10. AIR QUALITY

This chapter provides a summary of the air quality impact assessment. A full copy of the assessment is provided as *Technical Report 3 – Air Quality Impact Assessment*.

10.1 Assessment approach

A summary of the approach to the assessment is provided in this section, including the legislation, guidelines and policies driving the approach and the methodology used to undertake the assessment.

10.1.1 Legislative and policy context to the assessment

The assessment was undertaken with reference to the requirements summarised below.

Protection of the Environment Operations Act 1997

The POEO Act provides the statutory framework for managing pollution in NSW, including the procedures for issuing licences for environmental protection on aspects such as waste, air, water and noise pollution control. Companies and property owners are legally bound to control emissions from construction sites under the POEO Act. Activities undertaken on site must not contribute to environmental degradation, and pollution and air emissions must not exceed the standards.

The criteria outlined in this Act and considered in this assessment are specified in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (EPA, 2016).

Protection of the Environment Operations (Clean Air) Regulation 2010

The *Protection of the Environment Operations (Clean Air) Regulation 2010* (the Clean Air Regulation) provides regulatory measures to control emissions from motor vehicles, fuels and industry. The project would be operated to ensure it complies with the Clean Air Regulation.

The criteria outlined in this Regulation and considered in this assessment are specified in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (EPA, 2016).

Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (EPA, 2016)

The *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (Approved Methods) (EPA, 2016) lists the statutory methods for modelling and assessing emissions of air pollutants from stationary sources in NSW. It considers the above-mentioned legislation and constructs pollutant assessment criteria.

The Approved Methods (EPA, 2016) is the main guidance document that has been followed for this assessment.

National Environment Protection (Ambient Air Quality) Measure (2015)

The National Environment Protection Council (NEPC) *National Environment Protection (Ambient Air Quality) Measure* (Air NEPM) (NEPC 2015) sets national standards for the six key air pollutants to which most Australians are exposed: Carbon monoxide (CO), Ozone (O_3), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), lead and particulate matter with diameter less than 10 microns (PM_{10}) and less than 2.5 microns ($PM_{2.5}$). Under the Air NEPM, all Australians have the same level of air quality protection.

The criteria and pollutants specified in this NEPM have been considered in this assessment.

Approved Methods for the Sampling and Analysis of Air Pollutants in NSW (DEC, 2007)

The Approved Methods for the Sampling and Analysis of Air Pollutants in NSW (DEC, 2007) provides the approved methodology for sampling and analysing air pollutants.

This guidance was reviewed but as sampling was not undertaken as part of this air quality assessment this guidance has not been considered further.

Technical Framework – Assessment and Management of Odour from Stationary Sources in NSW (DEC, 2006b)

The Technical Framework – Assessment and Management of Odour from Stationary Sources in NSW (Technical Framework) (DEC, 2006b) provides a framework to assess and manage odour from stationary sources. The Approved Methods (EPA 2016) incorporates guidance supplied in the Technical Framework. An air quality assessment conducted in accordance with the Approved Methods (EPA 2016).

As odour was not found to be significant based on the train emissions reported in *Diesel Locomotive Fuel Efficiency and Emissions Testing*: Prepared for NSW EPA (ABMARC, 2016) and the findings of the contamination assessment for this project (*Technical Report 5 – Contamination Assessment*), detailed odour management has not been incorporated into this assessment.

Protocol for Environmental Management, State Environment Protection Policy (Air Quality Management) (Victorian EPA, 2007)

The Protocol for Environmental Management (PEM) (Victorian EPA, 2007) provides the requirements for assessment and management of emissions to the air environment from the mining and extractive industries. It provides an alternate method to assess air quality impacts by using the 70th percentile of background concentrations. This method is considered more appropriate for the construction phase of this project based on the intermittent and changing location of air quality emissions.

This policy was followed to develop the background concentrations used in this construction assessment based upon the 70th percentile particulate concentrations.

Western Regional Air Partnership Fugitive Dust Handbook (Countess Environmental, 2006)

Dust emissions from construction activities have been calculated using recommended particulate emission factors for general construction operations. The derived emission rates were characterised using recommended emission factors for average conditions and worst-case conditions published in the *Western Regional Air Partnership Fugitive Dust Handbook* (WRAP) (Countess Environmental, 2006).

10.1.2 Methodology

Key tasks

The air quality assessment involved the following tasks:

- a desktop review of site plans, aerial photographs and topographic maps undertaken to gain an understanding of the existing environment in terms of local terrain, existing/proposed operations and sensitive receptors within the study area
- the applicable air quality impact assessment criteria is defined by the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (Approved Methods) (EPA, 2016) and the *National Environment Protection (Ambient Air Quality) Measure* (‘the Air NEPM’)

- a review of available background air quality in the local area using DPIE (formerly Office of Environment and Heritage (OEH)) air quality monitoring data (Randwick and Earlwood monitoring stations)
- meteorological modelling to gain an understanding of the local wind climate for use as model input for conducting atmospheric dispersion modelling
- creation of a construction emissions inventory including emissions to air from the construction of the project (primarily particulates)
- review of *Technical Report 5 – Contamination Assessment* was undertaken to verify management plans have been recommended during construction
- creation of an operational emissions inventory to include locomotives on the project using the report *Diesel Locomotive Fuel Efficiency and Emissions Testing*: Prepared for NSW EPA (ABMARC, 2016) and National Pollutant Inventory (NPI) emission factors
- dispersion modelling to predict construction and operational impacts at nearby receptors in the study area using regulatory approved models was undertaken as follows:
    - using AUSPLUME 6.0 for construction impacts
    - using CALPUFF version 6 for operation impacts
- a cumulative impact assessment to consider potential regional air quality impacts combined with other projects
- development of general mitigation measures for construction and operation of the project to mitigate potential impacts which could arise as a result of the project.

Study area

The study area was selected to be large enough to capture all air quality impacts from the project. The model domain was selected to be 22 kilometres by 22 kilometres in size centred on the project site. The study area is considered the same size as the modelling domain. A cumulative impact assessment considered the local and regional impact of the project combined with other proposals.

Technical Report 13 – Health Impact Assessment provides further assessment of potential local and regional air quality impacts on receivers.

10.1.3 Risks identified

The preliminary environmental risk assessment undertaken for the project (provided in Appendix B) included potential risks associated with air quality. Potential risks were considered according to the impacts that may be generated by the construction or operation of the project. The likelihood, consequence and overall risk level of each potential risk were assessed, with avoidance and management measures defined for each potential risk. Further information on the risk assessment, including the approach, methodology, and the full results, is provided in Appendix B.

Prior to assessment and identification of mitigation measures, risks with an assessed level of medium or above include:

- generation of dust during construction (from exposed soil/stockpiles, excavations and vehicle movements)
- emissions from vehicles or plant during construction
- mobilisation of asbestos fibres from disturbance of contaminated soils
- impacts on local air quality during operation from maintenance vehicles and emissions from an increase in trains.

These potential risks and impacts were considered as part of the assessment. The assessment also considered matters identified by the SEARs and stakeholders (as described in Chapters 3 and 4). The residual risk levels, following implementation of the mitigation measures proposed in this EIS, are discussed in section 10.6.4.

10.1.4 How potential impacts have been avoided or minimised

As described in Chapters 6 and 7, design development and construction planning for the project has included a focus on avoiding or minimising the potential for environmental impacts during all key phases of the process. Measures taken to avoid or minimise impacts which relate to air quality include directing construction access points and construction traffic routes away from sensitive areas and consideration of sensitive land uses when defining the use and operation of specific compounds.

10.2 Existing environment

10.2.1 Background air quality

Pollutant average and maximum background concentrations from Randwick and Earlwood monitoring stations, for 2014, were considered as a representative year for input to the modelling undertaken for impact assessment. These stations were the closest stations providing this data. Records and the averaging period are shown in Table 10.1. Meteorological data was taken from the nearest Bureau of Meteorology monitoring station (Sydney Airport Aeronautical Meteorological Office).

Data was not available from Randwick and Earlwood monitoring stations for Carbon Monoxide (CO), therefore CO data was taken from the nearest representative station providing this data. CO data taken for 2018–2019 from the Chullora DPIE monitoring station was 4,140 µg/m^3.

Table 10.1 Background air quality daily concentrations (2014)

POLLUTANT	AVERAGING PERIOD	DPIE MONITORING SITE RECORDS (MAXIMUM MICRO GRAMS PER METRE CUBED (µg/m^3)	
		Randwick	Earlwood
NO_2	1 hour	88.4	75.2
	Annual	11.0	15.8
SO_2	1 hour	68.1	–
	24 hours	10.5	–
	Annual	2.4	–
O_3	1 hour	37.9 (average µg/m^3)	30.2 (average µg/m^3)
	1 hour	129.4	135.2
PM_{10}	24 hours	46.1	45.2
	Annual	18.2	18.4
	24 hours	20.5 (70th percentile µg/m^3)	20.7 (70th percentile µg/m^3)
$PM_{2.5}$	24 hours	–	22.7
	Annual	–	7.8
	24 hours	–	9.2 (70th percentile µg/m^3)

Note: '–' denotes data not sampled at the site

10.2.2 Local emission sources

The main local sources of air pollution in the study area which contributes to the existing background concentrations include:

- vehicle emissions especially from roads with high traffic volumes such as Qantas Drive, Joyce Drive, General Holmes Drive and Southern Cross Drive. Emissions can include NOx, volatile organic compounds (VOC), CO, PM_{10} and $PM_{2.5}$
- suspended dust along roadways, from pulverised pavement materials, particles from brake linings and tyres. Dust emissions from existing rail movements along the Botany Line. Dust can include Total Suspended Particles (TSP) PM_{10} and $PM_{2.5}$
- residential emissions such as domestic products as well as fuel combustion from domestic machinery like lawn mowers, etc. Diesel emissions from existing rail movements along the Botany Line. Emissions can include NOx, VOC, CO, TSP PM_{10} and $PM_{2.5}$
- secondary particulate emissions from freight movement (i.e. wheel and brake action, wagon turbulence in the rail corridor and windblown particulates). Secondary particulate matter pollution consists of NOx, VOC, sulfur dioxide (SO_2) and ammonia which react in the atmosphere to form secondary organic aerosols, nitrate, sulfate compounds and ozone (O_3).

10.2.3 Sensitive receptors

The Approved Methods (EPA 2016) defines sensitive receptors as locations where people are likely to work or reside and may include a dwelling, school, hospital, office and recreation areas.

The nearest sensitive receptors are anticipated to experience the worst case air quality impact and therefore have been selected to represent worst case scenario pollutant concentrations. If potential air quality impacts from the project comply with the impact assessment criteria at the nearest receptors, then those situated at a greater distance will also likely comply.

The location of the representative sensitive receptors to the site are presented in Table 10.2. The location of representative sensitive receptors in the study area are shown in Figure 10.1.

Table 10.2 Representative sensitive receptors locations

ID	DESCRIPTION	ID	DESCRIPTION
R01	Qantas Joy building	R11	Rovacraft
R02	Qantas Flight Training Centre	R12	Residential (on McBurney Avenue)
R03	Qudos Bank	R13	Sims Metal Management
R04	Redspot car rentals headquarters	R14	Eastlake Golf Club Halfway House
R05	Stamford Plaza Sydney Airport	R15	Big Picture Australia Pty Ltd
R06	Krispy Kreme Mascot	R16	Residential (between Myrtle Street and Bay Street)
R07	Regional Express (Rex)	R17	Residential (on Bay Street)
R08	IMO Carwash Mascot	R18	Residential (between Bay Street and Morgan Street)
R09	Residential (on Baxter Road)	R19	Gaiarine Gardens
R10	AEA Sydney airport serviced apartments	R20	Residential (on Ocean Street)

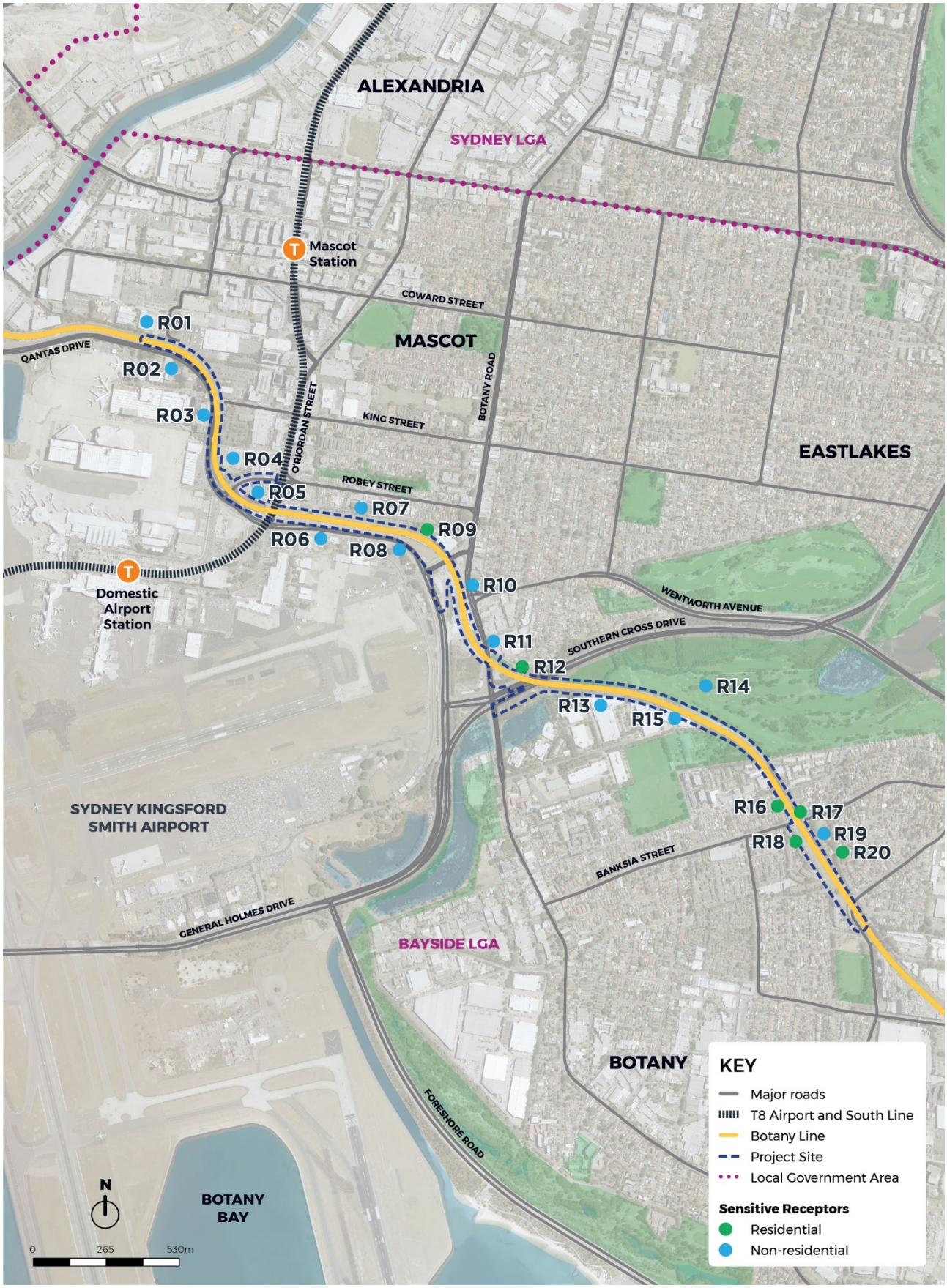


Figure 10.1 Sensitive receptors location

10.3 Assessment of construction impacts

10.3.1 Construction overview

Construction of the project would broadly involve the following key steps:

- early and enabling works including compound establishment, utility works, vegetation clearance, billboard removal and track slewing
- main construction works including track and bridge works
- finishing and rehabilitation works.

It is noted that the construction methodology including the plant and equipment usage presented in this section are indicative and would continue to be modified and refined as the design process continues. A final construction methodology and program would be developed by the construction contractor when appointed.

A high level conservative worst case construction assessment has been undertaken.

There is potential for air quality emissions to occur during the construction of the project. The principle activities which may result in emissions include:

- combustion and pollutant emissions from construction vehicles and plant exhaust
- odour and pollutant emissions from disturbance of contaminated land
- dust and particulate matter emissions from earth working activities.

10.3.2 Construction vehicles and exhaust emissions

Construction vehicles are expected to travel along the alignment and resulting emissions will be discontinuous, transient and mobile. Particulate emissions from the exhaust of mobile plant and stationary engines are accounted for in the emission factors for earthmoving and handling (emissions factors further discussed in section 10.3.4) used in the air quality assessment. Therefore, combustion vehicle exhaust emissions have not been considered further in this assessment.

10.3.3 Odour and pollutant emissions

There is potential for odorous and pollutant (including PFAS and asbestos) emissions to occur during the construction of the project from the disturbance of contaminated land. Previously contained contamination (covered by topsoil) may be agitated resulting in the release of contamination into the air.

A contamination assessment has been undertaken. The assessment identified the risk of airborne asbestos fibres being generated during construction activities associated with the excavation, movement and stockpiling of ACM.

PFOS and PFAS concentrations have been recorded in surface water and ground water samples located near the rail corridor. There is higher risk of these contaminants becoming airborne during constructions works in these areas. Management measures have been included in 10.6.2

Further details and a complete contamination assessment including measures to manage contamination is provided in the contamination land specialist report (*Technical Report 5 – Contamination Assessment*).

10.3.4 Dust

Source of dust emissions

Dust and particulate matter was identified as the primary emission to air during the construction of the project. Other air emissions such as combustion products (eg vehicle exhaust) will also be present during construction and maintenance activities. The combustion exhaust emissions from vehicles, plant and equipment are expected to be insignificant compared to existing combustion engine emissions from road and rail traffic.

Construction activities that generate dust include earthworks and the handling and transfer of earth and other material. The key construction activities that could generate dust include:

- vegetation clearing and grubbing
- installation of a new track and embankment widening
- track upgrading and minor adjustments
- bridge works and demolition
- retaining wall works
- drainage system construction and relocation of underground services and pipelines
- service routes and signalling works
- finishing and rehabilitation works.

Plant, equipment and activities likely to generate dust include:

- use of earth working plant including excavators, bull dozers and front-end loaders
- trucks dumping soil and aggregate
- drilling
- scraper/graders
- wheel generated dust from vehicle movements on unsealed surfaces.

Predicted impact from dust emissions

For this project, air quality impacts were assessed in terms of distances at which the relevant criteria are achieved at any time. The pollutant assessment criteria accord with the levels set in the Approved Methods (EPA, 2016). By complying with these assessment criteria, the construction phase of the project should meet air quality obligations under the POEO Act 1997 and the Clean Air Regulation 2010. Dust emissions from construction activities were characterised using recommended emission factors for average conditions and worst-case conditions published in the *Western Regional Air Partnership Fugitive Dust Handbook* (WRAP) (Countess Environmental, 2006). The WRAP scenarios are:

- average construction conditions were used to model general construction areas and include track upgrading and minor adjustments, retaining wall works, drainage system construction and relocation of underground services and pipelines, service routes and signalling works, and finishing and rehabilitation works
- worst case conditions were used to model heavy construction areas include vegetation clearing and grubbing, installation of a new track and embankment widening, bridge works and demolition.

The standard construction methodology for managing soils would be outlined in the relevant management plan and would include dust suppression watering. Two levels of watering are considered in this assessment:

- Level 1 watering (2 litres per metre squared per hour ($L/m^2/h$)) achieving a 50 percent reduction in dust generation was assumed to occur at all general construction areas.
- Level 2 watering (greater than 2 $L/m^2/h$) achieving a 75 percent reduction in dust generation was assumed to occur at all construction areas that would occur in the same location for a year or more in duration.

Detailed approach, assumptions for emissions rate calculations and modelling are provided in *Technical Report 3 – Air Quality Impact Assessment*.

The next sections present the predicted daily and annual construction dust impacts compared with the existing background levels and the assessment criteria as defined in the Approved Methods (EPA, 2016):

- The Daily impacts are expressed as the worst case impacts averaged over a 24 hour period. The worst case daily impacts are predicted to occur once (for one 24 hour period) in the modelled year. Lower dust impacts are predicted for all other days (remaining 364 days of the modelled year).
- The Annual impacts are expressed as the impacts averaged over the entire modelled year.

The modelling scenarios discussed below are used for assessment purposes only and do not suggest that these impacts would occur daily or annually.

Daily construction impacts

The results of the daily assessment show that impacts decrease the further the distance away from the site. Dust emissions from the project are relatively low compared with the assessment criteria and background concentrations. There are significant existing background particulate concentrations:

- the background PM_{10} accounts for 41 percent of the assessment criteria
- the background $PM_{2.5}$ accounts for 37 percent of the assessment criteria.

The results of the modelling of the worst case construction conditions with level 2 watering found that:

- the daily PM_{10} assessment criteria is met at six metres from the site boundary of the construction works
- the daily $PM_{2.5}$ assessment criteria is met at the site boundary of the construction works (no off site impacts are predicted).

The results of the modelling of the average construction conditions with level 1 watering:

- the daily PM_{10} criteria is met at the site boundary of the construction works (no off site impacts are predicted)
- the daily $PM_{2.5}$ criteria is met at the site boundary of the construction works (no off site impacts are predicted).

The majority of impacts are predicted to be contained within the project site. The only off site impacts are predicted for daily total impact (project emissions combined with background emissions) PM_{10} for worst case construction conditions with level 2 watering. The two areas of potential impact identified in Figure 10.2 are:

- Area A – the 6 metre impact zone extends on to residential properties located at 142 Banksia Street and 235 Bay Street to the east of the construction works and commercial premises located at 96A Bay Street and residential properties located at 23 Myrtle Street to the west of the construction works.
- Area B – the 6 metre impact zone extends on to commercial premises at 1010–1016 Botany Road, 1008 Botany Road to the northeast of the construction works.

Figure 10.2 Predicted daily PM10 impacts for worst case construction conditions with level 2 watering

Annual construction impacts

The majority of earthworks and dust generating activities would move throughout the project site as each segment of the project is completed. Therefore, it is unlikely that dust generating construction works will be active in the same location for the entire duration of the construction program.

To provide a conservative assessment however, annual project generated emissions and total impact (project emissions combined with background emissions) for TSP, PM_{10} and $PM_{2.5}$ impacts for general construction conditions with level 2 watering have been assessed. This comprehensively assesses potential worst-case air quality impacts for all long-term construction activities (construction activities that occur for over a year in the same location).

The results indicate that there are significant annual background particulate concentrations from existing sources of particulates in the area. The background PM_{10} accounts for 73 percent of the assessment criteria and the background $PM_{2.5}$ accounts for 98 percent of the assessment criteria.

The results of the assessment of general construction conditions with level 2 watering found that:

- the annual TSP assessment criteria is met at the site boundary of the construction works (no off-site impacts are predicted)
- the annual PM_{10} assessment criteria is me at the site boundary of the construction works (no off-site impacts are predicted)
- the annual $PM_{2.5}$ assessment criteria is met at 7 metres from the site boundary of the construction works.

The assessment identified the potential for elevated annually-averaged $PM_{2.5}$ concentrations to occur within seven metres of dust generating construction works if the works occur in the same location for an entire year. The $PM_{2.5}$ exceedance is attributed to high background $PM_{2.5}$ concentrations (98 percent of assessment criteria) despite relatively low project generated emissions.

Annual $PM_{2.5}$ impacts are not anticipated at any location as long-term dust generating construction activities (such as bridge demolition and construction) are not expected to result in continual dust generation for an entire year. It is also unlikely that significant dust generating activities within compound sites would continue for a year as the majority of dust generating activities would be associated with compound site establishment.

10.4 Assessment of operational impacts

10.4.1 Operation overview

The primary source of air quality emissions from the operation of the project are produced from combustion related particle emissions from locomotives. Combustion engines produce emissions that predominantly comprise the following pollutants:

- nitrogen dioxide (NO_2)
- carbon monoxide (CO)
- hydrocarbons (HC)
- sulfur dioxide (SO_2)
- dust in the form of PM_{10} and $PM_{2.5}$.

The quantity of the above pollutants emitted by locomotive operation depends on the following locomotive operational parameters:

- locomotive type
- locomotive speed and notch (throttle position) settings
- locomotive movement (pass bys) frequency.

Locomotive emissions were calculated assuming worst case notch and speed that resulted in the highest emissions. Locomotives were assumed to travel at that worst-case speed/notch for the entire length of track. Worst case emissions occurred when locomotives travel at their slowest speed. The assessment has modelled one operational locomotive per train.

Train movements to and from Port Botany for daytime and night-time periods are presented in Table 10.3. It is acknowledged that the actual train movements would be heavily dependent on demand so peak (maximum expected) movements have been provided and used to predict worst case impacts.

To account for all present and future operational possibilities, Table 10.3 presents the operational scenarios that been considered for peak and daily average train movements per hour. A detailed description of the scenarios is provided in section 6.2 of *Technical Report 3 – Air Quality Impact Assessment*.

Table 10.3 Detailed train movements

SCENARIO	TRAIN MOVEMENTS			
	Daytime (7 am–10 pm)		Night-time (10 pm–7 am)	
	To Port Botany	From Port Botany	To Port Botany	From Port Botany
2019 Existing (to and from Port Botany - daily total)	40			
2024 At opening – no build (without the project)	24	24	14	14
2024 At opening – build (with the project)	24	24	14	14
2034 10 year future – no build (without the project)	28	28	17	17
2034 10 year future – build (with the project)	35	35	21	21

Other sources of emissions are considered insignificant and are not assessed further. This includes:

- wheel and brake actions on rail tracks
- entrainment of surface particles in the rail corridor
- dust emissions during maintenance activities including minor earthworks, plant movements and vegetation trimming
- odour and pollutant emissions from the disturbance of contaminated land during maintenance activities including minor earthworks (further details are provided in sections 12.3 and 1.4).

10.4.2 Operational air quality impacts

Predicted concentrations for each pollutant emitted from operation of locomotives has been compared to the assessment criteria to identify potential exceedances. The results of the operational impact assessment for project generated (incremental) or total impact (project generated plus existing background air quality) emissions predict that:

- NO_2 concentrations – no project generated or total impact exceedances of the criteria are predicted.
- CO concentration – no project generated or total impact exceedances of the criteria are predicted.
- HC concentration (as benzene) – no project generated exceedances of the criteria are predicted. No background concentration data is available to predict total impact concentrations.
- SO_2 concentrations – no project generated or total impact exceedances of the criteria are predicted.
- PM_{10} concentrations – no project generated or total impact criteria exceedances are predicted for both daily and annual averaging periods.
- $PM_{2.5}$ concentrations – no project generated or total impact criteria exceedances are predicted for both daily and annual averaging periods.

Key findings of the operational impact assessment are:

- the air quality criteria are designed to reduce the risks to human health and the environment. The assessment predicts no exceedances of the assessment criteria for any of the assessed pollutants and therefore is not predicted to have adverse air quality impacts in the surrounding areas
- particulate (PM_{10} and $PM_{2.5}$) background concentrations are below the criteria. Background 24 hour concentrations account for 92 percent of the PM_{10} criteria and background annual concentrations account for 73 percent of the PM_{10} criteria. Background 24 hour concentrations account for 91 percent of the $PM_{2.5}$ criteria and background annual concentrations account for 98 percent of the $PM_{2.5}$ criteria
- all other pollutants are below assessment criteria.

General mitigation measures for operation of the project to help reduce any additional impacts are discussed in section 10.6 of this report.

10.5 Cumulative impacts

10.5.1 Overview

The methodology of the cumulative impact assessment and details of other projects considered are detailed in Chapter 24. A summary of the predicted cumulative impacts which relate to air quality are described below.

10.5.2 Cumulative construction impacts

A number of other projects are anticipated to be constructed at the same time and similar location as the project such as the Sydney Gateway road project.

Potential cumulative impacts may include an exacerbation of dust impacts (PM_{10} and $PM_{2.5}$). As the impacts from the construction of the project are predicted to be transitory and confined to an area of seven metres from the boundary of the project site, the cumulative impacts would be minimal unless an additional source of dust (to this project) was generated close to receptors.

10.5.3 Cumulative operational impacts

Background air pollutant concentrations recorded at the Randwick and Earlwood DPIE stations include emissions from all regional sources. Cumulative assessment of all existing regional sources of air pollution are accounted for by including the ambient air quality concentrations measured at the DPIE stations and adding them to the predicted project generated (incremental) emission.

Future sources of air quality emissions include a number of large proposals local to the project site, such as:

- Sydney Gateway road project
- WestConnex New M5
- WestConnex M4-M5
- F6 Extension stage 1
- Banksmeadow Waste Transfer Terminal
- Airport East and Airport North road projects.

