH1100	Kyle Street, Arncliffe	GS: 18.80 SI: -56.20 to -59.20	Sandstone	-27.46	Yes
BH002	Wickham Street, Arncliffe	GS: 21.18 SI: -36.82 to -48.82	Sandstone	-8.58	No
BH1102	Marinea Street, Banksia	GS: 8.76 SI: -62.24 to -65.24	Sandstone	6.12	Yes
BH1314	Spring Street (near Marinea Street), Banksia	GS: 7.95 SI: -11.05 to -17.05	Alluvium	4.965	Yes
BH1315	Beehag Reserve, Spring Street, Arncliffe	GS: 3.88 SI: -21.72 to -27.72	Alluvium	2.890	Yes
BH005	Cameron Street, Rockdale	GS: 25.68 SI: -30.62 to -43.02	Alluvium	7.05	No
BH1316	Garnet Street, Rockdale (north of Muddy Creek)	GS: 2.22 SI: -25.78 to -28.78	Alluvium	1.495	Yes
BH1300	Rockdale Tennis Club Chapel Street, Rockdale (north of Muddy Creek)	GS: 2.53 SI: -10.47 to -13.47	Alluvium	2.120	Yes
BH1313	400 West Botany Street, Rockdale	GS: 2.90 SI: -20.23 to -26.23	Alluvium	2.85	Yes

Monitoring well ID (figure reference)	Location	Ground surface (GS) and screened interval (SI) and RL (metres AHD)	Screened lithology	Groundwater elevation (metres AHD)	Sampled for contaminants
BH1318	Bicentennial Park, Rockdale	GS: 2.38 SI: -19.72 to -26.75	Alluvium	-0.95	Yes
BH1143	Bicentennial Park, Rockdale	GS: 4.58 SI: -10.32 to -13.82	Alluvium	1.31	Yes
BH1303	Bicentennial Park, Rockdale	GS: 5.02 SI: -4.98 to -13.98	Alluvium	1.200	No
TP1308	Bicentennial Park, Rockdale	GS: 5.47 SI: 3.97 to -0.53	Fill (landfill)	2.800	Yes
TP1309	Bicentennial Park, Rockdale	GS: 4.72 SI: 2.72 to 0.72	Fill (landfill)	1.400	Yes
TP1310	Bicentennial Park, Rockdale	GS: 5.02 SI: 4.02 to 0.02	Fill (landfill)	2.560	Yes
BH014a	Bicentennial Park, Rockdale	GS: 4.71 SI: -2.29 to -5.29	Alluvium	1.49	Yes
BH1212	Rockdale Bicentennial Park East	GS: 4.50 SI: -8.50 to -11.50	Alluvium (sand)	Approx. 1.4 metres AHD*	No
TP1303	Rockdale Bicentennial Park East	GS: 4.21 SI: 2.21 to 0.21	Fill (landfill)	1.320	Yes
TP1307	Rockdale Bicentennial Park East	GS: 3.28 SI: 1.28 to -0.72	Fill (landfill)	1.240	Yes
BH1121A	Rockdale Bicentennial Park East, Rockdale (north side of President Ave, Rockdale)	GS: 2.07 SI: -4.93 to -7.93	Alluvium	1.05	No
BH1214	Civic Avenue Reserve / Scarborough Park North (west of and adjacent to Rockdale wetland)	GS: 1.40 SI: -9.10 to -12.10	Alluvium (sand)	Approx. 1.0 metres AHD*	No
BH020a	Moorefield Reserve, Oakdale Avenue, Kogarah	GS: 8.49 SI: 4.99 to 1.99	Alluvium	4.57	Yes

* Data interpolated from hydrograph standing water level measurements not tabulated by SMEC (2017a)

Groundwater monitoring results

Groundwater monitoring wells were sampled by SMEC and analysed for the following parameters and contaminants of potential concern (CoPC):

- Major cations (calcium, magnesium, sodium, potassium) and major anions (chloride, sulphate, carbonate, bicarbonate) and electrical conductivity
- Dissolved and total heavy metals (arsenic, cadmium, chromium, copper, lead, iron, manganese, mercury, nickel and zinc)
- Nutrients (nitrate, nitrite, total Kjeldahl nitrogen [TKN], reactive phosphorous, ammonia)

- Total petroleum hydrocarbons (TPH); total recoverable hydrocarbons (TRH); polycyclic aromatic hydrocarbons (PAHs); benzene, toluene, ethylbenzene, xylenes and naphthalene (BTEXN); organochlorine pesticides (OCPs); organophosphorous pesticides (OPPs); volatile organic compounds (VOCs); semi volatile organic compounds (SVOCs); chlorinated hydrocarbons; and phthalates.

The groundwater results have been screened against the following criteria:

- National Environment Protection Measure (NEPM) Table 1C Groundwater Investigation Levels (GILs) for marine and fresh waters and drinking water, National Environment Protection Council (NEPC, 2013 as amended)
- NEPM Table 1A (4) Groundwater Health Screening Levels (HSLs) for vapour intrusion 2 m to < 4 m (NEPC, 2013 as amended).

Concentrations of CoPC detected in groundwater at concentrations greater than the criteria or the laboratory limit of reporting (LOR) listed in **Table 4-8**, **Table 4-9** and **Table 4-10** for groundwater wells screened in landfill, alluvium and sandstone, respectively.

There were exceedances of the criteria for heavy metals (arsenic, chromium, copper, lead and zinc), ammonia and nitrogen in groundwater from monitoring wells screened within landfill in Rockdale Bicentennial Park, at the proposed location of the cut and cover tunnel (**Table 4-8**). The ammonia concentrations were substantially elevated (over 100 times) above the GIL for fresh and marine water and indicative of landfill leachate. Heavy metals (arsenic, copper, nickel and zinc) and ammonia, also exceeded the GIL for fresh and marine water in the alluvium below Rockdale Bicentennial Park. .

In the alluvium between Arncliffe and Rockdale industrial area (**Table 4-9**), there were exceedances of zinc and ammonia, at lower concentrations than those at Rockdale Bicentennial Park. There were low concentrations of TRH and VOC compounds detected above the LOR in alluvium in wells in the Rockdale industrial area and in Banksia, and chloroform concentrations above the drinking water GIL. The groundwater contamination in Rockdale industrial could be sourced from numerous historical industrial sources and contaminated fill. The contamination in Banksia is likely sourced from historical workshops to the west along the Princes Highway.

In the two deep monitoring wells screened in sandstone (**Table 4-10**), there was one exceedance of the GIL for fresh and marine water for nickel (BH1102) and chloroform (BH1100) at Arncliffe. Low concentrations of TRH, VOCs and phenols were detected in the northern most groundwater well in Kyle Street (BH1100), Arncliffe and which is likely sourced from historical industrial businesses in that location.

Table 4-8 Summary of groundwater results – landfill/fill screened monitoring wells

CoPC	TP1309 Rockdale Bicentennial Park	TP1310 Rockdale Bicentennial Park	TP1308 Rockdale Bicentennial Park	TP1307 Rockdale Bicentennial Park East	TP1303 Rockdale Bicentennial Park East
Arsenic (dissolved)	17^	2	3	ND	2
Chromium (dissolved)	ND	2^	ND	ND	ND
Copper (dissolved)	ND	ND	ND	ND	2^
Nickel (dissolved)	ND	7	3	ND	6
Lead (dissolved)	1	5^^	2	3	14^^
Zinc (dissolved)	5	43^^	10^	27^^	95^^
Ammonia as N (mg/L)	64^^	130^^	110^^	4.7^^	4.6 ^^
TKN/Total Nitrogen (mg/L)	84##	170##	140##	7.5##	7.5##
Nitrate	ND	0.094	ND	ND	ND
Phosphate	0.008	ND	0.005	ND	0.005
TRH C6-C10	41	85	100	ND	ND
TRH C6-10 less BTEX	41	69	97	ND	ND
TRH C10-C16	320	600	760	ND	ND
TRH C10-C16 less Naphthalene	320	590	760	ND	ND

CoPC	TP1309	TP1310	TP1308	TP1307	TP1303
	Rockdale Bicentennial Park	Rockdale Bicentennial Park	Rockdale Bicentennial Park	Rockdale Bicentennial Park East	Rockdale Bicentennial Park East
TRH C16-C34	630	780	670	ND	ND
Benzene	ND	1	ND	ND	ND
Ethylbenzene	ND	6	1	ND	ND
Xylenes	ND	8	3	ND	ND
Naphthalene	ND	5	3	ND	ND
1,2,4-trimethylbenzene	ND	5	10	ND	ND
1,3,5-trimethylbenzene	ND	1	2	ND	ND
1,4-dichlorobenzene	ND	10	1	ND	ND
Chlorobenzene	1	12	6	ND	ND
Isopropyl benzene	12	5	10	ND	ND
n-propyl benzene	11	7	14	ND	ND

Notes:

ND = Not Detected, * Concentration exceeds NEPM GIL for drinking water, ^ Concentration exceeds NEPM GIL for marine and fresh waters, ^^ Concentration exceeds NEPM GIL for fresh water, ## Concentration exceeds ANZECC trigger value for NSW lowland rivers, all results in µg/L unless stated

Table 4-9 Summary of groundwater results – alluvium screened monitoring wells

CoPC	BH1314	BH1315	BH1313	BH1316	BH1300	BH1143	BH014a	BH020a	BH1303	BH1318
	Banksia	Arncliffe	Rockdale Industrial Area	Rockdale Industrial Area	Rockdale Industrial Area	Rockdale Bicentennial Park	Rockdale Bicentennial Park	Civic Ave	Rockdale Bicentennial Park	Rockdale Bicentennial Park
Arsenic (dissolved)	ND	ND	1	ND	2	ND	3	ND	55^	7
Chromium (dissolved)	ND	ND	ND	ND	ND	ND	2	ND	ND	1
Copper (dissolved)	ND	ND	ND	ND	ND	ND	2^^	ND	ND	2
Nickel (dissolved)	8	8	4	1	ND	22^^	88^^	52^^	11^	1
Lead (dissolved)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc (dissolved)	21^^	20^^	82	4	ND	9^	24^^	25^^	83^^	14^
Ammonia as N (mg/L)	0.1	0.3	7.4^^	0.17	1.1^^	0.14	63^^	0.01	2^^	33^^
Manganese (dissolved)	190	240	2900	370	72	ND	ND	ND	750	250
TKN/Total Nitrogen (mg/L)	0.3	1.7	10	10	2	0.4	120	3.9	3.4	33
Nitrate	1.9	ND	NA	0.02	ND	ND	NA	NA	ND	NA
Phosphate	ND	0.013	NA	ND	0.17	0.055	0.016	ND	ND	NA
TRH C6-C10	40	ND	ND	27	32	ND	92	ND	44	92
TRH C6-10 less BTEX	35	ND	ND	22	32	ND	77	ND	36	74
TRH C10-C16	ND	ND	ND	ND	ND	ND	ND	ND	ND	380
TRH C16-C34	ND	ND	ND	ND	ND	ND	ND	ND	ND	230
Toluene	ND	ND	ND	ND	ND	ND	1	ND	ND	ND
Ethylbenzene	ND	ND	ND	ND	ND	ND	2	ND	ND	2
Xylenes	6	ND	ND	5	ND	ND	8	ND	7	17
1,2,4-trimethylbenzene	5	ND	ND	2	ND	ND	ND	ND	8	ND
1,3,5-trimethylbenzene	3	ND	ND	3	ND	ND	ND	ND	4	ND
Chlorobenzene	ND	ND	ND	ND	ND	ND	14	ND	ND	ND
Chloroform	5*	2	ND	8*	22*	2	ND	ND	5*	ND
Bromodichloromethane	ND	ND	ND	ND	3	ND	ND	ND	ND	ND

CoPC	BH1314	BH1315	BH1313	BH1316	BH1300	BH1143	BH014a	BH020a	BH1303	BH1318
	Banksia	Arncliffe	Rockdale Industrial Area	Rockdale Industrial Area	Rockdale Industrial Area	Rockdale Bicentennial Park	Rockdale Bicentennial Park	Civic Ave	Rockdale Bicentennial Park	Rockdale Bicentennial Park
Cyclohexane	ND	ND	ND	ND	ND	ND	3	ND	ND	ND
Isopropylbenzene	ND	ND	ND	ND	ND	ND	4	ND	ND	ND
n-propylbenzene	ND	ND	ND	ND	ND	ND	4	ND	ND	ND
Phenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes:

ND = Not Detected, * Concentration exceeds NEPM GIL for drinking water, ^ Concentration exceeds NEPM GIL for marine waters, ^# Concentration exceeds NEPM GIL for fresh water,

Concentration exceeds ANZECC trigger value for NSW lowland rivers, all results in µg/L unless stated

Table 4-10 Summary of groundwater results – sandstone screened monitoring wells

CoPC	BH1100 Arncliffe	BH1102 Arncliffe
Arsenic (dissolved)	1	ND
Cadmium (dissolved)	ND	0.2
Nickel (dissolved)	ND	8
Lead (dissolved)	ND	ND
Zinc (dissolved)	6	33^^
TRH C6-C10	280	ND
TRH C6-10 less BTEX	260	ND
TRH C10-C16	160	ND
TRH C10-C16 less Naphthalene	160	ND
Toluene	20	ND
Xylenes	4	ND
1,2,4-trimethylbenzene	2	ND
1,3,5-trimethylbenzene	1	ND
Trichloroethene	9	ND
Bis(2-ethylhexyl)phthalate	10	ND
Chloroform	9*	ND
Phenol	170	ND

Notes:

ND = Not Detected, * Concentration exceeds NEPM GIL for drinking water, ^ Concentration exceeds NEPM GIL for marine and fresh waters, ^^ Concentration exceeds NEPM GIL for fresh water, ** Concentration exceeds ANZECC trigger value for NSW lowland rivers, all results in µg/L unless stated

4.1.13 Areas and contaminants of concern

The areas and contaminants of concern for the tunnel alignment based on the information reviewed are summarised in **Table 4-11**.

Table 4-11 Tunnel alignment – areas and contaminants of concern

Area of concern	Contaminants of potential concern
Commercial/industrial land uses located above and adjacent to the tunnel alignment particularly Rockdale Industrial area and former commercial/industrial land use along Princes Highway Arncliffe	<ul style="list-style-type: none"> Heavy metals PAHs TRH VOCs (including BTEX and chlorinated hydrocarbons) SVOCs (including phenols and OCPs) Nutrients Asbestos PCBs PFAS
Areas of historical landfilling in Rockdale Bicentennial Park and the lands east of Muddy Creek	
Historical use pesticides and herbicides in market gardens, waterways in the vicinity of the tunnel alignment and use of fertilisers in market gardens	<ul style="list-style-type: none"> OCPs OPPs Herbicides Nutrients (ammonia, nitrate, nitrite and phosphorus)

4.2 Arncliffe construction ancillary facility (C1)

The Arncliffe construction ancillary facility (C1) would be located within the New M5 Motorway Arncliffe construction compound, which was formerly part of Kogarah Golf Course, refer to **Figure 2-2** for ancillary facility boundaries. The Arncliffe construction ancillary facility (C1) would be used to support tunnelling; including loading of spoil and spoil removal.

The New M5 Motorway Arncliffe construction compound will be handed over to the F6 Extension Stage 1 contractor at completion of the New M5 Motorway construction works at the facility. The permanent facility consisting of New M5 Motorway building, water treatment plant, exhaust vent building and supply vent building will have been completed. The spoil stockpile from excavation of the decline access to the New M5 Motorway will remain within the ancillary facility for the duration of the project. The project will utilise the access of the decline tunnels to access the F6 Extension Stage 1 mainline tunnel construction. Following completion the spoil would be used to reinstate and decommission the decline tunnel.

The Arncliffe ventilation and tunnel site has previously been assessed by the New M5 EIS and in particular, in Volume 2F, Appendix O Technical Working Paper: Contamination New M5 Environmental Impact Statement prepared by AECOM, 18 November 2015 (AECOM 2015a) and WestConnex New M5 Phase 2 Environmental Site Assessment for Kogarah Golf Course (Golder, 2017). The findings in AECOM 2015a for Project Area 4 Arncliffe and the Golder 2017 report have been used to inform the following sections.

4.2.1 Site description

The description of the Arncliffe construction ancillary facility is detailed in **Table 4-12**.

Table 4-12 Arncliffe construction ancillary facility (C1) – site description

Item	Description
Address	19 Marsh Street, Arncliffe NSW
Lot and DP	Part Lot 1 DP 329283 Part Lot 1 DP 108492 Part Lot 14 DP 213314*
Site area	Around 3 hectares
Current owner	Council of the Municipality of Kogarah
Current site use	New M5 Motorway tunnelling construction compound
LEP Zoning	Open Space Special uses zone Trade and technology SREP 33^
Elevation	< 10 metres AHD

^ Sydney Regional Environmental Plan No 33 – Cooks Cove

4.2.2 Current land use

An inspection of the ancillary facility location was undertaken on Monday 11 December 2017. At the time of inspection the majority of the ancillary facility was not visible due to the presence of concrete hoarding and shipping containers along Marsh Street (refer **Plate 1** in **Annexure A**) around the construction compound currently used by the New M5 Motorway contractor. From the combined pedestrian walkway and cycleway above, north of and parallel to the M5 East roadway, portions of the New M5 Motorway construction compound were visible and comprised plant and machinery and large stockpiles of spoil (refer **Plates 2** and **3** in **Annexure A**). Adjacent and parallel to the pedestrian walkway/cycleway is the SWSOOS No.1 sewer pipeline visible partially above-ground. The SWSOOS is located immediately south of the New M5 Motorway construction compound and north of the M5 motorway (refer **Plate 4** in **Annexure A**).

4.2.3 Surrounding land use

The surrounding land use is summarised in **Table 4-13**.

Table 4-13 Arncliffe construction ancillary facility (C1) – surrounding land use

Direction from site	Description of surrounding land use and proximity to the ancillary facility
North	Marsh Street, followed by residential properties of Arncliffe and Cahill Park, followed by the Cooks River, then Tempe Recreation Reserve. Alexandra Canal enters the Cooks River at the northern extent of the site. Wolli Creek enters the Cooks River about 900 metres north of the ancillary facility.
South	M5 East Motorway, followed by a driving range, lake, cycleway and a sporting field. Muddy Creek and Saint George Soccer Stadium were located around 400 metres south of the ancillary facility.
East	The eastern extent of Kogarah Golf Course, Cooks River, followed by Kingsford Smith Sydney International Airport
West	Eve Street Cycleway, the SWSOOS No.1, M5 East Motorway and road reserve, Marsh Street wetlands followed by residential properties of Arncliffe

4.2.4 Previous investigations

AECOM 2015b. WestConnex Stage 2: New M5 Factual Contamination Assessment

AECOM was previously engaged to undertake a combined geotechnical and contamination investigation to obtain factual data along the New M5 Motorway project alignment. A total of 147 geotechnical boreholes were completed for this investigation and of those, 67 boreholes were sampled and analysed for contamination parameters.

No boreholes were able to be completed within the ancillary facility boundary. A summary of the soil results for boreholes located further south on land with a similar filling history are summarised in **Table 4-14**. The boreholes are shown on **Figure 4-5** and **Figure 4-6**.

Table 4-14 Summary of relevant soil and groundwater data from the Stage 2: New M5 Factual Contamination Assessment (AECOM, 2015b)

Boreholes	Soil results summary	Groundwater results summary
Barton Park (located immediately south and adjacent to the site) WCX_BH159 WCX_BH029 WCX_BH071 WCX_BH063 WCX_BH064 WCX_BH065 WCX_BH068 WCX_BH161	<ul style="list-style-type: none"> The fill varied from 3 to 6.7 metres deep consisting of clayey sand and silty sand with refuse in some locations and gravel sized fragments of concrete, plastic, ceramics, glass and brick. Strong organic odours were noted in WCX_BH064 from 2.5 metres onwards. Following results above adopted screening criteria: <ul style="list-style-type: none"> WCX_BH071_0.5-0.6 0.012 percent Friable Asbestos in soil WCX_BH159_5.0-5.45: TRH C6-C10 (90 mg/kg) and TRH C10-16 (2270 mg/kg), TRH>C16-C34 (24,200 mg/kg) WCX_BH063_0.5-0.6: 0.005 percent Friable Asbestos in soil WCX_BH064_0.9: Bis(2-ethylhexyl) phthalate – 323 mg/kg 	<ul style="list-style-type: none"> Monitoring wells were installed and screened in bedrock in BH029 (MW029) and BH063 (MW063). A shallow monitoring well was installed in the alluvium in BH063 (MW063A). Standing water level ranged from 2.575 metres below ground level (bgl)/0.730 metres AHD (MW063A) to 6.744 metres bgl/-3.377 metres AHD (MW029). Groundwater in MW063A was noted to have an organic odour. Samples were analysed for TRH, BTEX, heavy metals, SVOCs, VOCs, cations and anions. Concentrations of zinc exceeded the ANZECC (2000) 95 per cent trigger level for marine ecosystems in the three wells (0.036 to 0.046 mg/L). All other parameters were less than the adopted assessment criteria.

Golder, 2016. Westconnex New M5 Phase 2 Environmental Site Assessment – Kogarah Golf Course

Golder Associates Pty Ltd (Golder) previously undertook a Phase 2 ESA for the New M5 Arncliffe Construction Compound (ACC) which includes the footprint of the Arncliffe construction ancillary facility. The report was titled *Westconnex New M5 Phase 2 Environmental Site Assessment – Kogarah Golf Course, Marsh Street, Arncliffe, NSW* (Golder 2016).

The Phase 2 ESA included:

- A review of previous contamination reports, site history (aerial photography, historical titles, and anecdotal information from Kogarah Gold Club), NSW EPA records, Section 149 certificates, and Safework NSW dangerous goods records
- Drilling and soil sampling of 34 grid based boreholes and nine targeted boreholes and analysis including field screening for VOCs and laboratory analysis of selected samples for heavy metals, TRH, BTEX, PAHs, OCP, OPP, PCB, herbicides, fungicides, asbestos, field acid sulfate test and SPOCAS
- Installation and sampling of three single groundwater monitoring wells and two nested groundwater monitoring wells (two adjacent wells screened at different depth intervals) for heavy metals, TRH, BTEX, PAHs, OCP, herbicides, ammonia and dissolved gases.