It is acknowledged that the operation of the above mentioned projects have the potential to increase air quality pollutant emissions. It is deemed unlikely that future cumulative air quality criteria exceedances would occur as a result of the project due to the following reasons:

- Project generated (incremental) impacts due to the operation of the project account for a relatively small portion of the assessment criteria and localised around the location of the rail duplication.
- The above mentioned projects would complete their own air quality impact assessments that would also identify mitigation measures to reduce the likelihood of any future air quality criteria exceedances. The combination of management measures from all projects would minimise cumulative impacts across the study area.

10.6 Management of impacts

10.6.1 Approach

Overall, the majority of potential construction related air quality impacts would be short term and temporary in nature. The potential for these impacts would be significantly reduced by:

- effective construction design and planning
- implementation of the mitigation measures provided in Table 10.4.

Monitoring requirements are discussed in section 10.6.2. This includes ongoing visual monitoring for construction dust and complaint based particulate sampling. During operation, air quality would be managed in accordance with ARTC's environmental management system. Based on the findings of this assessment, no additional air quality monitoring is proposed during operation of the project. While it is noted that ARTC do not operate the locomotives, it is assumed these locomotives would be operated in accordance with relevant regulatory requirements to minimise air emissions.

A full description of the approach to environmental management and mitigation is provided in Chapter 25.

10.6.2 List of mitigation measures

The mitigation measures that would be implemented to address potential air quality impacts are listed in Table 10.4. This table also outlines which mitigation measures (during the construction stage) would be implemented during the enabling works and main construction works.

Table 10.4 Mitigation measures

STAGE	IMPACT	MEASURE	ENABLING WORKS	MAIN CONSTRUCTION
Construction	Minor and temporary elevated particulate matter (PM_{10}) at receptors within six metres of the construction boundary	Dust suppression will be undertaken as required using water sprays, water carts or other media on: • unpaved work areas subject to traffic or wind • sand, spoil and aggregate stockpiles • during the loading and unloading of dust generating materials. As a minimum, level 1 watering should be undertaken on general construction areas and level 2 watering should be undertaken on heavy construction areas. Further discussion including a description of construction work classification is provided in section 5.2 of *Technical Report 3 – Air Quality Impact Assessment*.	✓	✓
		Visual dust monitoring will be performed on a routine basis, and all staff will be trained to look out for visible dust leaving the worksite in the direction of sensitive receptors. If the works are creating visible dust plumes, the works will be modified or stopped until the dust hazard is reduced to an acceptable level. If complaints are received relating to dust from construction works, works will be reviewed to identify opportunities to reduce potential impacts from dust. In the instance of ongoing dust issues, or complaints, a short term dust monitoring device will be installed in the relevant area which may be adjacent to a sensitive receptor near any longer term construction area.	✓	✓
	Dust from construction vehicles	Construction vehicles with potential for loss of loads (such as dust or litter) will be covered when using public roads.	✓	✓
	Emissions from construction equipment and plant	Plant and equipment will be maintained in good condition to minimise spills and air emissions that may cause air quality impacts.	✓	✓
	Dust from stockpiles	The size of stockpiles will be minimised where possible and located as far as practicable from sensitive receptors.	✓	✓

STAGE	IMPACT	MEASURE	ENABLING WORKS	MAIN CONSTRUCTION
	Contaminated dust with PFAS may become airborne and disperse to receptors	Identified areas which may have elevated PFAS/PFOS concentrations are limited to small areas shown in the *Technical Report 5 – Contamination Assessment* (WSP 2019)). This report includes specific management measures. Dust management measures are considered sufficient to manage dust from areas potentially containing PFAS however high risk areas will be identified in the site induction so all personnel are aware of the importance of dust management in these areas. Dust management measures will prevent visible dust from potentially contaminated areas from leaving the construction site boundary.	✓	✓
	Release of odour and pollutants from disturbance of contaminated land	An unexpected finds protocol will be prepared and implemented as part of the relevant management plan. It would identify the process to follow in the event that indicators of contamination are encountered during construction (such as odours, ACM or visually contaminated materials).	✓	✓
Operation	Emissions	Plant and equipment used for maintenance works will be operated in accordance with manufacturer specifications and ARTC's Safety Management System and Environment Management System.	N/A – Operation	N/A – Operation
	Release of odour and pollutants from contaminated land	Ongoing management measures will be implemented for areas where contamination remains following construction. These management measures will be documented in an environmental management plan that is specific to contamination. In particular, the plan will clearly identify areas of remaining ACM impacts and detail the controls to be implemented during maintenance works likely to disturb soils. The plan will also detail the requirements for periodic inspections of ACM capping layer to ensure its integrity.	N/A – Operation	N/A – Operation

10.6.3 Consideration of the interaction between measures

The management of construction dust and pollutants such as asbestos or odorous contaminants, is described across a number of chapters. In Chapter 12 (Contamination) and Chapter 14 (Soils and water quality), soil and erosion control measures will be managed through a Soil and Water Management Plan during construction in accordance with *Soils and Construction – Managing Urban Stormwater Volume 1* (Landcom, 2004) and *Volume 2A* (DECC, 2008). Implementation of these measures will be guided by the relevant management plan.

Chapter 23 (Climate Change) provides measures to be implemented to manage emissions of greenhouse gases during construction and operation.

10.6.4 Managing residual impacts

A residual risk analysis was undertaken following the impact assessment summarised in this chapter. The results of the residual risk analysis are provided in Appendix B. Residual risks with an assessed level of medium or above are summarised below:

- generation of dust during construction (from exposed soil/stockpiles, excavation and vehicle movements)
- mobilisation of asbestos fibres from disturbance of contaminated soils.

Despite measures taken to avoid and mitigate impacts, the project would result in some unavoidable residual adverse impacts. The mitigation and management measures proposed are expected to manage the potential for impacts on air quality.

11. BIODIVERSITY

This chapter provides a summary of the biodiversity assessment. A full copy of the assessment is provided as *Technical Report 4 – Biodiversity Development Assessment Report*.

11.1 Assessment approach

A summary of the approach to the assessment is provided in this section, including the legislation, guidelines and policies driving the approach and the methodology used to undertake the assessment. A more detailed description of the approach and methodology is provided in *Technical Report 4 – Biodiversity Development Assessment Report*.

11.1.1 Legislative and policy context to the assessment

Biodiversity Conservation Act 2016 and *Biodiversity Conservation Regulation 2017*

The BC Act, together with the *Biodiversity Conservation Regulations 2017,* provides a mechanism to address impacts on biodiversity from land clearing associated with development. Under this legislation, there are provisions for a Biodiversity Offsets Scheme (BOS), which includes a framework to avoid, minimise and offset impacts of development on biodiversity. The Biodiversity Assessment Method (BAM) was established as a standard method to implement the aims of the BOS and to address the loss of biodiversity and threatened species.

The BOS and BAM have been addressed in accordance with the project SEARs through the preparation of *Technical Report 4 – Biodiversity Development Assessment Report*.

Fisheries Management Act 1994

The objectives of the *Fisheries Management Act 1994* (FM Act) are to conserve, develop and share the fishery resources of the State for the benefit of present and future generations. The FM Act provides for the listing of threatened species, populations and ecological communities, listing of ‘Key Threatening Processes’, and the requirements or otherwise for the preparation of a Species Impact Statement (SIS). One of the objectives of the FM Act is to 'conserve key fish habitats' which includes aquatic habitats that are important to the maintenance of fish populations. The NSW DPI has a ‘no net loss’ habitat policy which may require proponents to conduct habitat rehabilitation and/or provide environmental compensation.

This assessment considers the potential effects on key fish habitat associated with Mill Stream, Alexandra Canal and potential effects on threatened species.

The project is being assessed as SSI under Division 5.2 of the EP&A Act. Under section 5.23 of the EP&A Act, a permit under section 201, 205 or 219 of the FM Act is13.1 not required.

Biosecurity Act 2015

The *Biosecurity Act 2015* provides for risk-based management of biosecurity in NSW. It provides a statutory framework to protect the NSW economy, environment and community from the negative impact of pests, diseases and weeds. The primary object of the Act is to provide a framework for the prevention, elimination and minimisation of biosecurity risks posed by biosecurity matter, dealing with biosecurity matter, carriers and potential carriers, and other activities that involve biosecurity matter, carriers or potential carriers.

Priority weeds recorded in the study area have been identified and control measures detailed where appropriate.

Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act provides a legal framework to protect and manage nationally important flora, fauna, ecological communities and heritage places defined as 'matters of national environmental significance' (MNES).

The EPBC Act has been considered in this assessment through:

- a desktop review to determine the listed biodiversity matters that are predicted to occur within the locality of the project, subject to the habitats present
- targeted field surveys for listed threatened biota and migratory species
- assessment of potential effects on MNES and plants and animals, as a component of the environment of Commonwealth land, including assessments of significance in accordance with the EPBC Act Significant Impact Guidelines (Department of the Environment, 2013), where relevant
- identification of suitable impact mitigation and environmental management measures for threatened and migratory biota, where relevant
- identification of the need or otherwise for biodiversity offsets for effects on listed biodiversity matters.

Provisions for the protection of Ramsar sites of international importance are outlined in this Act.

Under the EPBC Act, proposed actions (ie activities or projects) with the potential to significantly impact matters protected by the EPBC Act must be referred to the Australian Minister for the Environment to determine whether they are controlled actions. The Commonwealth Department of Environment and Energy confirmed that the project is not a controlled action and does not require approval from the Australian Minister for the Environment and Energy. A detailed description of the legislative and policy context for the assessment is provided in section 2 of *Technical Report 4 – Biodiversity Development Assessment Report*.

NSW Sustainable design guidelines

NSW Sustainable design guidelines v3.0 (TfNSW 2013) are part of TfNSW process of achieving sustainable best practice. These guidelines identify initiatives and how they can be implemented through monitoring changes in technology and innovation. The initiatives in this guideline have not been included as the project specific mitigation measures provide greater detail on management of impacts.

Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources

Water sharing plans are being progressively developed for rivers and groundwater systems across NSW following the introduction of the *Water Management Act 2000* (WMA 2000). These plans protect the health of our rivers and groundwater. The relevant plan for the study area is for the greater metropolitan region. Communities of potential groundwater dependent ecosystems (GDEs) relating to the study area were identified from the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources* (NSW Government 2011b).

11.1.2 Methodology

Key tasks

Key tasks undertaken for this BDAR have included:

- desktop assessment, including a protected matters database search, to identify landscape-scale features, site context, distribution of native vegetation and threatened ecological communities, and a list of threatened species and populations of flora and fauna
- terrestrial flora surveys including vegetation mapping, identification of plant community types and vegetation zones in accordance with the BAM and targeted threatened flora surveys
- terrestrial fauna surveys including habitat assessments and targeted threatened fauna surveys

- aquatic habitat surveys
- assessment of potential impacts of the project, including identification of measures to avoid and minimise impacts on biodiversity
- identification of offset requirements, including calculation of credit requirements in accordance with the BAM and discussion of offset requirements under the EPBC Act and FM Act.

The assessment also includes:

- key threatening processes listed under the BC Act, FM Act and EPBC Act relevant to this project
- Serious and Irreversible Impact (SAII) entities under the BC Act
- prescribed biodiversity impacts.

The results of these are outlined in *Technical Report 4 – Biodiversity Development Assessment Report*.

Field survey

Threatened flora surveys were undertaken over a three-day period on the 26 June, 19 and 26 September 2018. Surveys focused on the mapping of native and non-native vegetation types and targeting the possible presence of threatened flora species using a combination of vegetation integrity plots, random meanders and parallel field traverses generally in accordance with the NSW *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities* (DEC 2004b).

Fauna surveys were undertaken on the 26 and 27 June, 26 September, 3, 10, 11 and 18 October 2018 in accordance with the BAM and with reference to the NSW *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities* (DEC 2004b) and other species specific survey guidelines. Surveys included habitat surveys, general fauna surveys, bird survey and nocturnal fauna including bats. Targeted Green and Golden Bell Frog surveys at Botany Wetland in and adjacent to the project site, and at Tempe Wetland were carried out on 10, 11, 18 and 30 October 2018.

Study area

The study area includes the project site and some additional areas outside of the rail corridor that would be used as compound sites. It extends to around 10 square kilometres centred on the project site for desk studies.

To determine site context as required under Section 4.3 of the BAM, an assessment of native vegetation cover and patch size in accordance with Subsections 4.3.2 and 5.3.2 of the BAM have been undertaken. This comprised an area of around 500 metres from the project site. Flora and fauna field surveys were carried out in this area.

A detailed description of the assessment methodology is provided in section 3 of *Technical Report 4 – Biodiversity Development Assessment Report*.

11.1.3 Risks identified

The preliminary environmental risk assessment undertaken for the project (provided in Appendix B) included potential risks associated with biodiversity. Potential risks were considered according to the impacts that may be generated by the construction or operation of the project. The likelihood, consequence and overall risk level of each potential risk were assessed, with avoidance and management measures defined for each potential risk. Further information on the risk assessment, including the approach, methodology and the full results, is provided in Appendix B.

Prior to assessment and identification of mitigation measures, risks with an assessed level of medium or above include:

- clearing of native vegetation resulting in loss of fauna habitat
- direct impacts on threatened species and endangered populations and communities (terrestrial) from clearing
- indirect impacts due to increased dust, sedimentation and erosion, noise, light
- disturbance to aquatic habitats and reduced water quality as a result of sedimentation and altered hydrology
- native fauna mortality from vehicle strikes due to construction vehicles.

These potential risks and impacts were considered as part of the assessment. The assessment also considered matters identified by the SEARs and stakeholders (as described in Chapters 3 and 4). The residual risk levels, following implementation of the mitigation measures proposed in this EIS, are discussed in section 11.7.5.

11.1.4 How potential impacts have been avoided or minimised

As described in Chapters 6 and 7, design development and construction planning has included a focus on avoiding or minimising the potential for environmental impacts during all key phases of the process.

The project has adopted the following 'avoid, minimise and offset' approach to mitigate impacts on biodiversity values in accordance with the BAM, the BC Act and associated policy. In line with this approach, potential biodiversity impacts have been avoided or minimised where possible by:

- avoiding impacts on habitat, through the project planning and design process
- minimising impacts on habitat, through the use of a range of environmental management and impact mitigation measures
- identifying offset requirements for any residual impact that could not be avoided or mitigated.

There are small patches of vegetation consistent with the EECs Swamp Oak Floodplain Forest and Sydney Coastal Freshwater Wetlands adjacent to the rail corridor. The project site has been purposefully designed to avoid vegetation removal in these areas as far as is practicable.

Construction compounds and other construction areas have been selected to avoid impacts on areas of significant ecological communities and species. Where possible, these areas have been positioned within previously disturbed areas. This may include the use of the current (Roads and Maritime Services) Airport East project site located adjacent to General Holmes Drive.

11.2 Existing environment

11.2.1 Terrestrial flora

Plant Community Type (PCT)

Two native vegetation PCTs were recorded in the project site. These are:

- PCT 1071 *Phragmites australis* and *Typha orientalis* Coastal Freshwater Wetlands of the Sydney Basin Bioregion (PCT 1071 Coastal Freshwater Wetlands)
- PCT 1234 Swamp Oak Swamp Forest Fringing Estuaries, Sydney Basin Bioregion and South East Corner Bioregion (PCT 1234 Swamp Oak Forest).

An overview of the type and zone is provided in Table 11.1.

Table 11.1 Overview of native vegetation types and zones identified within the project site

VEGETATION TYPE	VEGETATION ZONE (VZ)	BC ACT THREATENED ECOLOGICAL COMMUNITY	EPBC ACT STATUS	VEGETATION FORMATION	VEGETATION CLASS	PCT % CLEARED	PATCH SIZE (ha)	VEGETATION INTEGRITY SCORE	EXTENT IN PROJECT SITE (ha)
PCT 1071	VZ1 – Moderate	Freshwater wetland on coastal floodplains – Endangered BC Act	Not listed	KF_CH8 Freshwater Wetlands	Coastal Freshwater Lagoons	75	<5	65.2	0.10
PCT 1234	VZ2 – Poor	Swamp Oak Floodplain Forest – Endangered BC Act	Does not meet key characteristics or condition thresholds for EPBC Act listing.	KF_CH9 Forested Wetlands	Coastal Floodplain Wetlands	90	5-24	25.7	0.46
	VZ3 – Low						<5	22.7	0.16
								Total native vegetation	0.72

In addition, three non-native vegetation types were assigned to a miscellaneous ecosystem class. Non-native vegetation types do not meet floristic or structural characteristics of any recognised native PCT. The miscellaneous ecosystem types identified are:

- highly disturbed areas with no or limited native vegetation
- urban exotic/native landscape plantings
- water bodies.

An overview of the ecosystem types and extent in the project site is provided in Table 11.2. The highly disturbed vegetation type occurs over the majority of the project site (about 5.53 hectares) and is the result of previous clearing and ongoing maintenance of rail infrastructure.

Table 11.2 Overview of non-native vegetation types and zones identified within the project site

VEGETATION TYPE	VEGETATION ZONE (VZ)	EXTENT IN PROJECT SITE (ha)
Miscellaneous ecosystem – highly disturbed areas with no or limited native vegetation	VZ4	5.53
Miscellaneous ecosystem – urban exotic/native landscape plantings	VZ5	1.92
Miscellaneous ecosystem – water bodies	VZ6	0.10
	Total non-native vegetation	7.55

These two native and three non-native vegetation types (listed above) were assigned to six discrete vegetation zones based on broad vegetation condition class criteria. The total area of vegetation recorded is 8.27 hectares.

The project site is located predominantly within the existing rail corridor. The rail corridor is periodically cleared to allow for ongoing operations and maintenance of the existing line and management of weeds.

The location of vegetation types within the study area is illustrated in Figure 11.1.

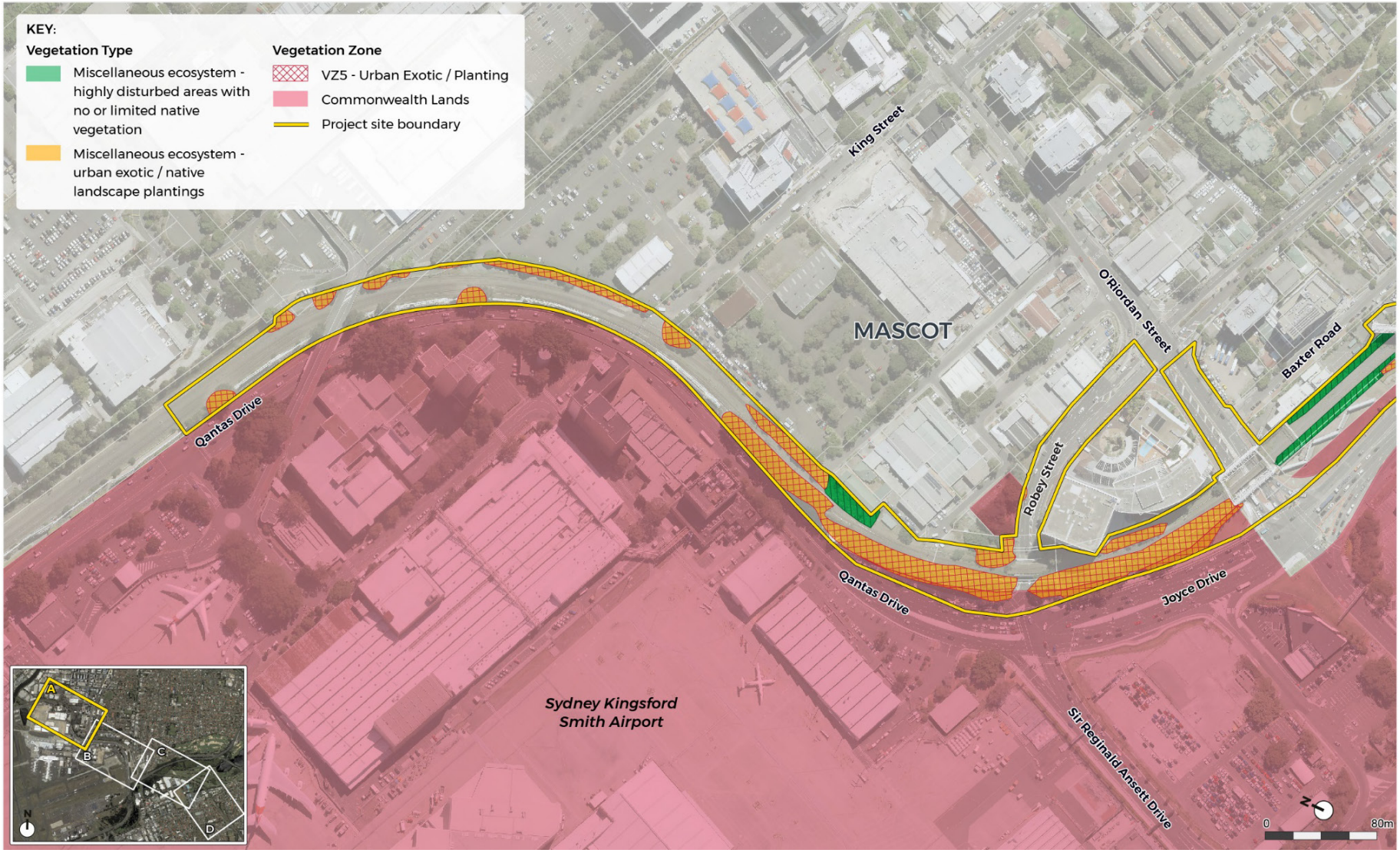


Figure 11.1a Vegetation types and threatened biodiversity with the study area

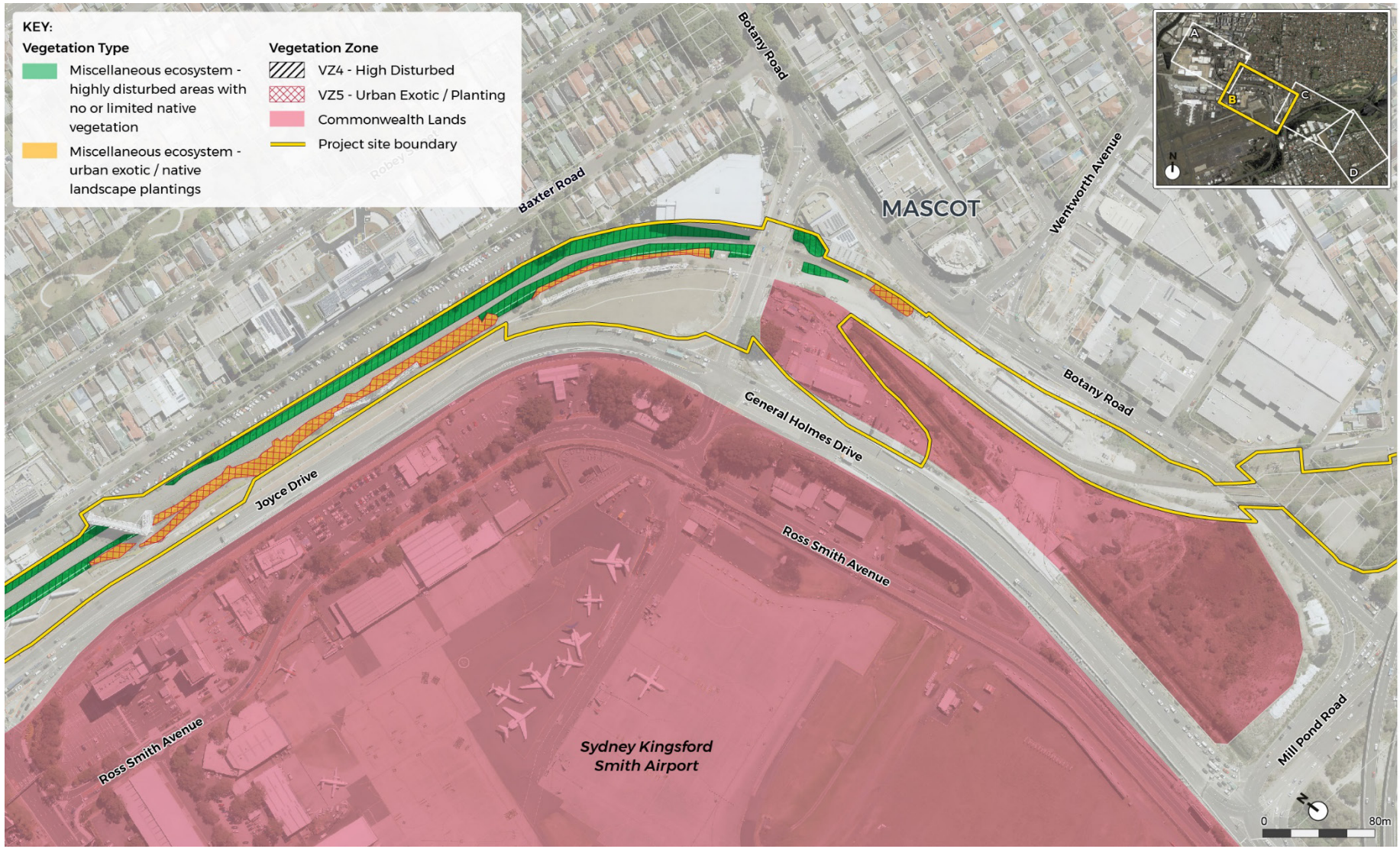


Figure 11.1b Vegetation types and threatened biodiversity with the study area

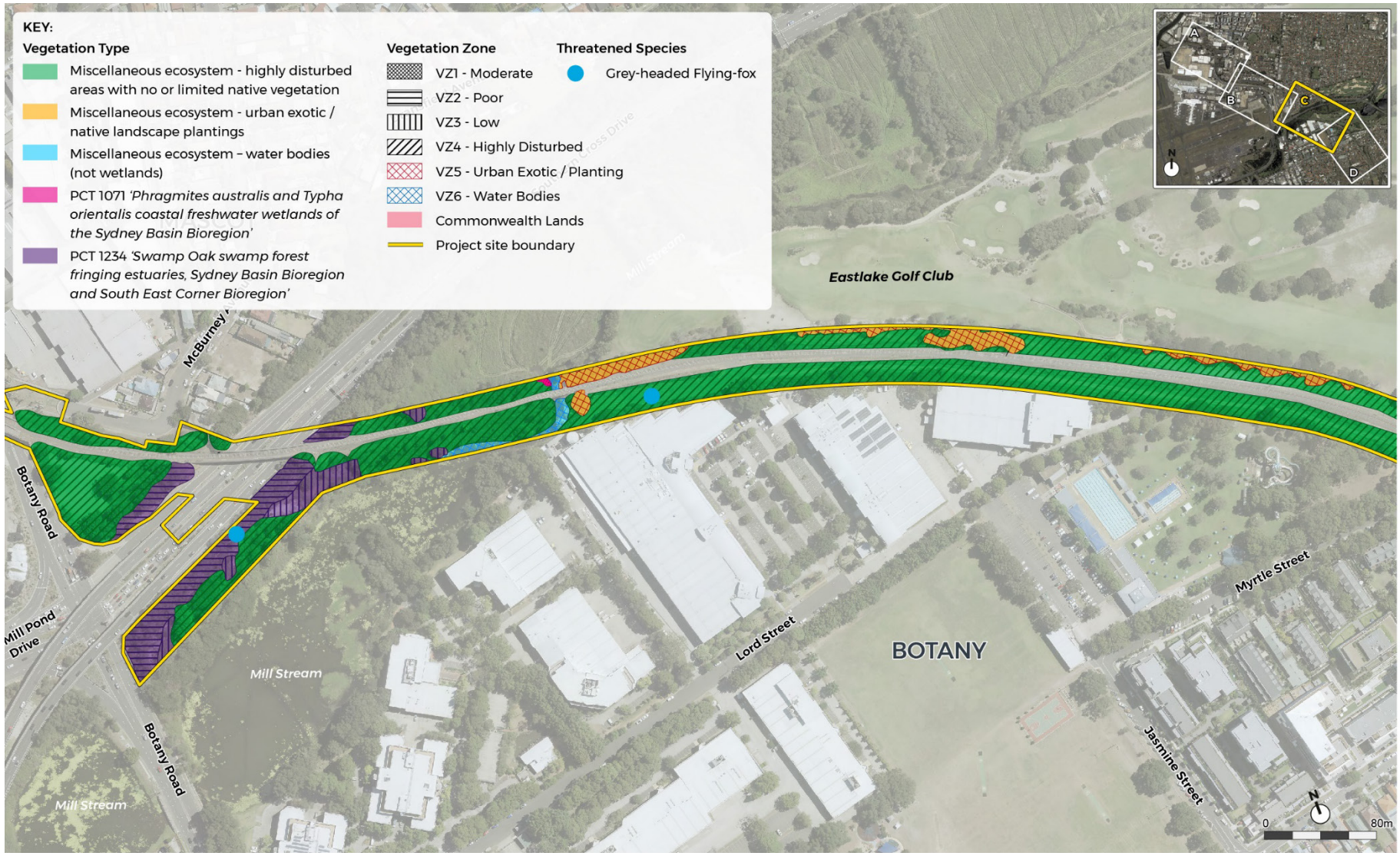


Figure 11.1c Vegetation types and threatened biodiversity with the study area

Figure 11.1d Vegetation types and threatened biodiversity with the study area

Priority weeds

Thirteen species identified during field survey were listed under the NSW *Biosecurity Act 2015* as priority weeds for the Greater Sydney region (DPI, 2018) while nine are also Commonwealth listed Weeds of National Significance (AWC, 2015) as weeds comprising the highest threat nationally. All priority weeds and Weeds of National Significance identified are outlined in Table 11.3. Landowners and land managers are responsible for managing these weeds and preventing their spread. Specific duties for land managers under the *Biosecurity Act 2015* are listed in Table 11.3.

Table 11.3 Priority weeds and weeds of national significance

SCIENTIFIC NAME	COMMON NAME	DUTY UNDER THE *BIOSECURITY ACT 2015*	WEED OF NATIONAL SIGNIFICANCE?
Alternanthera philoxeroides	Alligator Weed	Prohibition on dealings: Must not be imported into the State or sold. Land managers prevent spread from their land where feasible. Exclusion zone: The plant is eradicated from the land and the land kept free of the plant. Core infestation area: Land managers mitigate the risk of new weeds being introduced to their land. Land managers reduce the impact on priority assets.	Yes
Anredera cordifolia	Madeira Vine	Prohibition on dealings: Must not be imported into the State or sold.	Yes
Arundo donax	Giant Reed	Regional Recommended Measure: Land managers should mitigate the risk of new weeds being introduced to their land. The plant should not be bought, sold, grown, carried or released into the environment.	No
Asparagus aethiopicus	Ground asparagus	Prohibition on dealings: Must not be imported into the State or sold.	Yes
Asparagus plumosus	Climbing Asparagus Fern	Prohibition on dealings: Must not be imported into the State or sold.	Yes
Cestrum parqui	Green Cestrum	Regional Recommended Measure: Land managers should mitigate the risk of new weeds being introduced to their land. The plant should not be bought, sold, grown, carried or released into the environment.	No
Chrysanthemoides monilifera subsp. *rotundata*	Bitou Bush	Prohibition on dealings: Must not be imported into the State or sold. Biosecurity Zone: The Bitou Bush Biosecurity Zone is established for all land within the State except land within 10 kilometres of the mean high water mark of the Pacific Ocean between Cape Byron in the north and Point Perpendicular in the south (includes the study area).	Yes

SCIENTIFIC NAME	COMMON NAME	DUTY UNDER THE *BIOSECURITY ACT 2015*	WEED OF NATIONAL SIGNIFICANCE?
Cortaderia selloana	Pampas Grass	Regional Recommended Measure: Land managers should mitigate the risk of new weeds being introduced to their land. The plant should not be bought, sold, grown, carried or released into the environment. This Regional Recommended Measure applies to *Cortaderia jubata* (pink pampas grass).	No
Lantana camara	Lantana	Prohibition on dealings: Must not be imported into the State or sold.	Yes
Olea europaea subsp. *cuspidata*	African Olive	Regional Recommended Measure: The Greater Sydney region is classified as the core infestation area. Whole region: The plant or parts of the plant are not traded, carried, grown or released into the environment. Core infestation area: Land managers prevent spread from their land where feasible. Land managers reduce impacts from the plant on priority assets.	No
Opuntia sp.	Prickly Pear	Prohibition on dealings: Must not be imported into the State or sold.	Yes
Rubus fruticosus agg.	Blackberry	Prohibition on dealings: Must not be imported into the State or sold.	Yes
Senecio madagascariensis	Fireweed	Prohibition on dealings: Must not be imported into the State or sold.	Yes

Threatened ecological communities

One threatened ecological community listed under the EPBC Act, being the 'Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community', was considered as a candidate to occur within the study area. However, the patches of this habitat present within the study area do not meet the patch size or understory cover thresholds to meet the listing under the EPBC Act.

Two threatened ecological communities listed under the BC Act were recorded within the study area. These are:

- Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions.
- Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions.

The conservation status of each recorded threatened ecological community, associated PCT, vegetation zone and extent within the project site is provided in Table 11.4. Vegetation zones indicate the condition of an area related to levels of disturbance, weed invasion and resilience for example.

Table 11.4 A summary of threatened ecological communities listed under the BC Act recorded within the project site

THREATENED ECOLOGICAL COMMUNITY	STATUS[1]	PLANT COMMUNITY TYPE	VEGETATION ZONE	EXTENT IN PROJECT SITE
Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	E	PCT 1071 *Phragmites australis* and *Typha orientalis* Coastal Freshwater Wetlands of the Sydney Basin Bioregion	VZ1 Moderate condition	0.1 ha
Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	E	PCT 1234 Swamp Oak Swamp Forest Fringing Estuaries, Sydney Basin Bioregion and South East Corner Bioregion	VZ2 Poor condition	0.46 ha
			VZ3 Low condition	0.16 ha
			Total	0.72 ha

(1) E= listed as an endangered species under the BC Act

Groundwater dependent ecosystems

Communities of potential groundwater dependent ecosystems (GDEs) relating to the study area were identified from the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources* (NSW Government 2011b) and the Bureau of Meteorology (BOM) *Groundwater Dependent Ecosystems Atlas* (BOM 2018).

Parts of the Botany Wetlands northeast of Wentworth Avenue (over one kilometre upstream of the project site) are mapped as an aquatic GDE, while small patches of native vegetation associated with the Botany Wetlands, including some near the project site, are mapped as terrestrial GDEs (BOM 2018). Aquatic ecosystems rely on the surface expression of groundwater such as rivers and wetlands. Terrestrial ecosystems rely on the subsurface presence of groundwater.

The Botany Sand Beds Aquifer is a large subterranean GDE that extends from Botany Bay northwards to Surry Hills and Centennial Park (BOM 2018). It is relatively shallow (1–2 metres below the surface), and has been an important groundwater source for the area for many decades. Due to the permeability of the sands, shallowness of the aquifer and a long history of industry in many parts of the aquifer's catchment, the Botany Sand Beds Aquifer has been and continues to be, highly vulnerable to contamination (Bayside Council 2019).

It is likely that patches of PCT 1234 Swamp Oak Forest in the project site are dependent on groundwater to some degree, given the BOM (2018) mapping of other patches of PCT 1234 Swamp Oak Forest in the Botany Wetlands as being groundwater dependent. Surface water studies undertaken as part of this EIS suggest that Mill Stream and its associated riparian vegetation is contaminated from the Botany Sand Beds Aquifer (see section 14.2).

Threatened flora species and habitats

Limited potential habitat for threatened flora species has been identified in the study area. The overall likelihood of occurrence for the 27 threatened flora species that are known or predicted to occur within the locality have been assessed as low. Given remnant native vegetation patches of PCT 1071 and PCT 1234 are mostly disturbed and provide limited habitat for threatened flora species, the likelihood of future threatened flora occurrence is also considered low.

Four threatened flora species were considered as candidate species. These species were identified based on the BAM candidate species report for the project provided in *Technical Report 4 – Biodiversity Development Assessment Report*. A brief overview of survey and likelihood assessment results for each threatened flora candidate species and how this relates to the project is presented in Table 11.5.

Table 11.5 Threatened flora candidate species assessment results

SCIENTIFIC NAME COMMON NAME (if available)	BC ACT STATUS[1]	EPBC ACT STATUS[1]	DESCRIPTION AND SURVEY RESULTS
Ancistrachne maidenii	V	–	There are no known records of this species in the locality. The study area does not contain specific geological habitat and no individuals were observed within native vegetation patches (PCT 1234) during targeted surveys. Based on the lack of recent records and absence of suitable habitat, the potential occurrence of this species within the study area is considered low. Given this, *Ancistrachne maidenii* is not considered affected by the project and as such no further consideration or assessment of this species is deemed warranted.
Cryptostylis hunteriana Leafless Tongue Orchid	V	V	This species has not been recorded within the project locality. Within the study area, documented potential habitat identified by the BAM calculator occurs in the form of PCT 1234. This vegetation type has been recorded in poor and low condition with both classes exhibiting an understorey that has been highly disturbed, has low native species richness/cover and is mostly dominated by transformer exotic weed cover. While flora surveys were conducted outside the known flowering period for this species, the lack of any records in the locality and the generally unfavourable understorey habitat conditions lead to a low likely occurrence of this species within the study area is considered. Given this, *Cryptostylis hunteriana* is not considered affected by the project and as such no further consideration or assessment of this species is deemed warranted.
Wilsonia backhousei Narrow-leafed Wilsonia	–	–	This species has not been recorded within the project locality. The occurrence of this species within the broader Sydney region is mostly restricted to discrete populations in the localities of the Parramatta River at Ermington, Clovelly, Voyager Point and the Royal National Park (OEH 2018a). Habitat associated with this species is generally restricted to the margins of salt marshes and lakes with potential habitat listed to include PCT 1234. Within the study area, the vegetation type PCT 1234 has been recorded in poor and low condition with both classes exhibiting an understorey that has been highly disturbed, have low native species richness/cover and are mostly dominated by transformer exotic weed cover.

SCIENTIFIC NAME COMMON NAME (if available)	BC ACT STATUS[1]	EPBC ACT STATUS[1]	DESCRIPTION AND SURVEY RESULTS
			There are no seasonality issues associated with surveying for *Wilsonia backhousei* as the species is readily identifiable all year (OEH 2018b). Targeted surveys failed to identify any individuals of this species and given the lack of any records in the locality and the generally unfavourable understorey habitat conditions, the likely occurrence of this species within the study area is considered low. Given this, *Wilsonia backhousei* is not considered affected by the project and as such no further consideration or assessment of this species is deemed warranted.
Zannichellia palustris	E	–	*Zannichellia palustris* is a submerged aquatic plant that is only known from the lower Hunter and Sydney Olympic Park in NSW. The plant grows in fresh or slightly saline stationary or slowly flowing water. *Zannichellia palustris* flowers during the warmer months and completely dies back every summer. This species has not been recorded within the locality. Targeted surveys were conducted in PCT 1071 and standing water associated with the Mill Stream. No individuals of this species were observed despite surveys being conducted during favourable seasonal conditions. Given this, *Zannichellia palustris* is not considered affected by the project and as such no further consideration or assessment of this species is deemed warranted.

(1) E: endangered species; V: vulnerable species

No threatened flora were identified during surveys, and no threatened flora are likely to occur given the absence of suitable habitat in the project site. The project is therefore considered unlikely to impact on threatened flora species or their habitats and as such no species are considered affected in terms of project impacts and therefore no offset has been identified adopting relevant BAM calculations.

11.2.2 Terrestrial fauna

Fauna survey results

A moderate diversity of species was recorded during field surveys, with better quality habitats at Botany Wetlands contributing to the range of species present. Most species are those typical of urban environments and wetlands in urban areas.

A total of 67 species were recorded in the study area. This comprised 46 bird species, nine mammal species, five reptile species, four frog species, three fish species and ten introduced species.

Two threatened species listed as vulnerable under the BC Act, were recorded during surveys. These were the Grey-headed Flying-fox (*Pteropus poliocephalus*) and the Eastern Bentwing Bat (*Miniopterus schreibersii oceanensis*). The Grey-headed Flying-fox is also listed as vulnerable under the EPBC Act.

Migratory species

Botany Bay and surrounds, and in particular Towra Point Nature Reserve around 6.5 kilometres from the site, are known to provide habitat for a range of migratory species listed under the EPBC Act. Further discussion of these habitats is provided in section 11.2.3. No habitat suitable for migratory species has been identified within the project site.

Terrestrial fauna habitats

Much of the land within the study area has been previously cleared of native vegetation for the existing rail corridor, roads, residential, industrial and recreation areas. The majority of the rail corridor is cleared and planted with introduced grasses and herbs interspersed with bare ground, ballast and other artificial substrates. Planted trees also occur in some areas, as do thickets of weeds such as Lantana. Much of the study area therefore provides low habitat value for terrestrial fauna.

Fauna habitats with higher biodiversity value are located in areas adjacent to the rail corridor and include the Botany Wetlands associated with Mill Stream, which is crossed by the rail corridor. This area contains freshwater wetlands and PCT 1234 Swamp Oak Forest. Proposed compound sites also contain a combination of native vegetation, planted introduced trees and weed infestations.

Habitats identified comprise:

- highly disturbed areas (exotic grassland)
- urban exotic and planted native species
- PCT 1234 Swamp Oak Forest
- PCT 1071 Coastal Freshwater Wetlands.

These habitats and potential associated species are discussed further below.

Highly disturbed areas (exotic grassland)

Exotic grassland is present within areas of the rail corridor where areas are used for access, operations or other maintenance of the rail network. These areas are narrow and some areas are isolated from other habitat. Exotic grassland is interspersed with ballast, bare ground and other artificial substrate. Some planted trees and shrubs are present. These areas would have historically supported native woodland vegetation but have been extensively modified by previous clearing.

Exotic grassland contains few habitat resources of relevance to most native species due to its low structural and floristic diversity. Exotic grasses and herbs would provide foraging resources for relatively mobile and opportunistic native fauna species.

Figure 11.2 Exotic grassland adjacent to Banksia Street

Figure 11.2 shows a typical example of this habitat type located adjacent to Banksia Street. Table 11.6 identifies the potential species which may be recorded in this habitat type and species identified during the field surveys.

Table 11.6 Fauna habitats – Highly disturbed areas (exotic grassland)

	POTENTIAL SPECIES
Typical fauna species recorded or likely to occur	Bird species commonly recorded in this habitat type included the Crested Pigeon (*Ocyphaps lophotes*), Welcome Swallow (*Hirundo neoxena*), Magpie-lark (*Grallina cyanoleuca*), Superb Fairy-wren (*Malurus cyaneus*), Willie Wagtail (*Rhipidura leucophrys*) and Grey Fantail (*Rhipidura albiscapa*). These species are insectivorous and were observed foraging within mown portions of the grassland. Small, common lizards such as the Dark-flecked Garden Sunskink *(Lampropholis delicata*) are likely to occur in this habitat type, particularly in areas where shelter such as ballast or woody debris is present. The Common Eastern Froglet (*Crinia signifera*) was heard calling from a table drain in grassland areas. Other common native frog species, including the brown Striped Frog (*Limnodynastes peronii*) would also likely occur in drains in these areas.
Threatened fauna species	Microchiropteran bats such as the Eastern Bentwing Bat (*Miniopterus schreibersii oceanensis*) may forage over this habitat type on occasion.
Migratory species	No migratory species were observed and none are likely to occur in this habitat type.
Introduced species	During field survey the following were identified: Rock Dove (*Columba livia*) and feral/domestic cat (*Felis catus*).

Urban exotic and planted native species

Exotic forest and scrub and planted native species are present on the fringes of the rail corridor. Exotic forest and scrub is dominated by dense midstorey vegetation of variable structural complexity and includes Camphor Laurel (*Cinnamomum camphora*) and Lantana. These areas appear to have been once cleared, but have since overgrown.

Patches of weeds and planted native or exotic trees and shrubs within the rail corridor provide potential foraging habitat for a range of common bird species and mammal species typical of urban parks and gardens.

Figure 11.3 Urban exotic forest and scrub adjacent to Botany Road

Figure 11.3 shows a typical example of this habitat type located adjacent to Botany Road. Table 11.7 identifies the potential species which may be recorded in this habitat type and species identified during the field surveys.

Table 11.7 Fauna habitats – Urban exotic and planted native species

	POTENTIAL SPECIES
Typical fauna species recorded or likely to occur	Large flocks of honeyeaters, including the Yellow-faced Honeyeater (*Caligavis chrysops*) and New Holland Honeyeater (*Phylidonyris novaehollandiae*) were observed foraging within this habitat type. Red-whiskered Bulbuls (*Pycnonotus jocosus*) were recorded in exotic forest and scrub adjacent to wetland areas. Smaller flocks of Silvereyes (*Zosterops lateralis*) were recorded foraging on the edge of the rail corridor and in Eastlake Golf Club. Native mammals, including the Common Ring-tailed Possum (*Pseudocheirus peregrinus*) and small introduced mammals, such as Black Rats (*Rattus rattus*) may den and forage in the dense midstorey of exotic scrub, although none were recorded.
Threatened fauna species	The Grey-headed Flying-fox was recorded flying over the site, and may forage in planted eucalypts and figs when specimens are flowering or fruiting. No breeding camps are present. Microchiropteran bats such as the Eastern Bentwing Bat (*Miniopterus schreibersii oceanensis*) and Eastern Freetail Bat (*Mormopterus norfolkensis*) may forage in these habitats on occasion. No hollow-bearing trees were observed that would be suitable for bats to roost in.
Migratory species	No migratory fauna species were recorded during surveys. Migratory terrestrial woodland species such as the Rufous Fantail (*Rhipidura rufifrons*) could occur on occasion, but would unlikely depend on the habitats present.
Introduced species	During field survey the following were identified: Common Myna (*Sturnus tristis*), Eurasian Blackbird (*Turdus merula*), Red-whiskered Bulbul (*Pycnonotus jocosus*), feral cat (*Felis catus*) and Black Rat (Rattus rattus).

PCT 1234 Swamp Oak Forest

Riparian forest occurs in a small patch adjacent to Mill Stream within the rail corridor. This forest was dominated by Swamp Oak, with various introduced canopy species also present, including Coral trees and Mulberry trees. This vegetation contains a moderate to severe weed infestation with evidence of erosion where the batter slopes are steep.

Understorey vegetation closer to the Mill Stream waterline contains moisture loving species such as rushes and sedges.

No hollow-bearing trees were identified at the time of surveys in this habitat type.

Canopy species provide foraging and shelter resources for a range of bird species. Foraging resources include seasonal nectar resources, seeds and insects. Winter-flowering acacias would help provide year-round foraging resources for a range of nectarivorous native birds, bats and possums.

High quantities of woody debris and leaf litter are present, where exotic canopy species such as Camphor Laurel are present. Fallen timber and leaf litter provides shelter and foraging habitat for small reptiles and snakes. Dense weed infestations are present along the creek banks which may also reduce habitat quality for some species.

Figure 11.4 PCT 1234 Swamp Oak Forest alongside Botany Wetland

Figure 11.4 shows a typical example of this habitat type located alongside Botany Wetland. Table 11.8 identifies the potential species which may be recorded in this habitat type and species identified during the field surveys.

Table 11.8 Fauna habitats – PCT 1234 Swamp Oak Forest

	POTENTIAL SPECIES
Typical fauna species recorded	A moderate number of nectarivorous bird species were observed foraging within the dense midstorey of riparian forest, including the Scarlet Honeyeater (*Myzomela sanguinolenta*), Silvereye (*Zosterops lateralis*), Lewin's Honeyeater (*Meliphaga lewinii*) and Yellow-faced Honeyeater (*Caligavis chrysops*). Seed eaters, including Red-browed Finches (*Neochmia temporalis*) were also observed. Other bird species recorded included the Rufous Whistler (*Pachycephala rufiventris*), Spotted Pardalote (*Pardalotus punctatus*) and Grey Fantail (*Rhipidura albiscapa*). Some of these species also occur in forest patches away from riparian corridors. A number of snake eggs were recorded within mounds of sand in this habitat type, likely from the Eastern Brown Snake (*Pseudonaja textilis*).
Threatened fauna species	The Grey-headed Flying-fox (*Pteropus poliocephalus*) was recorded flying over the study area and foraging within fruiting Mulberry trees. Limited foraging habitat is present within the study area for this species. There is no roosting habitat or camp sites.
Migratory species	No migratory fauna species were recorded during surveys. Migratory woodland species such as the Rufous Fantail (*Rhipidura rufifrons*) could occur on occasion, but would not depend on the habitats present.
Introduced species	During field survey, the following were identified: Red-whiskered Bulbul (*Pycnonotus jocosus*), Common Starling (*Sturnus vulgaris*) and Black Rat (*Rattus rattus*).

PCT 1071 Coastal Freshwater Wetlands

The study area crosses Botany Wetland, which contains a number of ponds associated with Mill Stream. Large expanses of open water were observed in wetlands south of Southern Cross Drive. Smaller waterbodies with extensive reed beds also occur in the study area, particularly adjacent to East Lakes Golf Club. Wetlands in the study are connected with wetlands to the north in The Lakes Golf Club and also Eastlake Golf Club.

These areas range in habitat value for native fauna depending on their size and presence of emergent or aquatic vegetation. Wetlands contained a low diversity of aquatic vegetation including *Typha orientalis*. Open water in some areas was heavily choked with aquatic weed.

Figure 11.5 Wetland south of Southern Cross Drive bordered by reed habitat

Figure 11.5 shows a typical example of this habitat type in the study area. Table 11.9 identifies the potential species which may be recorded in this habitat type and species identified during the field surveys.

Table 11.9 Fauna habitats – PCT 1071 Coastal Freshwater Wetlands

	POTENTIAL SPECIES
Typical fauna species recorded	A moderate diversity and abundance of native waterfowl, waders and other wetland birds were observed in these water bodies. An unidentified falcon species (*Falco* spp.) was observed flying over the study area. A range of ducks and grebes was observed, including various common species. Many Eurasian Coot (*Fulica atra*) and some Australasian Grebe (*Tachybaptus novaehollandiae*) were recorded foraging in open water. The Purple Swamphen (*Porphyrio porphyrio*), Royal Spoonbill (*Platalea regia*), eastern Great Egret (*Ardea modesta*) and Dusky Moorhen (*Gallinula tenebrosa*) were observed foraging in the shallows of wetlands. Little Pied Cormorants (*Microcarbo melanoleucos*) and Little Egrets (*Egretta garzetta*) were recorded perching on submerged woody debris and on the edges of riparian vegetation overlooking the wetland in the study area. Eastern Snake-necked Turtles (*Chelodina longicollis*) were recorded basking at the old jetty, and Eastern Water Skinks (*Eulamptus quoyi*) were observed basking on the footpath at Botany Road. Eastern Water Dragons (*Intellagama lesueurii*) were observed near the rail bridge. The wetlands provide potential habitat for the Green and Golden Bell Frog (*Litoria aurea*) however none were recorded during targeted surveys (see *Technical Report 4 – Biodiversity Development Assessment Report* for detailed survey methodology). This species was last recorded in 1993 at this location and is considered to be no longer present at Botany Wetland (White and Pyke 2008a). Common frog species recorded included the Dwarf Eastern Tree Frog (*Litoria fallax*), Peron's Tree Frog (*Litoria peroni*) and Common Eastern Froglet (*Crinia signifera*). The Dwarf Eastern Tree Frog and Common Eastern Froglet were recorded at one backwater in Pond 1a about 200 metres upstream of the rail bridge. The Dwarf Eastern Tree Frog was also heard calling at various locations around Mill Pond downstream of the rail bridge. Peron's Tree Frog was heard calling near Botany Road. No frogs were heard or observed in the large *Typha orientalis* patch immediately upstream of the rail bridge. The location of water bodies are shown in Figure 11.6. Long-finned Eels (*Anguilla rhinehardtii*), Common Carp (*Cyprinus carpio*) and Mosquitofish (*Gambusia holbrooki*) were also observed in a number of wetlands.
Threatened fauna species	The Eastern Bentwing Bat was possibly recorded at the rail bridge based on Anabat analysis. No calls of the Southern Myotis (*Myotis macropus*) (or any similar calls of *Nyctophilus* species) were recorded. No bats were observed at the rail bridge at dusk, or foraging above the Botany Wetlands during frog surveys.
Migratory species	No migratory species were recorded during surveys. DPIE (OEH 2018a) records show that a number of species have been observed in the Botany Wetlands on rare occasions, including the Sharp-tailed Sandpiper (*Calidris acuminata*), Wood Sandpiper (*Tringa glariola*) and Latham's Snipe (*Gallinago hardwickii*).
Introduced species	During field survey the following were identified: Common Carp (*Cyprinus carpio*) and Mosquitofish (*Gambusia holbrooki*).

Threatened fauna species and populations

One threatened fauna species listed as vulnerable under the EPBC Act and the BC Act, the Grey-headed Flying-fox, was recorded in the project site. Occasional fig trees, eucalypts and mulberry trees occur along the edges of the rail corridor and in planted vegetation in the project site. Grey-headed Flying-foxes would forage in these trees on occasion when fruiting or flowering. There is no breeding camp in the project site. Nearby breeding camps include those at Wolli Creek (three kilometres to the west) and Centennial Park (5.5 kilometres to the northeast). Foraging habitat in the project site would be a negligible proportion of available foraging habitat used by individuals from these camps and thus would not be habitat critical to the survival of the species.

The location of threatened species identified within the study area is illustrated in Figure 11.1.

This assessment has considered the predicted threatened species and candidate species (credit species) as required by the BAM. The findings are summarised below.

Threatened species

Following the desktop assessment and habitat assessments conducted in the field, two threatened fauna species were considered to be species for which offsetting credits may need to be calculated: The Green and Golden Bell Frog and the Southern Myotis. A discussion of the presence of these species is summarised in Table 11.10.

Table 11.10 Threatened species (candidates for offsetting credits)

SCIENTIFIC NAME COMMON NAME	BC ACT STATUS[1]	EPBC ACT STATUS[1]	DISCUSSION
Litoria aurea Green and Golden Bell Frog	E	V	Detailed surveys for the Green and Golden Bell Frog were conducted in suitable weather conditions over a number of months. Most surveys were conducted in months identified as suitable in the survey guidelines for the species (DEWHA 2010a). Green and Golden Bell Frogs were active at other reference sites during the survey period indicating that the survey was conducted in the appropriate season. No evidence of the species has been recorded at Botany Wetlands since 1993, and it is accepted by DOEE in the Green and Golden Bell Frog species profile (DOEE 2018c) to no longer be present in this area. Given this, the Green and Golden Bell Frog is not considered likely to be affected by the project and as such no further consideration or assessment of this species is considered necessary.
Myotis macropus Southern Myotis	V	–	No evidence of roosting bats was observed at the bridge over Mill Stream at the Botany Wetlands. No hollow-bearing trees were observed in the vicinity of the wetland that could be used for roosting by this species. No calls attributable to this species were recorded on anabats at Botany Wetland, within the rail corridor, at the Alexandra Canal or Tempe Wetland. There are no records of the species in the last 30 years associated with Botany Wetlands (OEH 2018a). The Southern Myotis is therefore not considered likely to be affected by the project and as such no further consideration or assessment of this species is considered necessary.

(1) E: endangered species; V: vulnerable species

11.2.3 Aquatic ecology

Aquatic habitats

The project is located within the catchments of Alexandra Canal (which is a sub-catchment of the Cooks River catchment) and the Mill Stream catchment (which is a sub-catchment of the Georges River catchment). Mill Stream is part of the Botany Wetlands, which are the largest freshwater wetlands in the Sydney Metropolitan Region.

Figure 11.6 shows the location of the Botany Wetlands and Sydney Airport Wetlands which are local to the project site.

The project crosses the Botany Wetlands at Mill Stream adjacent to Mill Pond. Upstream of the existing rail bridge Mill Stream is a small water channel adjacent to a raised sediment island dominated by *Typha orientalis*. Some deeper pools occur further upstream. Large beds of Myriophyllum (*Myriophyllum aquaticum*) and Ribbon Weed (*Valiseria americana*) are present in the channel and larger polls. A large gross pollutant trap upstream of sediment island (between New Pond and Pond 1a) was observed during surveys to have trapped large amounts of rubbish and is also likely to be a barrier to fish movement along Mill Stream.

Mill Pond downstream of the existing rail bridge (and adjacent to Botany Road) is a large open pond area dominated by Myriophyllum. Lilies are present in the downstream end of the pond along with a high concentration of surface scum and algae. Some *Typha orientalis* stands are present in the upstream end of the pond.

Another gross pollutant trap is present near the Botany Road bridge, and similarly contained large amounts of rubbish at the time of survey. This would also likely be a barrier to fish passage. Mill Stream passes through four large culverts at Foreshore Drive.

The main areas of natural biodiversity value remaining at Sydney Airport are the Sydney Airport Wetlands (Engine Pond East and West). The project crosses the Botany Wetlands upstream of Mill Pond, and thus does not directly affect the Sydney Airport Wetlands.

The mouth of Mill Stream at Botany Bay has been substantially modified by the construction of Sydney Airport's third runway and Foreshore Drive. Further downstream the recent construction of the expanded Sydney Ports container terminal has further modified the natural environment of Botany Bay. A small section of Foreshore Beach remains alongside Mill Stream. Seagrasses are present off shore.

Key fish habitat

Mill Stream is mapped as key fish habitat (DPI 2007) and considered moderate key fish habitat according to DPI (2013) given the presence of clearly defined bed and banks with permanent waters in pools or in connected wetland areas, the presence of freshwater aquatic vegetation and native fish (eels).