The following findings were made:

- Subsurface consisted of various compositions of sand, silt and clay with minor inclusions of ceramic, wire, tile and rubber fragments, with no observations of soil discolouration or chemical odour noted
- There were no exceedances of the human health based assessment criteria (ASC NEPM HSL C&D/HIL C&D) with the exception of ACM and friable asbestos was identified in one soil sample at 0.5 metres (located in the eastern portion of the Arncliffe construction ancillary facility)
- PASS was identified to be present within the investigation area with liming rates of up to 12 kg CaCO₃/tonne required
- Arsenic and copper concentrations were greater than the adopted assessment criteria in four groundwater samples. As no sources were identified within the soil it was considered that it may be indicative of background conditions
- Ammonia was detected in all groundwater wells between 100 µg/L and 10,000 µg/L, exceeding the adopted trigger level of 910 µg/L at five of the six locations sampled. Dissolved methane concentrations ranged between <5 µg/L and 2,700 µg/L.

The following recommendations were made in regard to the requirements for the New M5 Motorway construction works:

- A site specific Contamination Management Summary for inclusion in the Arncliffe Construction Compound Construction Area Plan for the proposed site construction works was required to address potential contamination
- An Acid Sulfate Management Plan was required to be prepared which would also need to consider ammonia concentrations in groundwater which could impact management options
- Implement monitoring and mitigation measures to address the potential for ammonia in site groundwater during construction and operation of the New M5 Motorway project (occupational health and ecological impacts)
- Implement monitoring and mitigation measures to address the potential for the accumulation of methane and carbon dioxide in sub-surface structure at the site during the construction and operation of the New M5 Motorway project at the Arncliffe Construction Compound.

Golder 2017. Design Package Report Groundwater Monitoring Progress Report

The report Design Package Report Groundwater Monitoring Progress Report (Project-wide), July 2017 M5N-GOL-TER-100-200-GT-1516-C (Golder, 2017) was reviewed for data relevant to the Arncliffe ancillary facility. Three groundwater monitoring wells are located within the northern portion of the Arncliffe ancillary facility. Details of the well construction and groundwater elevation are summarised in **Table 4-7**.

Table 4-15 Summary of groundwater monitoring wells installed within C1

Monitoring well ID (figure reference)	Ground surface (GS) and screened interval (SI) and RL (metres AHD)	Screened lithology	Groundwater elevation (metres AHD)	Sampled for contaminants
LDS-BH-2029A	GS: 1.02 SI: -19.5 to -28.5	Alluvium	-0.37 (March 2016)	No
LDS-BH-2029	GS: 1.04 SI: -44 to -59	Sandstone	-0.42 (March 2016)	No
LDS-BH-2005	GS: 1.4 SI: -25.9 to -26.9	Sandstone	-0.43	Yes

LDS-BH-2005 was the only groundwater monitoring well sampled for contaminants, including dissolved heavy metals, TRH, BTEX, PAHs, OCPs, OPPs, phenols, volatile hydrocarbons, PFOA, PFOS, PCBs and nutrients. Concentrations of dissolved arsenic (8 µg/L), chromium (1 µg/L), copper (6 µg/L) and zinc (14 µg/L) exceeded the adopted assessment criteria.

The Golder (2017) report stated that high concentrations of ammonia (1.2 mg/L) and dissolved methane (8.8 mg/L) detected in LDS-BH-2001 were reported similar to those reported during a Phase 2 Environmental Site Assessment (M5N-GOL-TER-100-200-EV-1671-A) carried out in May 2016 within Kogarah Golf Course. LDS-BH-2001 is screened in alluvium and located to the south of the Arncliffe ancillary facility in Eve Street.

4.2.5 Site history

The review of the history of the ancillary facility is summarised in **Table 4-16**.

Table 4-16 Arncliffe construction ancillary facility (C1) – site history

Source	Summary
Historical aerials	<ul style="list-style-type: none"> The aerials showed the majority of the ancillary facility site was being used as market gardens until between 1970 and 1981. It was also noted that the path of the Cooks River was different and did not run along the eastern boundary of the site but looped further to the east. Filling of the land immediately to the east, south and north occurred between 1955 and 1961. In the 1961 aerial photograph, part of the ancillary facility was being used as a golf course. By 1981 the market gardens had been replaced with the golf course. No change to the 1970 aerial photograph was observed in the 1982 aerial photograph.
Contaminated sites currently or formerly regulated by the NSW EPA (Record of Notices)	<ul style="list-style-type: none"> The ancillary facility is not on the list of currently or formerly regulated sites. There are no regulated or formerly regulated sites within 200 metres of the ancillary facility.
Contaminated sites notified to the NSW EPA under Section 60 of the CLM Act 1997	<ul style="list-style-type: none"> The ancillary facility has not been notified. There are no notified sites within 200 metres of the ancillary facility.
Other NSW EPA records	<ul style="list-style-type: none"> Current NSW EPA licensed activity within and immediately north and south of the site: Environment Protection Licence (EPL) 20772 for CPB Contractors Pty Limited for WestConnex New M5 – road construction, located between Beverly Hills and St Peters. Surrendered NSW EPA license within and immediately east of the ancillary facility: Sydney Weed & Pest Management Pty Ltd relating to waterways including application of herbicides.

Source	Summary
National Waste Management site database	<ul style="list-style-type: none"> The ancillary facility is not listed in the database. There are no notified sites listed within 200 metres of the ancillary facility.
UBD Business Directories	<ul style="list-style-type: none"> There were no historical UBD records for businesses historically located within the ancillary facility . According to historical UBD records the following businesses were located within 200 metres and topographically up-gradient of the ancillary facility: <ul style="list-style-type: none"> Tempe Bus Service (formerly T. E Harrigan) 1 Marsh Street Arncliffe – bus operators (1950 to 1991), immediately south-west of the ancillary facility Usherwood G.A. & Son Pty Ltd, 50 West Botany St, Arncliffe – toolmakers, engineers, lawnmower sales, generator manufacturers, metal pressers and mechanical or manufacturing (1961 to 1986), immediately west of the ancillary facility.
Historical titles	<ul style="list-style-type: none"> Historical titles indicate that the site was formerly owned by the following: <ul style="list-style-type: none"> Lot 1 DP329283: <ul style="list-style-type: none"> 1970 to date: The Commissioner for Main Roads 1969 to 1970: The State Planning Authority for NSW 1961 to 1968: Lease to Tung War market gardener 1933 to 1969: Vera Corby Tasker, wife to market gardener 1933 to 1933: Wilfred Cambria Allen, estate agent 1930 to 1933: The Metropolitan Water Sewerage and Drainage Board Prior to 1929: Crown Road (part of site) 1888 to 1930 The Minister for Public Works Lot 1 DP 108492: <ul style="list-style-type: none"> 1958 to date: The Council of the Municipality of Rockdale 1957 to 1958: The Cumberland County Council 1957 to 1957: George Soren Bang, managing law clerk 1952 to 1957: The Commonwealth of Australia 1933 to 1952: Wilfred Cambria Allen, estate agent 1930 to 1933: The Metropolitan Water Sewerage and Drainage Board Prior to 1929: Crown Road (part of site) 1888 to 1930 The Minister for Public Works Lot 14 DP 213314 <ul style="list-style-type: none"> 1988 to date: Kogarah City Council 1957 to 1988: The Council of the Municipality of Rockdale 1947 to 1957: The Commonwealth of Australia 1922 to 1947: The Bonnie Doon Golf Club Limited Based on the above it appears the site may have been previously used for market gardening/agricultural/residential purposes or as a golf course.

Source	Summary
Section 149 Certificate	<ul style="list-style-type: none"> Bayside Council has adopted by resolution a policy on contaminated land that may restrict the development of the land. This policy is implemented when zoning or land use changes are proposed on lands that have been previously used for a certain purpose. Consideration of the Council's adopted policy and the application of provisions under State legislation is warranted. The Rockdale Local Environment Plan 2011 does not apply to the land within the site by virtue of application of the Sydney Regional Environmental Plan No. 33 – Cooks Cove. The development of the land or part of the land for such a purpose may be subject to flood-related development controls. The Council is aware of various information that suggests that the land may be affected by the one percent AEP flood. The land is on the 25 Annual Noise Exposure Forecast (ANEF) (2033) contour. This level may restrict the development of the land due to risk of exposure to aircraft noise.

4.2.6 Subsurface conditions, topography and drainage

The descriptions of the topography, drainage, soils, geology and hydrogeology are summarised in **Table 4-17**.

Table 4-17 Arncliffe construction ancillary facility (C1) – subsurface conditions, topography and drainage

Source	Summary
Topography	<ul style="list-style-type: none"> The ancillary facility comprises sealed and unsealed surfaces Surface water infiltration would occur Various man-made surface water bodies and a surface water channel are present on as part of the golf course adjacent to the ancillary facility Stormwater is expected to drain into the Cooks River.
Drainage	<ul style="list-style-type: none"> The site is located in close proximity to various surface water bodies on Kogarah Golf Course there is also a drainage channel in the middle of the course running west to east and outlet into the Cooks River. The drainage channel is located approximately 200 metres east of the ancillary facility. The nearest water body – Cooks River is located approximately 540 metres east of the ancillary facility. Drains to east or south-east towards the Cooks River which ultimately drains into Botany Bay.
Soils	<ul style="list-style-type: none"> Fill consisting of various compositions of sand, silt and clay between 0.5 and 3 metres deep underlain by quaternary sediments (Golder 2016) Quaternary sediments consisting of alluvium (gravel, sand, silt and clay). The alluvial soils are underlain by Hawkesbury Sandstone of the Wianamatta Group. The Hawkesbury Sandstone within the site consists of quartz with some shale. The Hawkesbury Sandstone is underlain by the undifferentiated sandstone of the Narrabeen Group. Acid sulfate soil risk is classified as Class 3: <ul style="list-style-type: none"> works beyond one metre below ground surface require an Acid Sulfate Management Plan; and High probability of occurrence and disturbed terrain. PASS confirmed to be present which requires an Acid Sulfate Management Plan where excavations beneath the water table occur (Golder 2016).

Source	Summary
Hydrogeology	<ul style="list-style-type: none"> Registered groundwater bore data from DPI Water indicated there is one registered bore within the ancillary facility. and 12 bores located within a 1 kilometre radius. Bores are generally used for the purposes of water supply, monitoring and irrigation. Based on the information obtained, shallow groundwater is present on within alluvial sediments consisting primarily of sands and clays at depths ranging from 0.7 to 14.0 metres below ground surface. Groundwater monitoring has been being undertaken within the ancillary facility and surrounds as described in Section 4.2.4.

4.2.7 Areas and contaminants of concern

The areas and contaminants of concern for the ancillary facility based on the information reviewed are summarised in **Table 4-18**.

Table 4-18 Arncliffe construction ancillary facility (C1) – areas and contaminants of concern

Area of Concern	Contaminants of concern
Historical use of the site for agricultural purposes and current use as a golf course and the use of pesticides and herbicides	<ul style="list-style-type: none"> OCPs OPPs Herbicides Nutrients (ammonia, nitrate, nitrite and phosphorus) Methane
Areas of historical landfilling to the south of the site and south, north, east and west of the site and the migration of potentially contaminated groundwater beneath the site	<ul style="list-style-type: none"> Heavy metals PAHs TRH VOCs (including BTEX) SVOCs (including phenols and OCPs)
Up-gradient commercial/industrial land uses	<ul style="list-style-type: none"> Asbestos PCBs PFAS
Areas mapped as Class 3 acid sulfate soils	<ul style="list-style-type: none"> Acid sulfate soils

4.3 Rockdale construction ancillary facility (C2)

This section outlines the environmental setting and the general conditions of the area proposed for the construction ancillary facility at West Botany Street, Rockdale, south of Bay Street, Rockdale (C2), refer to **Figure 4-9** for C2 ancillary facility boundary.

4.3.1 Site description

The Rockdale construction ancillary facility would be located above and below ground at Rockdale, off West Botany Street. This construction ancillary facility would require 12,000 square metres of the existing Roads and Maritime maintenance depot. C2 would be used to support tunnelling, including loading of spoil and spoil removal. The site description is detailed in **Table 4-19**.

Table 4-19 Rockdale construction ancillary facility (C2)– site description

Item	Construction ancillary facility
Address	400-404 West Botany Street, Rockdale (Lot 1 DP 655257 and Lot 1 DP433785) 400-404 West Botany Street, Brighton Le Sands (Lot 1 DP950820 and Lot 45 DP 15666)
Lot and DP	Lot 1 DP655257 Lot 1 DP 950820 Lot 45 DP15666 Lot 1 DP 433785
Site area	Around 4 hectares
Current owner	<ul style="list-style-type: none"> Lot 1 DP655257 and Lot 1 DP 950820: The commissioner for main roads and roads and traffic authority of NSW Lot 45 DP15666: Unknown Lot 1 DP 433785: Unknown
Current site use	Warehousing and car parking
LEP Zoning	IN2 Light Industrial and SP2 Infrastructure (eastern portion)
Elevation	Between 2-4 metres AHD

4.3.2 Current land use

An inspection of the ancillary facility was undertaken on Monday 11 December 2017. At the time of inspection, a sign on West Botany Street site entrance indicated the ancillary facility was being used by LendLease TYCO Joint Venture who is currently managing traffic assets on behalf of Roads and Maritime. AECOM was not able to enter and inspect the ancillary facility, however it is understood, based on information from Roads and Maritime, that the site is partially occupied by the Joint Venture, part by Roads and Maritime as a depot and partially by other leaseholders. In addition, parts of the ancillary facility are currently shared use. The site is accessible off West Botany Street in Rockdale via bitumen sealed roadway (refer **Plate 7** in **Annexure A**). Based on satellite imagery it is understood the site comprises bitumen or asphalt sealed surfaces, car spaces for vehicles and trucks and buildings of various sizes. Plant and materials are visible on site.

4.3.3 Surrounding land use

The surrounding land use is summarised in **Table 4-20**.

Table 4-20 Rockdale construction ancillary facility (C2) – surrounding land uses

Direction from site	Description of surrounding land use and proximity to the site
North	<ul style="list-style-type: none"> Low density residential adjoining to the north, followed by Bay Street (50 metres north), and then more low density residential properties
South	<ul style="list-style-type: none"> The proposed ventilation facility on West Botany Street (around 400 metres south-east) part of the President Avenue construction ancillary facility (C3), warehouses and industrial properties
East	<ul style="list-style-type: none"> Infrastructure land, comprised of car parking directly adjoining to the north east, open space with vegetation north of the Rockdale Bicentennial Park East to the south east, and then medium density residential properties (180 metres east from the centre of the compound)
West	<ul style="list-style-type: none"> Industrial properties, and West Botany Street (100 metres west from the centre of the compound)

4.3.4 Previous investigations

Three boreholes, BH208, BH217 and BH218 were completed within the Rockdale construction ancillary facility and results reported in the AECOM (2015) *Westconnex Stage 2: M5 Factual Contamination Assessment*. Selected samples from the boreholes were analysed for heavy metals, TRH, PAHs, OCPs, OPPs, PCBs and asbestos. Field acid sulfate soil tests and SPOCAS analysis were also undertaken on selected samples. The results are summarised in **Table 4-21**.

Borehole BH1313 was completed within the southwest portion of the Rockdale construction ancillary facility, as part of the project Geotechnical Investigations (SMEC 2018). Selected soil samples were analysed for heavy metals, TRH, PAHs, OCPs, OPPs, PCBs, SVOCs, VOCs, major cations and asbestos. Field acid sulfate soil tests and SPOCAS analysis were also undertaken on selected samples. The results are summarised in **Table 4-21**.

Table 4-21 Rockdale construction ancillary facility (C2) – soil results

Borehole	Borehole summary	Soil results
BH208	<ul style="list-style-type: none"> Fill logged to 3 m bgl and consisted of silty sand and sand with terracotta fragments No odours or staining described PID reading maximum of 12.4 ppm in fill at 1 m bgl Alluvium encountered to 38.5 m bgl 	<ul style="list-style-type: none"> No exceedances of adopted commercial/industrial land use screening criteria Concentrations of benzo(a)pyrene and lead exceeded CT1
BH217	<ul style="list-style-type: none"> Fill logged to 3 m bgl and of sandy gravel and cobbles and boulders of concrete with refuse including slag, steel and plastic Reading maximum of 0.5 ppm at 0.5 m bgl Alluvium encountered to 37 m bgl 	<ul style="list-style-type: none"> No exceedances of adopted commercial/industrial land use screening criteria PASS confirmed by SPOCAS
BH218	<ul style="list-style-type: none"> Fill logged to 1.4 m bgl of silty sand and sand with brick and concrete inclusions Black ash band logged at 0.75 m PID reading maximum of 0.2 ppm at 0.2 m bgl Alluvium encountered to 25.5 m bgl 	<ul style="list-style-type: none"> No exceedances of adopted commercial/industrial land use screening criteria Concentrations of benzo(a)pyrene and lead exceeded CT1 PASS indicated by field tests
BH1313	<ul style="list-style-type: none"> Fill logged to 1.25 m bgl of silty sand with glass and ceramic fragments Alluvium encountered to 29.5 m bgl 	<ul style="list-style-type: none"> No exceedances of adopted commercial/industrial land use screening criteria PASS confirmed by SPOCAS

4.3.5 Site history

The review of history of the ancillary facility is summarised in **Table 4-22**.

Table 4-22 Rockdale construction ancillary facility (C2) – site history

Source	Summary
Historical Aerials	<ul style="list-style-type: none"> From a review of historical aerial photographs (dating back to 1943), it appears that parts of the ancillary facility were first used as market gardens and green houses, which at the time was adjoining Rockdale westland. Filling of the western portion of the ancillary facility was visible in the 1961 aerial and the green houses were still visible in the central portion of the site, there also appeared to be filling or earthworks in the southeast and eastern portion in 1970. In the 1980 aerial the ancillary facility appeared similar to the 2015 photo, with the exception of a building along the northern boundary in the eastern part of the site and the absence of a building on the eastern boundary of the site (built between 2009 and 2015). Surrounding land uses have comprised of residential (unchanged to the present on the north and east), and agricultural land to the west and south. The development of surrounding industrial land to the west and south began after 1951.
Contaminated sites currently or formerly regulated by the NSW EPA (Record of Notices)	<ul style="list-style-type: none"> The ancillary facility is within an area where there have been activities licenced but still regulated by the EPA. They include Roads and Traffic Authorities (across the site) and Vulcan Industries (400 metres north east) for activities pertaining to Hazardous, Industrial or group A Generation or storage of waste. There no other regulated or formerly regulated sites under the CLM Act within 100 metres of the ancillary facility. The ancillary facility is not listed on the POEO public register. Former licenced activities under the POEO Act (now revoked or surrendered) comprise activities conducted on water ways in close proximity of the site (along Muddy Creek to the North West and within Rockdale wetland to the south of the ancillary facility (300 metres) which include application of herbicides. The closest site currently licenced under the POEO act is the Rockdale Waste and Recycling Centre (Suez) which is located approximately 400 metres west of the ancillary facility. The licence pertains to the non-thermal treatment and recovery of general waste, as well as storage of all types of waste including hazardous waste (including asbestos).
Contaminated sites notified to the NSW EPA under Section 60 of the CLM Act 1997	<ul style="list-style-type: none"> The ancillary facility has not been notified as Contaminated to the NSW EPA There are no contaminated sites notified to the NSW EPA within 200 metres of the ancillary facility. Notified properties within one kilometre are all service stations.
Other NSW EPA records	<ul style="list-style-type: none"> The closest property to conduct NSW EPA licensed activities is the Rockdale Waste and Recycling Centre which is located approximately 400 metres west of the ancillary facility. Former gasworks sites were not identified within 1 kilometre The ancillary facility is not within the EPA PFAS investigation program
National Waste Management site database	<ul style="list-style-type: none"> The ancillary facility is not listed in the database The closest notified site listed is Rockdale Waste and Recycling Centre which is located approximately 400 metres west of the ancillary facility.
UBD Business Directories	<p>According to historical UBD records the following businesses were located within the ancillary facility:</p> <ul style="list-style-type: none"> 402 West Botany Street, Rockdale <ul style="list-style-type: none"> Anderson Smash repairs – Motor Panel Beaters (circa 1978) Draper, E. Pty. Ltd – Nurserymen (Plant and Trees) (N190) (1961- 1970) <p>According to historical UBD records the following relevant businesses were located within 200 metres and topographically up-gradient of the ancillary facility:</p> <ul style="list-style-type: none"> Vokes Australia Pty. Ltd. – Engineering (1961), then Manufacturers of air conditioning units, filters, and tobacco processing (from 1965 to 1982) (adjoining to the west)

Source	Summary
	<ul style="list-style-type: none"> Pickrell, W.G.Ltd – stainless steel fabricators, boiler makers, engineering (1961), then grinding, stainless steel manufacturing (from 1965), tank manufacturer (1970 until 1975) (south west) – then The property was taken over by Marbltone Group Australia (from 1975 – 1978), and then Forest Hull Furniture (1982) BerryMan Furniture (1986), Watts Commercial Furniture, - for furniture manufacturers (until 1991) as well as Alcan Aluminium – aluminium manufacturers and Brashes – Video equipment manufacturers (1991) Ferro Corporation (Aust.). Pty Ltd – Paint, enamel, varnish/stain manufacturer and then Fibreglass Material manufacturer, evolving to manufacturer of cement additives, concrete, and various chemical manufacturing until 1991) , then Synthetic Resins Pty Ltd – Resin producers (1991)(south east) Crystalite Plastics (NSW) Pty. Ltd – Plastic Manufacturers (1961 to 1991) (south west) Cartwright, J.R. & Bailey Pty. Limited – Fibrous plaster Manufacturers/ ceilings (1961 to 1986) (adjoining to the north west) Harrison, T & Sons – Tilers/Slaters, Roofing contractors (1961 to 1970) (adjoining to the north east)
Historical Titles	<p>Historical titles indicate that the ancillary facility was formerly owned by the following:</p> <ul style="list-style-type: none"> Lot 1 DP 655257 <ul style="list-style-type: none"> 1915 to 1973: Ernest Edward Draper (then to the wood Family from 1949 - 1973) (Nursery man – plant and trees). Lot 1 DP 950820 was handed over to Falkirk Pty Ltd (1949-1956) and then to Nokes Australia (1956-1987). 1973 to 1987: The commissioner for Main Roads 1987 – To date: Roads and Traffic Authority of NSW Based on the above it appears the site may have been previously used for plant and tree nursery until 1973 when it was acquired by the government (roads). Historical titles not obtained for Lot 1 DP 950820, Lot 45 DP15666 and Lot 1 DP 433785
Section 149 Certificate	<ul style="list-style-type: none"> 400 West Botany Street Rockdale (Lot 1 DP655257, Lot 1 950820, Lot 45 DP15666 and Lot 1 DP 433785) <ul style="list-style-type: none"> The Council has adopted by resolution a policy on contaminated land that may restrict the development of the land. This policy is implemented when zoning or land use changes are proposed on lands that have been previously used for a certain purpose. Consideration of the Council's adopted policy and the application of provisions under State legislation is warranted. Part of the land/all of the land is classified as environmentally sensitive as it is identified on the Rockdale Local Environmental Plan 2011 Natural Resource – Biodiversity Map or the Rockdale Local Environmental Plan 2011 Natural Resource – Wetlands Map Development of the land or part of the land may be subject to flood related development controls The Council is aware of various information that suggests the land may be affected by the 1% annual exceedance probability (AEP) (1 in 100 year) flood. Rockdale Local Environment Plan 2011 requires development consent to ringbark, cut down, top, lop, remove, injure or wilfully destroy any tree covered by Clause 5.9 The ANEF affectation applying to the land is less than 20 decibels

4.3.6 Subsurface conditions, topography and drainage

The descriptions of the topography, drainage, soils, geology and hydrogeology are summarised in **Table 4-23**.