Threatened aquatic species identified in the study area

Botany Wetlands and Mill Stream are not habitat for any threatened fish species. Freshwater habitats crossed by the project are outside the natural range of the Australian Grayling (*Prototroctes maraena*). The Black Rock Cod (*Epinephelus daemelii*) occurs around rocky shores and reefs, and no habitat is present in the study area.

Coastal Management SEPP 2018 – Coastal Wetland

The small wetland located north of Mill Pond Drive and west of Botany Road is mapped as a Coastal Wetland according to the Coastal Management SEPP 2018. This wetland is located immediately adjacent to the project boundary and the project crosses its proximity area northwest of Southern Cross Drive.

Parts of the Botany Wetlands are also mapped as Coastal Wetlands. These comprise small areas upstream of the bridge over Mill Stream located adjacent to Eastlake Golf Club and larger areas located in Bonnie Doon Golf Club further upstream. No areas of Coastal Wetlands or their proximity areas along Mill Stream are within the project site.

Figure 11.6 shows the location of the main wetland areas which are local to the project site and their proximity areas (areas where development is restricted) as defined by Coastal Management SEPP 2018.

Wetlands of international importance (Ramsar wetlands)

Towra Point Nature Reserve Ramsar Site is located on the southern side of Botany Bay, about 6.5 kilometres from the project site. The reserve contains a gradation of environments from subtidal areas to extensive intertidal mudflats and mangrove forest to occasionally tidal-flooded saltmarsh to freshwater wetlands to shallow and deep sand dunes supporting littoral forest.

This Ramsar Site provides important habitat for a number of migratory waders. It also hosts one of the most important nesting sites in NSW for the Little Tern (*Sterna albifrons*) and a significant proportion of the state-wide nesting population of the Pied Oystercatcher (*Haematopus longirostris*) which are listed as endangered under the NSW BC Act (OEH 2013a).

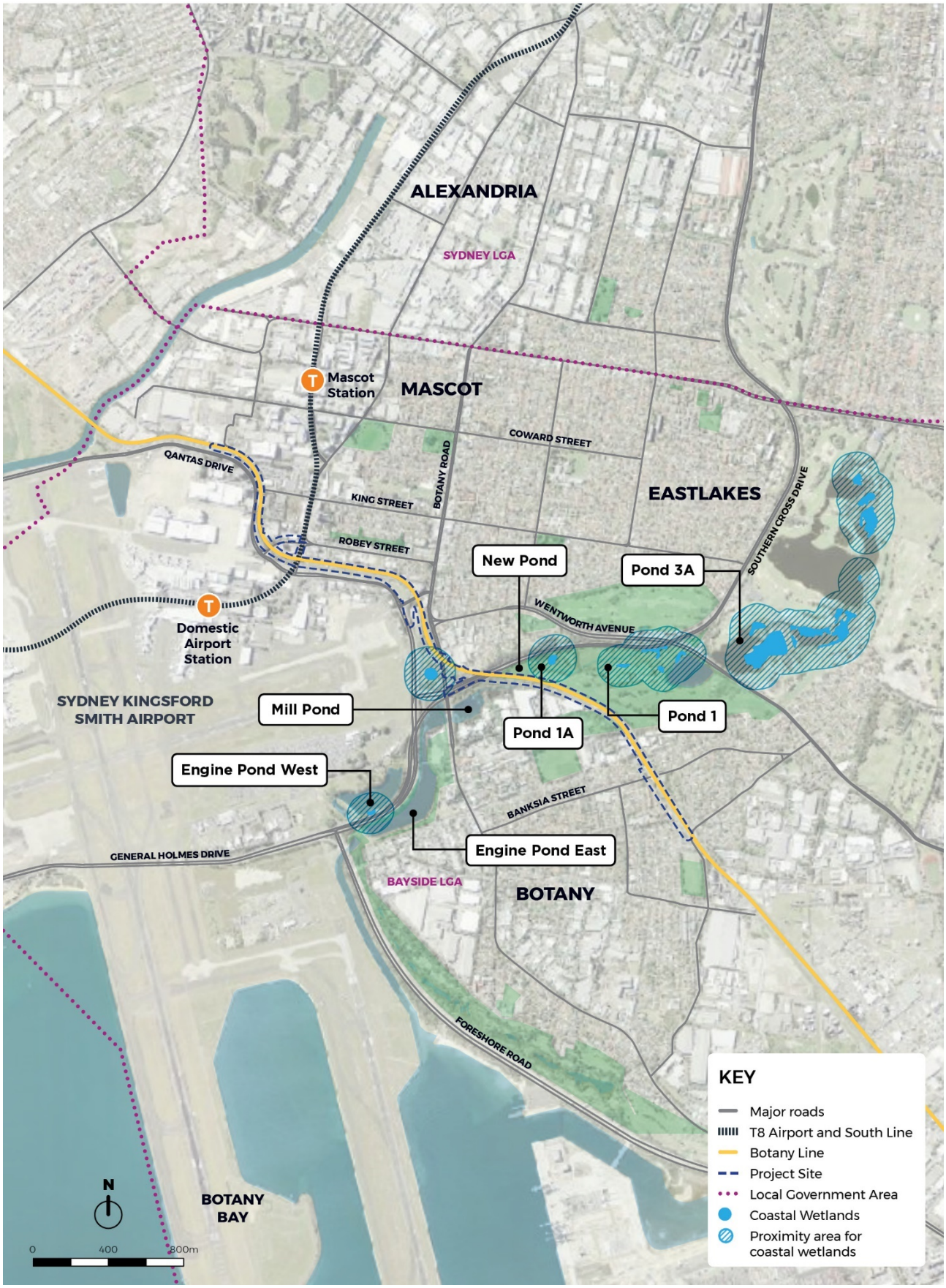


Figure 11.6 Aquatic habitat

11.3 Assessment of construction impacts

11.3.1 Direct impacts on vegetation and habitat

The project site is characterised in general by cleared land in a rail corridor with minimal value for native biodiversity. The project site is located predominantly within the existing rail corridor. The rail corridor is periodically cleared to allow for ongoing operations and maintenance of the existing line and management of weeds. The majority of the project would occur within the existing rail corridor, however in some areas, land outside the corridor is required to access the site or to facilitate construction works for key features such as bridges and retaining walls or embankments. Vegetation removal would be required predominantly in these areas outside the corridor.

The majority of the vegetation to be removed for the project is not native vegetation and comprises exotic plants or planted, often non-indigenous (native but not naturally occurring in this area) native species on fill material. Construction within these areas would remove a small number of individuals of non-threatened native plants, including planted trees and weeds.

Table 11.11 lists the areas of vegetation which would be potentially removed for the project. In total, the project would remove about 0.72 hectares of native vegetation from a total impact area of 8.12 hectares.

Table 11.11 Vegetation removal

VEG ZONE	PLANT COMMUNITY TYPE (PCT)	THREATENED ECOLOGICAL COMMUNITY	AREA IMPACTED (ha)
VZ1	PCT 1071 *Phragmites australis* and *Typha orientalis* Coastal Freshwater Wetlands of the Sydney Basin Bioregion (moderate condition)	Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	0.10
VZ2	PCT 1234 Swamp Oak Swamp Forest Fringing Estuaries, Sydney Basin Bioregion and South East Corner Bioregion (poor condition)	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	0.46
VZ3	PCT 1234 Swamp Oak Swamp Forest Fringing Estuaries, Sydney Basin Bioregion and South East Corner Bioregion (low condition)		0.16
VZ4	Miscellaneous ecosystem – highly disturbed areas with no or limited native vegetation	Not native	5.53
VZ5	Miscellaneous ecosystem – urban exotic/ native landscape plantings	Not native	1.89
VZ6	Miscellaneous ecosystem – water bodies (not wetlands)	Not native	0.05
		Total native vegetation	0.72
		Total area	8.12

11.3.2 Direct impacts on fauna and fauna habitat

The project may result in direct impacts on fauna and fauna habitats. The potential impact are described in Table 11.12.

Table 11.12 Direct impacts on fauna and fauna habitat resources

IMPACT	DESCRIPTION
Removal of habitat resources	Construction of the project would remove a very small area of fauna habitat, as most of the project site is already cleared land. The vegetation that would be removed or modified provides limited habitat resources for native fauna species due to its existing highly modified nature and the surrounding urban environment. Fauna habitat resources that would be removed include foraging and shelter resources for mainly common native fauna typical of urban environments. The project would remove a small number of trees which may be used for foraging by the Grey-headed Flying-fox and habitat used for foraging by microbats.
Impact on wetland habitat	There would be limited direct impacts on wetland habitat at the Botany Wetlands. Clearing would be limited in area, and would comprise mainly the removal of weed-infested planted vegetation. Impacts on native vegetation would be restricted to the removal of 0.62 ha of PCT 1234 Swamp Oak Forest and 0.1 ha of PCT 1071 Coastal Freshwater Wetlands from immediately adjacent to the rail bridge at Mill Stream. Some minor material within Mill Stream would be excavated and scour protection would also be constructed along the eastern and western banks of Mill Stream, where required. Impacts on the waterbody would be minor.
Removal of hollow-bearing trees	No hollow-bearing trees were recorded in the project site.
Injury and mortality	Construction is likely to result in the injury or mortality of some individuals of less mobile fauna species and other small terrestrial fauna that may be sheltering in vegetation within the project site during clearing activities. This could include nestlings, small lizards and frogs. More mobile native fauna such as native birds, bats, terrestrial and arboreal mammals that may be sheltering in vegetation in the project site are likely to evade injury during construction activities.
Fragmentation and isolation of habitat.	The project would require the removal of vegetation and habitat and would create or increase small gaps in habitat. The vegetation within the study area is currently fragmented by the existing rail corridor, roads and urban development. It is unlikely that the project would create an additional barrier to the movement of pollinator and seed dispersal vectors, such as insects and birds.
Impacts on key fish habitat	There would be no loss of key fish habitat. There would be no impacts on aquatic connectivity or fish passage along Mill Stream. The gap in riparian vegetation at this location would be increased, but would be unlikely to prevent the movement of any fauna along this corridor. Impacts on aquatic habitats are discussed further in section 11.3.6.

11.3.3 Indirect impacts on flora and fauna

The project may result in indirect impacts on flora and fauna. The potential impacts that may result from construction of the project are detailed in Table 11.13.

Table 11.13 Indirect impacts on biodiversity values

IMPACT	DESCRIPTION
Weed invasion and edge effects	'Edge effects' refer to increased noise and light or erosion and sedimentation at the interface of intact vegetation and cleared areas. Edge effects may result in impacts such as changes to vegetation type and structure, increased growth of exotic plants, increased predation of native fauna or avoidance of habitat by native fauna. Altered environmental conditions along new edges can allow invasion by pest animals specialising in edge habitats or change the behaviour of resident animals. Edge effects would result from construction activities and then continue to affect vegetation and habitats adjoining the project site. The project site and adjoining land has been extensively cleared for the existing rail corridor and surrounding urban development. Small, linear patches of vegetation occur at scattered locations. Due to the small size and linear arrangement of native vegetation patches in the study area, they are already severely affected by edge effects and associated negative impacts such as weed infestation. The project would create few new edge effects and is unlikely to result in a significant increase in the impact of existing edge effects.
Pests and pathogens	Construction activities, in general, have the potential to introduce or spread pathogens such as Phytophthora (*Phytophthora cinnamomi*), Myrtle Rust (*Uredo rangelii*) and Chytrid fungus (*Batrachochytrium dendrobatidis*) into native vegetation. There is little available information about the distribution of these pathogens within the locality, and no evidence of these pathogens was observed during surveys, however Chytrid fungus is likely to have contributed to the loss of the Green and Golden Bell Frog from the area (DECC 2008b). The potential for impacts associated with these pathogens is low, given the existing disturbed nature and high visitation rates to the study area, and lack of intact native vegetation in the vicinity of the project site.
Noise, light and vibration	Construction of the project would require the use of additional vehicles and plant in the site. Fauna that occupy habitats within the project site and adjacent areas are likely to be accustomed to existing high noise and vibration levels originating from trains, road traffic and the urban environment. Similarly, fauna and fauna habitats are already exposed to existing light from trains, cars, street lights and residential and industrial areas. Noise and vibration disturbance at the bridge at Mill Stream could disturb temporary roost habitat for threatened microchiropteran bats. While there would be localised increases in noise, vibration and light that would temporarily create substantial disturbance, increases above existing background levels during construction are unlikely to result in a significant impact on fauna that occur in the study area.
Sedimentation and erosion	Construction of the project has the potential to result in sedimentation and erosion within the construction corridor and adjoining native vegetation and aquatic habitats, through soil disturbance and construction activities. This is of particular risk during construction of the second bridge at Mill Stream. Sediment laden runoff to waterways can alter water quality and adversely affect aquatic life.
Aquatic disturbance and pollution	Impacts on aquatic habitats are discussed in section 11.3.6.

11.3.4 Threatened flora species

No threatened flora species or their habitat, listed under BC Act, have been determined to be affected by the project.

11.3.5 Threatened fauna species

The project could have minor impacts on threatened fauna species listed under the BC Act as a result of impact to potential foraging habitat. Only two species, the Grey-headed Flying-fox and the Eastern Bentwing Bat, were recorded during surveys. Some other highly mobile species may occur on occasion within the project site.

One threatened fauna species listed under the EPBC Act, the Grey-headed Flying-fox, was recorded in the project site.

Impacts on threatened fauna would comprise:

- the removal of up to 2.51 hectares of canopied foraging habitat for the threatened Eastern Bentwing Bat, Grey-headed Flying-fox and other threatened fauna species with potential habitat in the study area (consisting of 1.89 hectares of planted native species and 0.62 hectares of native vegetation)
- the removal of 0.10 hectares of Freshwater Wetland habitat, which is marginal potential foraging habitat for a variety of migratory waders
- noise and vibration disturbance at the bridge over Mill Stream, which could provide temporary roost habitat for threatened microchiropteran bats, although no roosting bats or evidence of roosting bats was observed during surveys.

There would be no impacts on habitat for species which would require offset. Targeted surveys did not find any evidence of the Green and Golden Bell Frog or Southern Myotis. No suitable habitat for any other candidate species credit species is present in the project site. It is highly unlikely that any threatened species or any fauna populations would rely on the habitat resources within the project site for their survival.

11.3.6 Aquatic fauna and habitats

The project includes a new bridge across Mill Stream, which is mapped as key fish habitat. Construction at this location would include piling for the bridge, some minor works along the banks and potentially instream to stabilise the abutments in this area. The aquatic habitats within and downstream of the project site have the potential to be impacted during construction if not mitigated. Potential aquatic issues during construction include:

- potential sedimentation of Mill Stream, as a result of soil disturbance, erosion and sediment-laden runoff
- exposure of actual or potential acid sulfate soils, which may generate acidic runoff and affect water quality
- potential effects on surface and groundwater quality as a result of disturbance of contaminated soils
- potential spills or leaks of fuels or oils from construction equipment or vehicle/truck incidents.

Construction involving excavation would interact with contaminated soils and groundwater during piling for the new bridge over Mill Stream. Works would intercept the Botany Sand Beds Aquifer, which is known to be shallow and contaminated. Construction water runoff and sedimentation in Mill Stream could affect habitat for fish, wading birds and other species that utilise this waterway. This waterway is already subject to substantial disturbance and pollution. Design of construction and mitigation measures would be in place to minimise these impacts where possible. No extraction or dewatering is anticipated for the project.

The project would not directly impact any habitat for threatened biota listed under the FM Act. Potential habitat for the Black Rock Cod is located over five kilometres downstream of the project (rock headlands of Botany Bay), and indirect effects on habitat are highly unlikely. Impacts on the geomorphology of the waterways are minor and short term and considered manageable with appropriate mitigation measures. There would be no blockage of fish passage and no removal of snags as a result of the project.

For the purposes of this assessment, it has been assumed that all native vegetation within the project site would be removed. The majority of this native vegetation removal (0.72 hectares) would occur in the vicinity of Mill Stream and the Botany Wetlands. This riparian vegetation would be impacted during construction of the bridge over Mill Stream and use of the associated compound site adjacent to Mill Pond. Following construction, disturbed areas alongside Mill Stream, Mill Pond and New Pond would be stabilised and revegetated with locally endemic species (see section 11.7.3).

11.3.7 Groundwater dependent ecosystems

The project would remove 0.62 hectares of PCT 1234 Swamp Oak Forest, which is likely to be somewhat dependent on groundwater. This vegetation is in a highly modified state. Construction of the bridge over Mill Stream has the potential to further mobilise contaminated groundwater at Mill Stream. There is a potential for a minimal increase in groundwater recharge during construction due to re-profiling works exposing more permeable materials. No groundwater extraction or dewatering is anticipated for the project. Given the existing contamination of the Botany Wetlands, limited clearing of native vegetation, and negligible drawdown of groundwater, impacts on GDEs outside the project site is likely to be minimal.

11.4 Assessment of operational impacts

Effects on biodiversity would be largely restricted to the construction phase of the project. Effects on biodiversity that may result from operation of the project are detailed in Table 11.14.

The project site is located within or immediately adjoining existing urban infrastructure and highly modified environments, in particular an existing operational freight rail corridor. Each of the potential operational impacts identified below would already be occurring in the project site and affecting the surrounding study area and the existing environment discussed above. Fauna that occupy habitats within the project site and adjacent areas are likely to be accustomed to existing noise originating from road traffic, trains, planes and the urban environment. The project when operational is unlikely to significantly increase the risk of fauna collisions above current levels, given the highly modified habitats present. In this context, the project is likely to comprise only a minor increase in any of these potential negative effects. The project is unlikely to increase the extent, duration or magnitude of any of these impacts to the extent that would result in a significant negative effect on biodiversity values.

Table 11.14 Potential operational effects on biodiversity values

IMPACT	DESCRIPTION
Noise, light and vibration	Operation of the project would introduce some additional noise, light and vibration from the movement of trains and maintenance vehicles. The project is located in a highly industrial urban environment already subject to substantial noise, light and vibration levels and with limited habitat value for biodiversity. Fauna species present would be accustomed to existing noise, light and vibration. The project is likely to involve only a minor increase in noise, light and vibration given the levels of existing disturbance and is not likely to result in a significant impact on fauna and flora that occur adjacent to the project site.
Vehicle strike	Few terrestrial fauna species occur in the project site that are at high risk of vehicle strike (trains and maintenance vehicles), and those that occur are already subject to the risk of vehicle strike given the location of the project. The project is unlikely to significantly increase the risk of vehicle collisions with fauna above current levels.
Erosion and sedimentation	Operation of the project has the potential to introduce pollutants to the environment as a result of incidental spills from trains or maintenance vehicles and result in erosion and sedimentation from runoff from impermeable surfaces. The project is located in a highly industrial area subject to substantial existing contamination and risk of chemical spills, and operation of the project would not substantially increase this risk.

11.5 Cumulative impacts

11.5.1 Overview

The methodology of the cumulative impact assessment and details of other projects considered are detailed in Chapter 24. A summary of the predicted cumulative impacts which relate to biodiversity are described below.

11.5.2 Cumulative construction impacts

The study area is located within central Sydney, with an extensive and complex road and rail network. Residential and industrial/commercial areas dominate the area.

The project would involve the removal of small patches of already highly fragmented, predominantly planted, vegetation. Other local rail projects such as the Chatswood to Sydenham metro project and Sydenham to Bankstown metro project would similarly affect small patches of fragmented habitat in highly modified urban areas (GHD 2017, Arcadis 2016), however these developments are not in close proximity to the project.

Road projects such as the proposed Sydney Gateway road project, as well as the WestConnex New M5 and future M4–M5 Link would also result in the removal of mainly planted vegetation and associated fauna habitats.

Losses in biodiversity from these projects and developments are also likely to be restricted in area, given their location in a highly modified environment. Together these projects and other developments would result in the further loss of habitat from an already modified environment with only limited natural biodiversity values.

11.5.3 Cumulative operational impacts

Operational impacts of the project would comprise a minor addition to the existing activities in the rail corridor and extent of development in the locality. The project is unlikely to increase the extent, duration or magnitude of any of the cumulative impacts on biodiversity values occurring in the study area and region to the extent that would result in a significant negative effect on biodiversity values.

11.6 Matters of national environmental significance

There is a general lack of habitat present and only small areas of vegetation to be removed within the project site. The project therefore, is unlikely to result in a significant impact on any MNES.

A summary of impacts on MNES is provided in Table 11.15.

Table 11.15 Impacts on MNES

MNES	IMPACT
Threatened ecological communities	No threatened ecological communities listed under the EPBC Act have been determined to be affected by the project.
Threatened flora species	No threatened flora species listed under the EPBC Act have been determined to be affected by the project.
Threatened fauna species	The project would result in the loss of 2.38 hectares of foraging habitat for the Grey-headed Flying-fox. The project is unlikely to impact any habitat of the Green and Golden Bell Frog. An assessment of significance has been prepared for the Green and Golden Bell Frog given the historic records of the species in the area and is provided in *Technical Report 4 – Biodiversity Development Assessment Report*. No other threatened fauna species listed under the EPBC Act are likely to rely on habitats present in the project site.
Migratory fauna species	The project would remove 0.1 ha of PCT 1071 Coastal Freshwater Wetlands habitat that is marginal potential habitat for migratory waders and 0.62 ha of forested vegetation that may provide habitat for migratory woodland bird species. This habitat is not considered important habitat for any species. An ecologically significant proportion of a migratory species would not occur at the site. The project is highly unlikely to impact Towra Point Nature Reserve, which provides important habitat for migratory waders, given its location over 6.5 kilometres from the project site.
Wetlands of National Significance	The project is highly unlikely to impact the Towra Point Ramsar site, given its location over 6.5 kilometres from the project site.
Commonwealth land	Limited areas of Commonwealth Land intersect with the project site. These are predominantly cleared hardstand, although occasional planted shrubs or trees and weeds are present (totalling 0.1 hectares). The majority of the vegetation to be removed in Commonwealth land for the project is not native vegetation. The removal of a small area of planted and exotic vegetation would remove limited habitat for some common flora and fauna species typical of urban and industrial areas. There would be no direct impacts on the Sydney Airport Wetlands. Construction at Mill Stream has the potential to result in downstream impacts on Mill Pond and other downstream areas. An assessment of the likely significance of effects on flora and fauna (as a component of the environment of Commonwealth land) pursuant to the *Significant Impact Guidelines 1.2* (DSEWPC 2013) for actions on Commonwealth land (provided in *Technical Report 4 – Biodiversity Development Assessment Report*). The conclusion of this assessment is that the project would not have a significant impact on plants and animals within Commonwealth land given the highly modified nature of the existing environment and the small magnitude and extent of effects on plants and animals.

11.7 Management of impacts

11.7.1 Approach

ARTC is committed to minimising the environmental impact of the project and is investigating opportunities to reduce actual impact areas where practicable. The area that would be directly impacted by construction activities would depend on factors such as presence of significant vegetation, constructability, construction management and safety considerations, land form, slopes and anticipated sub-soil structures. Direct impacts would be reduced as far as practicable. The exact amount of clearance (within the project site) would be refined during detailed design.

ARTC has, where possible, altered the project to avoid and minimise ecological impacts in the project planning stage. The project has adopted the following 'avoid, minimise and offset' approach to mitigate impacts on biodiversity values in accordance with the BAM, the BC Act and associated policy (see section 11.1.4 for further discussion). A range of impact mitigation strategies have been included in the project to mitigate the impact on ecological values. Further refinement will be made during detailed design, where possible, to minimise ecological impacts.

Further details on the approach to management is provided in Chapter 24.

11.7.2 Biodiversity offsets

Biodiversity offsetting for residual impacts on BC Act biodiversity values is mandatory for SSI developments being assessed under Part 7 of the BC Act and subject to a BDAR. Biodiversity offset obligations have been determined using the BAM calculator. The required ecosystem and species credit obligations are outlined below.

Ecosystem credits

The required ecosystem credits, as determined using the BAM calculator, for the project are provided in Table 11.16.

Table 11.16 Ecosystem credits required to offset project impacts

PLANT COMMUNITY TYPE (PCT)	THREATENED ECOLOGICAL COMMUNITY	AREA IMPACTED (ha)	ECOSYSTEM CREDIT OBLIGATION
PCT 1071 *Phragmites australis* and *Typha orientalis* Coastal Freshwater Wetlands of the Sydney Basin Bioregion	Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	0.10	3
PCT 1234 Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	0.62	8
	Total	0.72	11

Species credits

No species credit obligations were deemed warranted for this project.

Offsetting approach

The approach to biodiversity offsets for this project, that will enable the credit obligations to be met, comprises two options. These are, the purchase and retirement of existing biodiversity credits currently available on the biodiversity credit register or through making a payment into the Biodiversity Conservation Fund. The fund is managed by NSW Biodiversity Conservation Trust (BCT) which was established by the *Biodiversity Conservation Act 2016*.

Existing biodiversity credits

The purchase and retirement of existing biodiversity credits is required to be undertaken based on like for like trading rules as outlined under the *Biodiversity Conservation Regulation 2017* and as identified by the BAM calculator output for the project. The like for like ecosystem credit class options for each ecosystem credit obligation is summarised Table 11.17.

Table 11.17 Like for like trading credit classes

CREDIT CLASS PCT	ANY PCT WITH THE BELOW TEC	CONTAINING HBT[1]	IN THE BELOW AUSTRALIAN SUBREGIONS
PCT 1071 *Phragmites austra*lis and *Typha orientalis* Coastal Freshwater Wetlands of the Sydney Basin Bioregion	Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (including PCTs 780, 781, 782, 828, 1071, 1735, 1736, 1737, 1738, 1739, 1740, 1741, 1742, 1911).	No	Pittwater, Cumberland, Sydney Cataract, Wyong and Yengo. or Any sub region that is within 100 kilometres of the outer edge of the impacted site.
PCT 1234 Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (including PCTs 915, 916, 917, 918, 919, 1125, 1230, 1232, 1234, 1235, 1236, 1726, 1727, 1728, 1729, 1731, 1800, 1808).	No	Pittwater, Cumberland, Sydney Cataract, Wyong and Yengo. or Any sub region that is within 100 kilometres of the outer edge of the impacted site.

(1) HBT: hollow bearing tree

Payment into the Biodiversity Conservation Fund

Payments for the project offset obligations could be paid into the Biodiversity Conservation Fund as outlined in Table 11.18.

It should be noted that payment for offsets are subject to change and that credit payment prices are reviewed quarterly. The payment amounts presented within this report were calculated and valid as of 31 May 2019.

Table 11.18 Estimated biodiversity offset credit payment price

CREDIT CLASS	PRICE PER CREDIT	NUMBER OF CREDITS REQUIRED	FINAL CREDIT PRICE
PCT 1071 *Phragmites australis* and *Typha orientalis* Coastal Freshwater Wetlands of the Sydney Basin Bioregion	$2,499.32	3	$7,497.95
PCT 1234 Swamp Oak Swamp Forest Fringing Estuaries, Sydney Basin Bioregion and South East Corner Bioregion	$1,494.19	8	$11,953.55
		Subtotal (excl. GST)	$19,451.50
		GST	$1,945.15
		Total	$21,396.65

EPBC Act – Offset for affected threatened biota

Under the EPBC Act *Environmental Offsets Policy* (DSEWPaC, 2012) biodiversity offsets are required to compensate for significant residual effects on MNES. This BDAR includes the identification and assessment of potentially affected MNES, including an assessment of the likely significance of effects on the Grey-headed Flying-fox pursuant to the EPBC Act *Significant Impact Guidelines* 1.1 (DotE, 2013). The outcome of these assessments of significance is that the project would not be likely to result in a significant impact on the Grey-headed Flying-fox or on any other MNES.

The project is unlikely to impact Towra Point Ramsar site as it is located about 6.5 kilometres away on the southern side of Botany Bay.

No biodiversity offsets for effects on MNES are therefore required in accordance with the EPBC Act *Environmental Offsets Policy*.

11.7.3 List of mitigation measures

The mitigation measures that would be implemented to address potential biodiversity impacts are listed in Table 11.19 and will be included within the relevant management plan. This table also outlines which of the construction phase mitigation measures would be implemented during the enabling works and main construction works.

Table 11.19 Mitigation measures

STAGE	IMPACT	MEASURE	ENABLING WORKS	MAIN CONSTRUCTION
Construction	Additional clearing	If additional vegetation is identified to be impacted, an ecologist will undertake further assessment for impact and the need for offsetting in accordance with the legislation prior to clearing.	✓	✓
	Spread of chytrid fungus	Protocols to prevent introduction or spread of chytrid fungus will be detailed in the relevant management plan and implemented following the DPIE Hygiene protocol for the control of disease in frogs (DECC, 2008c).	✓	✓
	General	The project environmental induction will include information on the ecological values of the study area, protection measures to be implemented to protect biodiversity and penalties for breaches.	✓	✓
	Vegetation clearing	Disturbance of vegetation will be limited to the minimum necessary to construct works. The contractor will design the layout of the work areas to locate infrastructure, where practicable, to previously cleared areas or areas of exotic vegetation to minimise or avoid impacts on native vegetation (and particularly EECs). Equipment storage and stockpiling of resources will be restricted to designated areas in cleared land.	✓	✓
	Impact to flora and fauna during vegetation clearance or works to bridges	A trained ecologist will undertake pre-clearing surveys and be present during the clearing of native vegetation or removal of potential fauna habitat during construction where necessary to avoid impacts on resident fauna as far as is practicable. Pre-clearing surveys will include: • inspections of native vegetation for resident fauna and nests or other signs of fauna occupancy • inspections of bridges for roosting bats • pre-clearing surveys for the Green and Golden Bell Frog at Mill Stream as a precaution • capture and relocation or captive rearing of less mobile fauna (such as nestling birds) by a trained fauna handler and with assistance from Wildlife Information Rescue and Education Service (WIRES) as required.	✓	✓

STAGE	IMPACT	MEASURE	ENABLING WORKS	MAIN CONSTRUCTION
	Impact on vegetation to be retained	Where the project site adjoins native vegetation, the limits of clearing will be marked and temporary fencing installed and maintained around the vegetated areas prior to the commencement of construction activities to avoid unnecessary vegetation and habitat removal.	✓	
	Increase in weeds	Management and disposal of the weeds, including the priority weeds, will be conducted in accordance with the *Biosecurity Act 2015* and the *NSW Weed Control Handbook* (DPI 2018c). Vehicles and other equipment to be used within the rail corridor will be cleaned to minimise seeds and plant material entering the study area to prevent the introduction of further exotic plant species or disease.	✓	✓
	Reinstatement of vegetation	Revegetation of riparian areas along Mill Stream, Mill Pond and New Pond following construction will be undertaken by a bush regeneration contractor. Disturbed areas will be stabilised as soon as possible following construction and locally endemic species typical of Swamp Oak swamp forest and Coastal freshwater wetlands would be used to revegetate these disturbed riparian areas.		✓
Operation	Increase in weeds	ARTC's Assessment Management System (under the Safety Management System) includes provision for regular weed management and ARTC's Environmental Management System provides procedures for weed management and pesticide use. Ongoing weed management throughout the rail corridor will be undertaken in accordance with ARTC's procedures, as well as relevant legislation such as the *Biosecurity Act 2015*.	N/A – Operation	N/A – Operation

11.7.4 Consideration of the interaction between measures

In addition to the measures for biodiversity described above, there are interactions between the mitigation measures for noise and vibration (Chapter 9), contamination (Chapter 12), and soils and water quality (Chapter 14).

All mitigation measures for the project will be consolidated and described in the relevant management plan. The plan would identify measures that are common between different aspects. Common impacts and common mitigation measures will be consolidated to ensure consistency and implementation.

11.7.5 Managing residual impacts

A residual risk analysis was undertaken following the impact assessment summarised in this chapter. The results of the residual risk analysis are provided in Appendix B. Residual risks with an assessed level of medium or above are summarised below.

- clearing of native vegetation resulting in loss of fauna habitat
- direct impacts on threatened species and endangered populations and communities (terrestrial) from clearing

Despite measures taken to avoid and mitigate impacts, the project would result in some unavoidable residual adverse impacts imposed upon some elements of the natural environment. In total, the project would remove about 0.72 hectares of native vegetation, comprising 0.62 hectares of PCT 1234 Swamp Oak Forest and 0.10 hectares of PCT 1071 Coastal Freshwater Wetlands.

The project would remove a very small proportion of available habitat resources for local populations of native fauna. Impacts would include the removal of up to 5.34 hectares of patchily distributed potential foraging habitat for mobile threatened fauna species, including the Grey-headed Flying-fox and microbats. The site is unlikely to contain any important breeding, roosting or nesting habitat for native fauna.

Biodiversity offsetting for residual effects on BC Act biodiversity values is mandatory for SSI developments being assessed under Part 7 of the BC Act and subject to a BDAR. Biodiversity offset obligations have been determined using the BAM calculator.

12. CONTAMINATION

This chapter provides a summary of the contamination assessment. A full copy of the assessment report is provided as *Technical Report 5 – Contamination Assessment*.

12.1 Assessment approach

A summary of the approach to the assessment is provided in this section, including the legislation, guidelines and policies driving the approach and the methodology used to undertake the assessment. A more detailed description of the approach and methodology is provided in *Technical Report 5 – Contamination Assessment*.

12.1.1 Legislative and policy context to the assessment

Contaminated Land Management Act 1997

The CLM Act enables the EPA to respond to and manage site contamination when it considers that the contamination is significant enough to require remediation. The NSW EPA record of contaminated sites and records of notices (see section 12.2.1) has been developed and is managed in accordance with the CLM Act.

State Environmental Planning Policy No 55 – Remediation of Land

State Environmental Planning Policy No 55 – Remediation of Land (SEPP 55) aims to promote the remediation of contaminated land. In accordance with clause 7(1) of SEPP 55, a consent authority must not consent to carrying out development on land unless it has considered whether the land is contaminated. As described in section 12.6.1, an area for remediation has been identified. Any remediation works required would be undertaken in accordance with this SEPP.

National Environment Protection (Assessment of Site Contamination) Measure 2013

The National Environment Protection (Assessment of Site Contamination) Measure 2013 (NEPM 2013; NEPC, 2013) is approved by the EPA under section 105 of the CLM Act. It guides the methodology for site contamination assessment and provides health and ecological criteria for various land uses. The NEPM 2013 criteria for commercial/industrial land use has been used to assess site investigation results for this project. As described in section 12.6.1, remediation works required as part of the project would be undertaken in accordance with the NEPM 2013.

National Water Quality Management Strategy including the Australian and New Zealand Guidelines for Fresh and Marine Water Quality

The *National Water Quality Management Strategy* (NWQMS; Australian Government 2018) includes water quality guidelines that define desirable ranges and maximum levels for certain parameters for specific uses of water or for protection of specific values. The *Australian and New Zealand Water Quality Guidelines for Fresh and Marine Water Quality* (ANZG 2018) establish a guide for setting water quality objectives. Based on these guidelines, the criteria for 90 percent protection of freshwater ecosystems (for a disturbed system) has been adopted as the main surface water criteria for the project. For bioaccumulative toxicants, a more stringent 95 percent level has been considered.

PFAS *National Environmental Management Plan*

Per- and poly-fluoroalkyl substances (PFAS) have been identified as chemicals of high concern to human health and the environment, particularly due to their persistence and bioaccumulation. The PFAS *National Environmental Management Plan* (PFAS NEMP; HEPA, 2018) provides a consistent, practical, risk-based framework for the environmental regulation of PFAS contaminated materials and sites. The health and ecological criteria for a commercial/industrial land use from the PFAS NEMP have been used to assess site investigation results for the project (see section 12.2).

Acid Sulfate Soil Manual

Acid sulfate soils (ASS) are naturally occurring soils, which if drained, excavated or exposed to air, can form sulfuric acid. The Acid Sulfate Soil Manual (ASSMAC, 1998) provides best practice guidance in the assessment and management of projects in areas potentially affected by ASS. The guidelines set out a stepwise process to decide whether ASS is present on site and how to mitigate potential impacts. The presence of ASS is described further in section 12.2.3.

Managing Asbestos in or on Soil

The *Managing Asbestos in or on Soil* guide (Safework NSW, 2014) provides general guidance on the assessment of asbestos in soil. As described in section 12.2.5, asbestos has been identified at several locations within fill material along the entire length of this section of rail corridor. The guidelines provided in the *Managing Asbestos in or on Soil* guide would be used to guide the management of this contaminant during the construction of the project.

12.1.2 Methodology

Key tasks

The contamination assessment involved:

- a preliminary assessment of potential areas of environmental concern (AEC)
- a desktop review of publicly available information (including database searches) and previous investigation reports to identify current of historical potentially contaminating land uses
- a walkover of the project site on 6 July 2018 to compare the current site conditions to the conditions documented in historical reports and to identify any additional potential sources of contamination along the alignment (see section 7 of *Technical Report 5 – Contamination Assessment*)
- preparation of a conceptual site model (CSM), which identified potential contamination sources, receptors and exposure pathways.

A detailed description of the assessment methodology is provided in section 3 of *Technical Report 5 – Contamination Assessment*.

Study areas

For the purpose of the contamination assessment (*Technical Report 5 – Contamination Assessment*), the project site was divided into two study areas:

- Area 1 (shown in blue on Figure 12.1) – extending to the east and southeast towards Port Botany from Southern Cross Drive and Mill Pond Road.
- Area 2 (shown in green on Figure 12.1) – extending west and northwest towards Alexandra Canal from Southern Cross Drive and Mill Pond Road.

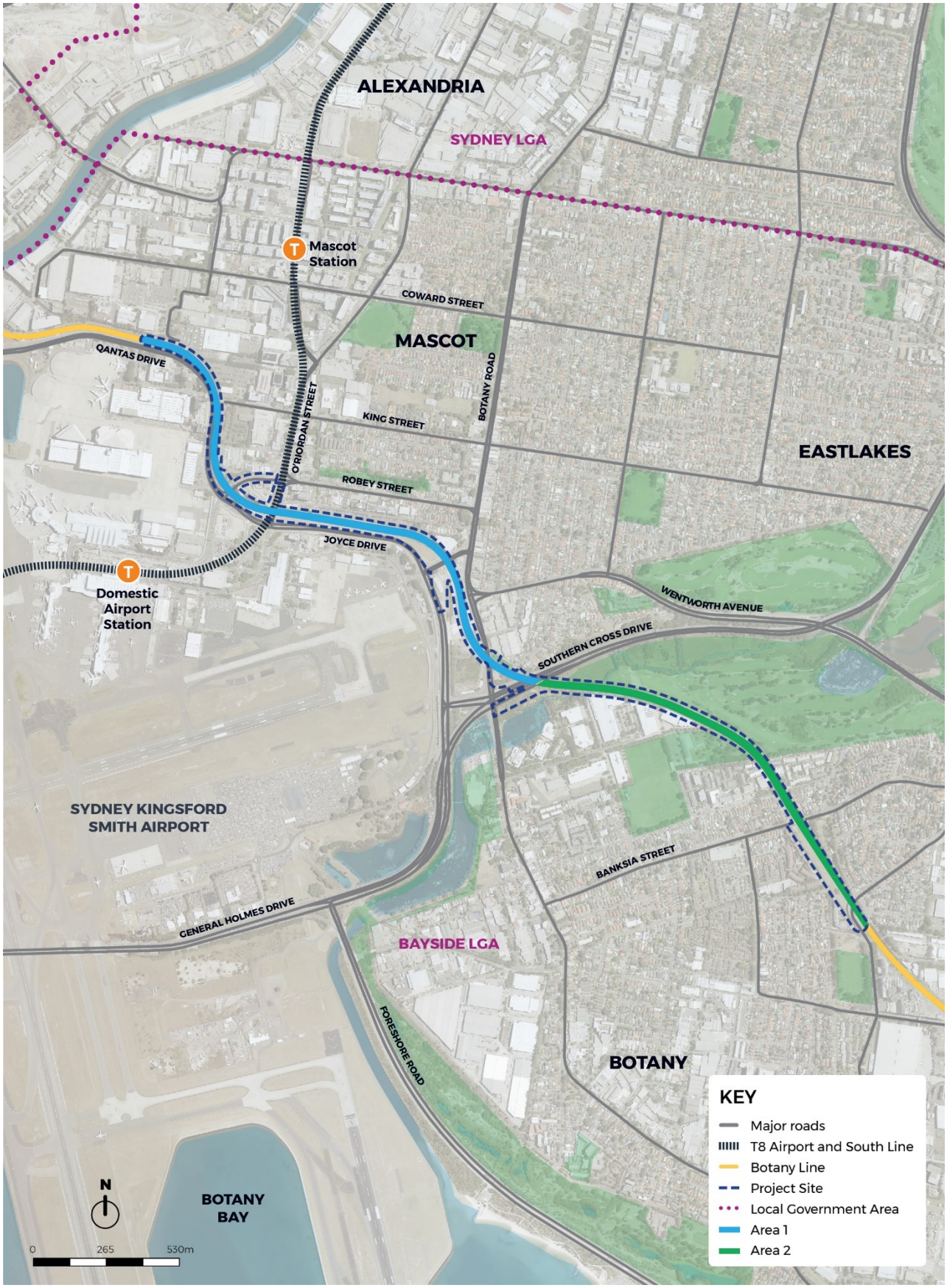


Figure 12.1 Study areas for the contamination assessment

12.1.3 Risks identified

The preliminary environmental risk assessment undertaken for the project (provided in Appendix B) included potential risks associated with contamination. Potential risks were considered according to the impacts that may be generated by the construction and operation of the project. The likelihood, consequence and overall risk level of each potential risk were assessed, with avoidance and management measures defined for each potential risk. Further information on the risk assessment, including the approach, methodology and the full results, is provided in Appendix B.

Risks with an assessed level of medium or above (without mitigation) included:

- very high for impacts associated with the disturbance of contaminated soil during construction
- medium for contamination due to spills and leaks during construction and operation.

These potential risks and impacts were considered as part of the assessment. The assessment also considered matters identified by the SEARs and identified by stakeholders (as described in Chapters 3 and 4). The residual risk levels, following implementation of the mitigation measures proposed in this EIS, are discussed in section 12.6.4.

12.1.4 How potential impacts have been avoided/minimised

As described in sections 6.1.2 and 7.1.1, design development and construction planning for the project has included a focus on avoiding or minimising the potential for environmental impacts during all key phases of the process.

Where areas of known contamination have been identified, detailed design would seek to:

- minimise the depth and volume of excavation required, minimise the amount of soil disturbance and avoid intercepting potentially contaminated groundwater
- optimise allowance for capping of contaminated material to reduce generation of contaminated waste and reduce the ongoing risk from potential disturbance during operations.

12.2 Existing environment

12.2.1 Contaminated sites notified to the EPA within and surrounding the project site

A search of the NSW EPA Contaminated Sites Register identified that there are seven sites within 500 metres of the project site that have previously been notified to the EPA for contamination.

Five of the sites listed have not been identified as requiring regulation under the CLM Act. The two sites listed (the former Mascot Galvanising site and former Email site), which currently require regulation under the CLM Act are also listed on the NSW EPA record of notices. The NSW EPA holds records of written notices issued by the EES Group of the DPIE (formerly Office of Environment and Heritage)) under Section 58 of the CLM Act. These sites are described further in Table 12.1.

Table 12.1 Contaminated sites known to the EPA within 500 metres of the project site

SITE NAME	SITE ADDRESS	DISTANCE TO THE PROJECT SITE	NOTICE TYPE AND STATUS	CONTAMINATION TYPE
Former Mascot Galvanising	336–348 King Street, Mascot	150 m east	Site declared as a remediation site Four current remediation orders	Zinc, lead and chromium in soil and groundwater Low groundwater pH Groundwater plume migrating off site
Former Email Site	Corner of Page Street and Holloway Street, Pagewood	420 m east	Site declared as a remediation site One current voluntary management proposal	Chlorinated hydrocarbons (trichloroethene and tetrachloroethene) Groundwater plume migrating off site (to the south)

The Former Email Site located in Pagewood is unlikely to pose a potential risk during construction or operation activities due to its location across-gradient (ie not in the direction of groundwater flow) of the project site.

The former Mascot Galvanising site is hydraulically up-gradient of the project, which means that contamination from the site could migrate in the groundwater towards the project site. Since the last notice was issued for the site in 2004, the site buildings and infrastructures have been removed (as evidenced by historical aerials from 2017 and 2018) and earthworks (most likely to remediate the site) appear to have been conducted between 2005 and 2015. The site has since been redeveloped and is currently a high-rise hotel and car park. There is a potential that groundwater impacts from the former Mascot Galvanising may have migrated beneath the project site.

Under Section 308 of the POEO Act, the NSW EPA is required to record, and make available to the public, details about environmental protection licences (EPLs). There are 12 facilities within a 500 metre radius of the project site at the time of writing (see Table 12.2) that have been subject to revoked or surrendered licences, audits, notices or pollution studies associated with their EPL. Of these facilities, three (Sydney Airport, Qantas Jet Base and Industrial Galvanizers Corporation Pty Ltd) include activities which have the potential to impact soil or groundwater and are located in close proximity to the project site. There are also five licenced facilities within 500 metres of the project site that may result in potential contamination if not appropriately managed in accordance with the EPLs (see section 5.3 of *Technical Report 5 – Contamination Assessment* for more detail).

Table 12.2 Record of notices, audits, revoked or surrendered licences or pollution studies within 500 metres of the project site

FACILITY NAME	LICENCE NUMBER	ADDRESS AND DISTANCE TO THE PROJECT SITE	ACTIVITY INCIDENT TYPE	NOTICE/INCIDENT TYPE	POTENTIAL CONTAMINATION
Airport East Precinct	20851	Botany Line freight rail corridor at General Holmes Drive within the project site	Railway systems activity	Multiple licence variations (2016–2017)	Unknown (associated with construction activities)
Sydney Airport	7288	241 O'Riordan Street, Mascot 15 m north	Waste generation or storage	Multiple licence variations (2004–2005) Licence no longer in force	Hydrocarbons PFAS compounds
Botany Aquatic Centre	1791	Cnr Jasmine and Myrtle Street, Botany 50 m southwest	Miscellaneous licensed discharge to waters	Multiple licence variations (2001–2005) Licence surrendered in October 2006	Chlorine
Qantas Jet Base	12152	Sydney Airport, Mascot 80 m southwest	Waste generation or storage	Multiple licence variations (2006–2008) Licence no longer in force	Metals Acids Solvents Hydrocarbons
Industrial Galvanizers Corporation Pty Ltd	6728	342 King St, Mascot 115 m east	Waste generation or storage	Licence surrendered in 2001	Metals Acids Solven Metals Acids Solvents Cyanide Volatile hydrocarbons Cyanide Volatile hydrocarbons
Enwave Mascot Pty Ltd	20246	10 Bourke Street, Mascot 320 m northeast	Generation of electrical power from gas	Two licence variations (2014–2017) One mandatory environmental audit (pending)	Emission of gases to air
Gate Gourmet Flight Kitchen	10332	Keith Smith Avenue and Sixth Street, Mascot 400 m southwest	Waste generation or storage	Licence revoked in 2002	Unknown

FACILITY NAME	LICENCE NUMBER	ADDRESS AND DISTANCE TO THE PROJECT SITE	ACTIVITY INCIDENT TYPE	NOTICE/INCIDENT TYPE	POTENTIAL CONTAMINATION
SIMS Group Limited	2009	283 Coward Street, Mascot 400 m west	Waste generation or storage Scrap metal processing	Multiple licence variations (2001–2002) Licence surrendered in May 2004	Metals Hydrocarbons Suspended solids Acids PCBs PAHs
Kellogg (Aust) Pty Ltd	823	Swinbourne Street, Botany 400 m south	General agricultural processing Storage of clinical and related wastes permitted	Multiple licence variations (2002–2013)	Hydrocarbons, nutrients Clinical and related waste contamination
Allnex Resins Australia Pty Ltd	993	49–61 Stephen Street, Botany 450 m south	Chemical production and storage waste generation Contaminated groundwater treatment Dangerous goods production General chemical storage Toxic substances production	Multiple licence variations (2002–2018) Penalty notice (#3085765349, September 2012): breach of licence Two pollution studies: air quality assessment and remediation of toluene, ethylbenzene and xylene compounds in groundwater	Known toluene, ethylbenzene and xylene contamination plume in groundwater
Ecolab Pty Ltd	2086	3–5 Anderson St, Banksmeadow 450 m southeast	Waste storage Non-thermal treatment of liquid waste Toxic substances production Container reconditioning Chemical production and storage waste generation Dangerous goods production General chemicals storage	Multiple licence variations (2002–2016) Surrender of licence (1 Aug 2016)	Hydrocarbons Solvents Asbestos Clinical and related waste contamination

12.2.2 Acid sulfate soils

Acid sulfate soils or sediments (ASS), can result in acidic leachate when exposed to oxygen, which may affect water quality, lead to the death or disease of aquatic organisms, harm human health or damage infrastructure. ASS are typically found in estuarine, low-lying environments up to 10 metres above Australian height datum (mAHD) and generally consist of clays and sands containing pyritic material.

A search of the Australian Soil Resource Information System (CSIRO, 2014) and ASS risk map (Department of Land and Water Conservation, 1997) indicated that there is a low probability of acid sulfate soils occurrence within the project site, except for the area surrounding Mill Pond.

The ASS maps prepared for the Botany Bay LEP show that the project site has the following ASS classifications (see Table 4.1 in *Technical Report 5 – Contamination Assessment*):

- class 1 from Southern Cross Drive bridge to Mill Stream bridge
- class 2 from the western end of the project site to the O'Riordan Street bridge
- class 4 from the O'Riordan Street bridge to the western end of Southern Cross bridge and from the Mill Stream bridge to Banksia Street.

Based on the ASS assessment framework presented in the *Acid Sulfate Soil Manual* (ASSMAC, 1998), this classification indicates that work conducted in several areas of the project site would trigger the requirement for an ASS management plan (ASSMP) to be prepared.

12.2.3 Soil salinity

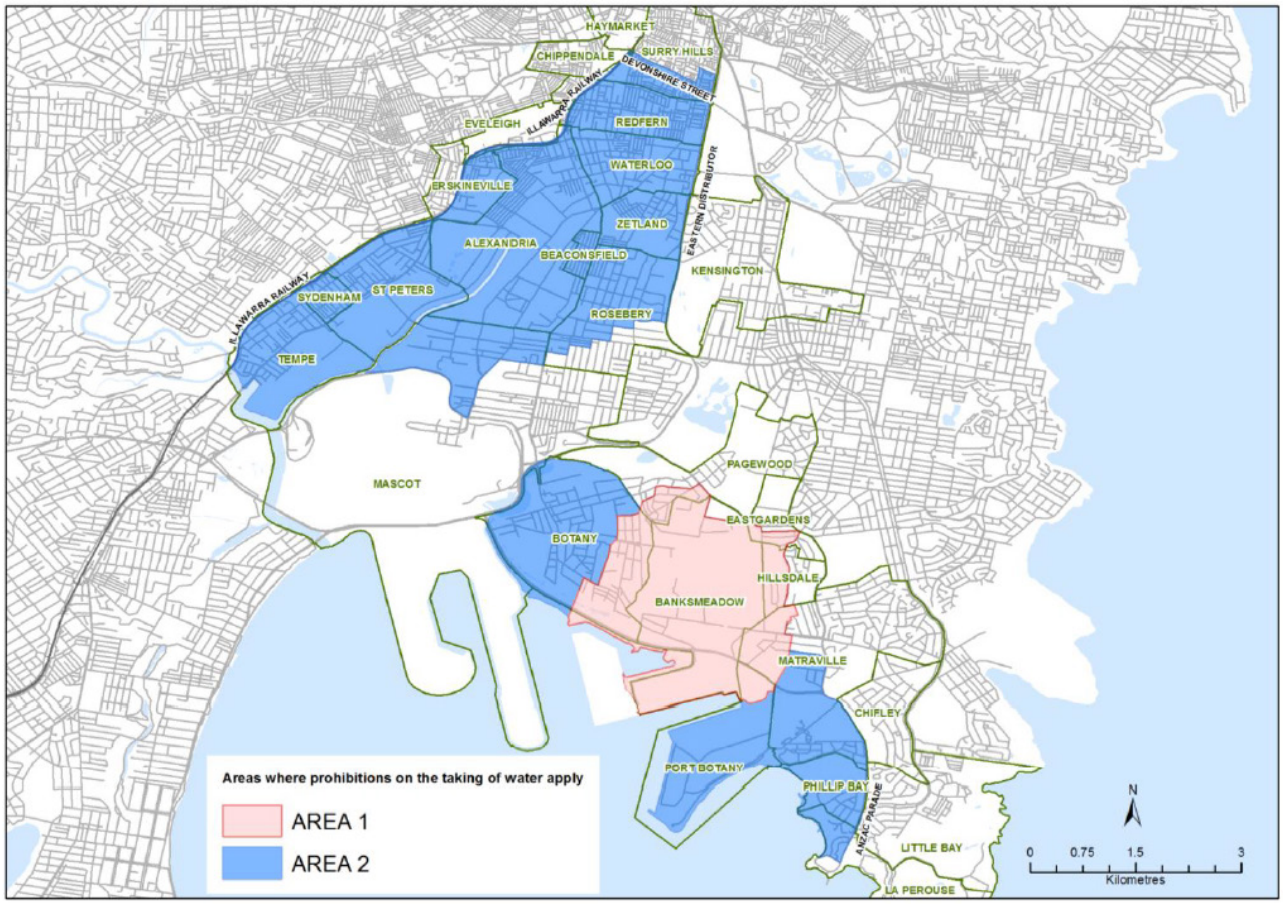
Saline soils are typically present in areas along tidal waterways, such as Alexandra Canal. A soil salinity assessment completed by Golder (2016) classified the northern portion of the project site as having a low potential for salinity. This was likely due to the high permeability soils in the area that allow for rapid drainage and flushing of salts. This is expected to be similar to the conditions present within the rest of the project site.

12.2.4 Restrictions on groundwater extraction

There are two main groundwater systems beneath the site: a deeper confined groundwater system associated with the Triassic aged, fractured/porous Hawkesbury Sandstone and a shallow, unconfined/semi-confined system within Quaternary aged marine sands (the Botany Sands aquifer). See Chapter 13 for more information on the flow of groundwater within and surrounding the project site.

In 2006, the NSW Government implemented a restriction on groundwater extraction on parts of Botany, which is underlain by the Botany Sands aquifer, due to the contamination of the aquifer from the Orica Botany site. Under the current *Temporary Water Restrictions Order for the Botany Sands Groundwater Source 2018* (issued by the NSW DPI, 2018b) (see Figure 12.2):

- In Area 1, taking of water from the Botany Sands groundwater source is prohibited.
- In Area 2 (which includes the project site), groundwater extraction is prohibited for domestic use, and requires monitoring for industrial and irrigation purposes.
- Water extracted for purposes other than remediation, temporary construction dewatering, testing or monitoring purposes, must be fit for purpose (sampled, tested and treated in accordance with a certified water testing plan and certified in writing by a consultant as being safe and suitable for its intended use).



Source: NSW DoI, 2018

Figure 12.2 Restriction areas under the current Temporary Water Restrictions Order

12.2.5 Areas of environmental concern within and surrounding the project site

Several areas of environmental concern (AECs), which may contain contamination have been identified within and surrounding the study area (see Chapter 8 in *Technical Report 5 – Contamination Assessment*). These AECs are summarised in Table 12.3 and shown in Figure 12.3.

Table 12.3 Summary of areas of environmental concern

AEC	LOCATION	CONTAMINANTS OF POTENTIAL CONCERN (COPCs)	NATURE OF CONTAMINATION
AEC1	Length of the rail corridor within Area 1	Asbestos	Asbestos has been identified at several locations within fill material along the entire length of this section of rail corridor. The asbestos is likely associated with the demolition and construction waste observed within this area.
AEC2	West of Robey Street bridge, adjacent to the wall of an existing building within Area 2	Asbestos	During a site inspection on 6 July 2018 several fragments of ACM were observed on the site surface.
AEC3	Between the rail corridor and Botany Road (near Bronti Street), off-site near Area 2	PFAS	Elevated concentrations of PFAS were recorded in groundwater samples obtained for the WestConnex Enabling Works – Airport East Project from monitoring well MW5, which is located approximately five metres east of the project site near the intersection of Bronti Street and Botany Road (EES, 2018). The perfluorooctane sulfonate (PFOS, a type of PFAS) concentrations were reported above the adopted human health and ecological criteria.
AEC4	Sydney Airport (including the Qantas Jet Base), west of the project site near Area 2	Hydrocarbons, PFAS	The potential for contamination was identified based on a review of the NSW EPA contaminated sites notices and licenses under the POEO Act, and consideration of historic and current commercial and industrial activities (see section 12.2.1).
AEC5/6	Former Mascot Galvanising site (Industrial Galvanizers Corporation Pty Ltd), east of the project site near Area 2	Metals Acids Solvents Cyanide Volatile hydrocarbons	The potential for contamination was identified based on a review of the NSW EPA contaminated sites notices and licenses under the POEO Act, and consideration of historic and current commercial and industrial activities (see section 12.2.1).