Table 4-23 Rockdale construction ancillary facility (C2) – subsurface conditions, topography and drainage

Source	Summary
Topography	<ul style="list-style-type: none"> The ancillary facility is generally flat and has a low elevation of between 2-4 metres AHD.
Drainage	<ul style="list-style-type: none"> Nearest water body is Rockdale wetland, which are located within the Rockdale Bicentennial Park (300 metres south) Drainage at the ancillary facility is expected to be captured by the local stormwater drainage system.
Soils	<ul style="list-style-type: none"> According to the Sydney Soil Landscape Map 1:100,000, most of the ancillary facility is located within disturbed terrain, identified as DTxx. The eastern portion of the ancillary facility is located with the Warriewood soil classification which is referred to as Swamp (SWwa) area. Generally, natural soils across the area are expected to be Podzols, described as coastal sand plains and dunes, lagoon and swampy areas. With respect to acid sulfate soils (ASS), the ancillary facility is classified as Class 3, and has a high (>70%) probability of occurrence of ASS (risk and class), as per the Atlas of Australian Acid Sulfate Soils Maps.
Hydrogeology	<ul style="list-style-type: none"> The groundwater under the ancillary facility is expected to be shallow (<2 metres bgl) Due to the shallow groundwater beneath the site and the location of the site in close proximity of wetland areas, it is expected that the groundwater would flow towards the North West. A search of groundwater (GW) bores indicated that GW107531 is located within the site for Industrial Purposes. Recorded information indicates that groundwater below the site is shallow (2 m bgl). A number of GW bores are located within a 100 metres radius of the site, with industrial as well as domestic purposes.

4.3.7 Areas and contaminants of concern

The areas and contaminants of concern for the ancillary facility based on the information reviewed are summarised in **Table 4-24**.

Table 4-24 Rockdale construction ancillary facility (C2) – areas and contaminants of concern

Area of concern	Contaminants of concern
Historical use of the site for agricultural purposes including the use of pesticides and herbicides	<ul style="list-style-type: none"> OCPs OPPs Herbicides Nutrients (ammonia, nitrate, nitrite and phosphorus)
Former, current and surrounding industrial properties (chemical manufacturing)	<ul style="list-style-type: none"> TRH/BTEXN, PAHs, Metals, PCB, OP/OC Pesticides, VOCs, SVOCs, Phenols
Soils underlying the site comprising uncontrolled fill	<ul style="list-style-type: none"> TRH/BTEXN, PAHs, Metals, PCB, OP/OC Pesticides, VOCs, SVOCs, Asbestos
Areas mapped as high risk of acid sulfate soils	<ul style="list-style-type: none"> Acid sulfate soils

4.4 President Avenue construction ancillary facility (C3) and construction site

4.4.1 Site description

The President Avenue construction ancillary facility site (C3) mostly comprises parts of the Rockdale Bicentennial Park and Rockdale Bicentennial Park East, and sections of President Avenue, leading to the intersection with Princes Highway to the west. Several residential properties are also affected. The site also includes the new ventilation facility at West Botany Street, Rockdale, south of Lindsey Street and north of French Street, Rockdale (Rockdale ventilation facility). The site description is detailed in **Table 4-25**. The location of the President Avenue construction ancillary facility (C3) is shown on **Figure 4-9** and **Figure 4-10**.

The construction site around C3 includes widening of sections the Princes Highway and President Avenue, works within West Botany Street and the shared cycle and pedestrian pathways between Civic Avenue and England Street.

Table 4-25 President Avenue construction ancillary facility (C3) and construction site – site description

Item	Description
Addresses	<ul style="list-style-type: none"> • 427 to 441 West Botany Street, Rockdale • Rockdale Bicentennial Park – 468 West Botany Street, Rockdale • Civic Avenue Reserve – 76R Barton Street, Monterey • Rockdale Bicentennial Park East – 112-132 President Avenue, Brighton Le Sands • 2B Kings Road, Brighton Le Sands • 34-36 Kurnell Street Brighton Le Sands • 134 to 138 President Avenue, Brighton Le Sands • 69 to 65 O'Neill Street, Brighton Le Sands • 140 to 144 President Avenue, Brighton Le Sands • Parts of O'Neill Street (roadway), Brighton Le Sands • Parts of West Botany Street (roadway), Rockdale • Parts of Civic Avenue (roadway), Kogarah • Parts of President Avenue (roadway), Rockdale and Brighton Le Sands • Parts of Princes Highway (roadway), Kogarah • Part of 7-Eleven, 734 Princes Highway, Kogarah • Parts of 728 to 732 Princes Highway, Kogarah • Western boundary of 750 Princes Highway, Kogarah • Western boundary of 800 Princes Highway, Kogarah
Lot and DP	<ul style="list-style-type: none"> • Lot 71 and 72 DP738382 • Lot 73 and 74 DP 746043 • Lot 194 DP752056 • Part Lot 1 DP 535905 • Lots 1 to 6 DP28912 • Lots 164 to 166 DP 4393 • Part Lot 1 and Part Lot 2 DP1113262 • Lot 50 DP 27727 • Lots 1 and 2 DP 100164 • Lots 3 to 6 DP 22338 • Lot 7 DP381773

Item	Description
	<ul style="list-style-type: none"> • Lot A DP360801 • Lot 3 DP653999 • Lot 1 DP190849 • Lot 22 DP960656 • Lot 3 DP525538 • Lot 1 DP229723 • Lot 1 DP214047 • Lot 2 DP659367 • Lot 2 DP659366 • Lot 1 DP659365 • SP66921 • SP9797 • Lot 4 DP650223 • Part Lot 8 DP810353 • Part Lot 2 DP810353
Site area	Around 15 hectares
Current owners	<ul style="list-style-type: none"> • Lot 1 DP 535905, Lot 73 DP 746043 and Lot 72 DP 738382: <ul style="list-style-type: none"> – Rockdale Bicentennial Park and Rockdale Bicentennial Park East: Part Rockdale City Council (now Bayside Council) and part Commissioner for Main Roads, various private owners • All other Lots: Various private owners unknown
Current site use	<ul style="list-style-type: none"> • Recreation (Rockdale Bicentennial Park and Rockdale Bicentennial Park East, Civic Avenue Reserve Kogarah), residential (along President Avenue) and Infrastructure (Parts of President Avenue, West Botany Street, Civic Avenue and O'Neill Street) • Recreation Civic Avenue Reserve Kogarah and Monterey • Various commercial/industrial premises on West Botany Street proposed Rockdale ventilation facility site: <ul style="list-style-type: none"> – 427 West Botany Street: Botany Car Detailing and R&R Shieldrust – 429 West Botany Street: Vacant land (unsealed), former factory building demolished – 433 West Botany Street: Kogarah Tyrepower – 435 West Botany Street: Bubblegum clothing outlet – 437 West Botany Street: Glass Direct Australia – 439-441 West Botany Street: P&C Joinery (furniture store) • Service station (7-Eleven) at 734 Princes Highway, Kogarah • Residential properties along President Avenue and Princes highway • TAFE NSW St George campus (only narrow strip of western boundary) and substation • James Cook Boys Technology High School (narrow strip of western boundary)
LEP Zoning	RE1 Public Recreation, SP2 Infrastructure, IN2 Light Industrial, R4 High density residential, R2 Low density residential and B4 Mixed use
Elevation	Between 2-6 metres AHD, and from 2-18 metres AHD along President Avenue (east to west)

4.4.2 Current land use

An inspection of the ancillary facility was undertaken on Monday 11 December 2017. At the time of inspection, the site consisted of:

- Rockdale Bicentennial Park – recreational parkland, with a carpark, pathways, skate park and children's playground
- Rockdale wetland – located between Rockdale Bicentennial Park and Rockdale Bicentennial Park East
- Rockdale Bicentennial Park East – sports fields
- Ilinden Sports Centre
- President Avenue
- Civic Avenue
- O'Neill Street
- West Botany Street
- Residential houses
- Scarborough Park north – wetland
- Residential properties along President Avenue and O'Neill Street, Brighton Le Sands
- Civic Avenue wetland and reserve, Kogarah and Monterey
- Commercial/industrial premises along West Botany Street, Rockdale.

Demolition waste such as bricks, concrete and tiles were observed protruding on the embankments along Rockdale wetland and on islands within the wetland, and along the northern embankment of Rockdale Bicentennial Park. Fragments of potential asbestos containing material (ACM) were observed along the northern embankment of Rockdale Bicentennial Park.

Ilinden Sports Centre is elevated higher than the surrounding land with embankments/mounds surrounding the soccer fields. Passive ventilation fans were observed on the north east and southeast corners of the field and the northern side of the building. Refer **Plates 8 and 9** in **Annexure A**.

4.4.3 Surrounding land use

The surrounding land use is summarised in **Table 4-26**.

Table 4-26 President Avenue construction ancillary facility (C3) and construction site – surrounding land use

Direction	Description of surrounding land use
North	<ul style="list-style-type: none">• Commercial/industrial properties along Bermill Street and West Botany Street
South	<ul style="list-style-type: none">• Parkland - Civic Avenue Wetlands and Reserve• Residential land use• Retail shops on President Avenue• Caltex service station at 29 President Avenue, Kogarah
East	<ul style="list-style-type: none">• President Avenue, Rockdale Bicentennial Park East open space, residential properties either side of President Avenue, and then The Grand Parade and Botany Bay
West	<ul style="list-style-type: none">• Rockdale Industrial Area (north west)• Residential properties either side of President Avenue• TAFE NSW St George campus corner of Princes Highway and President Avenue and then Princes Highway and various commercial premises along the Princes Highway including Caltex Woolworths service station at 69 Princes Highway, Kogarah and a car wash at 71 Princes Highway Kogarah

4.4.4 Site history

The site history review of the ancillary facility is summarised in **Table 4-27**.

Table 4-27 President Avenue construction ancillary facility (C3) and construction site – site history

Source	Summary
Historical Aerials	<ul style="list-style-type: none"> The 1943 aerial photograph showed a narrow strip of market gardens along the western side of the now Rockdale Bicentennial Park and Illinden Sports Field along West Botany Street. Possible use of the land for agricultural purposes on the western side of West Botany Street. The remainder of the land appeared uncultivated. Land to the west of West Botany Street, Rockdale Bicentennial Park on the western side of Rockdale wetland and area south of President Avenue appeared to be infilled in the 1950s. Part of the land west of West Botany Street appeared to be developed for industrial purposes in the 1960's. The warehouses/buildings on the Site of the proposed Rockdale Ventilation Facility appear largely unchanged since the 1961 aerial photograph. Rockdale Bicentennial Park appeared to be developed into the parklands and sports field in the 1980s. The Rockdale Bicentennial Park East on the east side of Rockdale wetland appeared to undergo filling in the 1980s. Prior to the 1980s the land appeared to be wetland. Further filling and redevelopment into sports fields occurred between 2003 and 2009. Moorefield Racecourse was located to the south of President Avenue until after 1956 when it was redeveloped into residential housing, with the eastern section remaining as part of Scarborough Park north. Generally the surrounding land uses have comprised industrial, parkland, residential and roadway. The industrial area of Rockdale to the north and west of the ancillary facility has been developed and consolidated since circa 1961.
Contaminated sites currently or formerly regulated by the NSW EPA (Record of Notices)	<ul style="list-style-type: none"> There are no currently or formerly regulated sites There are no currently licensed facilities Former licenced activities under the POEO Act (now revoked or surrendered) comprise activities conducted on waterways within Rockdale wetland which included application of herbicides and pesticides.
Contaminated sites notified to the NSW EPA under Section 60 of the CLM Act 1997	<ul style="list-style-type: none"> There is one notified site within the boundary of the President Avenue ancillary facility: <ul style="list-style-type: none"> 7-Eleven service station on Princes Highway adjoining the northern end of the Princes Highway connection at Kogarah. There are two notified service stations adjacent to the boundary of the President Avenue ancillary facility: <ul style="list-style-type: none"> Caltex service station on President Avenue, Kogarah Woolworths service station on the Princes Highway, Kogarah
Other NSW EPA records	<ul style="list-style-type: none"> The closest property to conduct NSW EPA licensed activities is the Rockdale Waste and Recycling Centre which is located approximately 500 metres north west There are no other records of sites within or surrounding the President Avenue ancillary facility
National Waste Management site database	<ul style="list-style-type: none"> There are no sites listed within the ancillary facility The closest notified site listed is Rockdale Waste and Recycling Centre which is located approximately 500 metres north west of the ancillary facility.

Source	Summary
UBD Business Directories	<ul style="list-style-type: none"> According to historical UBD records the following businesses were located on the opposite side of West Botany Street within 200 metres of the ancillary facility: <ul style="list-style-type: none"> Globe Chemicals & Trading Pty. Ltd (previously Green keeping Supplies (1986); Agricultural Chemicals Manufacturers (insecticides, pesticides, fertilisers) (1986 to 1991) Spearpoint, T. R: moulding manufacturers/ wood moulding (1961–1970) Johns Pine Board Centre; Builders Supplies (1986 to 1991) Paris Engineering: Engineering, mechanical, and manufacturing (1975-1982) St George Wholesale/Toy Barn: Fireworks Manufacturers and Toy importers (1970-1986) Austraphane Converting Company Pty Ltd : Packaging/plastic/cellulose fabricator (1961-1970) – then Bragg Industries Pty Ltd (Lawn Mowers/motor importers/distributors (1975); then Russons Engineering: manufacturing/mechanical (1978-1982); then Rockdale Automatics - Motor Transmission Specialist (1986) According to historical UBD records the following businesses were located within 200 metres and topographically up-gradient of the ancillary facility: <ul style="list-style-type: none"> Golden Fleece Kogarah Service Station: Motor garage and service station (1965 to 1986) – Previously EPA listed Caltex Service Station (1965) (on 29 President Avenue adjoining to the south) St George Auto Port: Motor service stations (1965 to 1975) Esso Kogarah service centre: Motor garage and engineers (1970-1986) Corinthian Service Station: Motor, marine, brake and steering, garage (1961 to 1970) previously Moorfield Motor Centre (1950) Valhalla service station: Motor Service station (1965) Ace Footware: Footware manufactures (1961-1965)
Historical Titles	<ul style="list-style-type: none"> Historical titles indicate that the former ownership and land use: <ul style="list-style-type: none"> Lot 1 DP 535905: Various individuals (civil engineer, greengrocer, doctor of medicine) until 1968, then State Planning Authority of NSW (1968 to 1995) then Minister (until 1998) and then Rockdale City Council from 1998 to date. Lot 73 DP 746043: Various individuals (milk vendor) until 1972, then State Planning Authority of NSW (1972 to 1987), then Commissioner for Main Roads (1987 to date) Lot 72 DP 738382: Various individuals (company director, builders, agents) until 1957, then Cumberland County Council (1957 -1987), then State Planning Authority of NSW (1987) then Commissioner for Main Roads (1987 to date) Based on the above it appears that the Rockdale Bicentennial Park and the Rockdale Bicentennial Park East are likely to have been originally used for agricultural purposes prior to being purchased by the state and local governments for development as recreational space. Historical titles were not obtained for some Lot and DP's within the ancillary facility.

Source	Summary
Section 149 Certificate	<ul style="list-style-type: none"> • 468 West Botany Street, Rockdale (Lot 194 DP 752056, Lot 1 DP 535905, Lot 74 DP 746043 and Lot 71 DP 738382) <ul style="list-style-type: none"> – The Council has adopted by resolution a policy on contaminated land that may restrict the development of the land. This policy is implemented when zoning or land use changes are proposed on lands that have been previously used for a certain purpose. Consideration of the Council's adopted policy and the application of provisions under State legislation is warranted – The whole lot is located within the coastal zone under the Coastal Management SEPP 2018 – A building, work, relic, tree or place located on this land is identified as an item of environmental heritage in Rockdale Local Environment Plan 2011 – Part of the land is identified as Class 2 or Class 3 Acid Sulfate Soils on the Rockdale LEP 2011 – Part of the land is classified as environmentally sensitive land as it is identified on the Rockdale Local Environment Plan 2011 – Natural Resource Biodiversity map or Rockdale Local Environment Plan 2011 – Natural Resource Wetlands map – The development of the land or part of the land may be subject to flood-related development controls – All or part of the land is reserved for acquisition under the Rockdale Local Environment Plan 2011 by Roads and Maritime for the purposes of a new classified road – The Council is aware of various information that suggests the land may be affected by the 1% AEP (1 in 100 year) flood. – Rockdale Local Environment Plan 2011 requires development consent to ringbark, cut down, top, lop, remove, injure or wilfully destroy any tree covered by Clause 5.9 – The ANEF affectation applying to the land is less than 20 decibels • 427 to 441 West Botany Street, Rockdale (Lots 1 and 2 DP 100164, Lots 3 to 6 DP 22338 and Lot 7 DP381773) <ul style="list-style-type: none"> – The Council has adopted by resolution a policy on contaminated land that may restrict the development of the land. This policy is implemented when zoning or land use changes are proposed on lands that have been previously used for a certain purpose. Consideration of the Council's adopted policy and the application of provisions under State legislation is warranted – The development of the land or part of the land may be subject to flood-related development controls – The Council is aware of various information that suggests the land may be affected by the 1% AEP (1 in 100 year) flood. – Rockdale Local Environment Plan 2011 requires development consent to ringbark, cut down, top, lop, remove, injure or wilfully destroy any tree covered by Clause 5.9 – The ANEF affectation applying to the land is less than 20 decibels

Source	Summary
Online sources	<p>The following information was contained about the history of Rockdale Bicentennial Park within a Rockdale City Council report titled Uncovering Rockdale's Migration Heritage Story (MacLeod, V and Curby, P, 2013):</p> <ul style="list-style-type: none"> • The subject land was originally cultivated by market gardeners until the 1950s when Annabelle Dairy operated within the boundary • Rockdale Municipal Council took control of the subject land in 1971 and the land was infilled with refuse over a five year period followed by a period to allow settling • In 1980 additional soil was imported to allow construction of a bike track • A grant was received in 1986 to develop the remainder of Rockdale Bicentennial Park including a raised mound around the sports field (now Illinden Sports Centre).

4.4.5 Subsurface conditions, topography and drainage

The descriptions of the topography, drainage, soils, geology and hydrogeology are summarised in **Table 4-28**.

Table 4-28 President Avenue construction ancillary facility (C3) and construction site – subsurface conditions, topography and drainage

Source	Summary
Topography	<ul style="list-style-type: none"> • The lowest elevation is Rockdale wetland (2 metres AHD). The northern section slopes downwards towards the north west. President avenue slopes downwards west to east from 18 metres AHD to 2 metres AHD near the wetlands, then slopes slightly upwards towards the east. The area drains into Rockdale wetland. • The elevation of the proposed Rockdale ventilation facility is generally flat (around 2 m AHD). West Botany Street is also generally flat and at lower elevation than Rockdale Bicentennial Park and Illinden Sports Centre (both around 4 to 6 m AHD) located to the east of West Botany Street.
Drainage	<ul style="list-style-type: none"> • The nearest water body is Rockdale wetland, which are within the ancillary facility area. Muddy Creek runs approximately 600 metres to the north west. • Botany Bay is located approximately 800 metres to the east. • Surface waters are expected to infiltrate in unsealed portions and ultimately drain towards the wetland. • Drainage of surface waters along President Avenue and West Botany Street will be within the local stormwater system along President Avenue and West Botany Street, which feed into the wetland, and/or drain towards Botany Bay further to the east.
Soils	<ul style="list-style-type: none"> • According to the Sydney Soil Landscape Map 1:100,000, the proposed Rockdale Ventilation Facility, most of the Rockdale Bicentennial Park and part of the Rockdale Bicentennial Park East are located within disturbed terrain, identified as DTxx. • The eastern portion of the ancillary facility is located with the Warriewood soil classification which is referred to as Swamp (SWwa) area. President Avenue runs across various soil profiles, namely being Residual soils RElh (Lucas Heights), Aeolian AEnp (Newport), Swamp SWwa (Warriewood), and Aeolian AEtg (Tuggerah) from west to east. • Generally, natural soils across the area are expected to be Podzols, described as coastal sand plains and dunes, lagoon and swampy areas. • The respect to ASS, most of the ancillary facility is located across Class 2 and Class 3, and with a high (>70%) to Low (6-70%) probability of occurrence of ASS (risk and class), as per the Atlas of Australian Acid Sulfate Soils Maps.