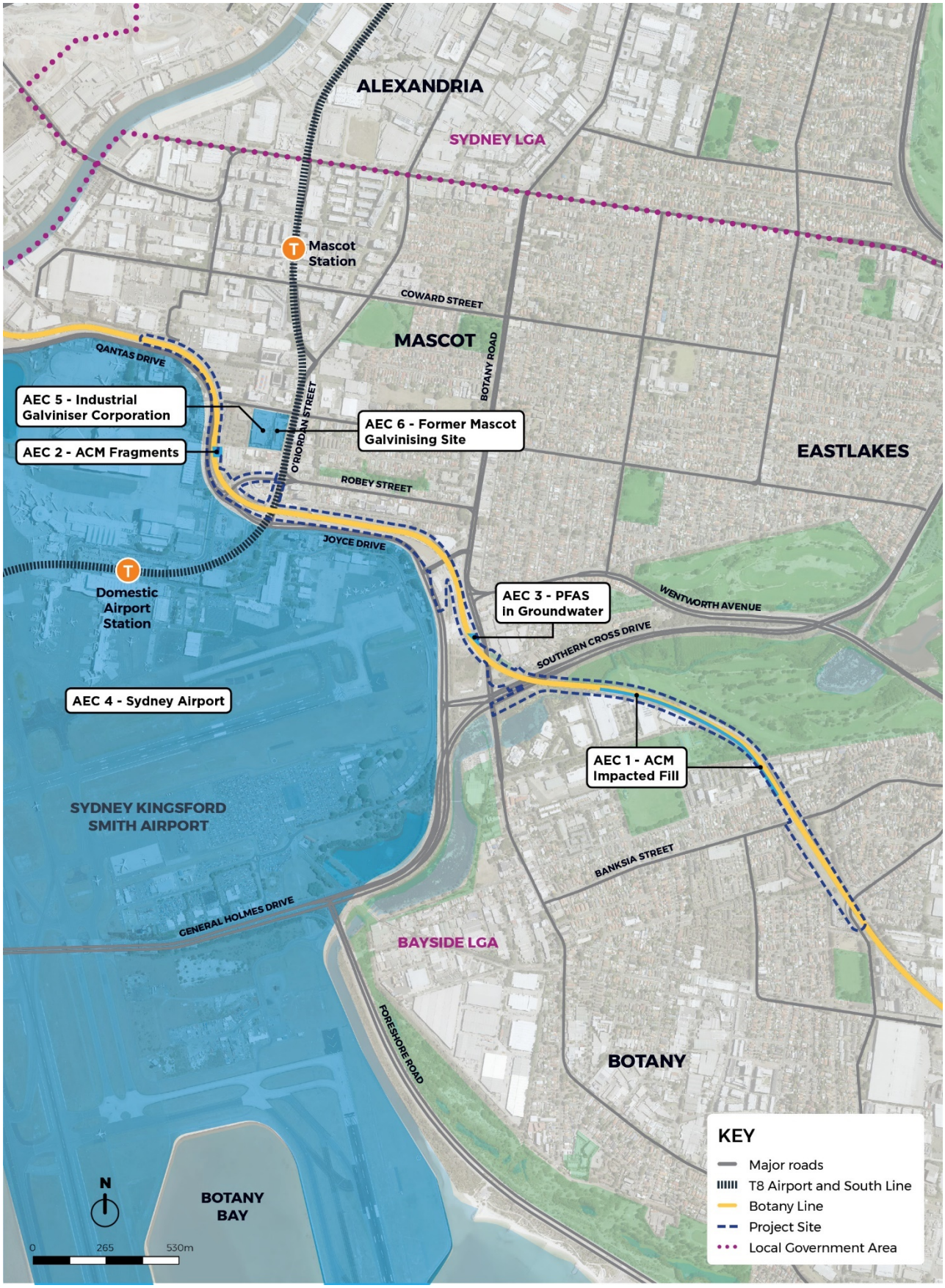


Figure 12.3 Areas of environmental concern (AEC) within and surrounding the project site

12.2.6 Conceptual site model

For contamination to result in an ecological or human health risk, there must be a plausible pollutant linkage between the source of contamination and a receptor (ie exposure pathway). Table 12.4 presents a CSM for the project, which provides the framework for identifying how potential receptors may be exposed to contamination. The CSM shows that there is an ecological risk to Mill Pond associated with ongoing elevated PFAS concentrations.

Table 12.4 Conceptual site model

SITE ASPECT	DETAILS	
Potential sources of contamination (see section 12.2.5)	• ACM in soil along Area 1 (AEC1). • Surface ACM in Area 2 (AEC2). • Off-site sources of PFAS including airport activities (south and west) (AEC4) and industrial activity (south and north) (AEC5). • Off-site former galvanising plant located on King Street in Mascot (north) (AEC6).	
Geology	**Fill material** • Various layers of fill encountered. • Area 1 – Fill generally present at depths between 1.5 mBGL and 3 mBGL. Generally, gravel and gravelly sand with building rubble observed at most locations. • Area 2 – Fill thickness is variable, generally ranging between 0.5 mBGL and 3.0 mBGL. Building rubble only observed at three locations. • Adjacent to Mill Pond – Locations either side of Mill Pond, fill recorded up to depths of 7 mBGL. Generally described as sand or gravel reworked natural material.	**Natural soils** • 1 mBGL to 20 mBGL sand, generally fine to medium grained, yellow, grey, light brown. • Intermittent clay bands encountered from 8 mBGL. • 17 mBGL to 32 mBGL clay/sandy clay, high plasticity, grey, brown. • Shale encountered at 18 mBGL (SG-BH065).
Depth and flow of groundwater	**Shallow aquifer** • Depth to groundwater on site was recorded between 3.3 mBGL and 5.2 mBGL. • Groundwater elevations within the project site ranged from 3.9 mAHD to 4.3 mAHD (AECOM, 2017). • Inferred groundwater flow is to the west/southwest. • It appears that the groundwater aquifer has a high yield. • Groundwater beneath the project site is likely to be subject to tidal influence.	
Influences on groundwater conditions at the site	• The project site intersects Mill Stream which flows into Mill Pond. • Engine Pond is located to the west of Mill Pond beyond General Holmes Drive. • Regional groundwater flow in the Botany Sands Aquifer flows predominantly towards Cooks River and Botany Bay.	
Nature of known soil contamination	**Area 1** • Asbestos in soil identified at several locations (AEC1). • PFAS concentrations recorded above the laboratory limit of reporting.	**Area 2** • ACM observed on site surface (west of Robey Street Bridge) (AEC2).

SITE ASPECT	DETAILS				
Nature of known groundwater contamination	**Area 1** • Elevated concentrations of manganese and arsenic.			**Area 2** • Elevated concentrations of manganese. • PFOS in off-site monitoring well MW5 NEMP criteria (AEC3).	
Nature of known surface water contamination	PFOS concentrations above the adopted criteria have been reported in surface water samples collected from Mill Pond. Total nitrogen, phosphorus, ammonia, heavy metals, turbidity and total suspended solids exceeded the adopted guidelines (ANZECC, 2000).				
Potential transport mechanisms and exposure pathways	• Leaching of soil contaminants into groundwater. • Lateral migration of contamination in groundwater. • Surface water runoff. • Outdoor inhalation of dust or fibres. • Direct dermal contact or ingestion of contaminants in soil or groundwater.				
Potential receptors	**On-site ecological** • None	**Off-site ecological** • Mill Pond • Mill Stream	**On-site workers** • Commercial • Intrusive	**Construction workers** • Construction • Maintenance	**Off-site community** • Commercial worker • Residential
Existing complete source-pathway-receptor links	No	Yes, concentrations of PFAS have been recorded in Mill Pond, which could be received by the aquatic ecosystem.	Yes, ACM observed on the site surface (west of Robey Street), which could mobilise as airborne fibres and be received by construction workers on-site.	Yes, ACM identified in soil (Area 1), which could mobilise as airborne fibres and be received by construction workers.	No, groundwater extraction restricted under 2018 order.
Future source-pathway-receptor links (project influence)	None	Yes, the off-site source of PFAS is unknown. Potential for ongoing concentrations of PFAS in Mill Pond.	Yes, ACM identified in soil will be capped and retained on site, which could mobilise as airborne fibres and be received by on-site workers.	Yes, ACM identified in soil will be capped and retained on site, which could mobilise as airborne fibres and be received by on-site workers.	No, groundwater extraction restricted under 2018 order.

12.3 Assessment of construction impacts

Contaminated soil and groundwater within or surrounding the project site, if encountered and not managed appropriately, it could potentially impact the environment or site workers.

During construction, contamination is likely to be encountered during construction activities that involve disturbing soil or groundwater, including:

- excavation such as for trackwork and retaining wall footings
- utility adjustment or relocation
- piling for bridge construction
- vegetation clearing
- vehicle movement.

Table 12.5 provides an assessment of the potential contamination risks for the project site during construction. The potential contamination risks during construction would be dependent on the likelihood and consequence of encountering contamination. The risk classifications correspond to the following definitions:

- Low risk: impact can be managed by implementing standard construction management measures.
- Medium risk: contamination specific management plans and controls required.
- High risk: engineered controls and environmental/health monitoring required.

Table 12.5 Contamination risk associated with construction of the project

AREA	POTENTIAL CONTAMINATION IMPACT	LIKELIHOOD OF ENCOUNTERING CONTAMINATION	CONSEQUENCE (POTENTIAL FOR EXPOSURE TO CONTAMINATION)	RISK
Area 1	If not managed appropriately, disturbance of the contaminated soil could result in human health or water quality impacts from: • airborne asbestos fibres being generated by excavation, movement and stockpiling of ACM contaminated soils • dust or asbestos exposure to construction workers (through direct contact, ingestion or inhalation) • off-site transport of contaminants via dust or vehicle/plant movements • surface water runoff to surrounding waterways, such as Mill Pond or Mill Stream.	High – Contaminant (asbestos and PFAS) identified above relevant assessment criteria and widespread.	High – Exposure pathway complete during construction (without implementation of appropriate controls).	High
Area 2	If not managed appropriately, disturbance of surface ACM could result in human health impacts from: • airborne asbestos fibres being generated during construction activities • dust or asbestos exposure to construction workers.	Medium – Contaminant (asbestos) potentially present at concentrations above the relevant assessment criteria and limited in extent.	Medium – Exposure pathway potentially complete during construction (without implementation of appropriate controls).	Medium

As shown in Table 12.5, due to the widespread contamination within the project site, human health and water quality impacts associated with encountering contamination during construction are possible. The potential soil contamination risks during construction are considered to be:

- high in Area 1, due to widespread presence of asbestos and elevated concentrations of PFAS, the potential for worker exposure and the potential for runoff of these contaminants to into Mill Pond or Mill Stream
- medium in Area 2, due to ACM being observed in some locations and the potential for worker exposure.

Therefore, in accordance with the risk classifications, contamination specific controls and management plans would be required during construction to minimise the risk associated with contamination (see section 12.6).

There is also a potential for cross-contamination associated with incorrect handling or disposal of contaminated soils, or spills and leaks of fuels from construction equipment across the whole of the project site. However, this potential impact would be minimised through implementation of appropriate equipment and material storage and handling procedures during construction.

No notable impacts associated with contaminated groundwater are expected as dewatering of excavations is not expected to be required, and the potential for encountering groundwater during piling works would be minimised as far as is reasonably practicable through the choice of construction methodology. Incidental groundwater extraction and subsequent disposal and reuse would be managed in accordance with the PFAS NEMP (see section 12.6).

12.3.1 Acid sulfate soils

The exposure of ASS to oxygen during earthworks and other soil disturbing activities can lead to the generation of sulfuric acid. The subsequent acidic leachate can then lead to mobilisation of heavy metals such as aluminium and iron into water bodies. As discussed in section 12.2.2, ASS are likely to be present within the project site, particularly in the area from the Southern Cross Drive bridge to the Mill Stream bridge. Therefore, ASS needs to be managed during construction (as outlined in section 12.6) to minimise the potential for water quality and ecological impacts associated with acidic runoff into Mill Stream.

12.3.2 Salinity

Soils within the study area are generally expected to have a low salinity potential (see section 12.2.3). The project is unlikely to influence groundwater levels as such, no significant impact on soil salinity is expected.

12.4 Assessment of operational impacts

During operation, maintenance works have the potential to disturb minor amounts of soils, which could result in human health impacts on the maintenance workers if the disturbed soil is contaminated. However, users of the project (eg maintenance workers or train drivers) are not expected to be exposed to potentially contaminated soil or groundwater. This is because the project proposes, where feasible and reasonable, to contain existing contaminated soil (that has not been removed during the construction phase of the project) using capping. The capping would consist of a demarcation layer (comprising geofabric and a contrasting-coloured marking layer), a layer of clean fill material, which would be at least 0.3 metres thick, and an additional 0.15 metres of topsoil.

If this capping is not well maintained, the contaminated soil may escape containment and result in cross contamination to previously uncontaminated areas via dust migration or water runoff. However, this potential impact would likely be minor and localised within the project site, and minimised with implementation of the management and mitigation measures outlined in section 12.6.2.

The primary operational impact related to the project is the potential contamination of soil, surface water and groundwater arising from intermittent vehicle accidents, leaks and spills on the rail track. However, as the project is located within an existing operational rail corridor, this would not introduce new sources of contamination to the surrounding environment. Additionally, the increase in frequency of potential vehicle accidents, leaks and spills from more frequent trains travelling along the Botany Line within the project site during operation of the project is expected to be negligible. However, there may be an increased potential for spills of grease and oil products, which are proposed to be used for lubrication of the rail line to minimise noise generated by wheel squeal. The lubricant products, which may cause minor temporary human health impacts such as skin or eye irritation, would be stored in a reservoir next to the track. If the storage or handling of the lubricant products is inadequate, there is a risk of spills and leaks that may cause additional soil contamination within the project site. However, providing ARTC's Standard Environmental Management Measures and incident response procedures are implemented (see section 12.6.2) to contain and clean up any spills as required, the potential impact of spills and leaks would be minor.

12.5 Cumulative impacts

Major developments currently under construction in the vicinity of the project include:

- M4–M5 Link and New M5
- Sydney Metro Southwest
- Airport North upgrades – O'Riordan Street
- Airport East upgrades – General Holmes Drive, Botany Road, Joyce Drive.

Other developments in the vicinity of the project, proposed but not yet approved include the Sydney Gateway and F6 Stages 1 and 2.

As the project is primarily within the rail corridor of the existing Botany Line and surrounded by other potentially contaminating land uses (such as Sydney Airport and the Former Mascot Galvanising site, see section 12.2.5), sources of contaminants are already likely to be present and entering the receiving environment. The potential for the project to increase the existing level of contaminants is expected to be negligible. Additionally, any impacts associated with contamination during construction and operation are expected to be temporary, minor and localised. Therefore, there is not expected to be a cumulative impact with other projects.

12.6 Management of impacts

12.6.1 Approach

A Soil and Water Management Plan would be developed to manage all soil and water risks during construction of the project, including risks associated with existing and potential contamination. Specific plans required to address identified contamination risks would be integrated into this plan, including an asbestos management plan and ASSMP. The requirement for remediation has been identified in Area 1. The preferred hierarchy of options for site clean-up and management presented in the NEPM 2013 (NEPC, 2013) would be adopted for remediation of the site. The site would be confirmed to be suitable for the proposed development following remediation. The remediation would be undertaken in accordance with a remediation action plan (RAP) prepared by a suitably qualified environmental consultant.

Further details on the overall approach to management of impacts is provided in Chapter 24.

12.6.2 List of mitigation measures

The mitigation measures that would be specifically implemented to address potential contamination impacts are listed in Table 12.6. This table also outlines which mitigation measures (during the construction stage) would be implemented during the enabling works and main construction works. As discussed in section 12.6.3, additional non-contamination specific mitigation measures relating to the handling of soil and water may also minimise contamination impacts.

Table 12.6 Mitigation measures

STAGE	IMPACT	MEASURE	ENABLING WORKS	MAIN CONSTRUCTION
Construction	Asbestos contaminated fill material	A remediation action plan (RAP) will be prepared for Area 1 in accordance with the NEPM 2013 prior to placement of the asbestos capping layer. Remediation in Area 1 will be undertaken in accordance with the endorsed RAP. Following this, a validation report will be prepared by a suitably qualified environmental consultant to validate the suitability of the project site for its proposed use. Installation of the capping layer will be done under the supervision of a suitably qualified and experienced consultant, as defined in Schedule B9 of the NEPM. The final elevation of residual contaminated soils will be surveyed prior to the installation of the marking layer and capping layers. Final levels should also be surveyed and included in the SWMP and ARTC asbestos register.	✓	✓
	Potential for unidentified ACM	West of Robey Street within Area 2, existing investigations will be supplemented with additional sampling using a test pit or trenching method in accordance with NEPM 2013 and WA Department of Health (WA-DoH) 2009, *Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia*. If enabling works in this area are undertaken prior to additional sampling, ACM will be assumed to be present and works will be supervised by an appropriately licensed contractor. This will be specified in site EMPs for the enabling works.	✓	
	Potential for encountering ASS	An ASSMP will be developed prior to the start of enabling works in accordance with the ASSMAC (1998) *Acid Sulfate Soils Manual* and included in the SWMP. ASS encountered during construction will be managed in accordance the ASSMP.	✓	✓

STAGE	IMPACT	MEASURE	ENABLING WORKS	MAIN CONSTRUCTION
	ACM impacted soils	An asbestos management plan (AMP) will be prepared prior to the start of enabling works in accordance with NSW EPA guidelines (including waste guidelines), SafeWork NSW 2014, *Managing Asbestos in or on Soil* and relevant industry codes of practice. This AMP will be included in the SWMP.	✓	✓
	Surface ACM	An emu pick involving the systematic manual collection of identified asbestos surface fragments will be undertaken prior to soil disturbance in Area 1 and the section west of Robey Street in Area 2, to remove ACM fragments from the site surface. A clearance certificate will be obtained from a licensed asbestos assessor.	✓	
	Contaminated groundwater	Adopt construction techniques to avoid groundwater disturbance where practicable. If groundwater is encountered, temporarily store all extracted groundwater to be disposed of off-site in appropriate containers then ensure it is tested for potential contaminants (including PFAS). Options for final disposal of extracted groundwater include: • removal off site to a water recycling facility if the level of contaminants does not exceed the water acceptance thresholds • discharge to a sewer via a trade waste agreement with Sydney Water • treatment through a groundwater remediation system before being released to surface water (with approval from NSW EPA). For the above options, the analytical testing results will need to demonstrate compliance with the applicable licence or discharge criteria.		✓
	Spills and leaks contaminating soil or groundwater	Procedures to store, handle and use materials and equipment appropriately to prevent spills will be prepared and implemented during construction, and included in the SWMP. Immediately contain and clean up leakage of fuels, oils, chemicals and other hazardous liquids in accordance with the Safety Data Sheet and ARTC's NSW Pollution Incident Response Management Plan to prevent migration of contaminants to other parts of the site.	✓	✓

STAGE	IMPACT	MEASURE	ENABLING WORKS	MAIN CONSTRUCTION
	Stockpile management and soil handling.	Employ stockpile management procedures as per ARTC's Standard Environmental Management Measures for segregating soil and preventing cross-contamination of clean soil with contaminated soil. These will be documented in the SWMP.	✓	✓
	ACM contaminated areas	ACM impacted soil will be handled and managed in accordance with the AMP at all times during construction. Areas that are designated as ACM contaminated areas will be clearly fenced off and suitable warning signs posted prior to soil disturbance in that area. Hygiene facilities will be provided incorporating a high standard of washing facilities and storage area for contaminated clothing/footwear. These areas will only be accessible to authorised personnel and work permitted only under controlled/supervised conditions by appropriately qualified/licensed personnel.	✓	✓
	Unexpected contamination	An unexpected finds procedure will be prepared prior to start of enabling works, and included as part of the SWMP. It will identify the process to follow in the event that indicators of contamination are encountered during construction (such as odours, ACM or visually contaminated materials).	✓	✓
Operation	Spills and leaks contaminating soil or groundwater	Potential spills and/or leaks will be managed in accordance with ARTC's pollution incident response procedure (under the Environment Management System) or in accordance with an Operator's Operational Management Environmental Management Plan (OEMP) prepared in accordance with ARTC's access agreement requirements (depending on the extent and natural of the spill).	N/A – Operation	N/A – Operation
	Potential spillage from lubricant system	Biodegradable low risk non-petrogenic products will be used where appropriate.	N/A – Operation	N/A – Operation

STAGE	IMPACT	MEASURE	ENABLING WORKS	MAIN CONSTRUCTION
	Containment of contaminated soils	The location and nature of any known contamination will be registered on ARTC's Contaminated Land Register and ARTCMap (internal GIS system). Prior to maintenance works in the corridor, a Task Based Environmental Assessment (TBEA) will be prepared which identifies known environmental sensitivities, including contamination. ARTC's Standard Environment Management Measures (under the Environment Management System) include procedures for no go zones for known areas of in-situ contamination, which will be implemented prior to maintenance works likely to disturb soils. ARTC's Work, Health and Safety work instructions will also be used for works near known contamination. Any required inspections of the capping layer undertaken by ARTC will be undertaken in accordance with ARTC's Asset Management System procedures. These procedures will be summarised in a site management plan in accordance with the CLM framework, which will be prepared by an environmental consultant and guide the management of residual contamination within the project site. This may be a standalone plan, or combined with site management plans that relate to adjacent areas.	N/A – Operation	N/A – Operation

12.6.3 Consideration of the interaction between measures

In addition to the measures for contamination described above, there are interactions between the mitigation measures for hydrology (Chapter 13) and soils and water quality (Chapter 14). For example, erosion and sediment control measures (as described in Chapter 14) would be implemented to prevent migration of contaminants within and surrounding the project site. All mitigation measures for the project are consolidated in Chapter 24 to ensure consistency in implementation.

12.6.4 Managing residual impacts

A residual risk analysis was undertaken taking into account the impact assessment summarised in this chapter and implementation of the mitigation measures as recommended in section 12.6.2. The residual risk levels were assessed to be medium for all potential contamination impacts (see Appendix B) including:

- disturbance of contaminated soil during construction
- contamination due to spills and leaks during construction and operation.

The reduction in risk level for the disturbance of contaminated soil or saline soils during construction from very high (prior to mitigation) to medium (with mitigation) is due to the implementation of management plans. These management plans would prescribe procedures for appropriate handling and management of contaminated soils, which are almost certain to be encountered during construction, to prevent cross-contamination and reduce the consequence of the disturbance.

13. HYDROLOGY AND FLOODING

This chapter provides a summary of the hydrology and flooding impact assessment. A full copy of the assessment report is provided as *Technical Report 6 – Flooding Impact Assessment*.

13.1 Assessment approach

A summary of the approach to the assessment is provided in this section, including the legislation, guidelines and policies driving the approach and the methodology used to undertake the assessment. A more detailed discussion of the guiding legislation and methodology for the flood assessment is provided in Chapter 2 and Chapter 3 of *Technical Report 6 – Flooding Impact Assessment*.

13.1.1 Legislative and policy context to the assessment

The assessment was undertaken with reference to the requirements summarised below.

Australian Rainfall and Runoff (Commonwealth)

Australian Rainfall and Runoff (ARR) is a national guideline for estimating design flood characteristics in Australia. ARR is important in providing reliable and robust estimates of design flood behaviour for projects such as the Botany Rail Duplication. The third edition of ARR was released in 1987 (ARR 1987) (Institute of Engineers Australia (IEAust), 1987), while a fourth edition of ARR was issued during the present investigation (ARR 2019) (Geoscience Australia (GA), 2019).

Hydrologic modelling for the project was based on ARR 1987, which is also consistent with the approach adopted for previous flood studies in the study area. Given the recent release of ARR 2019, a comparison was also made in the vicinity of the project between ARR 1987 and ARR 2019 on predicted flood behaviour.

Floodplain development manual (NSW)

The *Floodplain Development Manual* (FDM) (DIPNR, 2005) incorporates the NSW Government's Flood Prone Land Policy. The primary objectives of the policy are to reduce the impact of flooding and flood liability on owners and occupiers of flood prone property and to reduce public and private losses resulting from floods. The FDM promotes the concept that proposed developments be treated on their merit rather than through the imposition of rigid and prescriptive criteria.

A similar merits-based approach was adopted for the assessment of potential flood impacts associated with the project, including development of potential mitigation measures. In accordance with the FDM, the hydraulic and hazard categorisation of the floodplain was also considered when assessing the potential impacts on the project and its users.

Guideline on development controls on low risk flood areas (NSW)

The *Guideline on Development Controls on Low Flood Risk Areas* (NSW Government 2007) confirms that unless there are exceptional circumstances, councils should adopt the 1% AEP flood as the basis for deriving the Flood Planning Level (FPL) for residential development. The 1% AEP flood was therefore used as a basis for the assessment of potential flood impacts associated with the project.

Environmental Planning and Assessment Act 1979 (NSW) Section 117 Directions

In July 2009 the NSW Minister for Planning issued a list of directions to local councils under section 117(2) of the EP&A Act. *Direction 4.3 - Flood Prone Land* applies to all councils that contain flood prone land within their LGA and requires a draft LEP to contain a number of development controls associated with flooding. Controls include restrictions on development within floodway areas and on development that would result in significant impacts on other properties.

The flooding assessment has considered Ministerial Direction 4.3 when assessing the impacts and determining mitigation measures for the project.

Floodplain risk management guidelines (NSW)

The NSW Government's *Floodplain Risk Management Guideline: Practical Considerations of Climate Change* (DECC 2007) recommends that until more work is completed in relation to the climate change impacts on rainfall intensities, sensitivity analyses should be undertaken based on increases in rainfall intensities of between 10 and 30 percent. Under current climatic conditions, increasing the 1% AEP design rainfall intensities by 10 percent would produce about a 0.5% AEP flood. Increasing those rainfalls by 30 percent would produce about a 0.2% AEP flood. On current projections the increase in rainfall within the design life of the project is likely to be around 10 percent, with the higher value of 30 percent representing an upper limit. Therefore a 0.5% AEP flood and 0.2% AEP flood were modelled to represent these climate change rainfall scenarios, respectively.

In 2009 the NSW Government released its *Sea Level Rise Policy Statement* (NSW Government 2009) which supported adaptation to projected sea level rise impacts. The policy statement included sea level rise planning benchmarks for use in assessing potential impacts of projected sea level rise in coastal areas, including flood risk and coastal hazard assessment. These benchmarks were a projected rise in sea level (relative to 1990 mean sea level) of 0.4 metres by 2050 and 0.9 metres by 2100. The NSW Government recommended that these benchmark rises should be used to assess the sensitivity of flood behaviour to future sea level rise.

In the absence of a formal State Government policy on sea level rise benchmarks, the previously recommended rises in sea level of 0.4 metres by 2050 and 0.9 metres by 2100 have been adopted for assessing the impact future climate change could have on flooding conditions in the vicinity of the project.

Flood planning controls (local)

The project is located in the former Botany Bay (now Bayside) LGA. The *Botany Bay Local Environmental Plan 2013* (City of Botany Bay 2013a), which still applies to land located in the former Botany Bay LGA, does not include a 'flood planning' clause. As a result, the FPL has not been defined for development located in the vicinity of the project.

For the purpose of the flood impact assessment, it was assumed that the FPL in the vicinity of the project was equal to the peak 1% AEP flood level plus an allowance of 0.5 metres for freeboard (a safety factor to allow for uncertainties in modelling).

Drainage related standards (local)

Bayside Council relies on the *Botany Development Control Plan 2013* (City of Botany Bay 2013b) to guide development in the former Botany Bay LGA in accordance with *Botany Bay Local Environmental Plan 2013* (City of Botany Bay 2013a). These requirements include the provision of on-site detention in order to mitigate an increase in the quantity of runoff discharging into Council's receiving drainage system as a result of future development.

Notwithstanding the above council requirements, there would be a general requirement for the project to manage adverse changes to existing flow behaviour, should they occur.

13.1.2 Methodology

Key tasks

The flooding assessment involved the following tasks:

- a review of available data and existing flood studies within the catchments that are crossed by the project
- development of a set of hydrologic and hydraulic models (collectively referred to as 'flood models') of the catchments that are located within the study area
- flood modelling and preparation of maps showing flood behaviour under present day (ie pre-project) conditions for design floods with AEPs of 50%, 20%, 10%, 5%, 2%, 1% 0.5% and 0.2%, as well as the Probable Maximum Flood (PMF; the largest conceivable flood at a particular location and the area considered to be the 'floodplain')
- assessment of the potential impact that the project would have on flood behaviour for the identified design flood events (both during its construction and operation)
- assessment of the impact future climate change would have on flood behaviour under operational conditions
- assessment of the impact a partial blockage of major hydraulic structures would have on flood behaviour under operational conditions
- assessment of potential measures to mitigate the risk of flooding to the project and the project's impact on existing flood behaviour.

Study area

The project is located within the following two catchments:

- Alexandra Canal
- Mill Stream.