Source	Summary
Hydrogeology	<ul style="list-style-type: none"> Aquifers under the ancillary facility are expected to be shallow (<3 metres bgl), porous, extensive of low to moderate productivity. Due to the shallow groundwater beneath the site and the location of the ancillary facility in close proximity to wetland areas, it is expected that the groundwater would flow towards the north west (northern half of the ancillary facility), and to the south east (southern section of the ancillary facility). A search of groundwater (GW) bores indicated that GW107531 is located within the ancillary facility (northern portion) for Industrial Purposes, and that GW026647 (central portion) for private use. Recorded information indicates that groundwater below the site is shallow (2 to 3 metres bgl). A number of GW bores are located within a 100 metres radius of the ancillary facility, with industrial as well as domestic purposes.

4.4.6 Previous Investigations

Staged combined geotechnical and contamination investigations have been within the President Avenue construction ancillary facility (C3) boundary since 2016. These have comprised:

- F6 Northern Geotechnical Investigations (SMEC, 2016): investigation locations BH1143, BH014A and BH1121A
- F6 Northern SEA Geotechnical Investigations (SEMC, 2017a): investigation location BH1212
- EIS Section A Phase 1 Geotechnical Investigations (SMEC, 2017b): investigation locations BH1302, BH1303
- F6 Stage 1 Extension Phase 2 Geotechnical Site Investigations (SMEC, 2018): investigation locations TP301 to TP310, BH1302, BH1304 and BH1318

These investigation locations are shown on **Figure 4-9** and **Figure 4-10** and the findings are summarised in the follow sections.

F6 Northern SEA Geotechnical Investigations

One borehole was completed (BH1212) within the President Avenue construction ancillary facility as part of the F6 Northern SEA Geotechnical Investigations (SMEC 2017a) (see **Table 4-29**). The borehole was sampled for geotechnical purposes.

Table 4-29 Summary of F6 Northern SEA geotechnical investigation locations within President Avenue construction ancillary facility

Borehole ID	Location	Matrix sampled	Summary
BH1212	Rockdale Bicentennial Park East	<ul style="list-style-type: none"> No sampling for contamination assessment 	<ul style="list-style-type: none"> Fill encountered to 2 metres bgl Alluvium screened monitoring well (13 to 16 m bgl)

F6 Northern geotechnical investigations

Two boreholes were completed within (BH1143 and BH1121A) or one just south (BH014A) of the President Avenue construction ancillary facility as part of the F6 Northern Geotechnical Investigations (SMEC, 2016).

The scope included analysis of soil and groundwater samples from BH014A and BH1143 for:

- Soil analysis: heavy metals, TRH/TPH, BTEX, PAHs, phenols, VOCs, OCPs, PCBs, nutrients, TOC and SPOCAS
- Groundwater analysis: major anions and cations, heavy metals, TRH/TPH, BTEX, SVOC and VOCs, cyanide and nutrients.

The investigation locations and results are summarised in **Table 4-30**.

Table 4-30 Summary of F6 Northern SEA geotechnical investigation locations within President Avenue construction ancillary facility

Borehole ID	Location	Matrix sampled	Summary
BH014A	Rockdale Bicentennial Park (to the south and outside the ancillary facility boundary)	<ul style="list-style-type: none"> • Soil • Groundwater 	<ul style="list-style-type: none"> • Fill encountered to 6 metres bgl, with refuse including plastic and hydrocarbon odour at 4.2 metres bgl • Alluvium monitoring well (7 to 10 metres bgl) • All soil results were less than the adopted HIL and HSLs for commercial/industrial and open space land use • Concentrations of copper, nickel, zinc and ammonia in groundwater exceeded the marine and freshwater GILs • Low concentrations of TRH, BTEX, chlorobenzene, cyclohexane, isopropylbenzene and n-propylbenzene were detected above the LOR but below the assessment criteria
BH1143	Rockdale Bicentennial Park	<ul style="list-style-type: none"> • Soil • Groundwater 	<ul style="list-style-type: none"> • Fill encountered to 7 metres bgl, with refuse including glass, metal, plastic and timber • All soil results were less than the adopted HIL and HSLs for commercial/industrial and open space land use • Alluvium screened monitoring well (16.4 to 18.4 metres bgl) • Concentrations of nickel and zinc in groundwater exceeded the marine and freshwater GILs • Low concentrations of chloroform was detected above the LOR but below the assessment criteria
BH1121A	Rockdale Bicentennial Park East	<ul style="list-style-type: none"> • No sampling for contamination assessment 	<ul style="list-style-type: none"> • Fill encountered to 1.5 m metres bgl • Alluvium screened monitoring well (7 to 10 m bgl)

EIS Section A Phase 1 geotechnical investigations

One borehole (BH1303) was completed within the President Avenue construction ancillary facility as part of the EIS Section A Phase 1 Geotechnical Investigations (SMEC 2017b).

The scope included analysis of soil and groundwater samples for:

- Soil analysis: heavy metals, TRH/TPH, BTEX, PAHs, phenols, VOCs, OCPs, PCBs, PFAS and SPOCAS
- Groundwater analysis: major anions and cations, heavy metals, TRH/TPH, BTEX, SVOC and VOCs, cyanide and nutrients.

The investigation locations and results are summarised in **Table 4-31**.

Table 4-31 Summary of EIS Section A Phase 1 geotechnical Investigation locations within President Avenue construction ancillary facility

Borehole ID	Location	Matrix sampled	Summary
BH1303	Rockdale Bicentennial Park	<ul style="list-style-type: none"> Soil Groundwater 	<ul style="list-style-type: none"> Fill encountered to 5.0 m metres bgl, with inclusions of refuse including plastic, metal, glass, and rubber All soil results were less than the adopted HIL and HSLs for commercial/industrial and open space land use Concentrations of arsenic in groundwater exceeded the freshwater GIL and concentrations of ammonia and zinc exceeded the marine GILs Low concentrations of TRH, xylene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, chloroform and manganese detected above the LOR but below the assessment criteria

Phase 2 geotechnical investigation works

SMEC undertook the drilling and sampling of ten boreholes (TP1301 to TP1310) to target suspected landfill and contamination within Rockdale Bicentennial Park and Rockdale Bicentennial Park East within the ancillary facility (refer **Figure 4-9** and **Figure 4-10**). The boreholes were drilled between depths between 5.45 and 8.45 metres bgl and extended into natural alluvium in all boreholes. Groundwater monitoring wells were installed in two boreholes and dual groundwater and gas monitoring wells were installed in three boreholes (SMEC 2018). A summary of the locations and the sampled matrix is provided in **Table 4-32**.

Additionally three boreholes (BH1302, BH1304 and BH1318) and one monitoring well (BH1302) were installed for the geotechnical investigations (SMEC 2018).

Table 4-32 Summary of investigation locations within President Avenue construction ancillary facility

Borehole ID	Location	Matrix sampled	Summary
BH1302	Rockdale Bicentennial Park	<ul style="list-style-type: none"> Soil 	<ul style="list-style-type: none"> Fill encountered to 6 metres bgl with inclusions of plastic, glass, metal and timber
BH1304	Rockdale Bicentennial Park East	<ul style="list-style-type: none"> Soil 	<ul style="list-style-type: none"> Fill encountered to 3.3 metres bgl
BH1318	Rockdale Bicentennial Park	<ul style="list-style-type: none"> Soil Groundwater 	<ul style="list-style-type: none"> Fill encountered to 4.5 metres bgl with organic odour at 0.8 to 2 m bgl noted Groundwater monitoring well installed and screened 5.8 to 8.8 metres bgl in alluvium Groundwater level 2.06 metres below top of casing (b toc)
TP1301	Rockdale Bicentennial Park East	<ul style="list-style-type: none"> Soil 	<ul style="list-style-type: none"> Fill encountered to 2 metres bgl
TP1302	Rockdale Bicentennial Park East	<ul style="list-style-type: none"> Soil 	<ul style="list-style-type: none"> Fill encountered to 3 metres bgl with inclusions of timber, wire and polystyrene between 0.8 and 3 metres bgl.

Borehole ID	Location	Matrix sampled	Summary
TP1303	Rockdale Bicentennial Park East	<ul style="list-style-type: none"> Soil Groundwater 	<ul style="list-style-type: none"> Fill encountered to 4.1 metres bgl with inclusions of brick, ceramic, timber, plastic and glass. Groundwater monitoring well installed and screened 2 to 4 metres bgl in fill Groundwater level 2.89 metres below top of casing (b toc) (21 December 2017)
TP1304	Civic Avenue Reserve	<ul style="list-style-type: none"> Soil 	<ul style="list-style-type: none"> Fill encountered to 1 metre bgl
TP1305	Civic Avenue Reserve	<ul style="list-style-type: none"> Soil 	<ul style="list-style-type: none"> Fill encountered to 1.1 metres bgl
TP1306	Civic Avenue Reserve	<ul style="list-style-type: none"> Soil 	<ul style="list-style-type: none"> Fill encountered to 1.5 metres bgl with inclusions of fragments of brick, ceramic and rubber.
TP1307	Rockdale Bicentennial Park East	<ul style="list-style-type: none"> Soil Groundwater 	<ul style="list-style-type: none"> Fill encountered to 1.8 metres bgl with inclusions of brick, ceramic and trace organics. Groundwater monitoring well installed and screened 2 to 4 metres bgl in alluvium Groundwater level 2.04 metres below toc (21 December 2017)
TP1308	Rockdale Bicentennial Park	<ul style="list-style-type: none"> Soil Groundwater Gas 	<ul style="list-style-type: none"> Fill encountered to 6 metres bgl with inclusions of plastic, fabric, glass rubber, metal and timber. Dual groundwater and gas monitoring well installed and screened from 1.5 to 6 metres bgl in fill Groundwater level 2.67 metres below toc (21 December 2017) Hydrocarbon sheen in groundwater
TP1309	Rockdale Bicentennial Park	<ul style="list-style-type: none"> Soil Groundwater Gas 	<ul style="list-style-type: none"> Fill encountered to 4 metres bgl with inclusions of metal, plastic, rubber and timber. Dual groundwater and gas monitoring well installed and screened from 2 to 4 metres bgl in fill Groundwater level 3.32 metres below toc (21 December 2017)
TP1310	Rockdale Bicentennial Park	<ul style="list-style-type: none"> Soil Groundwater Gas 	<ul style="list-style-type: none"> Fill encountered to 5.3 metres bgl with inclusions of plastic, timber, metal, rubber, polystyrene, glass, newspaper and charcoal. Dual groundwater and gas monitoring well installed and screened from 1 to 5 metres bgl in fill Groundwater level 2.46 metres below toc (21 December 2017) Hydrocarbon sheen in groundwater

The field and analytical scope included:

- Field screening soil samples for VOCs using a photoionisation detector (PID)
- Laboratory analysis of soil samples for heavy metals , TRH, BTEX, PAHs, VOCs, SVOCs, PCBs, asbestos and SPOCAS
- Laboratory analysis of groundwater samples for heavy metals, TRH, BTEXN, PAHs, VOCs, SVOCs, ion balance and inorganics
- Field measurement of sub-surface bulk gases (methane, carbon dioxide, carbon monoxide, oxygen, hydrogen sulphide) and gas flow rate.

A preliminary screening of soil results against the site suitability criteria for both commercial/industrial and recreational open space land use scenarios from the following guidelines was undertaken:

- National Environment Protection Council (1999). National Environmental Protection Measure (Assessment of Site Contamination), as amended May 2013 (ASC NEPM, 2013)
- Friebel, E. and Nadebaum, P., 2011. Health screening levels for petroleum hydrocarbons in soil and groundwater. Part 1: Technical development document. CRC for Contamination Assessment and Remediation (CRC CARE) Technical Report no. 10 (CRC CARE, 2011).

A summary of the results for TP1301 to TP1310 compared to the human health and ecological criteria are provided in **Table 4-33** to **Table 4-36**. Sample exceedances of the human health based criteria are as follows:

- TP1310/4.0-4.45 metres bgl: heavy metal concentrations exceeded the ASC NEPM (2013) health investigation level (HIL) for open space land use (HIL C) and commercial land use (HIL D) for arsenic, cadmium, copper, lead, mercury, nickel and zinc. It is noted that due to the abnormally high metals results (the maximum concentrations in **Table 4-33**) and the encountered refuse in the fill, the results may be due to degraded metal alloy waste in the fill sampled. The result is a statistical outlier compared to the concentrations of metals in all other sample results.
- TP1310/3.5-3.6 metres bgl: TRH C16-C34 concentration exceeded the health screening level (HSL) for direct contact for open space land use (HSL C)
- Chrysotile asbestos was detected in sample collected from 3.0-3.45 metres bgl from TP1308.

Acid sulfate soils were identified in samples collected from Rockdale Bicentennial Park East (TP1301/ 3.0-3.45 m bgl; TP1304/1.4-1.5, 2.0-2.45 and 3.0-3.45 m bgl) and potential acid sulfate soils identified in a sample collected from Civic Avenue Reserve (TP1305/2.0-2.1 m bgl).

Soil results for TP1301 to 1310 were screened against the NSW EPA (2014) *Waste Classification Guideline: Part 1 Classifying Waste* classification criteria in **Table 4-37**.

Results for combined geotechnical and contamination boreholes BH1302, BH1304 and BH1318 were also compared to the site suitability criteria for both commercial/industrial and recreational open space land use. All results were less than the criteria with the exception of:

- BH1318: Lead concentration at 2.5 metres bgl (760 mg/kg) exceeded the HIL C criteria
- BH1313: TRH C16-C34 concentration (340 mg/kg) exceeded the ESL for coarse grained soil at 0.0-0.1 metres bgl.

Soil results for BH1302, BH1304 and BH1318 were screened against the NSW EPA (2014) *Waste Classification Guideline: Part 1 Classifying Waste* classification criteria. All concentrations were less than the contaminant threshold value for general solid waste (CT1) with the exception of lead in samples BH1302/2.4-2.5 (150 mg/kg), BH1302/3.9-4.0 (270 mg/kg), BH1304/4 (160 mg/kg) and BH1318/2.5 (760 mg/kg).

Table 4-33 TP1301 to TP1310 soil results screened against Health Investigation Levels (HIL), ASC NEPM, NEPC (2013 as amended)

CoPC	As	Cd	Cr	Cu	Pb	Hg	Ni	Zn	CPAHs	PAHs	Heptachlor	HCB	Pentachloro-phenol
ASC NEPM (2013) HIL C	300	90	-	17000	600	80	1200	30000	3	300	10	10	120
ASC NEPM (2013) HIL D	3000	900	-	240000	1500	730	6000	400000	40	4000	50	80	660
No. of Results	65	65	65	65	65	65	65	65	67	67	65	65	65
No. of Detects	33	25	65	64	65	34	64	65	15	46	0	0	0
Minimum Concentration (mg/kg)	<4	<0.4	3	<1	2	<0.1	<1	4	<0.5	<0.05	<0.1	<0.1	<5
Maximum Concentration (mg/kg) (excluding outlier ⁺)	16	3	52	1300	450	5.3	180	640	22	240	<0.5	<0.5	<5
+TP1308/4.0-4.45(mg/kg)	3800	5200	290,000	490,000	140,000	1800	27,000	940,000	<50	<50	<100*	<100*	<5000*
Mean Concentration (mg/kg)(excluding outlier ⁺)	4.6	0.6	15	52	75	0.32	12	178	2.8	8.1	-	-	-
No. of results > HIL C	1	1	-	1	1	1	1	1	0	0	0 [^]	0 [^]	0 [^]
No. of results > HIL D	1	1	-	1	1	1	1	1	0	0	0 [^]	0 [^]	0 [^]

* Raised LORs in sample TP1310/4.0-4.45 metres bgl

[^] Raised LOR exceeds criteria in sample TP1310/4.0-4.45 metres bgl

⁺ Analytical results reported for sample TP1308/4.0-4.45 are considered a statistical outlier

HIL C – health investigation level for open space land use

HIL D - health investigation level for commercial/industrial land use

Table 4-34 TP1301 to TP1310 soil results screened against Health Screening Levels (HSL), ASC NEPM, NEPC (2013 as amended)

CoPC	Benzene	Toluene	Ethylbenzene	Xylenes	F1	F2	C6-C10	C10-C16	C16-C34	C34-C40	Naphthalene
HSL C Direct Contact	120	5300	18,000	15,000			5100	3800	5300	7400	1900
HSL IMW 0-<2 m	77	NL	NL	NL			NL	NL			NL
HSL D 0 to <1 m sand	3	NL	NL	230	260	NL					NL
HSL D Direct Contact	430	27,000	99,000	81,000			26,000	20,000			11,000
No. of Results	65	65	65	65	65	65	65	65	65	65	64
No. of Detects	0	2	0	2	4	11	5	11	26	19	11
Minimum Concentration (mg/kg)	<0.2	<1	<0.5	<1	<25	<50	<25	<50	<100	<100	<0.1
Maximum Concentration (mg/kg) (excluding outlier+)	<0.2	<0.5	19	39	3600		3700	2800	6000		9.6
+TP1308/4.0-4.45	<200*	<1000*	<500*	<1000*	<25,000*	2800	<25,000*	<50,000*	6000	1300	1100
Mean Concentration (mg/kg) (excluding outlier+)			0.79	1.1	74	86	76	86	495	149	0.39
No. of results >HSL C Direct Contact	0^	0	0	0	-	-	0^	0^	1	0	0
No. of results > IMW 0-<2 m	0^	-	-	-	-	-	-	-	-	-	-
No. of results > HSL D 0 to <1 m sand	0^	-	-	0^	2^	-	-	-	-	-	-
No. of results > HSL D Direct Contact	0	0	0	0	-	-	0	0^	-	-	0

Notes: NL = Non-limiting

* Raised LORs in sample TP1310/4.0-4.45 metres bgl

^ Raised LOR exceeds criteria in sample TP1310/4.0-4.45 metres bgl

* Analytical results reported for sample TP1308/4.0-4.45 are considered a statistical outlier

HSL C – Health screening level for open space land use

HSL D – Health screening level for commercial/industrial land use

HSL IMW - Health screening level for intrusive maintenance worker

Table 4-35 TP1301 to TP1310 soil results screened against Ecological Investigation Levels (EIL), ASC NEPM, NEPC (2013 as amended)

CoPC	As	Cr	Cu	Pb	Ni	Zn	DDT	Naphthalene
ASC NEPM (2013) EIL C	105#	205#	90#	1260#	35#	190#	180	170
ASC NEPM (2013) EIL D	165#	325#	170#	1960#	565#	230#	640	370
No. of Results@	42	42	42	42	42	42	42	42
No. of Detects	26	42	42	42	42	42	0	4
Minimum Concentration (mg/kg)	<4	5	1	2	1	4	<0.1	<0.1
Maximum Concentration (mg/kg)	16	44	1300	450	180	640	<0.5	0.2
Mean Concentration (mg/kg)	5.2	17	65	86	14	186	-	0.064
No. of results > EIL C	0	0	4	0	4	15	0	0
No. of results > EIL D	0	0	2	0	0	12	0	0

Minimum EIL published in NEPM (NEPC, 2013)

@ Number of results <2 metres bgl

EIL C – Ecological investigation level for open space land use

EIL D - Ecological investigation level for commercial/industrial land use

Table 4-36 TP1301 to TP1310 soil results screened against Ecological Screening Levels (ESL), ASC NEPM, NEPC (2013 as amended)

CoPC	Benzene	Toluene	Ethylbenzene	Xylenes	Benzo(a)pyrene	C6-C10	C10-C16	C16-C34	C34-C40
ESL C (Fine Grained)	65	105	125	45	0.7	180	120	1300	5600
ESL C (Coarse Grained)	50	85	70	105				300	2800
ESL D (Fine Grained)	95	135	185	95	1.4	215	170	2500	6600
ESL D (Coarse Grained)	75	135	165	180				1700	3300
No. of results [@]	42	42	42	42	42	42	42	42	42
No. of detects	0	0	0	1	30	3	6	16	13
Minimum concentration (mg/kg)	<0.2	<1	<0.5	<1	<0.05	<25	<50	<100	<100
Maximum concentration (mg/kg)	<0.2	<1	<0.5	2	5	49	200	2800	760
Mean concentration (mg/kg)	-	-	-	-	0.45	14	39	387	129
No. of results > ESL C (Fine Grained)	0	0	0	0	10	0	2	4	0
No. of results > ESL C (Coarse Grained)	0	0	0	0				10	0
No. of results > ESL D (Fine Grained)	0	0	0	0	3	0	1	4	0
No. of results > ESL D (Coarse Grained)	0	0	0	0				4	0

[@] Number of results <3 metres bgl

ESL C – Ecological screening level for open space land use

ESL D - Ecological screening level for commercial/industrial land use

Table 4-37 TP1301 to TP1310 soil results screened against NSW EPA (2014) Waste Classification Guidelines

CoPC	As	Cd	Pb	Hg	Ni	Benzo(a)pyrene	TPH C6-C9	Asbestos
NSW EPA (2014) CT1	100	20	100	4	40	0.8	-	-
NSW EPA (2014) CT2	400	80	400	16	160	3.2	-	-
NSW EPA (2014) SCC1	500	100	1500	50	1050	10	650	-
NSW EPA (2014) SCC2	2000	400	6000	200	4200	23	2600	-
No. of results	65	65	65	65	65	65	65	65
No. of detects	33	25	65	34	64	41	2	1
Minimum concentration (mg/kg)	<4	<0.4	2	<0.1	<1	<0.05	<25	ND
Maximum concentration (mg/kg) (excluding outlier+)	16	3	450	5.3	180	15	1000	Detected
+TP1308/4.0-4.45	3800	5200	140,000	1800	27,000	<50*	<25,000*	ND
Mean concentration (mg/kg)	4.6	0.6	75	0.32	12	0.6	215	-
No. of results > CT1	1	1	16	2	3	11^	-	1
No. of results > CT2	1	1	2	1	2	2^	-	1
No. of results > SCC1	1	1	1	1	1	1^	1	1
No. of results > SCC2	1	1	1	1	1	0^	0^	1

* Raised LORs in sample TP1310/4.0-4.45 metres bgl

^ Raised LOR exceeds criteria in sample TP1310/4.0-4.45 metres bgl

Chrysotile asbestos detected in sample collected from TP1308 3.0-3.45 metres bgl

CT1 – contaminant threshold value for general solid waste [without toxicity characteristic leaching procedure (TCLP) results]

CT2 – contaminant threshold value for restricted solid waste (without TCLP results)

SCC1 – specific contaminant concentration threshold value for general solid waste (with TCLP results)

SCC2 – specific contaminant concentration threshold value for general solid waste (with TCLP results)

Groundwater results are summarised in **section 4.1.12**.

The concentrations of landfill bulk gases measured in three dual groundwater/gas monitoring wells are presented in **Table 4-38**. The gas screening value (GSV) calculated in accordance with the NSW EPA *Guidelines for the Assessment and Management of Sites Impacted by Hazardous Ground Gases* (NSW EPA 2012) is 0.02 (assuming a conservative flow rate of the instrument resolution of 0.1 L/hr, as 0 L/hr was measured in field).

In summary, hydrogen sulphide concentrations exceed human health and aesthetic criteria. Carbon monoxide concentrations were slightly less than workplace exposure criteria and aesthetic and health criteria. Carbon dioxide exceeded the workplace exposure limits.

Table 4-38 Rockdale Bicentennial park landfill gas results

Parameter	Workplace Exposure	Aesthetic and Health Criteria*	TP1308	TP1309	TP1310
Methane	-	-	16.8%	0%	3.5%
Carbon Dioxide	TWA: 5000 ppm (0.5%) STEL: 30,000 ppm (3%)	Nil	4.2 %	10.9 %	4.2 %
Oxygen	-	-	4.1 %	9.6 %	2 %
Hydrogen Sulphide	TWA:10 ppm STEL:15 ppm	Aesthetic (odour): 0.007 mg/m ³ Health: 0.15 mg/m ³	2 ppm (2.8 mg/m ³)	3 ppm (4.2 mg/m ³)	0 ppm
Carbon monoxide	TWA: 30 ppm	100 mg/m ³ (90 ppm for 15 minutes)	28 ppm (35 mg/m ³)	0 ppm	0 ppm
VOC	-	-	220 ppm	14.2 ppm	9.9 ppm
Flow Rate	-	-	0 L/hr	0 L/hr	0 L/hr
LEL	methane -5% hydrogen sulphide – 4.5% carbon monoxide – 12.5%		<u>>100%</u>	0%	<u>78.6%</u>

Notes:

*WHO 2000a and 2000b

NC – not combustible

% - volume/volume concentration

Bold – exceeds workplace exposure or aesthetic and health criteria

TWA – time weighted average (8 hr exposure)

STEL – Short term exposure limit (15 minute exposure)

Underline – exceeds LEL

Discussion of results

The soil investigation results indicate that fill containing demolition type waste and waste typical of inert landfills (plastic, glass, metal, and timber) is present below Rockdale Bicentennial Park, and portions of Rockdale Bicentennial Park East and Civic Avenue Reserve, within the ancillary facility. No observations of putrescible type waste were described. Based on the results and due to the heterogeneous nature of the fill, CoPC are likely to exceed the human health and ecological criteria for commercial/industrial and open space variably across the ancillary facility within Rockdale Bicentennial Park, Rockdale Bicentennial Park East and Civic Avenue Reserve, particularly for heavy metals, PAHs and TRH. There may be more localised impacts from other CoPC including OCPs, SVOCs, VOCs and PCBs. Due to the type of fill described and detection of asbestos; it is likely that ACM would be encountered throughout the filled area. Further investigation would be required during detailed design to adequately characterise the fill and soil that is to remain *in situ* within the ancillary facility and operational footprint.

The results indicate waste classifications of mainly general solid waste and restricted solid waste, with the potential for some hazardous waste. Substantial portions of the fill may also be classified as Special Waste (asbestos). Acid sulfate soils and potential acid sulfate are also present within the alluvial sediments. Further sampling for classification with a higher sampling density would be required during detailed design to adequately classify the fill and soil in proposed excavation areas accordance with the NSW EPA (2014) Waste Classification Guidelines.

The elevated concentrations of methane and carbon dioxide gas detected within the monitoring wells are typical of general uncontrolled fill (of 0-20% and 0-10% respectively) according to NSW EPA (2012) guidelines. A GSV of 0.02 was calculated from the maximum methane and flow rate results. A GSV of 0.02 is classified as characteristic gas situation (CGS) 1 (very low risk). As carbon dioxide concentrations exceeded 1% for methane and 5 % for carbon dioxide, the guidelines recommend consideration of classification of sites in this incidence as CGS 2 (low risk). Where CGS 2 is identified, the guidelines recommend appropriate gas protection measures should be selected in accordance with Section 5 of the NSW EPA (2012) guidelines. This means suitable gas protection measures will need to be considered during detailed design for the prevention of accumulation of gases within buildings and subsurface voids such as service pits, trenches and shafts etc. This could include passive ventilation and impermeable barriers.

Hydrogen sulphide was also detected in subsurface gases at concentrations exceeding health and aesthetic (odour) criteria. It is likely attributed to the decaying natural organic matter (former wetland) underlying the uncontrolled fill, organic matter within the fill and shallow groundwater. Mitigation measures will need to be adopted during construction of the project within Rockdale Bicentennial Park to prevent nuisance odours and potential health impacts during construction. Further assessment should be undertaken during detailed design.

There were concentrations of ammonia, lead and zinc exceeding the NEPM GIL for marine and fresh waters and arsenic exceeding the NEPM GIL for drinking water in shallow groundwater. Total nitrogen exceeded the ANZECC (2000) trigger value for NSW lowland rivers. The concentrations of ammonia and nitrogen were substantially elevated and typical of landfill leachate. The concentrations of metals were slightly above the criteria (same order of magnitude as criteria). Concentrations of ammonia and nitrogen were highest in shallow groundwater monitoring wells (TP1308, TP1309 and TP1310) located in Rockdale Bicentennial Park screened in landfill materials compared to those screened in alluvial materials in Rockdale Bicentennial Park Esat (TP1303 and TP1307).

Concentrations of heavy metals, ammonia, nitrogen, TRH, BTEXN, VOCs and SVOCs were detected and/or higher than concentrations in shallow groundwater wells with deeper groundwater elevation i.e. TP1303, TP1307 and TP1309 groundwater elevations range between 1.24 and 1.4 metres AHD compared to TP1308 and TP1310 2.8 and 2.56 metres AHD, respectively.

4.4.7 Areas and contaminants of concern

The areas and contaminants of concern for the ancillary facility based on the information reviewed are summarised in **Table 4-39**.

Table 4-39 President Avenue construction ancillary facility (C3) – areas and contaminants of concern

Area of concern	Contaminants of concern
Historical use of the ancillary facility for agricultural purposes and the use of pesticides, herbicides and fertilisers	<ul style="list-style-type: none">• OCPs• OPPs• Herbicides• Nutrients (ammonia, nitrate, nitrite and phosphorus)
Former, current and surrounding industrial properties (chemical manufacturing, plastic, fertilisers, pesticides/herbicides)	<ul style="list-style-type: none">• TRH/BTEXN, PAHs, Metals, PCB, OP/OC Pesticides, VOCs, SVOCs, Phenols
Uncontrolled fill within Rockdale Bicentennial Park, Rockdale Bicentennial Park East and Civic Avenue	<ul style="list-style-type: none">• TRH/BTEXN, PAHs, Metals, PCB, OP/OC Pesticides, VOCs, SVOCs, Asbestos• Landfill gas (methane, carbon monoxide, carbon dioxide, hydrogen sulphide)
Areas of high risk of Acid sulfate soils	<ul style="list-style-type: none">• Acid sulfate soils
Up-gradient service stations, motor and mechanical businesses	<ul style="list-style-type: none">• TRH/BTEXN, PAHs, Metals, VOCs, SVOCs, Phenols

4.5 Shared cycle and pedestrian pathways - north

4.5.1 Site description

The project would deliver new pedestrian and cyclist infrastructure, in the form of a shared cycle and pedestrian pathways. The shared cycle and pedestrian pathways would be developed from Bestic Street, Brighton-le-Sands, south to Civic Avenue, Kogarah through the reinstated Rockdale Rockdale Bicentennial Park. The shared cycle and pedestrian pathways intersects with several existing and proposed east-west paths. As part of the corridor, a dedicated shared overpass would be built over President Avenue.

Construction ancillary facilities for the shared cycle and pedestrian pathways – north would include:

- Shared cycle and pedestrian pathways East construction ancillary facility (C5), within southern portion of 310 West Botany Street, Rockdale, Rockdale Women's Sportsfields (part Lot 1 DP34647 and part Lot 1 and 2 DP613347)
- Shared cycle and pedestrian pathways West construction ancillary facility (C4), within southwest portion of Redmond Field. The existing environment for the southern parts of the shared cycle and pedestrian pathways for the project have been assessed in **section 4.4**. The general alignment of the shared cycle and pedestrian pathways and the location of the construction ancillary facilities are shown on **Figure 4-8**.

4.5.2 Current land use

The current land uses of the shared cycle and pedestrian pathways - north comprises part of Bestic Street and recreational open space comprising:

- Whiteoak Reserve
- C A Redmond Field
- Rockdale Women's Sportsfields
- Greg Atkins Mini Field.

4.5.3 Surrounding land use

The surrounding land use is summarised in **Table 4-40**.

Table 4-40 Shared cycle and pedestrian pathways - north – surrounding land use

Direction	Description of surrounding land use
North	<ul style="list-style-type: none"> Muddy Creek, Barton Park, Lance Studdert Reserve, residential land use in suburbs of Kyeemagh and Banksia Market gardens to the north-east and 7-Eleven to the north-west on West Botany Street
South	<ul style="list-style-type: none"> Residential land use in the suburb of Brighton-le-Sands, Bay Park, Bay Street and the C2 ancillary facility
East	<ul style="list-style-type: none"> Cairnsfoot Special School Residential land use in the suburb of Brighton-le-Sands
West	<ul style="list-style-type: none"> Residential land use in the suburb of Rockdale, West Botany Street Rockdale Park, Ador Avenue Reserve and McCarthy Reserve

4.5.4 Previous investigations

Two boreholes (WCX_BH211 and WCX_BH_212) were completed as part of AECOM (2015) *Westconnex Stage 2: M5 Factual Contamination Assessment*, within or adjacent to the shared cycle and pedestrian pathways in Whiteoak Reserve (BH212) and Redmond Field (BH211). The boreholes were not sampled for the contamination assessment. The following descriptions were logged:

- No fill or observations of odour were observed in BH211
- Fill was logged to 4.5 metres bgl, with inclusions of concrete and building debris in BH212.

The location of the boreholes are shown on **Figure 4-8**. There are no other known previous contamination investigations undertaken.

4.5.5 Site history

Site history review of the shared cycle and pedestrian pathways - north is summarised in **Table 4-41**.

Table 4-41 Shared cycle and pedestrian pathways - north – site history

Source	Summary
Historical Aerials	<ul style="list-style-type: none"> The 1943 historical aerial¹ showed that the shared cycle and pedestrian pathways – north and immediate surrounding land was cultivated as market gardens.
Contaminated sites currently or formerly regulated by the NSW EPA (Record of Notices)	<ul style="list-style-type: none"> There are no currently or formerly regulated sites within 200 metres There are no currently licensed facilities within 200 metres Former licenced activities under the POEO Act (now revoked or surrendered) comprise activities conducted on waterways within Muddy Creek which included application of herbicides and pesticides.
Contaminated sites notified to the NSW EPA under Section 60 of the CLM Act 1997	<ul style="list-style-type: none"> There are no notified site within the boundary of the shared cycle and pedestrian pathways - north There are no notified sites within in the area surrounding the shared cycle and pedestrian pathways - north
Other NSW EPA records	<ul style="list-style-type: none"> The closest property to conduct NSW EPA licensed activities is the Rockdale Waste and Recycling Centre which is located around 500 metres south west of the shared cycle and pedestrian pathways - north There are no other records of sites within or surrounding the shared cycle and pedestrian pathways - north
National Waste Management site database	<ul style="list-style-type: none"> There are no sites listed within the shared cycle and pedestrian pathways - north The closest notified site listed is Rockdale Waste and Recycling Centre which is located around 500 metres south west of the shared cycle and pedestrian pathways - north

Notes. 1. <http://maps.six.nsw.gov.au/>

4.5.6 Subsurface conditions, topography and drainage

The descriptions of the topography, drainage, soils, geology and hydrogeology are summarised in **Table 4-42**.

Table 4-42 Shared cycle and pedestrian pathways - north – subsurface conditions, topography and drainage

Source	Summary
Topography	<ul style="list-style-type: none"> Elevations across the shared cycle and pedestrian pathways - north are expected to be relatively flat with elevations ranging between 1 and 3 m AHD A mounded area or open space (around 100 m wide) is present immediately north of CA Redmond Field with elevation increasing from CA Redmond Field towards Bruce Street (open space) in a southerly direction The elevation of Muddy Creek is around 0 m AHD
Drainage	<ul style="list-style-type: none"> The nearest water body is Muddy Creek located immediately adjacent and west, east or immediately below the shared cycle and pedestrian pathways - north Botany Bay is located around 1 kilometre to the east Surface waters are expected to infiltrate in unsealed portions and ultimately drain towards Muddy Creek.
Soils	<ul style="list-style-type: none"> The soils within the shared cycle and pedestrian pathways - north consist of Hawkesbury colluvial, Lambert erosional, Newport aeolian and Gynea erosional soils in higher elevated areas. Warriewood swamp soil landscapes occur in the low lying areas around Muddy Creek Areas of disturbed terrain are mapped along the low lying areas of Muddy Creek. With respect to ASS, the shared cycle and pedestrian pathways - north is located within Class 3 and with a high (>70%) probability of occurrence of ASS (risk and class), as per the Atlas of Australian Acid Sulfate Soils Maps.
Hydrogeology	<ul style="list-style-type: none"> Aquifers under the shared cycle and pedestrian pathways are expected to be shallow (<3 metres bgl), porous, extensive of low to moderate productivity Due to the shallow groundwater beneath the site and the location of the shared cycle and pedestrian pathways - north in close proximity to Muddy Creek, it is expected that the groundwater would flow towards the north west or south east. Muddy Creek flows north east towards the Cooks River which ultimately discharges to Botany Bay in the east.

4.5.7 Areas and contaminants of concern

The areas and contaminants of concern for the shared cycle and pedestrian pathways (not within ancillary facilities) based on the information reviewed are summarised in **Table 4-43**.

Table 4-43 Shared cycle and pedestrian pathways – areas and contaminants of concern

Area of concern	Contaminants of concern
Historical use for agricultural purposes and the use of pesticides, herbicides and fertilisers	<ul style="list-style-type: none"> OCPs OPPs Herbicides Nutrients (ammonia, nitrate, nitrite and phosphorus)
Uncontrolled fill along Muddy Creek in areas mapped as disturbed terrain	<ul style="list-style-type: none"> TRH/BTEXN, PAHs, Metals, PCB, OP/OC Pesticides, VOCs, SVOCs, asbestos Landfill gas (methane, carbon monoxide, carbon dioxide, hydrogen sulphide)
Areas of high risk of Acid sulfate soils	<ul style="list-style-type: none"> Acid sulfate soils

4.6 Proposed permanent power supply connection

4.6.1 Site description

A proposed permanent power supply connection would be required within and outside of the project footprint to service the construction and operation of the project. The proposed permanent power supply connection would run from the Ausgrid Canterbury sub-transmission substation, located at 16A Hansen Avenue Earlwood, to the Rockdale Motorway Operations Complex south (MOC3).

The power line would run mainly underground from Westfield Street, along Mooney Avenue, through local roads until Harthill-Law Avenue in the suburb of Earlwood. It would then pass through the local roads of Bardwell Park and Bardwell Valley including part of Bardwell Valley Golf Club and Silver Jubilee Park. It would then run along Wolli Creek Road, Kimpton Street through the Banksia railway line, the Princess Highway and Tarbrett Street in the suburb of Banksia and through Farr Street, Bay Street and finally ending in West Botany Street in Rockdale.

The existing environment and areas and contaminants of concern for the section of power line between MOC3 and Princes Highway, Banksia has been assessed in **section 4.1** and **section 4.3**. **Section 4.6.2** to **4.6.3** describes the existing environment between Princes Highway Rockdale and the Ausgrid Canterbury sub-transmission substation, located at 16A Hansen Avenue Earlwood.

4.6.2 Current land use

The power line would be installed underground, within the existing road reserve with the exception of:

- Ausgrid Canterbury sub-transmission substation, 16A Hansen Avenue, Earlwood
- Bardwell Valley Golf Club
- Silver Jubilee Park
- Banksia Railway Line.

4.6.3 Surrounding land use

Current land use along the power line route is low to medium residential housing, with the exception of the following (from Ausgrid Canterbury sub-transmission substation to Rockdale):

- Hughes Park, Earlwood
- Earlwood Park, Earlwood
- Retail/commercial and high density residential properties along William Street, Earlwood
- Girrahween Park, Earlwood
- East Hills Railway and Bardwell Park Railway Station
- Retail/commercial properties along Harthill-Law Avenue and Slade Road, Bardwell Park
- Slade Road Reserve, Bardwell Park
- Retail/commercial properties at the intersection of Wolli Creek Road and Wollongong Road, Arncliffe
- Gardiner Park, Banksia.

Table 4-44 Current surrounding commercial and industrial land uses

Property identification	Proximity to power line route	Activity
Earlwood Dry Cleaners & Commercial Laundry 334 Homer Street, Earlwood	130 metres north east and topographically up-gradient	Dry cleaning
Bardwell Park Dry Cleaners 8 Harthill-Law Avenue, Bardwell Park	<3 metres west and topographically up-gradient	Dry cleaning

Property identification	Proximity to power line route	Activity
262 Wollongong Road, Arncliffe	<3 metres east and topographically up-gradient	Former dry cleaning premises
T&G Auto Repairs 270 Wollongong Road, Arncliffe	45 m west and topographically up-gradient	Mechanical workshop
Nissan Rockdale 371 Princes Highway, Rockdale	<3 metres north and topographically up-gradient	Mechanical workshop
Storage King 373 Princes Highway, Rockdale	<3 metres south and topographically up-gradient	Former Ricketts & Thorp Pty Ltd furniture manufacturers factory

4.6.4 Previous investigations

4.6.5 Site history

The site history review of the powerline route from Ausgrid Canterbury sub-transmission substation to Princes Highway Rockdale is summarised in **Table 4-45**.

Table 4-45 Powerline route – summary of historical information

Source	Summary
Historical Aerials	<ul style="list-style-type: none"> The 1943 aerial photograph showed the same general land use as the 2016 aerial with the exception of the following: <ul style="list-style-type: none"> Bardwell Valley Golf course was mostly undeveloped, consisting of uneven terrain with gullies and tracks in 1943 The retail buildings along William Street, Earlwood and Hartill-Law Avenue and Slade Road, Bardwell Park were not present in 1943 There was a quarry between Slade Road and the railway in 1943, that has since been filled and now consists of a public carpark and Slade Road Reserve
Contaminated sites currently or formerly regulated by the NSW EPA (Record of Notices)	<ul style="list-style-type: none"> There were no sites within 200 m of the power line route
Contaminated sites notified to the NSW EPA under Section 60 of the CLM Act 1997	<ul style="list-style-type: none"> There were no sites within 200 m of the power line route
Other NSW EPA records	<ul style="list-style-type: none"> There were no sites within 200 m of the power line route
National Waste Management site database	<ul style="list-style-type: none"> There were no sites within 200 m of the power line route
Other sources	<ul style="list-style-type: none"> Storage King at 373 Princes Highway, Banksia was formally Ricketts & Thorp Pty Ltd furniture manufacturing factory and consisted of workshops and timber yards from 1910s to 1970s¹.

¹ Woodmakers Association of NSW newsletter, May-June 2012

4.6.6 Subsurface conditions, topography and drainage

The descriptions of the topography, drainage, soils, geology and hydrogeology along the power line route from Ausgrid Canterbury sub-transmission substation to Princes Highway Rockdale is summarised in Table 0.

Table 4-46 Powerline route – subsurface conditions, topography and drainage

Source	Summary
Topography	<ul style="list-style-type: none"> The northern most end of the power line route is situated at 15 m AHD and slopes towards Cup and Saucer Creek to the west The high points along the route are at Woolcott Street and William Street in Earlwood at around 40 m AHD, Bardwell Park in Bardwell Road at around 40 m AHD, Forest Road in Arncliffe at around 50 m AHD The power line crosses two valleys, one in the Wolli Creek gully in Earlwood with an elevation of 4 m AHD and in Bardwell Valley Golf course at 4 m AHD
Drainage	<ul style="list-style-type: none"> The power line route is located approximately 100 metres east and up gradient of Cup and Saucer Creek which drains into the Cooks River 900 meters to the north The powerline crosses the following creeks: <ul style="list-style-type: none"> Wolli Creek, consisting of an open natural channel Bardwell Creek, consisting of an open natural channel and underground culvert within Bardwell Valley Golf Course The area west of Forest Road in Arncliffe and Banksia drains to the east into Muddy Creek.
Soils	<ul style="list-style-type: none"> The soil landscapes along the powerline route consist of Hawkesbury colluvial soils, Gynea erosional soils, Blacktown residual soils and Newport Aeolian. The probability of acid sulfate soil occurrence along the majority of power line route is very low or no known occurrence and are mapped as Class 5, with the exception of Class 3 mapped areas within the Wolli Creek valley in Bardwell Park and within Bardwell Valley Golf Course.
Geology	<ul style="list-style-type: none"> The majority of the power line route is mapped Hawkesbury Sandstone and Ashfield Shale with the exception of Quaternary sediments at: <ul style="list-style-type: none"> the Wolli Creek valley in Bardwell Park/ Earlwood Bardwell Valley Golf Course valley Part of Wolli Creek Road and Kimpton Street in Banksia (between intersection with Judd Street and Curtis Street)
Hydrogeology	<ul style="list-style-type: none"> Aquifers along the power line route are expected to be shallow (<3 metres bgl), porous, extensive of low to moderate productivity.

4.6.7 Areas and contaminants of concern

The areas and contaminants of concern for the power line route based on the information reviewed are summarised in **Table 4-46** and shown on **Figure 4-12**.