Alexandra Canal forms part of the larger Cooks River catchment, while the Cooks River and Mill Stream both drain to Botany Bay. The flood study incorporates drainage of water within both catchments, but the study area is defined by the flood model boundary (shown in Figure 13.1). It is in this area that flood waters can impact upon the rail line, and where the rail line (existing and proposed duplication) can influence surrounding and downstream flood conditions.

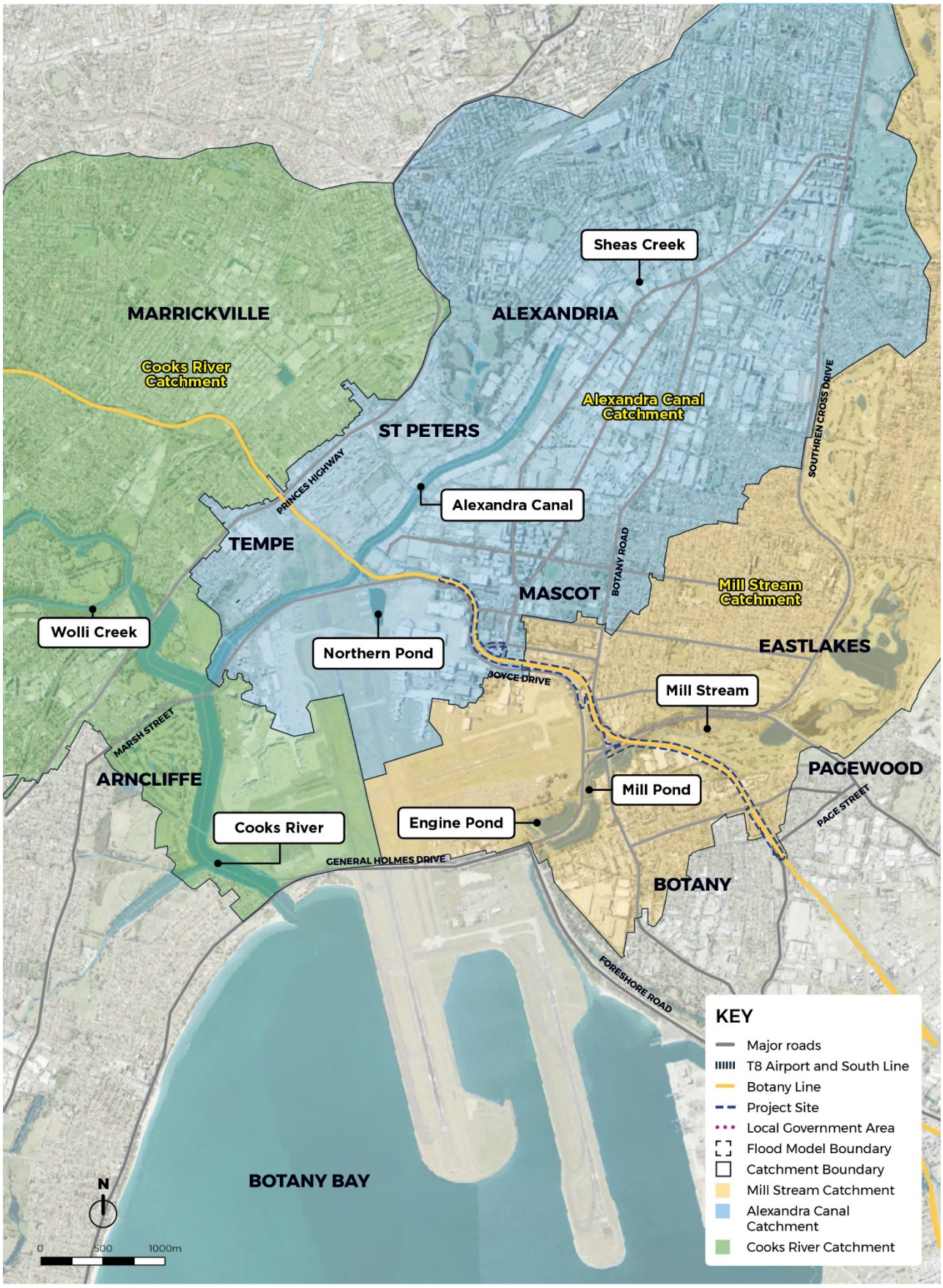


Figure 13.1 Flood study area

13.1.3 Risks identified

The preliminary environmental risk assessment undertaken for the project (provided in Appendix B) included potential risks associated with hydrology and flooding. Potential risks were considered according to the impacts that may be generated by the construction and/or operation of the project. The likelihood, consequence and overall risk level of each potential risk were assessed, with avoidance and management measures defined for each potential risk. Further information on the risk assessment, including the approach, methodology, and the full results, is provided in Appendix B.

Prior to assessment and identification of mitigation measures, risks with an assessed level of medium or above include:

- High risk:
    - blockages of flow paths affecting low flows through erosion and sedimentation control measures
    - impacts upstream and downstream drainage due to the introduction of built structures such as embankments, culverts and bridges
- Medium risk:
    - changes to flow patterns and altered hydrology due to construction in watercourses
    - sedimentation and changes to geomorphology (aggradation in bed channels) in watercourses
    - temporary impact to the behaviour of local surface water systems during construction
    - presence of or change to structures associated with the project that could impact upstream and downstream local flood behaviour
    - changes to structures associated with the project and track height that could impact upstream and downstream regional flood behaviour.

These potential risks and impacts were considered as part of the assessment. The assessment also considered matters identified by the SEARs and stakeholders (as described in Chapters 3 and 4). The residual risk levels, following implementation of the mitigation measures proposed in this EIS, are discussed in section 13.6.4.

13.1.4 How potential impacts have been avoided or minimised

As described in Chapters 6 and 7, design development and construction planning for the project has included a focus on avoiding or minimising the potential for environmental impacts during all key phases of the process. With respect to potential hydrology and flooding impacts, the project has sought to avoid or minimise potential impacts where possible.

Mitigation measures to protect the project from flooding impacts mainly involve locating critical infrastructure above the peak 1% AEP. Managing potential adverse impacts from the project on the surrounding environment would involve planning construction works outside of flood-prone areas and designing new and modified drainage infrastructure to avoid hazardous flood behaviour. The exact scope of the required mitigation measures would be subject to further flood assessment which would be undertaken during the detailed design phase.

13.2 Existing environment

13.2.1 Catchment description

The Alexandra Canal and Mill Stream catchments contribute runoff to the existing drainage systems and waterways located within the study area. Alexandra Canal forms part of the larger Cooks River catchment. Both the Cooks River and Mill Stream drain to Botany Bay.

Alexandra Canal catchment

Alexandra Canal is a major tributary of the Cooks River. The original creek was widened in the late 1800s over about a four kilometre length to form the Alexandra Canal. The size of the catchment draining to the canal increases from about 660 hectares at its northern (upstream) end near Sydney Park Road, to about 1,770 hectares at its confluence with the Cooks River.

The Alexandra Canal catchment is located within the suburbs of Alexandria, Rosebery, Tempe, Erskineville, Beaconsfield, Zetland, Waterloo, Redfern, Newtown, Eveleigh, Surry Hills and Moore Park.

Land use within the catchment comprises medium and high density residential, commercial and industrial development. More significant areas of open space within the overall catchment area include Sydney Park, Moore Park Playing Fields, Moore Park Golf Course, The Australian Golf Course and Alexandria Park.

The section of the project site between Lancastrian Road and about 160 metres east of O'Riordan Street is located within the Alexandra Canal catchment. The existing drainage along the rail corridor within this section of the catchment generally comprises informal open drains and overland flowpaths that convey runoff to the receiving drainage lines. An open drain exists north of the rail corridor in the Lancastrian Bridge area, while piped drainage crosses the rail corridor at the western end of King Street and through a series of pipes between Ewan Street and O'Riordan Street.

Mill Stream catchment

The Mill Stream catchment extends from Centennial Park in the north to its outlet into Botany Bay in the south. The catchment draining to Mill Stream is about 2,000 hectares at Foreshore Drive (around two kilometres to the south of the project site). The upper reach of the catchment is located within the Randwick City Council, City of Sydney and Waverley LGAs, while the lower reach is located within the Bayside Council LGA. The catchment includes the suburbs of Centennial Park, Queens Park, Kensington, Randwick, Kingsford, Daceyville, Eastlakes, Rosebery, Mascot, Pagewood and Botany.

Land use within the catchment predominantly comprises medium and high density residential and commercial development.

Mill Stream comprises a man-made channel where it runs along the eastern side of Sydney Airport from Foreshore Drive to its outlet into Botany Bay. Mill Stream comprises a vegetated channel where it runs in a southerly direction through Eastlake Golf Course from Gardeners Road and feeds a series of interconnected freshwater ponds that are referred to as the Botany Wetlands. The section of Botany Wetlands between Eastlake Golf Course and Botany Road is owned and maintained by Sydney Water under the *Plan of Management – Botany Wetlands 2018–2028* (Sydney Water, 2018).

The section of the project site between about 160 metres east of O'Riordan Street and Stephen Road (at the southern end of the project site) is located within the Mill Stream catchment. As is the case with drainage infrastructure in within the Alexandra Canal catchment, the existing drainage along the rail corridor within the Mill Stream catchment generally comprises informal open drains and overland flowpaths that convey runoff to the receiving drainage lines.

Piped drainage crosses the rail corridor north and immediately south of General Holmes Drive, eventually discharging into Mill Stream. Piped drainage also crosses the rail corridor in the area of Wentworth Avenue and Bronti Street. A vegetated channel runs along the eastern side of the existing rail line between Banksia Street and Myrtle Street, where piped drainage crosses the line and flows into Mill Stream to the north of Foreshore Drive.

13.2.2 Existing flooding and drainage behaviour

There are some locations adjacent to the rail line where both main stream flooding and major overland flow occur under pre-project conditions. These locations are summarised and described in Table 13.1 and shown in Figure 13.2.

Table 13.1 Description of existing flood behaviour

LOCATION	DESCRIPTION OF EXISTING FLOOD BEHAVIOUR (UP TO AND INCLUDING 1% AEP EVENTS)
North of rail line (Lancastrian Bridge area)	Floodwater would surcharge (ie overflow) the southern bank of the existing concrete lined channel running along the northern side of the rail corridor during a 2% AEP flood event or greater. Floodwater at this location during this event would still be around 0.3 metres below the level of the adjacent rail line.
King Street	Overflow from the stormwater drainage system in King Street would pond in a low point at its western end to a maximum depth of about 0.2 metres at this location during a 10% AEP event. During greater flood events, water would flow to the north along the western side of the rail corridor to a maximum depth of about 0.2 metres.
Ewan Street/ O'Riordan Street	Overflow from the stormwater drainage system in Ewan Street would pond in a low point adjacent to the rail corridor to a maximum depth of about 1.3 metres at this location. This would still be 1.6 metres below the level of the adjacent rail line. The depth of ponding during events greater than a 10% AEP event would be sufficient to result in hazardous flooding conditions to people and property.
Robey and O'Riordan Street underpasses	The rail line is on an elevated bridge structure where it crosses the low points in Robey Street and O'Riordan Street. Flow in excess of the capacity of the stormwater drainage system would pond at the low points in the Robey and O'Riordan Street underpasses to between 0.9 and 1.1 metres during a 1% AEP event. During a 1% AEP event the depth of ponding at the Robey Street underpass would result in water flow into the basement carpark of the Stamford Plaza Sydney Airport (Stamford Plaza) via the entrance located immediately to its east. Flooding was reported at the Robey Street underpass during a storm that occurred on 7 September 2018. A photo that was taken during the storm indicated that the depth of ponding at the low point could have been in the order of 0.2 to 0.3 metres. An analysis of the rainfall that was recorded at Sydney Airport during this event indicated the storm was equivalent to less than a 1 Exceedance per Year (EY) event (ie its intensity was less than that of a storm that occurs once every year on average). Flooding has also recently been reported at the low point in the O'Riordan Street underpass during a storm that occurred on 28 November 2018. A video taken of the flooding to the underpass indicates that the depth of ponding at the low point could have been in the order of 0.5 metres. An analysis of the rainfall that was recorded at Sydney Airport during this event shows that the storm was also equivalent to a 1 EY event or less.

LOCATION	DESCRIPTION OF EXISTING FLOOD BEHAVIOUR (UP TO AND INCLUDING 1% AEP EVENTS)
Qantas Drive sag	Depths of ponding of between 0.9 and 1.1 metres would also occur at the low point in Qantas Drive located to the west of Robey Street (denoted 'Qantas Drive sag') during a 1% AEP event. Drainage overflow at the low point at Qantas Drive sag discharges in a southerly direction into an adjoining carpark within Sydney Airport. Depths of inundation in the carpark occur to a maximum of 0.6 metres during a 10% AEP design storm, increasing to a maximum of 0.9 metres during a 1% AEP design storm.
Mill Stream	The peak 1% AEP flood level at the bridge that spans Mill Stream would be about 1.5 metres below the underside of the bridge. Southern Cross Drive, where it runs under the rail line to the west of Botany Road, acts as an overland flowpath for water from Mill Stream within the Lakes Golf Club during events greater than about 2% AEP. During a 1% AEP event overland flow along Southern Cross Drive collects at the low point in Botany Road between Wentworth Avenue and Southern Cross Drive. A section of rail line about 220 metres to the east of the Mill Stream bridge would be inundated by overland flow that surcharges Mill Stream and discharges through the southern portion of the Lakes Golf Club during events greater than about 10% AEP.
West of Mill Stream	Flooding would occur at a low point on Baxter Road where water surcharges the drainage pipes that cross the rail corridor at this location. A section of the existing track that is located 140 metres to the north of General Holmes Drive would be impacted by local catchment runoff that collects at the low point in the rail corridor along its southern boundary. The rail underpass at Wentworth Avenue would be inundated by floodwater to a depth of about 0.5 metres during a 10% AEP event, increasing to 0.9 metres during a 1% AEP event. During a 1% AEP event, a 150 metre length of Botany Road between Wentworth Avenue and Southern Cross Drive would be inundated by floodwater, including the section of road that runs under the rail line to the south of Bronti Street.
East of Mill Stream	Flow that surcharges the stormwater drainage system in Banksia Street will collect at its low point to the north of the rail corridor before discharging into the rail corridor. Similarly, flow that surcharges the stormwater drainage system in Bay Street will collect at its low point to the north of the rail corridor before discharging into the vegetated channel that runs along the eastern side of the rail line during events for frequent than 50% AEP. This flow would surcharge the inlet pipe that crosses the rail corridor at Myrtle Street. This surcharge flood water will flow north toward the Eastlake Golf Course and combine with flow that surcharges Mill Stream. A section of the existing rail line that is located 150 metres to the north of Myrtle Street is impacted by local catchment runoff that collects at the low point in the rail corridor along its northern boundary. During a 10% AEP event, runoff that collects at the low point will overtop the rail line where it will discharge in a westerly direction toward Mill Stream.

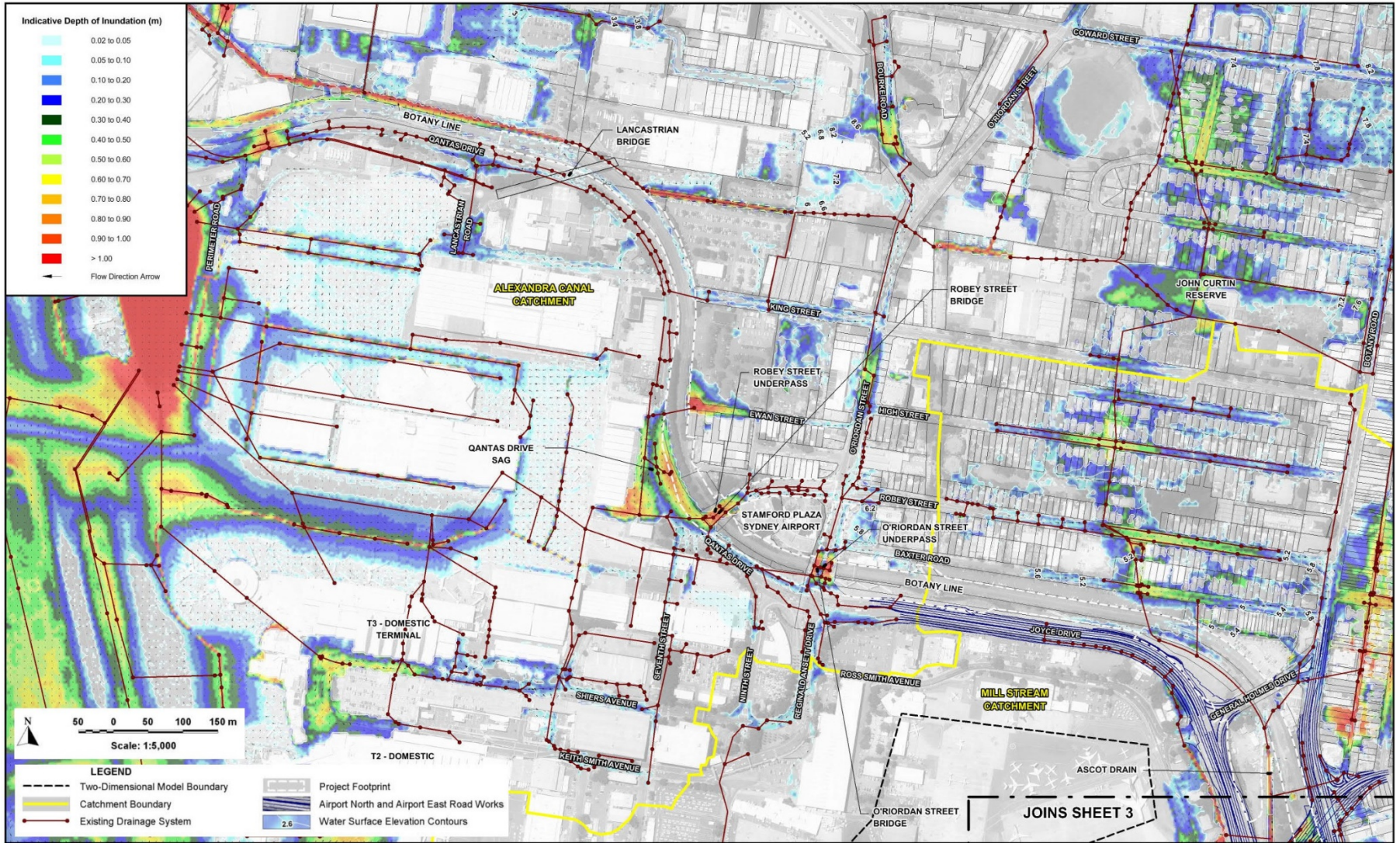


Figure 13.2a Pre-Project flooding – 1% AEP event

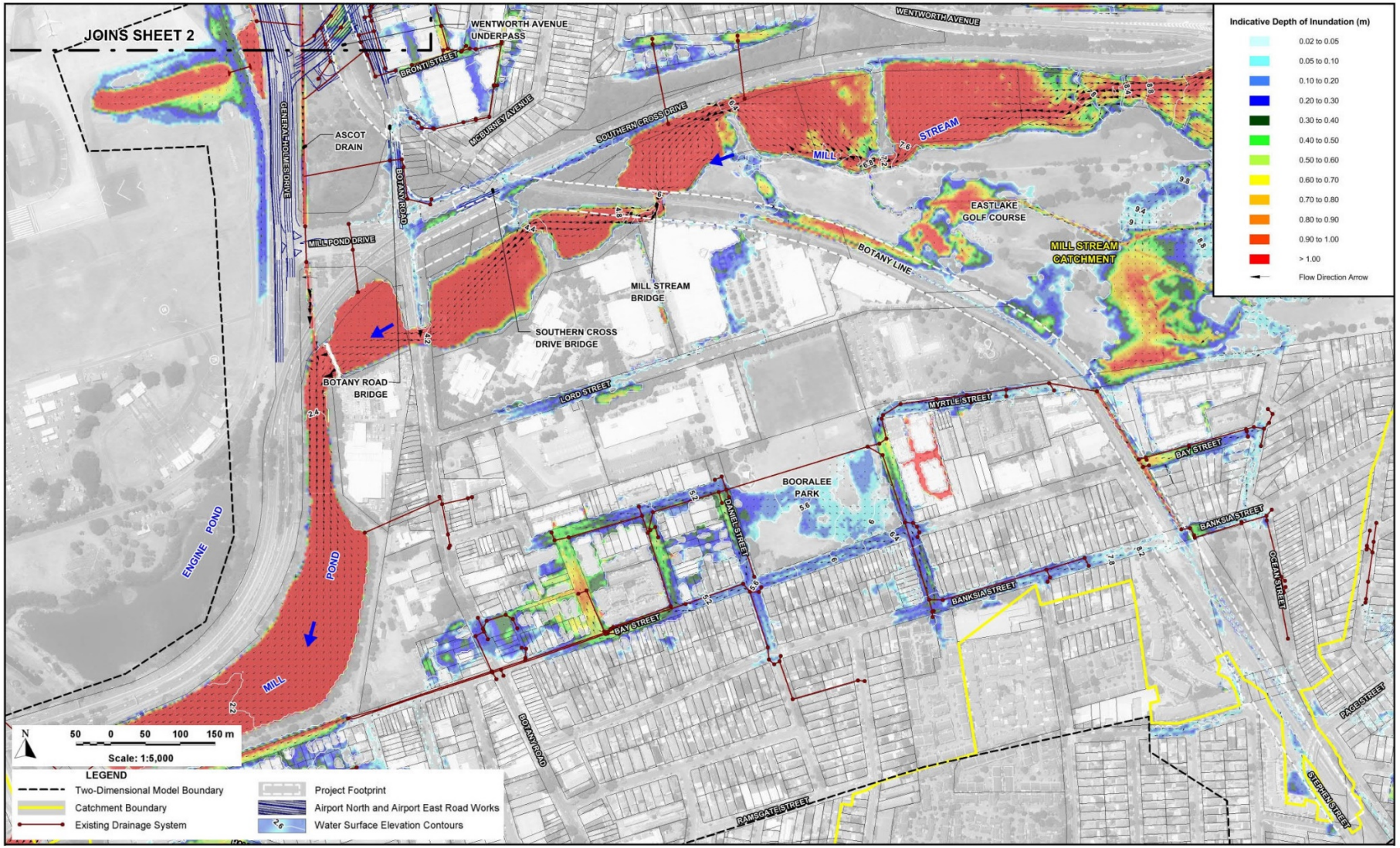


Figure 13.2b Pre-Project flooding – 1% AEP event

13.3 Assessment of construction impacts

13.3.1 Construction compounds, storage areas and earthworks

A number of construction compound sites are proposed along the length of the project site. Each compound would contain a range of site facilities that would include offices, staff amenities, parking and storage areas for plant, equipment and materials, as well as fencing and security facilities.

The inundation of the proposed construction compounds by floodwater would have the potential to:

- cause damage to the project works and delays in construction programming
- pose a safety risk to construction workers
- detrimentally impact the downstream waterways through the transport of sediments and construction materials by floodwaters
- obstruct the passage of floodwater and overland flow through the provision of temporary measures such as site sheds, bunding, stockpiles and some types of temporary fencing, which in turn could exacerbate flooding conditions in existing development located outside the construction footprint.

In addition to the identified construction compound sites, a series of additional construction areas have been identified along the project site for the storage of materials and equipment. The construction of the project would generate spoil which may also need to be temporarily stored in stockpile areas for reuse on site or haulage to an appropriately licensed facility.

Stored equipment and stockpiles located on the floodplain would have the potential to obstruct floodwater and alter flooding patterns. Inundation of stockpile areas by floodwater can also lead to significant quantities of material being washed into the receiving drainage lines and waterways.

Earthworks would be required along the length of the project site and would include excavation works for subgrade formation and fill to expand embankments and support new retaining walls and bridge abutments.

The inundation of floodwater to areas where earthworks are undertaken has the potential to cause scour of disturbed surfaces and the transport of sediment and construction materials into the receiving waterways.

13.3.2 Bridge construction

The following six bridge structures are proposed to be constructed as part of the project:

- Robey Street bridge (comprising two bridges)
- O'Riordan Street bridge (comprising two bridges)
- Southern Cross Drive bridge
- Mill Stream bridge.

Crane pads would be required at each of the proposed bridge structures to support cranes to install various bridge components including precast sections and beams. All crane pads would be in areas that are impacted by overland flow during storm events of 50% AEP or more frequent.

13.3.3 Potential impacts of construction activities on flood behaviour

The previous section covered flood impacts *on* the construction activities, whereas this section covers flood impacts *from* construction activities on the surrounding area. Construction activities have the potential to exacerbate flooding conditions when compared to both pre-project and operational conditions. This is because the construction activities typically impose a larger footprint on the floodplain due to the need to provide temporary structures, such as construction compounds, outside the operational footprint of the project, which would be removed following the completion of construction activities.

Mill Stream bridge

While all construction work areas would involve works within the floodplain, the assessment found that the greatest potential for adverse impacts on flood behaviour would occur during construction of the Mill Stream bridge and the associated Mill Stream construction compound. This would include the provision of proposed crane pads and temporary piling platforms that could impact on the flow of Mill Stream during this period. The works also have the potential to increase flow velocities and therefore scour and erosion potential in Mill Stream.

Robey Street and O'Riordan Street bridges

While the proposed crane pads for the construction of the Robey Street and O'Riordan Street bridges have the potential to obstruct overland flow that is conveyed along the roadways, the temporary crane pads would only be in place during a short-term rail possession period of around 48 hours and therefore the potential for impacts is considered to be minimal.

13.4 Assessment of operational impacts

Inundation of the project by floodwater during operation has the potential to cause damage to infrastructure, impact on train movements and pose a safety risk to rail users. The project also has the potential to exacerbate flooding and drainage conditions in adjacent development by obstructing or diverting floodwaters, displacing floodplain storage or altering runoff behaviour from the rail corridor. An assessment was undertaken of the flood risk to the project in its as-built form, as well as the impact it would have on the characteristics of flooding in adjacent areas. A summary of this assessment is provided below, with additional detail provided in *Technical Report 6 – Flooding Impact Assessment*.

13.4.1 Potential flood risk to the project

The project would provide a level of flood immunity to the 10% AEP for both the existing and new rail tracks, which is slightly greater than that of the existing rail track, resulting in the existing rail line being more resilient to flooding once construction is completed due to additions and modifications to the existing drainage system. Some sections of the rail line ballast would however still be inundated during a 1% AEP event. This would include a section of the southern track to the west of General Holmes Drive and a section of the northern track to the west of Myrtle Street. Inundation is predicted to be 0.5 metres and 0.4 metres below the top of rail levels at these locations, respectively.

The proposed bridge over Mill Stream would provide more than 0.5 metres of freeboard between the underside of the bridge structure and the peak 1% AEP flood level.

The new corridor access roads would provide a 10% AEP level of flood immunity with the exception of a section of road about 140 metres west of Myrtle Street. This location is predicted to be inundated to a maximum depth of around 0.3 metres due to local catchment runoff that ponds along the northern side of the rail corridor.

13.4.2 Impact of the project on flood behaviour

An assessment was carried out into the impact the project would have on flood behaviour due to changes in flow conveyance and a reduction of flood storage across the floodplain. The assessment found that once constructed, the project would generally have only a minor impact on flood behaviour for floods up to the PMF event, with the exception of residual flood impacts near Mill Stream and along Myrtle Street. The impact of project operation on flood behaviour for a 1% AEP event is shown in Figure 13.3a and 13.3b. Those maps show the amount of afflux, or change in flood depth, that is predicted to occur once the project is constructed, compared to pre-project conditions.

The project would generally have a minor impact on flow behaviour (ie flow depths and velocities) in the drainage systems downstream of the proposed outlets that would control runoff from the project. Additions and modifications to the drainage system will allow flows to generally behave in a similar way to pre-project conditions.

Mill Stream

Peak 1% AEP flood levels upstream of Mill Stream bridge would be increased by a maximum of around 0.1 metres. This would lead to an increase in the rate (and therefore depth) of flow that overtops the western bank of Mill Stream and is conveyed along the travel lanes of Southern Cross Drive and Botany Road. The increase in peak flood levels upstream of Mill Stream would also lead to an increase in the frequency with which flow overtops the western bank of Mill Stream onto the travel lanes of Southern Cross Drive. This would change from about a 1% AEP event under pre-project conditions to about a 2% AEP event under post-project conditions (ie twice as frequent). The road would be impacted (affecting traffic flow) approximately once every 50 years, instead of once every 100 years.

The assessment found that the project would have only a minor impact on the extent and duration of inundation of flooding within Mill Stream.

Myrtle Street (and surrounding properties)

During a 1% AEP event, operation of the project would result in an increase in peak flood levels upstream of the inlet to the 1,050 millimetre diameter pipe that crosses the rail corridor at Myrtle Street. This would also result in potential to impact the existing adjoining developments at this location.