Table 4-47 Powerline route – subsurface conditions, topography and drainage

Area of concern	Contaminants of concern
Ausgrid Canterbury sub-transmission substation	<ul style="list-style-type: none"> TRH, BTEX, PAHs, metals and PCBs
Sections of the powerline adjacent and route downgradient to current and former dry cleaners (334 Homer Street, Earlwood, 8 Hartill-Law Avenue, Bardwell Park and 262 Wollongong Road, Arncliffe)	<ul style="list-style-type: none"> VHCs, BTEX
Uncontrolled filling within parts of Bardwell Valley Golf Course, a former quarry adjacent to Slade Road in Bardwell Park and West Botany Street Rockdale	<ul style="list-style-type: none"> TRH/BTEXN, PAHs, Metals, PCB, OP/OC Pesticides, VOCs, SVOCs, asbestos Landfill gases (if putrescible/organic waste present)

Area of concern	Contaminants of concern
Former and current commercial/industrial properties on Kimpton Street and Princes Highway, Banksia	<ul style="list-style-type: none"> • TRH/BTEXN, PAHs, metals, VOCs, SVOCs
West Botany Street – surrounding Rockdale industrial area (former, current and surrounding industrial properties including chemical manufacturing)	<ul style="list-style-type: none"> • TRH/BTEXN, PAHs, Metals, PCB, OP/OC Pesticides , VOCs, SVOCs, Phenols
Areas mapped Class 3 for acid sulfate soil risk	<ul style="list-style-type: none"> • Acid sulfate soils

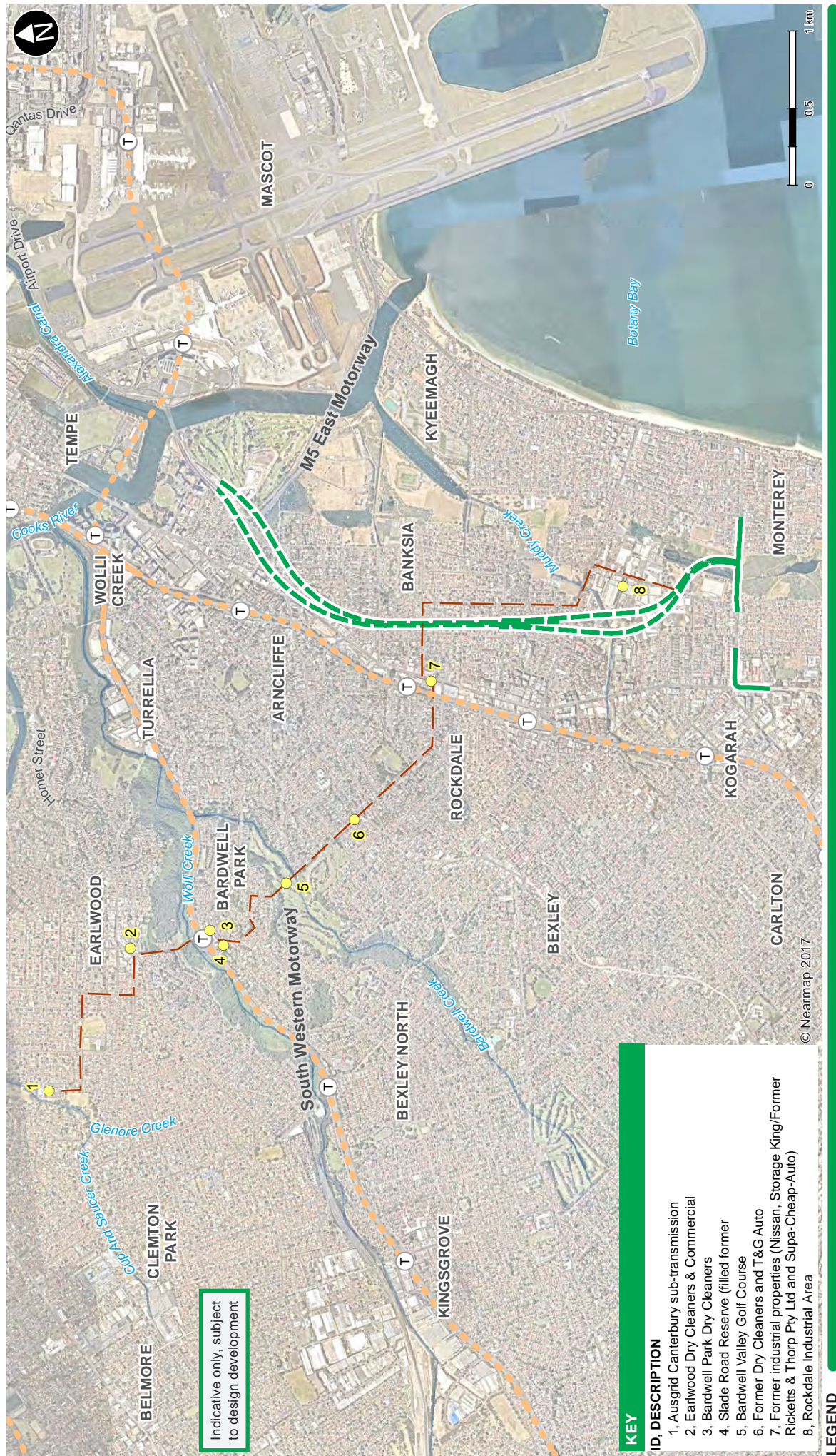


Figure 4-12 Permanent power supply connection

5 Assessment of construction impacts

5.1 Ancillary Facilities and project footprint

The assessment of impacts for the ancillary facilities and construction footprint are presented in **Table 5-1**. It is noted that the risk rankings presented in **Table 5-1** are prior to the implementation of the management measures identified in **Section 8**. Following the implementation of management measures, it is anticipated that any identified high or medium risk rankings for the ancillary facilities and project footprint will ultimately present a low risk.

Table 5-1 Assessment of construction impacts – ancillary facilities and construction footprint

Area	Construction works	Potential contamination impacts associated with construction phase	Likelihood of soil or groundwater contamination to be present	Consequence	Risk
Arnccliffe construction ancillary facility (C1)	<ul style="list-style-type: none"> Establishment of temporary noise attenuation measures Construction of an acoustic shed Construction of construction water treatment plant and sedimentation pond Excavation of the existing tunnel access shaft to required depth Stockpiling of excavated material and spoil haulage Fitout of the Arnccliffe Motorway Operations Complex as required Fitout and installation works of the F6 Extension stage 1 section of the Arnccliffe ventilation facility being built as part of the New M5 Motorway project, including: <ul style="list-style-type: none"> Installation of mechanical and electrical equipment Testing and commissioning Construction of substation Construction of water treatment plant Finishing works including asphaltting, lighting, line marking, utilities and signage installation Backfilling of tunnel decline with spoil originally excavated and stockpiled from construction of the decline tunnel during the New M5 Motorway project Rehabilitation and landscaping of areas that will not be occupied by permanent operational infrastructure 	<p>A Phase 2 ESA (Golders 2016) completed within the New M5 Construction Compound and Arnccliffe construction ancillary facility (C1) footprint, identified asbestos in fill at one location which exceeded the adopted assessment criteria. There were no other soil exceedances of the adopted criteria identified. Ammonia and methane concentrations in groundwater were identified as a potential concern during construction works, due to the potential for worker exposure to ammonia in groundwater during dewatering and excavation and the potential for methane to accumulate in subsurface structures. Management plans for mitigation measures for these issues were recommended during construction.</p> <p>Acid sulfate soil risk is classified as Class 3 and a high probability of occurrence and disturbed terrain. The Phase 2 ESA (Golders 2016) confirmed the presence of PASS within the construction ancillary facility.</p> <p>The works would include further excavation of the existing access shaft for the construction of the mainline tunnel; and minor excavations at the surface may occur. Temporary stockpiling would also occur. Cross contamination associated with the incorrect handling or disposal of spoil/unexpected finds is a potential impact during construction if appropriate controls and handling procedures are not implemented.</p> <p>Use of the site as an ancillary construction facility also has the potential for leaks and spills from plant and machinery.</p> <p>Potential pathways could be through:</p> <ul style="list-style-type: none"> • Direct contact, ingestion and inhalation by construction workers • Off-site transport via dust, vehicle/plant movements • Surface water runoff and discharge to receiving environment • Groundwater extraction and discharge to receiving environment. 	<p>Potentially present at concentrations above the relevant assessment criteria and widespread.</p>	<p>Exposure pathway for human or ecological receptors likely to be present and complete during construction (without implementation of appropriate controls).</p>	<p>Medium</p>

Area	Construction works	Potential contamination impacts associated with construction phase	Likelihood of soil or groundwater contamination to be present	Consequence	Risk
Rockdale construction ancillary facility (C2)	<ul style="list-style-type: none"> Establishment of temporary noise attenuation measures Construction of an acoustic shed Construction of construction water treatment plant and sedimentation pond Construction of temporary ventilation plant Tunnel excavation and other tunnel works, as well as stockpiling of excavated material and spoil haulage Construction of the cut-and-cover structures including excavation, piling, concrete works, installation of diaphragm walls and, installation of mechanical and electrical services Finishing works including asphaltting, lighting, line marking and signage installation Construction of operational infrastructure including the Operational Motorway Control Centre Reconfiguration of the site to enable ongoing/future use for maintenance activities, including rehabilitation and landscaping 	<p>The area has been used for market gardens and industrial activities and was formerly filled, therefore there is potential for soil and groundwater contamination to be present.</p> <p>Previous limited investigations have confirmed the presence of uncontrolled fill. Soil contamination was not detected above the assessment criteria, however additional investigations would be required to characterise the site adequately.</p> <p>Acid sulfate soil risk is classified as Class 3:</p> <ul style="list-style-type: none"> Works beyond one metre below ground surface require an Acid Sulfate Management Plan High probability of occurrence and disturbed terrain. <p>The works would include bulk excavation for the construction of the decline (cut and cover) to the mainline tunnels. Demolition activities, use of plant and machinery and spoil stockpiling and loading are proposed, with the potential for leaks and spills from plant and machinery.</p> <p>Cross contamination associated with the incorrect handling or disposal of spill/unexpected finds is a potential impact during construction if appropriate controls and handling procedures are not implemented.</p> <p>Potential pathways could be through:</p> <ul style="list-style-type: none"> Direct contact, ingestion and inhalation by construction workers Off-site transport via dust, vehicle/plant movements Surface water runoff and discharge to receiving environment Groundwater extraction and discharge to receiving environment. 	Potentially present at concentrations above the relevant assessment criteria and widespread.	Exposure pathway for human or ecological receptors likely to be present and complete during construction (without implementation of appropriate controls).	Medium

Area	Construction works	Potential contamination impacts associated with construction phase	Likelihood of soil or groundwater contamination to be present	Consequence	Risk
President Avenue construction ancillary facility (C3) and construction site	<p>Works within Rockdale Bicentennial Park and Rockdale Bicentennial Park East:</p> <ul style="list-style-type: none"> Vegetation clearing and removal Establishment of temporary noise attenuation measures (including acoustic barriers) Temporary stockpiling of spoil and fill materials for later re-use or off-site removal On-site treatment and/or management of contaminated soils, leachate, landfill gas and acid sulfate soils Construction of construction water treatment plant and sedimentation pond Construction of the cut-and-cover structures including excavation, piling, concrete works, installation of diaphragm walls and, installation of mechanical and electrical services Construction of new and upgraded drainage infrastructure and combined bioretention and stormwater basin Rehabilitation and landscaping of areas that will not be occupied by permanent operational infrastructure 	<p>Rockdale Bicentennial Park is known to have been used as an uncontrolled landfill and the area is surrounded to the north west by industrial land use which has included a range of manufacturing industries, workshops and garages since the 1950s and 1960s.</p> <p>Acid sulfate soil risk is classified as Class 2 and a high probability of occurrence and disturbed terrain.</p> <p>Preliminary investigations within the C3 facility have been completed and indicate that concentrations of PAHs, TRH C10-C40, heavy metals, asbestos and acid sulfate soils are present in soil and fill materials above the assessment criteria.</p> <p>Concentrations of ground gases including methane, hydrogen sulphide, carbon dioxide and carbon monoxide were also detected within the subsurface in Rockdale Bicentennial Park. The results were interpreted as having a risk classification of CGS 2 (low risk) in accordance with NSW EPA (2012) guidelines. Sites classified as CGS 2 are recommended to have mitigation measures to address the risk of explosive conditions or exposure to the site. The concentrations of hydrogen sulphide also present a potential risk of nuisance odours and risk to health.</p> <p>Concentrations of ammonia and nitrogen in groundwater were elevated, exceeding the assessment criteria and indicative of typical landfill leachate. Concentrations of heavy metals arsenic, lead and zinc were detected at concentrations slightly above the assessment criteria in groundwater within the fill. Concentrations of TRH, BTEXN, VOCs and SVOCs were detected above the LOR but less than the assessment criteria.</p> <p>Use of the site as an ancillary construction facility also has the potential for leaks and spills from plant and machinery. Cross contamination associated with the incorrect handling or disposal of spoil/unexpected finds is a potential impact during construction if appropriate controls and handling procedures are not implemented.</p>	Known to be present at concentrations above the relevant assessment criteria and widespread.	Exposure pathway for human or ecological receptors likely to be present and complete during construction (without implementation of appropriate controls).	High

Area	Construction works	Potential contamination impacts associated with construction phase	Likelihood of soil or groundwater contamination to be present	Consequence	Risk
		<p>The works would include bulk surface excavation for the construction of cut and cover tunnels. Potential pathways could be through:</p> <ul style="list-style-type: none"> • Direct contact, ingestion and inhalation by construction workers • Off-site transport via dust, vehicle/plant movements • Surface water runoff and discharge to receiving environment • Groundwater extraction and discharge to receiving environment • Landfill gas migration and exposure (Rockdale Bicentennial Park/Rockdale Bicentennial Park East) • Generation of odour during excavation and dispersion in wind. 			
President Avenue construction ancillary facility (C3) and construction site (continued)	<p>Rockdale ventilation facility construction area (427 to 441 West Botany Street):</p> <ul style="list-style-type: none"> • Demolition of existing buildings for the construction of the Rockdale ventilation facility • Excavation of ventilation shaft 	<p>The review of historical information indicates that properties at 427 to 441 West Botany Street, Rockdale have been used for potentially contaminating activities, are within land mapped as disturbed terrain and are mapped Class 3 for acid sulfate soil risk.</p> <p>The works would include bulk surface excavation for the construction of the ventilation shaft. Potential contamination pathways could be through:</p> <ul style="list-style-type: none"> • Direct contact, ingestion and inhalation by construction workers • Off-site transport via dust, vehicle/plant movements • Surface water runoff and discharge to receiving environment • Groundwater extraction and discharge to receiving environment • Generation of odour during excavation and dispersion in wind. <p>Cross contamination associated with the incorrect handling or disposal of spoil/unexpected finds is a potential impact during construction if appropriate controls and handling procedures are not implemented.</p>	Potentially present at concentrations above the relevant assessment criteria and widespread.	Exposure pathway for human or ecological receptors likely to be present and complete during construction (without implementation of appropriate controls).	Medium
	<p>Installation of temporary water pipeline from the Rockdale ancillary facility (C2) along West Botany Street to the Rockdale ventilation facility</p>	<p>West Botany Street is surrounded by a range of potentially former potentially contaminating activities and is mapped as disturbed terrain and mapped Class 3 for acid sulfate soil risk.</p> <p>The works would include excavation of the trench for the water</p>	Potentially present at concentrations above the	Exposure pathway for human or ecological	Medium

Area	Construction works	Potential contamination impacts associated with construction phase	Likelihood of soil or groundwater contamination to be present	Consequence	Risk
		<p>pipeline. Potential contamination pathways would be through:</p> <ul style="list-style-type: none"> • Direct contact, ingestion and inhalation by construction workers • Off-site transport via dust, vehicle/plant movements • Surface water runoff and discharge to receiving environment • Groundwater extraction and discharge to receiving environment • Generation of odour during excavation and dispersion in wind. 	relevant assessment criteria and widespread	receptors likely to be present and complete during construction (without implementation of appropriate controls).	
	Demolition of substation within St George TAFE would be required as part of the President Avenue and Princes Highway intersection widening works	<p>The use of the substation could have resulted in localised PCB and hydrocarbon contamination of underlying soils. The substation may also contain hazardous building materials (asbestos, lead and PCBs). Potential contamination pathways could be through:</p> <ul style="list-style-type: none"> • Direct contact, ingestion and inhalation by construction workers • Off-site transport via dust, vehicle/plant movements • Surface water runoff and discharge to receiving environment. 	Potentially present at concentrations above the relevant assessment criteria and widespread.	Exposure pathway for human or ecological receptors likely to be present and complete during construction (without implementation of appropriate controls).	Medium
	Construction of the shared cycle and pedestrian pathways, including the bridge over President Avenue	<p>The shared cycle and pedestrian pathways intersects Rockdale Bicentennial Park and disturbed terrain to the north and south. Potential contamination pathways could be through:</p> <ul style="list-style-type: none"> • Direct contact, ingestion and inhalation by construction workers • Off-site transport via dust, vehicle/plant movements • Surface water runoff and discharge to receiving environment • Generation of odour during excavation and dispersion in wind. 	Known to be present at concentrations above the relevant assessment criteria and widespread.	Exposure pathway for human or ecological receptors likely to be present and complete during construction (without	High

Area	Construction works	Potential contamination impacts associated with construction phase	Likelihood of soil or groundwater contamination to be present	Consequence	Risk
Shared cycle and pedestrian pathways construction ancillary facilities (C4 and C5)				implementation of appropriate controls).	
	Demolition of houses, acquired by Roads and Maritime, along northern side of President Avenue	The buildings may contain hazardous building materials (asbestos and lead). Potential contamination pathways are through: <ul style="list-style-type: none"> Inhalation by construction workers Off-site transport via dust. 	Hazardous building materials potentially present	Exposure pathway for human receptors likely to be present and complete during construction (without implementation of appropriate controls).	Medium
	<ul style="list-style-type: none"> Vegetation clearing and removal Temporary stockpiling of spoil and fill materials for later re-use prior to off-site removal Construction of the shared cycle and pedestrian pathways including shallow surface works and possible piling for footbridges Finishing works including lighting, line marking and signage installation 	<p>Potential for shallow soil contamination to be present due to:</p> <ul style="list-style-type: none"> Historical use of the shared cycle and pedestrian pathways for agricultural purposes and the use of pesticides, herbicides and fertilisers Areas of high risk of acid sulfate soils. <p>Use of the site as an ancillary construction facility also has potential for leaks and spills from plant and machinery. Cross contamination associated with incorrect handling or disposal of spoil/unexpected finds is a potential impact during construction if appropriate controls/handling procedures are not implemented. Potential pathways are through:</p> <ul style="list-style-type: none"> Direct contact, ingestion and inhalation by construction workers Off-site transport via dust, vehicle/plant movements Surface water runoff and discharge to receiving environment. 	Potentially present at concentrations above the relevant assessment criteria and widespread.	Exposure pathway for human or ecological receptors likely to be present and complete either now, during or post construction (without implementation of appropriate controls).	Medium

Area	Construction works	Potential contamination impacts associated with construction phase	Likelihood of soil or groundwater contamination to be present	Consequence	Risk
Princes Highway construction ancillary facility (C6)	<ul style="list-style-type: none"> Property adjustment, decommissioning and validation of UPSS and demolition of service station Relocation of utilities, stormwater infrastructure and substation Laydown and parking of construction vehicles and equipment Pavement works along Princes Highway and President Avenue Rehabilitation and landscaping. 	<p>The 7-Eleven Service Station within the C6 boundary is currently under assessment by the NSW EPA for contamination. Petroleum soil and/or groundwater contamination is therefore known to be present at concentrations above the relevant assessment criteria. Works would require excavation of soil for the removal of the underground storage tanks (USTs). Potential contamination pathways could be through:</p> <ul style="list-style-type: none"> Direct contact, ingestion and inhalation by construction workers Off-site transport via dust, vehicle/plant movements Surface water runoff and discharge to receiving environment Groundwater extraction and discharge to receiving environment Generation of odour during excavation and dispersion in wind. Cross contamination associated with the incorrect handling or disposal of spill/unexpected finds is a potential impact during construction if appropriate controls and handling procedures are not implemented. 	Known to be present at concentrations above the relevant assessment criteria.	Exposure pathway for human or ecological receptors likely to be present and complete either now, during or post construction (without implementation of appropriate controls).	High
Proposed Permanent power supply connection (power line)	<ul style="list-style-type: none"> Trenching and excavation of the road reserve, park area or railway corridor Protection of services Placement of power cables Horizontal Directional Drilling (HDD) or pipe jacking to place the power cables in some areas 	<p>There may be areas of contaminated soils encountered along the route in areas that have been filled or contaminated from surrounding land use. The soils would be excavated and groundwater dewatering may be required where shallow groundwater is encountered in trenches or directional drilling excavations. Potential pathways could be through:</p> <ul style="list-style-type: none"> Direct contact, ingestion and inhalation by construction workers Off-site transport via dust, vehicle/plant movements Surface water runoff or groundwater discharge and discharge to receiving environment Generation of odour during excavation and dispersion in wind. 	Potentially present at concentrations above the relevant assessment criteria and widespread.	Exposure pathway for human or ecological receptors likely to be present and complete either now, during or post construction (without implementation of appropriate controls).	Medium

5.2 Tunnelling and groundwater treatment and discharge

5.2.1 Potential contamination sources

A review of potential contamination sources along the alignment identified as medium or high risk based on the presence of potential current and former contamination sources and investigation results are listed in **Table 5.2**. All other areas along the tunnel alignment are considered to be a low risk for substantial sources of groundwater contamination.

Table 5-2 Summary of key groundwater contamination sources relevant to proposed tunnelling

Tunnel section	Tunnelling description	Identified potential source sites/areas	Risk
New M5 Motorway tunnel to Forest Road Arnccliffe to Bay Street, Rockdale	<ul style="list-style-type: none"> Underground connection to New M5 Motorway stub tunnels at Arnccliffe in a south-westerly direction at a depth of approximately 75 metres bgl Installation of stabilisation and excavation support (retention systems) such as sheet pile walls, diaphragm walls (where required) Construction of required retaining structures Depth of mainline tunnels between C1 and C2 is approximately 60 to 110 metres bgl Ventilation tunnels at a proposed depth of 60 metres bgl 	Kogarah Golf Course and surrounding filled land to the south	Medium
		Former Tempe Bus Depot	Medium
		Up-gradient former and current commercial/ industrial properties (mechanics and workshops) along Princes Highway, Arnccliffe	Medium
		Former Goodfellow Dry Cleaners	Medium
Bay Street Rockdale to President Avenue ancillary facility	<ul style="list-style-type: none"> Excavation of the construction access decline from the C2 site to the west of West Botany Street, to the Bunnings Warehouse Car Park and south-west to the northbound entry ramp, from surface to a depth of approximately 50 metres bgl Installation of stabilisation and excavation support (retention systems) such as sheet pile walls, diaphragm walls (where required) Construction of required retaining structures Depth of tunnels between C2 and C3 is approximately 60 metres bgl to 5 m above ground surface (north bound and south bound exit ramps) Tunnel dive and cut-and-cover structures at the President Avenue ancillary facility (C3) The President Avenue ancillary facility, including entry and exit ramps to connect with the surface road network Stub tunnels to connect to the potential future stages of the F6 Extension 	Rockdale Industrial area	Medium
		Rockdale Bicentennial Park and surrounding filled land	High

5.2.2 Potential impacts

During tunnel construction, groundwater would be extracted from the excavation, which would require disposal. The extracted water would be either:

- Treated onsite and then discharged to the Cooks River or to stormwater under an EPL, or to sewer under a trade waste agreement (TWA) from Sydney Water; or
- Transported to a liquid waste facility for offsite disposal.

There is a potential for shallow tunnelling (such as near portals, adits or cut-and-cover tunnels) to encounter impacted groundwater from sources such as petrol stations with dissolved and undissolved petroleum hydrocarbon plumes or other industrial sources. The highest risk location for the project, due to the geology and large area of potential contamination sources, is the Rockdale industrial area and Rockdale Bicentennial Park.

The likelihood of encountering plumes of high concentrations of contaminants or non-aqueous phase liquids (NAPL) is low given that they have not been detected in the monitoring wells sampled along the proposed tunnel alignment to date and there are no sites that are regulated by the NSW EPA within the vicinity of the alignment. The extracted groundwater however is likely to contain concentrations of metals and nutrients above background concentrations and low concentrations of chemical and petroleum hydrocarbon contaminants as detected in groundwater investigations to date. The groundwater would require treatment to meet water quality requirements prior to discharge to the receiving environment (for example Muddy Creek/Cooks River).

Further groundwater investigations would be completed during detailed design to provide a higher degree of certainty on the likely concentrations of contaminants so that the water treatment plants are adequately designed and are able to meet discharge quality requirements. The investigations would target areas of medium and high risk areas as well as spatial coverage to enable reliable estimates of the expected concentrations of contaminants in groundwater.

Potential impacts on receiving water bodies and ecological receptors through the disturbance of contaminated sediments associated with the construction of new drainage outlets and drainage infrastructure adjustments and upgrades could occur at the following locations:

- Cooks River
- Muddy Creek
- Rockdale wetland.

Potential impacts on workers include exposure to extracted contaminated groundwater from either direct contact or inhalation of vapours or vapours encountered during tunnelling, which would require management in accordance with protocols outlined in a site specific occupational health and safety plan and safe work method statement specific to the work activity being conducted.

Dewatering during construction works may cause changes in the migration of plumes of contaminated groundwater, by changing groundwater gradients and drawing the contamination towards the tunnel. This is most likely in areas where the tunnels are shallow and approaching the surface such as the adit at West Botany Street, Rockdale and the cut and cover sections in Rockdale leading towards President Avenue intersection and is discussed further in **Appendix K** (Groundwater Technical Report) of the EIS.

A permanent water treatment plant is proposed at Arncliffe construction ancillary facility (C1), and discharging to the Cooks River. The treatment plant is designed to treat construction water and groundwater inflows encountered during tunnel construction. Temporary construction water treatment plants and sedimentation ponds would be used for the Rockdale (C2) and President Avenue (C3) construction ancillary facilities. Where feasible and reasonable, construction wastewater would be discharged to Muddy Creek or the Cooks River to protect the more sensitive environment of Rockdale wetland.

Discharge criteria is presented and discussed in in **Appendix L** (Surface Water Technical Report) of the EIS, along with further details on construction wastewater treatment. Where feasible and reasonable, construction wastewater would be treated such that discharge concentrations would be equal to or less than the discharge criteria set for the receiving waterways . The criteria have been developed in accordance with ANZECC (2000) and with consideration to the NSW WQOs.

6 Assessment of operational impacts

6.1 Operational sites

For the purposes of this contamination assessment, identified operational impacts primarily relate to the potential contamination of soil, surface water and groundwater arising from vehicle accidents, leaks and spills on constructed project roadways including tunnels.

To manage spills and leaks associated with vehicle accidents during the operation of the project, spill containment facilities would be located in tunnels and where the risk of impact from spills is high. A risk assessment of all project roads would be carried out during detailed design to determine the final locations of these facilities. Typically they would be located on motorway sections where the chance of vehicle accidents is higher. This risk assessment would also take into account proximity to waterways, where the risk of harm to aquatic environments is assessed to be greater.

Potential contamination impacts associated with the presence of roads and permanent operational infrastructure such as motorway operations complexes (MOCs) and associated infrastructure (ventilation facilities, water treatment plants and substations etc.) is presented in **Table 6-1**.

Table 6-1 Assessment of operational impacts – operational facilities and project boundary

Area	Operation	Potential contamination impacts associated with operation
Arncliffe Motorway Operations Complex (MOC1)	<ul style="list-style-type: none"> • Arncliffe Motorway Operations Complex (MOC1) • Arncliffe ventilation facility • Arncliffe WTP • Substations • Fire pump room and water tanks • Remaining land to be handed back to Cooks Cove 	<ul style="list-style-type: none"> • Contamination impacts associated with the operation of the project include leaks and spills on constructed roadways from vehicles and vehicle accidents • Minimal soil or groundwater contamination impacts would be expected from the operation of the substation and ventilation facility. Sources of contamination could be from small volumes of oils, fuels, solvents and other chemicals used for operation and maintenance if not stored and handled in accordance with regulations.
Rockdale Motorway Operations Complex (north) (MOC2)	<ul style="list-style-type: none"> • Operational Motorway Control Centre (MOC2) • Car parking • Deluge tanks • Workshop • Office • Bulky equipment store • Pump station and pump room • Work yard 	<ul style="list-style-type: none"> • Contamination impacts associated with the operation of the project include leaks and spills on constructed roadways from vehicles and vehicle accidents • Sources of contamination could be from small volumes of oils, fuels, solvents and other chemicals used for operation and maintenance if not stored and handled in accordance with regulations.

Area	Operation	Potential contamination impacts associated with operation
Rockdale Motorway Operations Complex (south) (MOC3)	<ul style="list-style-type: none"> • Ventilation facility • Car parking • Two substations and power supply • Disaster recovery site 	<ul style="list-style-type: none"> • Contamination impacts associated with the operation of the project include leaks and spills on constructed roadways from vehicles and vehicle accidents • Minimal soil or groundwater contamination impacts would be expected from the operation of the substation and ventilation facility. Sources of contamination could be from small volumes of oils, fuels, solvents and other chemicals used for operation and maintenance if not stored and handled in accordance with regulations.
Shared cycle and pedestrian pathways	<ul style="list-style-type: none"> • Footpaths • Bike paths • Bus stops 	<ul style="list-style-type: none"> • No contamination impacts associated with the operation of the project.

6.2 Tunnel groundwater treatment and discharge

During operation, groundwater seepage, stormwater drainage at tunnel portals, tunnel wash-down water, fire suppressant deluge or fire main rupture and spillage of flammable and other hazardous materials would be captured by tunnel drainage. The captured water would be treated and discharged to the receiving water bodies. If the discharged water is not treated to the required standard there could be adverse impacts on water quality of the receiving environments.

As described in **section 4.1**, groundwater quality may be impacted along parts of the tunnel alignment due to overlying contamination sources impacting groundwater. As discussed in **Appendix K** of the EIS (Groundwater Technical Report), the mainline tunnels have been aligned to minimise intersecting highly permeable material that could result in high groundwater inflows into the tunnels. The proposed tunnel alignment avoids the underlying palaeochannels and unsuitable geology that lies to the east of the project alignment. The horizontal alignment maximises the extent of the project footprint within competent Hawkesbury Sandstone and minimises the alignment traversing immediately beneath sensitive environmental areas, creeks and wetlands to reduce the risk of surface water leakage.

The vertical tunnel alignment dives beneath palaeochannels where possible to reduce groundwater and surface water inflows into the tunnels. Where the project footprint intersects palaeochannels and alluvium, the tunnels would be tanked (undrained) to prevent groundwater inflow in these areas. As such, where present, contaminated groundwater would be unable to enter the tunnels at those locations due to tanked sections. In addition, the proposed depth of the tunnel alignment within the Hawkesbury Sandstone would increase the rock cover and reduce the risk of substantial groundwater inflows from potential hydraulic connections with the palaeochannels and surface water systems.

Assessment on the potential impacts to surface water receiving environments and proposed treatment and management is provided in **Appendix L** (Surface Water Technical Report) of the EIS and Chapter 18 of the main EIS body (Surface water and flooding)

An assessment of the expected groundwater seepage rates and groundwater drawdown which may have an effect on existing or future groundwater contamination plumes is provided in **Appendix K** of the EIS (Groundwater Technical Report).

7 Assessment of cumulative impacts

7.1 Other projects

Other major projects in the surrounding the area that are underway and/or committed include:

- WestConnex:
 - New M5 Motorway: under construction and due to be completed in early 2020
 - M4-M5 Link: in planning approvals stage, construction (pending approval) to occur between 2018 and 2023
 - M4 East: under construction and due to be complete in early 2019
- Sydney Gateway: currently in business case stage

Other substantial local projects include:

- Bayside West Precincts: residential redevelopment at Cooks Cove, Wolli Creek, Arncliffe, Banksia, and Turella of which parts have commenced and likely to be undertaken throughout the period of project construction works
- Muddy Creek naturalisation between Bestic Street and West Botany Street: in planning stage, construction anticipated between 2018 and 2021.

The following sections consider these projects in a qualitative, cumulative impact assessment with the F6 Extension Stage 1 project in relation to soil and groundwater contamination.

7.2 Potential cumulative construction impacts

Potential construction impacts from these projects, prior to appropriate mitigation measures being implemented are summarised in **Table 7-1**.

Table 7-1 Potential cumulative construction impacts

Potential cumulative impacts	WestConnex	Sydney Gateway	Sydney Metro	Bayside West Precinct	Muddy Creek naturalisation	Future F6 stages
Excavation, disturbance, and temporary stockpiling of potentially contaminated soils generating potential dust and odours. There could be potential human health impacts due to exposure to contaminated dust, direct contact with inappropriately managed spoil, vapour migration and odours.	✓	✓	✓	✓	✓	✓
Demolition of hazardous building materials. There could be potential human health impacts due to exposure to lead, ACM and PCBs if not managed appropriately.	✓	✓	✓	✓	-	✓
Excavation and stockpiling of potential acid sulfate soils. There could be impacts to aquatic and terrestrial ecosystems if not managed appropriately	✓	✓	✓	✓	✓	✓
Transport and disposal of contaminated soils to landfill or treatment facilities	✓	✓	✓	✓	✓	✓
Short term changes in hydrogeology from dewatering during construction that could alter existing groundwater contamination migration	✓	✓	-	✓	-	✓
Short term discharge of potentially contaminated groundwater from dewatering to surface water (Cooks River and Botany Bay)	✓	✓	✓	✓	-	✓

Potential cumulative impacts	WestConnex	Sydney Gateway	Sydney Metro	Bayside West Precinct	Muddy Creek naturalisation	Future F6 stages
Short term discharge of potentially contaminated stormwater and construction waste water to surface water (Cooks River and Botany Bay)	✓	✓	✓	✓	✓	✓

Potential construction impacts for these projects are related primarily to the disturbance and management of existing land contamination and discharge of treated groundwater and stormwater. EIS's have been prepared for WestConnex New M5 Motorway, WestConnex M4-M5 Link, WestConnex M4 East and Sydney Metro – Sydney to Bankstown. As the project directly links with the New M5 project, further discussion on cumulative construction impacts with the New M5 Motorway project is provided in **section 7.4**.

All of these major projects have included assessment of contamination within the project footprints and assessed impacts and management measures. These projects are not expected to generate substantial new land contamination during construction, however they are all likely to encounter and disturb existing contamination from past land uses that will require investigation, management or remediation.

The Bayside West Precinct is likely to be developed on a site by site basis and the requirement for contamination assessment under SEPP 55 would be determined during the development application (DA) process. A DA was formerly submitted (and subsequently withdrawn) for the Cooks Cove project which proposed redevelopment of Kogarah Golf Course into high density residential and recreational land use and redevelopment of Barton Park to the south into a new golf course. If the DA were to be re-submitted and approved, the development would include extensive remediation works of the formerly filled land within Barton Park.

During construction there would be the requirement for remediation works, which would result in the requirement for disposal and haulage of contaminated soil and/or acid sulfate soils to landfill. Further assessment of cumulative impacts associated with transport and waste are discussed in **Appendix D** of the EIS (Traffic and Transport Technical Report).

7.3 Potential cumulative operational impacts

Potential operational impacts from these projects, prior to appropriate mitigation measures being implemented, are summarised in **Table 7-2**.

Table 7-2 Potential cumulative operational impacts

Potential cumulative impacts	WestConnex	Sydney Gateway	Sydney Metro	Bayside West Precinct	Muddy Creek naturalisation	Future F6 stages
Leaks and spills on constructed roadways from vehicles and vehicle accidents	✓	✓	✓	-	-	✓
Leaks and spills from railway operations	-	-	✓	-	-	-
Leaks and spills from permanent facilities such as maintenance and operations facilities and substations	✓	✓	✓	-	-	✓
Residual (pre-existing or from construction) soil and groundwater contamination. Potential human health and ecological impacts if land not suitable for intended land use.	✓	✓	✓	✓	✓	✓
Long term changes in hydrogeology from dewatering during operation (due to tunnel dewatering), altering existing groundwater contamination migration	✓	-	✓	-	-	✓
Long term treatment and discharge of potentially contaminated groundwater (due to tunnel dewatering) surface water (Cooks River and Botany Bay)	✓	-	✓	-	-	✓

Provided the projects are completed in accordance with conditions of approval, legislation under the CLM Act and in accordance with NSW EPA guidelines, cumulatively the projects should reduce the risks of existing land contamination within the combined project boundaries. Land within these projects are required to be assessed on a site by site basis and appropriate mitigation measures implemented. As the project directly links with the New M5 Motorway project, further discussion on cumulative operational impacts with the New M5 Motorway project is addressed in **section 7.4**.

Cumulative operational impacts are likely to result from increased stormwater runoff, discharge and treated groundwater discharge from roads, rail and urban development. Further assessment of cumulative impacts associated with surface water and groundwater are discussed in **Appendix L** of the EIS (Surface Water Technical Report) and **Appendix K** of the EIS (Groundwater Technical Report).

7.4 WestConnex New M5 Motorway

The northern connection of the project is proposed to connect to the New M5 Motorway underground, at stub tunnels constructed at Arncliffe. This will provide a direct connection for the project to Sydney's 'orbital motorway' network.

As a result of the direct connection with the New M5 Motorway tunnels, the project would facilitate a connection between southern Sydney and the St Peters surface road network, the Sydney CBD, and the M4-M5 Link and therefore the surface road network at Rozelle, Lilyfield and Haberfield. It would also allow direct tunnel connections from southern Sydney to the proposed future Sydney Gateway, and the Western Harbour Tunnel and Beaches Link program of works.

Management measures were identified to mitigate impacts on surrounding properties for both the construction and operational phases of the New M5 Motorway project. The objective being to reduce environmental harm, by working to achieve the requirements of the planning conditions and to implement the landfill closure requirements of the Alexandria Landfill in St Peters.

A Phase 2 ESA was completed for the New M5 Motorway Arncliffe Construction Compound (Golders 2016). Contamination impacts arising from works undertaken as part of the New M5 Motorway project are being managed by the implementation of the Arncliffe Construction Compound Construction Area Plan to manage asbestos in fill and elevated ammonia and methane concentrations identified in groundwater. Mitigation measures being adopted for the New M5 Motorway Arncliffe Construction Compound would be expected to continue to be adopted during the project works. The mitigation measures in place would be assessed during detailed design to confirm applicability to the project construction works.

There are not expected to be substantial cumulative impacts from contamination from the construction and operation of the New M5 Motorway and the project at Arncliffe.

8 Management of impacts

8.1 Management of construction impacts

8.1.1 Ancillary facilities and project footprint

The methods for the management of construction impacts are outlined in the following section and specified for each ancillary facility in **Table 8-2**.

Construction environmental management plan (CEMP)

Procedures and protocols to manage potentially contaminated fill, soil, bedrock and extracted groundwater would be detailed in the CEMP prepared for the project. The CEMP would include procedures and controls applicable to managing contamination related impacts as summarised in **Table 8-1**.

Table 8-1 Construction environmental management plan – contamination component

Management issue	Summary of procedures and controls
Waste	<ul style="list-style-type: none">Waste management plans would include procedures for handling and storing spoil, including potentially or known contaminated soil/fill in accordance with the POEO Act 1997Protocols for waste classification for off-site disposal or assessment under a resource recovery exemption and waste tracking in accordance with the POEO Act 1997.
Stockpile management and spoil handling	<ul style="list-style-type: none">Stockpile management procedures for segregating spoil and preventing cross-contamination of clean spoil (VENM or ENM) with contaminated soilOdour management procedures in the event that odorous material is identified during stockpile management and spoil handling activities.
Surface water runoff erosion of contaminated soils	<ul style="list-style-type: none">Procedures for the prevention of erosion and management of potentially contaminated stormwater runoff would be detailed in the CEMP and construction soil and water management plan (CSWMP) included as an appendix to the CEMP.
Asbestos	<ul style="list-style-type: none">A Hazardous Building Materials Management Plan will be prepared detailing measures to manage the removal of known and unexpected hazardous building materials, including asbestos within buildings and soil. The plan is to be prepared in accordance with relevant guidelines.
Hazardous materials	<ul style="list-style-type: none">A Hazardous Building Materials Management Plan will be prepared detailing measures to manage the removal of known and unexpected hazardous building materials, including asbestos within buildings and soil. The plan is to be prepared in accordance with relevant guidelines.
Dangerous goods	<ul style="list-style-type: none">A dangerous goods search of the SafeWork NSW records for licensed dangerous goods would be undertaken for all sites that were former commercial or industrial premises and where subsurface works are planned as part of the project.
Acid sulfate soil management	<ul style="list-style-type: none">An Acid Sulfate Management Plan will be prepared in accordance with ASSMAC (1998) guidelines, detailing processes to manage actual and potential acid sulfate soils disturbed during construction. The plan would be prepared for all excavation works within the ancillary facilities and shared cycle and pedestrian pathways.Acid sulfate soils would be disposed off-site (where required) in accordance with the NSW EPA (2014) Waste Classification Guidelines; Part 4: Acid sulfate soils.

Management issue	Summary of procedures and controls
Unexpected finds	<ul style="list-style-type: none"> The Roads and Maritime Unexpected Discovery of Contaminated Lands Procedure Roads and a Hazardous Building Materials Management Plan are to be adopted for the project. In the event an unexpected find of contamination and/or odorous material is encountered during construction, work in the affected area would cease until an appropriately qualified environmental consultant can inspect the find and provide a recommendation on further investigation, remediation or control measures, as deemed appropriate. An unexpected find may include soil discoloration, offensive odours, buried waste or ACM, for example. Further assessment and management/remediation, where required, would be undertaken in accordance with section 105 of the CLM Act
Prevention of new/cross-contamination	<ul style="list-style-type: none"> Plant and equipment would be maintained and serviced within hardstand areas equipped with adequate spill response kits Chemicals, oils and fuels would be handled and stored in appropriately bunded areas equipped with adequate spill response kits Emergency response plans, clean up and reporting procedures would be developed.

Further investigations

Additional soil and groundwater investigations would be undertaken within the following ancillary facilities and construction sites during detailed design:

- Rockdale construction ancillary facility (C2)
- President Avenue construction ancillary facility (C3), specifically Rockdale Bicentennial Park, Brighton Memorial Playing Fields and 427 to 441 West Botany Street
- Parts of the active transport corridor where earth works are required within Civic Avenue, Bicentennial Park, Rockdale Women's Sports Field, Greg Atkins Mini Field, CA Redmond Field and White Oak Reserve
- Princes Highway construction ancillary facility (C6), the 7-Eleven service station at 734 Princes Highway, Kogarah
- The substation within St George TAFE.

Further investigations are not anticipated to be required for the Arncliffe construction ancillary facility as investigation works were completed by the New M5 Motorway contractor. Applicable management and mitigation measures adopted for managing contamination at the New M5 Motorway Arncliffe construction compound would be continued for the Arncliffe construction ancillary facility.

Areas that are considered low risk and require minimal earthworks are the construction area along the Princes Highway and President Avenue. These construction works would be managed by implementation of the CEMP.

The site investigations would be designed in accordance with NSW EPA (1995) *Sampling Design Guidelines* and in accordance with the relevant guidelines listed in section 3.1. The consultant would prepare a sampling, analysis and quality plan (SAQP) which would be reviewed by the appointed independent NSW EPA accredited site auditor prior to completion of the site investigation. The final site investigation report prepared would also be reviewed by the appointed independent NSW EPA accredited site auditor.

Where required based on the results of the additional investigations, a Remedial Action Plan (RAP), would be prepared prior to commencement of construction.

Remediation

Parts of the permanent operational footprint which are assessed as containing soil or groundwater contamination that poses an unacceptable risk to human or ecological receptors, would be remediated following further investigations. These are likely to include operational areas within C2 and C3 as well as part of 7-Eleven service station at 734 Princes Highway, 734 Kogarah.

Sites requiring remediation would have a RAP developed prior to the commencement of construction. The RAP would be prepared by a suitably qualified and experienced contaminated lands consultant and independently audited by a NSW EPA accredited site auditor.

Remediation and validation activities would be completed by a contaminated lands consultant, independent to the construction contractor. A validation report would be prepared by the consultant and reviewed by the appointed independent NSW EPA accredited site auditor.

The RAPs would be prepared in accordance with the relevant legislation and guidelines listed in section 3.1.

The need for remediation would be undertaken by considering the risks of undertaking the works. If the risks posed to the environment and human health is greater than the contamination remaining *in situ*, then the need for active remediation would be reconsidered and alternative management options such as capping or implementation of long-term environmental management plans investigated. The RAPs would include the assessment of sustainable remediation options and consideration of the *Waste Avoidance and Resource Recovery Act 2001* (NSW).

Remediation works may need to occur in a staged approach throughout the construction and post construction periods, depending on the final land use following completion of construction of the project.

Landfill gas and leachate management

Landfill gases and leachate have been identified to be present within Rockdale Bicentennial Park, based on the results of preliminary investigations. The landfill gases and leachate have a potential to cause nuisance odours to the surrounding area during excavation for the construction of the cut and cover tunnel and associated works. The landfill gases also have the potential to accumulate within the subsurface service trenches and pits as well as within aboveground spaces such as buildings and basins.

Further detailed investigation and assessment would be undertaken in order to develop plans for leachate and landfill gas management that may comprise:

- Leachate extraction, storage, treatment and disposal during construction
- Landfill gas drainage and ventilation
- Staging of landfill excavation and spoil management to manage odour impacts
- Landfill gas monitoring of the subsurface at the ancillary facility boundary, of the surface within the ancillary facility and of service pits and trenches within and surrounding the ancillary facility
- Ambient air quality and odour monitoring around the ancillary facility boundary, including the development of site specific action criteria
- Capping and drainage plans for areas not to be excavated within the ancillary facility
- Downstream surface water monitoring during construction (refer to **Appendix L**).

Table 8-2 Management of construction impacts – ancillary facilities and construction footprint

Area	Construction works	Management of construction impacts
Arnccliffe construction ancillary facility (C1)	<ul style="list-style-type: none"> Establishment of temporary noise attenuation measures Tunnel excavation and other tunnelling works, as well as stockpiling of excavated material and spoil haulage Fitout of the Arnccliffe Motorway Operations Complex as required Fitout and installation works would also occur at the Arnccliffe ventilation facility being built as part of the New M5 Motorway project to enable use of a section of this facility by the project. These works would include: <ul style="list-style-type: none"> Installation of mechanical and electrical equipment Testing and commissioning. Backfilling of tunnel decline with spoil originally excavated and stockpiled from construction of the decline tunnel during the New M5 project Finishing works including asphaltting, lighting, line marking, utilities and signage installation Rehabilitation and landscaping of areas that will not be occupied by permanent operational infrastructure 	<ul style="list-style-type: none"> Management and mitigation implemented for the New M5 Motorway project at the Arnccliffe ancillary facility would continue to be implemented where applicable to the project works. Assessment of the applicability of the measures during construction would be undertaken during detailed design Acid sulfate soils: Management of acid sulfate soils would be undertaken through the development, implementation and adherence to management procedures for acid sulfate soils as part of the Acid Sulfate Management Plan, to be developed prior to construction CEMP: Potential construction impacts including disturbance of soil would be managed by the development and implementation of the CEMP prior to construction, which is to include measures for asbestos in fill and ammonia and dissolved methane in groundwater, prior to construction.

Area	Construction works	Management of construction impacts
Rockdale construction ancillary facility (C2)	<ul style="list-style-type: none"> Establishment of temporary noise attenuation measures Construction of an acoustic shed Construction of the decline tunnel Tunnel excavation and other tunnel works, as well as stockpiling of excavated material and spoil haulage Finishing works including asphaltting, lighting, line marking and signage installation Construction of operational infrastructure including the Operational Motorway Control Centre Reconfiguration of the ancillary facility to enable ongoing/future use for maintenance activities, including rehabilitation and landscaping 	<ul style="list-style-type: none"> Site investigations: A grid based in situ characterisation of soil and fill materials proposed to be excavated/disturbed as part of future construction activities is to be undertaken, where required, to supplement the existing data/fill in data gaps. The lateral extent and depth of intrusive investigation would be determined by the design and location of the ground disturbance and underground infrastructure Hazardous materials assessment and management plans would be undertaken for buildings and structures prior to demolition RAP: Based on the future investigations, preparation of a RAP for the excavation and off-site disposal of contaminated materials to licensed landfill or on-site treatment/beneficial reuse is to be undertaken (if identified and practicable) prior to construction Waste management: In situ /ex-situ waste classification/virgin excavated natural material (VENM)/excavated natural material (ENM) assessment of excavated fill, natural soils and rock to evaluate suitability for potential reuse or disposal to landfill is to be undertaken prior to construction Acid sulfate soils: Management of acid sulfate soils and sediment would be undertaken through the development, implementation and adherence to management procedures for acid sulfate soils as part of the Acid Sulfate Management Plan prior to construction CEMP: Potential construction impacts would also be managed by the development and implementation of a CEMP (refer to Table 8-3)

Area	Construction works	Management of construction impacts
President Avenue construction ancillary facility (C3)	<ul style="list-style-type: none"> Demolition of houses along northern side of President Avenue Demolition of commercial buildings on west side of West Botany Street Vegetation clearing and removal Establishment of temporary noise attenuation measures (including acoustic barriers) Temporary stockpiling of spoil and fill materials for later re-use or prior to off-site removal Managing any contaminated land identified or encountered during site establishment and construction (refer to Chapter 16 (Soils and contamination)) Construction of the cut-and-cover structures including excavation, piling, concrete works, installation of diaphragm walls and, installation of mechanical and electrical services Construction of the Rockdale ventilation facility President Avenue intersection upgrade works Construction of the shared cycle and pedestrian pathways, including the bridge over President Avenue Construction of new and upgraded drainage infrastructure and combined bioretention and stormwater basin Finishing works including asphaltting, lighting, line marking and signage installation Rehabilitation and landscaping of areas that will not be occupied by permanent operational infrastructure 	<ul style="list-style-type: none"> Site investigations: A grid based in situ characterisation of soil and fill materials proposed to be excavated/disturbed as part of future construction activities, where required, to supplement the existing data. Additional subsurface gas investigations would also be required. The lateral extent and depth of intrusive investigation would be determined by the design and location of the ground disturbance and underground infrastructure Hazardous materials assessment and management plans would be undertaken for buildings and structures prior to demolition RAP: Based on the investigations, a RAP is to be prepared for the excavation and off-site disposal of contaminated materials to licensed landfill or on-site treatment/beneficial reuse (if identified and practicable) Waste management: In situ /ex-situ waste classification/virgin excavated natural material (VENM)/excavated natural material (ENM) assessment of excavated fill, natural soils and rock is to be undertaken prior or during construction to evaluate suitability for disposal to landfill or potential reuse Acid sulfate soils: Management of acid sulfate soils and sediment would be undertaken through the development, implementation and adherence to management procedures for acid sulfate soils as part of the Acid Sulfate Management Plan CEMP: Potential construction impacts including disturbance of surface water and contaminated sediment within Rockdale wetland and landfill gas would also be managed by the development and implementation of the CEMP.

Area	Construction works	Management of construction impacts
Shared cycle and pedestrian pathways east construction ancillary facility (C4) and shared cycle and pedestrian pathways west construction ancillary facility (C5) and shared cycle and pedestrian pathways - north	<ul style="list-style-type: none"> • Temporary stockpiling of spoil and fill materials for later re-use prior to off-site removal • Construction of the shared cycle and pedestrian pathways including shallow surface works and possible piling for footbridges • Finishing works including lighting, line marking and signage installation 	<ul style="list-style-type: none"> • Waste management: In situ /ex-situ waste classification/virgin excavated natural material (VENM)/excavated natural material (ENM) assessment of excavated fill, natural soils and rock to evaluate suitability for disposal to landfill or potential reuse, prior to or during construction. • Acid sulfate soils: Management of acid sulfate soils would be undertaken through the development, implementation and adherence to management procedures for acid sulfate soils as part of the Acid Sulfate Management Plan (where triggered by excavation beyond 1 metre depth) • CEMP: Potential construction impacts would also be managed by the development and implementation of a CEMP (refer to Table 8-4)
Princes Highway construction ancillary facility (C6)	<ul style="list-style-type: none"> • Decommissioning of underground petroleum storage system (UPSS) and backfilling of resultant excavations • Relocation of utilities, stormwater infrastructure and substation • Laydown and parking of construction vehicles and equipment • Pavement works along Princes Highway and President Avenue • Rehabilitation and landscaping. 	<ul style="list-style-type: none"> • Site investigations: completion of additional soil and groundwater assessment to address data gaps and assess current conditions. • Preparation of a RAP for the removal and validation of the UPSS and associated soil and groundwater impacts. • CEMP: Potential construction impacts would also be managed by the development and implementation of a CEMP (refer to Table 8-5)

Area	Construction works	Management of construction impacts
Proposed Permanent power supply connection (power line)	<ul style="list-style-type: none"> • Trenching and excavation of the road reserve, park area or railway corridor • The works would require small amounts of localised excavation for trenching/drilling activities, where the excavated material will be stockpiled adjacent to the trenches for use as backfill material at the completion of works • There would be no surface disturbance beyond the limits of the utility trenches. 	<ul style="list-style-type: none"> • Site investigations: targeted characterisation of soil and fill materials within areas of concern that are proposed to be excavated. • Waste management: In situ /ex-situ waste classification/virgin excavated natural material (VENM)/excavated natural material (ENM) assessment of excavated fill, natural soils and rock to evaluate suitability for disposal to landfill or potential reuse, prior to or during construction. • Acid sulfate soils: Management of acid sulfate soils would be undertaken through the development, implementation and adherence to management procedures for acid sulfate soils as part of the Acid Sulfate Management Plan (where triggered by excavation beyond 1 metre depth) • CEMP: Potential construction impacts would also be managed by the development and implementation of a CEMP (refer to Table 8 4)

8.1.2 Management of construction impacts – tunnelling

Groundwater and surface water captured as a result of tunnelling activities may be contaminated with suspended solids, increased pH due to tunnel grouting activities and chemical contamination from surrounding land uses, including leachate from Rockdale Bicentennial Park. A water treatment plant is proposed at the Arncliffe construction ancillary facility (C1), and temporary construction water treatment plants and sedimentation basins will be constructed at the Rockdale construction ancillary facility (C2) and President Avenue construction ancillary facility (C3) to treat surface water and extracted groundwater. These measures aim to mitigate adverse water quality impacts which would arise from the discharge of untreated construction water.

Groundwater reuse (if required) would be undertaken in accordance with the policies of sustainable water use of (DPI-Water). As stated in the **Appendix L** (Surface Water Technical Report) of the EIS a Water Reuse Strategy would be developed during detailed design.

8.2 Management of operational impacts

8.2.1 Operational sites

The methods for the management of operational impacts are specified for each operational area in **Table 8-6**.

Table 8-6 Management of operational impacts – operational sites

Area	Operational activities	Management of operational impacts
Arncliffe Motorway Operations Complex (MOC1)	<ul style="list-style-type: none"> • Arncliffe Motorway Operations Complex (MOC1) • Substations • Fire pump room and water tanks • WTP • Remaining land to be handed back to Council for Kogarah Golf Club 	<ul style="list-style-type: none"> • Operations to be undertaken in accordance with the POEO Act. The storage of chemicals, oils and wastes are to be in accordance with NSW regulations in force at the time.
Rockdale Motorway Operations Complex (north) (MOC2)	<ul style="list-style-type: none"> • Rockdale Motorway Operations Complex (MOC2) • Substations • Fire pump room and water tanks 	<ul style="list-style-type: none"> • Operation is to be undertaken in accordance with the POEO Act. The storage of chemicals, oils and wastes are to be in accordance with NSW regulations in force at the time.
Rockdale Motorway Operations Complex (south) (MOC3) and President Avenue ancillary facility	<ul style="list-style-type: none"> • Rockdale ventilation facility (MOC3) • Substations • Fire pump room and water tanks • Roadway • Roads, entry and exit ramps and tunnel portals • Shared cycle and pedestrian pathways • Remaining land to be handed back to Council for open space land use 	<ul style="list-style-type: none"> • Operations are to be undertaken in accordance with the POEO Act. The storage of chemicals, oils and wastes are to be in accordance with NSW regulations in force at the time.

Area	Operational activities	Management of operational impacts
Shared cycle and pedestrian pathways	<ul style="list-style-type: none">• Footpaths• Bike paths• Bus stops	<ul style="list-style-type: none">• No operational impacts

8.2.2 Management of operational impacts – roadways including tunnels

A risk assessment of all project roads will be carried out during detailed design to evaluate the likelihood of vehicle accidents during the operation of the project. Spill containment facilities would be located where high risk spill/contamination risk areas of roadway are identified.

Tunnel groundwater inflows during operation of the project would be pumped to the New M5 Motorway water treatment plant for treatment and disposal. The groundwater treatment facilities at the New M5 Motorway water treatment plant will be designed such that effluent will be of suitable quality for discharge to the receiving environment, in accordance with the New M5 Motorway approval conditions and agreed discharge criteria.

Trigger levels for the Cooks River were provided within the New M5 EIS Technical Working Paper: Surface Water, Appendix N (AECOM 2015). Full details are provided in **Annexure F** of the **Appendix L** of the EIS (Surface Water Technical Report).

An Operation Environmental Management Plan (OEMP) would be developed to manage potential operational groundwater and surface water impacts on the receiving environment. The OEMP would be a 'live' document with the capacity to be updated if conditions are different to those expected. As part of the OEMP the following plans or protocols would be prepared and implemented throughout operation of the project:

- Groundwater management plan
- Groundwater monitoring program
- Surface water monitoring program
- Drainage system maintenance plan.

8.3 Management of cumulative impacts

A qualitative assessment of cumulative impacts associated with other projects in the vicinity of project, in particular other WestConnex projects, such as the New M5 Motorway project, has been carried out. The projects could result in the identification of pre-existing contamination which may require management or remediation. The projects currently under construction all incorporate construction and operation contamination management and mitigation measures to prevent adverse impacts on human health and the environment. Other committed projects that are still in the planning stages would be required to incorporate similar mitigation measures in accordance with legislative requirements to prevent adverse impacts.

Therefore, with due consideration of the proposed management measures to be implemented as part of the project, there are likely to be minimal adverse cumulative contamination impacts associated with the construction and operation of these projects.

9 Conclusions

9.1 Key findings

This technical working paper has identified a number of areas of potential or known contamination which require management during the construction and operation of the project. Existing identified contamination issues are primarily related to historical land uses which have adversely impacted the quality of soil, fill, groundwater, ground gas and surface water within the project footprint.

The areas within the surface construction footprint identified as having a medium or high risk of existing contamination are:

- Arncliffe ancillary facility (C1)
- Rockdale construction ancillary facility (C2)
- President Avenue construction ancillary facility (C3), specifically parts of Rockdale Bicentennial Park, Rockdale Bicentennial Park East, President Avenue, West Botany Street and commercial/industrial properties at 427 to 441 West Botany Street, Rockdale
- Shared cycle and pedestrian pathways and shared cycle and pedestrian pathways east (C4) and shared cycle and pedestrian pathways west (C5) construction ancillary facilities including
- Princes Highway construction ancillary facility (C6), 7-Eleven service station, 734 Princes Highway, Kogarah
- Substation within St George TAFE, Princes Highway, Kogarah
- Sections of the proposed permanent power supply connection in Earlwood, Bardwell Park, Arncliffe, Banksia and Rockdale.

Areas identified with a medium or high risk of groundwater contamination due to historical land uses, that could impact on groundwater quality along the tunnel alignment are:

- Kogarah Golf Course and surrounding filled land to the south
- Former Tempe Bus Depot in Arncliffe
- Up-gradient former and current commercial/ industrial properties (mainly mechanics and workshops) along Princes Highway, Arncliffe
- Former Goodfellow Dry Cleaners at 122 Cameron St, Rockdale
- Rockdale industrial area
- Rockdale Bicentennial Park and surrounding filled land.

There is also a potential that contamination arising from tunnel construction and associated project works, such as stockpiling of contaminated soil and acid sulfate soils and storage and use of fuel and chemicals, could adversely impact soil, sediment, groundwater and surface water if not managed appropriately.

9.2 Construction impacts and mitigation measures

The areas identified as medium and high risk within the construction footprint would be further investigated during detailed design and investigation sampling plans would be informed by existing data and project design. It is noted that that further investigations would not be required within the Arncliffe ancillary facility (C1), as they have been completed by the New M5 Motorway project.

All contamination investigations would be required to 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 investigations, Remediation Action Plan (RAPs) may be required and implemented in the event that site remediation is warranted prior to construction. An independent NSW EPA Accredited site Auditor would be engaged to review all contamination reports and evaluate the suitability of sites for a specified use as part of the project.

Following completion of project construction, ancillary facilities will be remediated in accordance with RAP(s), where required, based on the findings of investigations and the intended land use or rehabilitation requirements. 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 sites for a specified use as part of the project.

A CEMP would also be prepared for the project. The CEMP would include management measures for areas within the project footprint identified as being potentially contaminated as well as 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.

The CEMP would incorporate the Roads and Maritime Unexpected Discovery of Contaminated Lands Procedure Roads and a Hazardous Building Materials Management Plan. The CEMP prepared for implementation during construction of the project and should encompass all construction activities associated with the project. The plan should accurately reflect the existing conditions and potential contamination likely to be encountered during construction at various locations within the project footprint.

The CEMP would include CSWMP sub-plans to manage potentially contaminated soil and water for each construction ancillary facility. Sub-plans for President Avenue construction ancillary facility (C3), must have specific mitigation measures for leachate and landfill gas management for works within Rockdale Bicentennial Park based on the findings of additional investigations.

Management procedures for acid sulfate soils as part of the CEMP would be prepared for implementation during the project, which should encompass the management of all potential or actual acid sulfate soils which may be disturbed as part of construction activities associated with the project. An Acid Sulfate Management Plan would be prepared for the construction ancillary facilities (C1 to C5).

Groundwater and surface water captured as a result of tunnelling activities may be contaminated with suspended solids and increased pH, in addition to existing groundwater contamination due to tunnel grouting activities. Targeted groundwater investigations would continue to be undertaken along the tunnel alignment prior to construction, to obtain adequate data to estimate the concentrations of contamination to be treated during construction. Water would be captured during construction and treated on-site or at the Arncliffe water treatment plant and at the temporary construction water treatment plants and sedimentation ponds at the Rockdale construction ancillary facility (C2) and President Avenue construction ancillary facility (C3).

9.3 Operation impacts and mitigation measures

An Operational Environmental Management Plan (OEMP) would be prepared to manage potential impacts on groundwater and surface water during the operational phases of the project. Groundwater and surface water inflows drained from the tunnel will be treated at the Arncliffe water treatment plant to the required quality for discharge to the Cooks River.

9.4 Conclusion

Based on the findings of this technical working paper, AECOM concludes that there are areas of soil, vapour, ground gas, acid sulfate soil, surface water, sediment, fill and groundwater contamination associated with historical land uses to be encountered during construction, and further investigation and assessment is warranted.

Following adoption of the mitigation and management measures during the construction and operational phase of the project, the desired performance outcome could be achieved, which is to ensure that risks arising from the disturbance of soil and groundwater contamination and acid sulfate soils would be mitigated.

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Annexure A Site Inspection Photographs

PHOTOGRAPHIC LOG

Project Name: Stage 1 F6 Extension		Site Location: 19 Marsh Street, Arncliffe (New M5 Motorway construction ancillary facility), proposed Arncliffe construction ancillary facility (C1) and Motorway Operations Complex (MOC1)	
Photo No. 1	Date: 11/12/2017		
Direction Photo Taken: South-east			
Description: Concrete hoarding and shipping containers – boundary of New M5 Motorway construction compound view from Marsh Street			

Photo No. 2	Date: 11/12/2017	
Direction Photo Taken: North		
Description: View of New M5 Motorway construction ancillary facility from pedestrian/cycleway above M5 East roadway, immediately south of the New M5 Motorway construction ancillary facility		

PHOTOGRAPHIC LOG

Project Name:
Stage 1 F6 Extension

Site Location:

19 Marsh Street, Arncliffe (New M5 Motorway construction ancillary facility), proposed Arncliffe construction ancillary facility (C1) and Motorway Operations Complex (MOC1)

Photo No.
3

Date:
11/12/2017

Direction Photo Taken:
North-east

Description:

Stockpiles, plant and machinery visible from pedestrian/cycleway above M5 East roadway immediately south of the New M5 Motorway construction ancillary facility



Photo No.
4

Date:
11/12/2017

Direction Photo Taken:
East

Description:

South and Western Suburbs Ocean Outfall Sewer pipeline (SWSOOS No. 1) (partially below ground) running west to east south of the New M5 Motorway construction ancillary facility



PHOTOGRAPHIC LOG

Project Name:
Stage 1 F6 Extension

Site Location:
Proposed Rockdale Motorway Operations Complex (north) (MOC2) and construction ancillary facility (C2)

Photo No.
5

Date:
11/12/2017

Direction Photo Taken:
South-east

Description:
Site entrance off West Botany Street, Rockdale to the proposed Rockdale Motorway Operations Complex (MOC2) and construction ancillary facility (C2), currently in use by Lendlease TYCO Joint Venture on behalf of Roads and Maritime Services



PHOTOGRAPHIC LOG

Project Name:
Stage 1 F6 Extension

Site Location:
President Avenue, Kogarah NSW

Photo No.
6

Date:
11/12/2017

Direction Photo Taken:
North-west

Description:
Memorial Fields located along President Avenue, Kogarah



Photo No. 7	Date: 11/12/2017	
Direction Photo Taken: North		
Description: Scarborough Ponds between Rockdale Bicentennial Park and the Memorial Fields		