In particular, it is predicted that peak flood levels at:

- 104 Bay Street would be increased by a maximum of around 0.02 metres (ie two centimetres). Impacts would occur in the northern portion of the development over an area that includes several units that front Myrtle Street
- 15 Begonia Street would be increased by a maximum of around 0.02 metres. Impacts would occur in the north eastern portion of the development, what appears to be the entry to basement carparking.

The modelling suggests that the properties currently experience around 0.1 metre inundation in some areas, however it is currently unknown whether it affects basement car parks or habitable rooms. Similarly, it is unknown whether the additional 0.02 metres would or would not worsen existing pre-project impacts. As such the discussion of potential social or economic impacts as a result of this assessment is qualitative and would be further understood following any additional assessment, as required. Mitigation measures provided have identified detailed floor level surveys would be undertaken to provide further understanding of where additional inundation could affect, in the event that the increase in inundation cannot be designed out.

The potential social and economic impact of this predicted increase in peak flood levels is discussed in section 19.4.5.

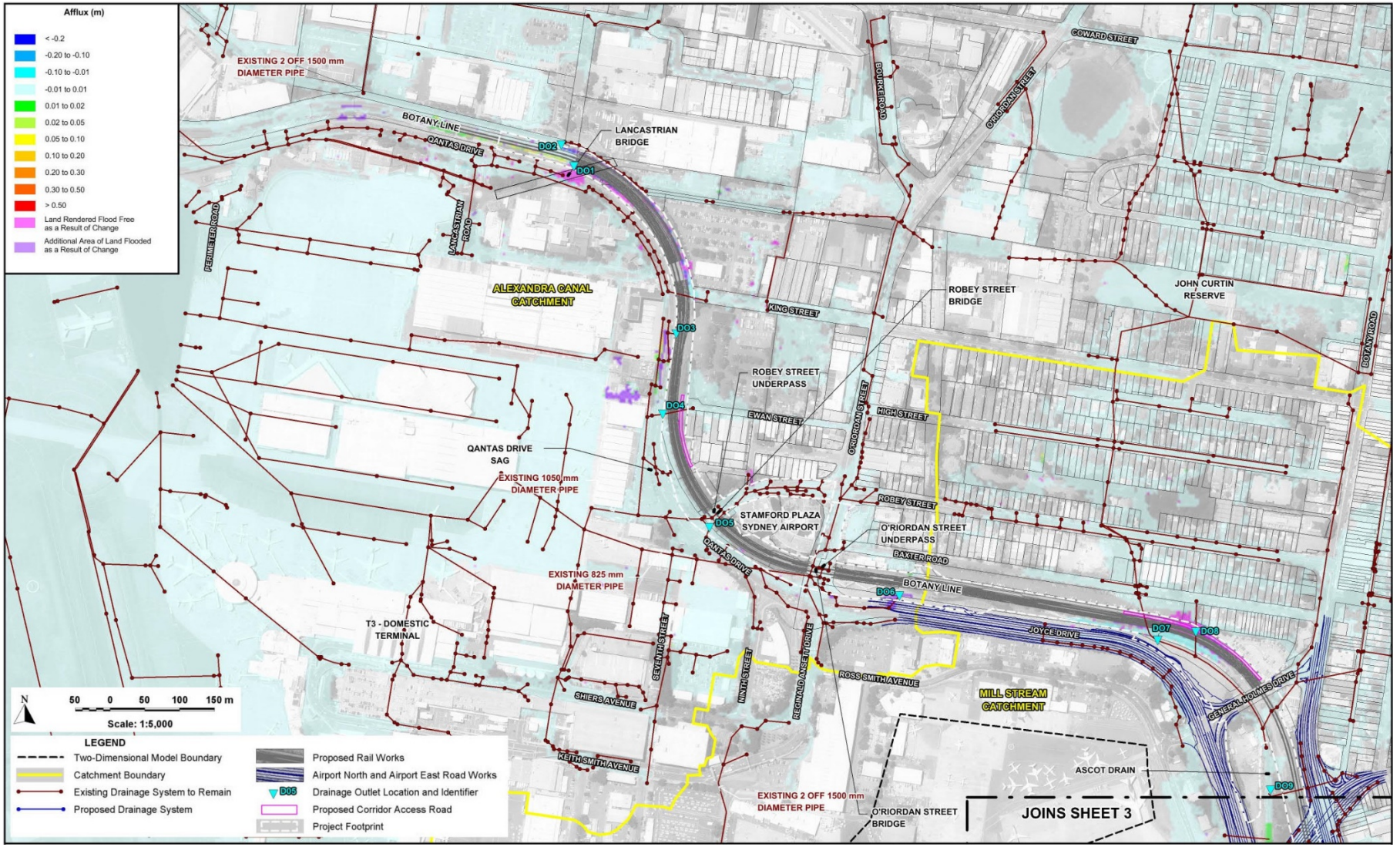


Figure 13.3a Impact of Project operation on flood behaviour – 1% AEP event

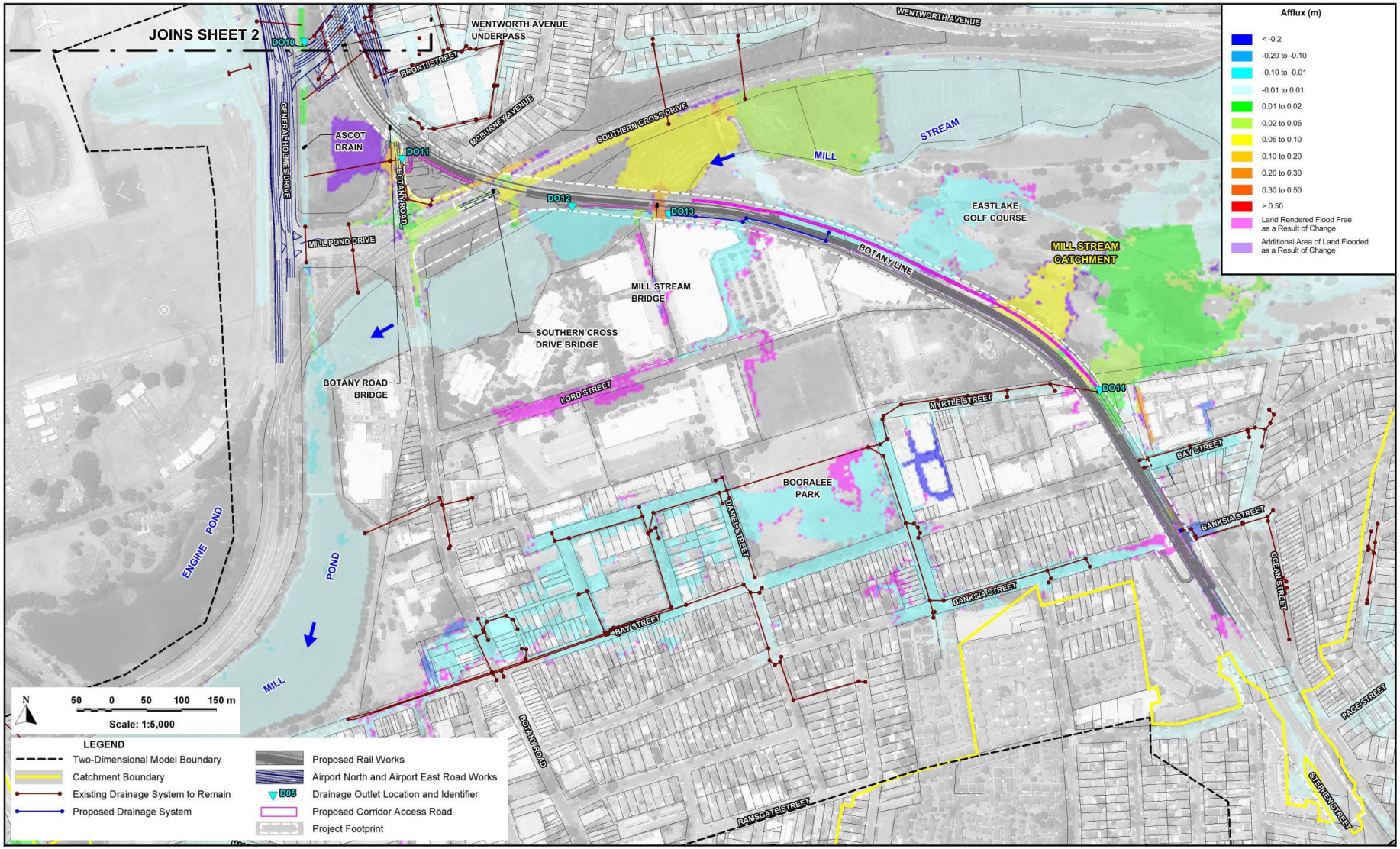


Figure 13.3b Impact of Project operation on flood behaviour – 1% AEP event

13.4.3 Impact of a partial blockage of major drainage structures on flood behaviour

The assessment showed that a partial blockage of major hydraulic structures (eg pipes crossing the rail corridor) would result in an increase in peak 1% AEP flood levels upstream of the Mill Stream bridge by a maximum of around 0.03 metres. As a result, there would be an increase in the rate and depth of flow that overflows the western bank of Mill Stream onto Southern Cross Drive.

The resulting peak flood level would however still be more than one metre below the underside of the existing and new bridge structures at Mill Stream. There would also be an increase in peak 1% AEP flood level upstream of the inlet to the 1,050 millimetre diameter pipe that crosses the rail corridor at Myrtle Street by around 0.01 metres, which would have a negligible impact on flooding to the rail line.

13.4.4 Impact of future climate change on flood behaviour

For this project 0.5% and 0.2% AEP events were adopted as proxies for assessing the sensitivity to an increase in 1% AEP design rainfall intensities of between 10 and 30 percent due to future climate change. The assessment found that there would be relatively minor increases in flood impacts attributable to the project under both the lower and upper bound future climate change scenarios.

While flooding under future climate change conditions would increase the depth of inundation to the ballast below the duplicated rail line, the depth of inundation would still be a minimum 0.25 metres below the top of rail level and is therefore unlikely to impede train operations during a climate-adjusted 1% AEP event. The increase in the frequency and depth of inundation of the ballast is likely to increase the rate of deterioration and therefore maintenance requirements of the track.

Raising the level of the rail line in order to reduce the depth of inundation to the ballast would be constrained by the level of the existing rail line and would also be likely to result in adverse impacts on flood behaviour in areas outside the rail corridor.

13.5 Cumulative impacts

13.5.1 Overview

The methodology of the cumulative impact assessment and details of other projects considered are detailed in Chapter 24. A summary of the predicted cumulative impacts which relate to hydrology and flooding are described below.

13.5.2 Cumulative construction impacts

Given the short-term nature of exposure to potential flood impacts during its construction together with the general requirement to manage adverse impacts on the existing development, cumulative construction impacts relating to hydrology and flooding were not assessed. Furthermore, the flooding assessment found that the greatest potential for impacts associated with the construction of the project would be as a result of the construction of the Mill Stream bridge, which is located in an area of the Mill Stream floodplain that is remote from the other projects in the area.

13.5.3 Cumulative operational impacts

Given the minor nature of impacts that are attributable to the project on flood behaviour in the drainage systems that control runoff from the rail (as described in section 13.4 above), it is expected that the cumulative impacts of it in combination with other projects in the area would also be minor in nature.

13.6 Management of impacts

13.6.1 Approach

The assessment of flood impacts associated with the project has provided an understanding of the scale and nature of the flood risk to the project, as well as the increased flood risks on the surrounding environment during its construction and operation. Further assessment will be undertaken during the detailed design phase of the project that will build on the flood assessment presented in this technical working paper and will be based on further design development and flood modelling where required.

A full description of the approach to environmental management and mitigation is provided Chapter 25.

13.6.2 List of mitigation measures

The mitigation measures that would be implemented to address potential flooding impacts are listed in Table 13.2. This table also outlines which mitigation measures (during the construction stage) would be implemented during the enabling works and main construction works.

Table 13.2 Mitigation measures

STAGE	IMPACT	MEASURE	ENABLING WORKS	MAIN CONSTRUCTION
Design	Rail duplication	As a minimum, the modification and duplication of the existing rail line is to be configured to ensure the existing level of flood immunity is not reduced by the project. Measures to improve the existing level of flood immunity are to be further investigated during detailed design with the goal of providing a 1% annual exceedance probability (AEP) level of flood immunity.	N/A – Design phase	N/A – Design phase
	New bridge over Mill Stream	The new bridge crossing over Mill Stream is to provide a minimum freeboard of 0.5 metres between the underside of the bridge structure and the peak 1% AEP flood level.	N/A – Design phase	N/A – Design phase
	System and control network	Rail location cabinets (LOCs) for housing communications, power and signalling equipment for the system and control network will be located a minimum 0.5 metres above the peak 1% AEP flood level in accordance with ARTC standards.	N/A – Design phase	N/A – Design phase
	New corridor access roads	A 10% AEP level of flood immunity is to be provided to the new access roads.	N/A – Design phase	N/A – Design phase

STAGE	IMPACT	MEASURE	ENABLING WORKS	MAIN CONSTRUCTION
	Management of adverse flood impacts on the existing environment (design)	A detailed hydrologic and hydraulic (flood) assessment of the impacts of the project on flood behaviour and the associated measures which are required to mitigate those impacts will be undertaken during detailed design. Works within the floodplain will be designed to minimise adverse impacts on surrounding development (including roads) for flooding up to the 1% AEP event in magnitude. Assessment will also be made of impacts during floods up to the probable maximum flood (PMF) in the context of impacts on critical infrastructure and flood hazards. Subject to the flood assessment during detailed design, it may be necessary to collect detailed ground survey (including floor levels and entry levels to buildings and basement carparks) in affected areas to determine whether the project will increase flood damages in adjacent development (ie in properties where there is a potential for increases in peak flood levels for events up to 1% AEP in magnitude) or increase the flood hazard to basement carparks (ie in basement carparks where there is a potential for increases in the frequency, rate and volume of flow into basement carparks for events up to the PMF). The design of the project will need to incorporate measures that are aimed at mitigating the impact of the project on flood behaviour in properties where existing buildings will experience above-floor inundation during floods up to the 1% AEP event, or where there is the ingress of floodwater to basement carparks during storms up to the PMF. Drainage structures will be sized and positioned more precisely during detailed design to mitigate these impacts. Localised increases in flow velocities at the outlets to upgraded or, relocated, or new stormwater drainage systems will be mitigated through the provision of scour protection and energy dissipation measures.	N/A – Design phase	N/A – Design phase
Construction	Earthworks	Plan, implement and maintain measures which are aimed at: • intercepting flow from areas upstream of the project and diverting it in a controlled manner whether through or around the construction sites • implementing construction practices that minimise the potential for scour through stabilisation of disturbed surfaces.	✓	✓

STAGE	IMPACT	MEASURE	ENABLING WORKS	MAIN CONSTRUCTION
	Spoil management	Spoil stockpiles will need to be located in areas which are not subject to frequent inundation by floodwater and ideally outside the 1% AEP flood extent. The CEMP will define the flood immunity criteria for stockpiles proposed to be located in areas that are inundated during a 1% AEP event. These criteria will be based on the duration of stockpiling operations, the type of material stored, the nature of the receiving drainage lines and also the extent to which the stockpile would impact flooding conditions in adjacent areas.	✓	✓
	Site facilities and flood emergency management	As a minimum, site facilities are to be located outside high flood hazard areas based on a 1% AEP flood and ideally outside the 1% AEP flood extent. For site facilities located within the floodplain, the CEMP is to identify how risks to personal safety and damage to construction facilities and equipment will be managed. The CEMP will need to include details of: • the procedure to monitor accurate and timely weather data, and disseminate warnings to construction personnel of impending flood producing rain • an evacuation plan for construction personnel should a severe weather warning be issued.	✓	✓
	Management of adverse flood impacts on existing development (construction)	The CEMP will need to include details and procedures to manage the potential for proposed construction activities to adversely impact on flood behaviour in adjacent development. A more detailed assessment of the impact that construction activities would have on flood behaviour, as well as the scope of measures which will be required to mitigate those impacts, will need to be undertaken during the detailed design phase, with the benefit of more refined construction plans and details by the preferred construction contractor. Subject to the outcomes of further design development and flood assessment during the detailed design phase, a floor level survey may need to be undertaken of affected properties (ie in properties where there is a potential increase in flood levels) to determine whether construction activities will increase flood damages in adjacent development and if mitigation measures are required.	✓	✓

STAGE	IMPACT	MEASURE	ENABLING WORKS	MAIN CONSTRUCTION
		The layout of the construction compounds, material storage areas, as well as temporary crane pads and temporary piling platforms will need to be designed to: • limit the extent of works located in floodway areas • divert overland flow either through or around work areas in a controlled manner • minimise adverse impacts on flood behaviour in adjacent development. Measures to manage residual flood impacts may include: • staging construction to limit the extent and duration of temporary works on the floodplain • ensuring construction equipment and materials are removed from floodplain areas at the completion of each work activity or should a weather warning be issued of impending flood producing rain • providing temporary flood protection to properties identified as being at risk of adverse flood impacts during any stage of construction of the project developing flood emergency response procedures to remove temporary works during periods of heavy rainfall.		

13.6.3 Consideration of the interaction between measures

In addition to the measures for hydrology and flooding described above, there would be interactions between the mitigation measures for soils and water quality (Chapter 14).

All mitigation measures for the project will be consolidated and described in the relevant management plan. The plan would identify measures that are common between different aspects. Common impacts and common mitigation measures will be consolidated to ensure consistency and implementation.

13.6.4 Managing residual impacts

The flood study found that once constructed, the project would generally have only a minor impact on flood behaviour in surrounding areas for floods up to the PMF. Residual impacts at the Mill Stream bridge and along Myrtle Street referred to in section 13.4.2 would be resolved during detailed design. Possible measures identified include adjusting the span of Mill Stream bridge, refinements in drainage design (eg pipe sizes), and providing retaining walls and oversized channels in appropriate locations.

14. WATER QUALITY AND SOIL

This chapter provides a summary of the groundwater and surface water assessments. A full copy of the assessment reports are provided as *Technical Report 7 – Groundwater Impact Assessment* and *Technical Report 8 – Surface Water Impact Assessment*.

Some sections of this chapter, which relate to contamination in water and soil, were also informed by the contamination assessment, which is provided as *Technical Report 5 – Contamination Assessment* and summarised in Chapter 12 of this EIS.

14.1 Assessment approach

A summary of the approach to the assessment is provided in this section, including the legislation, guidelines and policies driving the approach and the methodology used to undertake the assessment. A more detailed description of the approach and methodology is provided in *Technical Report 7 – Groundwater Impact Assessment* and *Technical Report 8 – Surface Water Impact Assessment*. Impacts associated with contaminated soils are outside the scope of this chapter and are addressed in Chapter 12 and *Technical Report 5 – Contamination Assessment.*

14.1.1 Legislative and policy context to the assessment

National Water Quality Management Strategy

The National Water Quality Management Strategy (NWQMS (DAWR, 2016)) includes water quality guidelines that define desirable ranges and maximum levels for certain parameters for specific uses of waters or for protection of specific values. The NWQMS water quality guidelines include the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC, 2000) and the *Australian Drinking Water Guidelines* (NHMRC, 2011).

The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC, 2000) provide water quality guidelines, objectives or guideline trigger values. These guidelines align with the NSW Water Quality and River Flow Objectives (NSW WQOs) (DECC, 2006). The ANZECC 2000 guidelines have been considered as a conservative trigger value for groundwater.

The ANZECC 2000 guidelines acknowledge that different levels of protection may be appropriate for different water bodies. The method for defining the trigger values for toxicants depends on the level of protection required for receiving aquatic ecosystems. An 80 percent protection level (95 percent for bioaccumulative toxins) for Alexandra Canal and the Cooks River is proposed, due to the highly disturbed and poor condition of this aquatic ecosystem (see section 14.2.1). A higher 95 percent protection level (99 percent for bioaccumulative toxins) is proposed for aquatic ecosystems in Mill Stream. The recommended trigger values for the project are provided in Appendix A of *Technical Report 8 – Surface Water Impact Assessment*.

The *Australian Drinking Water Guidelines* (NHMRC, 2011), which are only applied for projects where the water is suitable for drinking water or as a conservative value for human health where no other criteria is available. Given there is a restriction on groundwater extraction from the Botany Sands aquifer for domestic use (see section 12.2.4), these guidelines are not applicable to the project.

Water Act 1912 and *Water Management Act 2000*

The *Water Act 1912* governs licences from water sources in NSW. It also manages the trade of licences and water allocations. The *Water Act 1912* is progressively being replaced by the *Water Management Act 2000*.

The *Water Management Act 2000* is intended to ensure that water resources are conserved and properly managed for sustainable use benefitting both present and future generations. The *Water Management Act 2000* requires the development of water sharing plans to manage water use and access.

The project is located within the Greater Metropolitan Region Water Sharing Plan, as well as the water management zone for the Botany Sands Groundwater Source (see section 14.2.2). The water management zone for the Botany Sands Groundwater Source means it is at a level of more refined implementation of access and trading rules applied (see section 12.2.4).

The project is being assessed as SSI under Division 5.2 of the EP&A Act. Under section 5.23 of the EP&A Act, a water use approval under section 89, a water management work approval under section 90 or an activity approval (other than an aquifer interference approval) under section 91 of the WM Act are not required.

NSW Aquifer Interference Policy

The *NSW Aquifer Interference Policy* (AIP) (NOW, 2012a) clarifies the water licencing and approval requirements for aquifer interference activities in NSW. The AIP requires that potential impacts on groundwater sources, including their users and high priority GDEs, be assessed against minimal impact considerations, outlined in Table 1 of the AIP. In accordance with the AIP, the predicted groundwater impacts of the project have been assessed with reference to the minimal impact considerations for highly productive groundwater sources for coastal sand water sources. The AIP water criteria requires that the beneficial use potential of the groundwater systems cannot change beyond 40 metres of the activity. As such, the project would aim to maintain the baseline groundwater quality during construction and operation, which has informed the approach to assessment of impacts (see sections 14.3 and 14.4).

Other guidelines and policies

Other legislation, guidelines and policies relevant to the water quality and soil assessment for the project include:

- Airports Act and Airports (Environment Protection) Regulations 1997, which provides guidelines and strategy documents (including the *Sydney Airport Master Plan 2039* (SACL 2019a) and the *Sydney Airport Environment Strategy 2019-2024* SACL 2019b*)*, which would need to be followed for the construction compound on Sydney Airport land.
- EPBC Act*,* which outlines several MNES (including threatened and migratory species), which have been considered when assessing the potential water quality related impact on downstream sensitive receivers*.*
- *Managing Urban Stormwater: Soils and Construction Volume 1* (Landcom, 2004), which has informed the approach to management of soil and water impacts (see section 14.6).
- Water Management (General) Regulation 2018*,* which states that ARTC, as a transport authority, is exempt from the requirement to hold a water access license or water use approval for ongoing take of groundwater as well as controlled activity approvals for activities on waterfront land.
- *PFAS National Environmental Plan* (PFAS NEMP) (HEPA, 2018), which provides screening criteria applicable to this project for certain PFAS analytes for aquatic ecosystems (see section 12.2.6).

- *Guidelines for Managing Risks in Recreational Water* (NHMRC, 2008), which were considered as Botany Bay, Mill Stream and Cooks River surrounding the project site are used for a range of recreational purposes.
- *NSW Water Quality and River Flow Objectives,* which align with the ANZECC 2000 guidelines and provides water quality objectives to assess the water quality of the Botany Bay Catchment.
- *Botany Bay and Catchment Water Quality Improvement Plan* (SMCMA 2011), which set targets for pollutant load reductions required to protect the condition of Botany Bay, its estuaries and waterways.
- *Approved Methods for the Sampling and Analysis of Water Pollutants in New South Wales* (DEC, 2004a), which lists the sampling and analysis methods to be used when acquiring water samples.
- *Risk Assessment Guidelines for Groundwater Dependent Ecosystems* (NOW, 2012b), which was used to guide the assessment of potential impacts on GDEs.
- *NSW State Groundwater Policy Framework Document* (DLWC, 1997), which provides guidance for the assessment of impacts on groundwater quality, groundwater quantity and GDEs.
- *Landslide risk management guidelines* (Australian Geomechanics Society, 2007), which would inform the design to minimise landslide risk.
- *Soil and Landscape Issues in Environmental Impact Assessment* (DLWC, 2000), which guides assessment of soil disturbance and landscape issues.

A detailed description of the legislative and policy context for the assessment is provided in *Technical Report 7 – Groundwater Impact Assessment* and *Technical Report 8 – Surface Water Impact Assessment*.

14.1.2 Methodology

Key tasks

The groundwater assessment involved (see section 3 of *Technical Report 7 – Groundwater Impact Assessment* for a detailed description of the methodology):

- reviewing existing data to understand the groundwater management zones, existing hydrology and groundwater quality and determine the baseline groundwater conditions for the project
- establishing a conceptual hydrogeological model for the project and surrounding areas
- characterising the existing local and regional hydrogeological conditions
- inferring the magnitude of potential changes in groundwater conditions and surface flows from the conceptual model developed
- assessing the predicted changes in groundwater conditions to identify any potential adverse impacts
- identifying mitigation and management measures and monitoring requirements.

The surface water quality assessment involved (see section 3 of *Technical Report 8 – Surface Water Impact Assessment* for a detailed description of the methodology):

- reviewing existing data from the project site and its catchment to provide an understanding of existing environmental conditions, water quality data, current uses of the waterways and sensitive receivers
- applying the ANZECC 2000 framework to identify catchment and waterway specific water quality management goals for different potential pollutants (trigger values)
- identifying activities that could result in water quality impacts during construction and operation
- identifying mitigation and management measures and monitoring requirements.

No groundwater or surface water monitoring was undertaken in the preparation of the groundwater and surface water impact assessments. This desktop-based approach was adopted because:

- the magnitude of impacts is expected to be localised and temporary
- any intersection of groundwater would be managed by adopting non-dewatering techniques, in line with normal construction practice
- baseline surface water monitoring had already been undertaken for the proposed Sydney Gateway road project, which shares common catchments with the Botany Rail Duplication project (see section 3.2.1 in *Technical Report 8 – Surface Water Impact Assessment*)
- any long-term impacts are expected to be negligible relative to existing conditions.

Study area

Surface water quality impacts have been primarily assessed at two locations: Mill Stream and Alexandra Canal (see section 14.2.1), as these are the main surface water features that would receive surface water runoff from the project site. Existing surface flows to Mill Stream is from the southern portion of the project site via existing stormwater outlets and overland flow. Surface water from the northern portion of the project site currently flows to Alexandra Canal via the Upper Mascot open channel or the Sydney Airport stormwater drainage network via Northern Pond.

Groundwater impacts have primarily been assessed with respect to the Botany Sands Aquifer (see section 14.2.2), as this is the aquifer that is most likely to be intercepted by construction activities.

14.1.3 Risks identified

The preliminary environmental risk assessment undertaken for the project (provided in Appendix B) included potential risks associated with water quality and soils. Potential risks were considered according to the impacts that may be generated by the construction or operation of the project. The likelihood, consequence and overall risk level of each potential risk were assessed, with avoidance and management measures defined for each potential risk. Further information on the risk assessment, including the approach, methodology, and the full results, is provided in Appendix B.

Risks with an assessed level of medium or above (prior to mitigation) include:

- reduced water quality (increased total suspended solids (TSS) and turbidity) due to earthworks and erosion and sedimentation near watercourses during construction
- impacts on water quality from contamination from spills and leaks during construction
- loss or degradation of soil quality and landform stability during earthworks
- increased erosion and sedimentation due to excavation activities and vehicle movement
- pollution of watercourses due to operation (freight materials, contaminants from train operation)
- increased potential for erosion and sedimentation due to vegetation removal and creation of embankments during operation of the project.

These potential risks and impacts were considered as part of the assessment. The assessment also considered matters identified by the SEARs and identified by stakeholders (as described in Chapters 3 and 4).

14.1.4 How potential impacts have been avoided or minimised

As described in sections 6.1.2 and 7.1.2, design development and construction planning has included a focus on avoiding or minimising the potential for environmental impacts during all key phases of the process. Potential water quality and soil impacts have been avoided or minimised where possible by:

- designing the Mill Stream bridge to avoid the need for instream structures
- optimising the design of the Mill Stream bridge to minimise upstream or downstream scour effects on the existing watercourse
- adopting construction techniques that avoid the need for dewatering of excavations and groundwater drawdown impacts, such as cast in situ techniques for any piling works.

14.2 Existing environment

14.2.1 Surface water

Surface water features

Figure 14.1 shows the location of surface water features within and surrounding the project site.

Surface water features north of the project site

Surface water from the northern 1.4 kilometres of the project site flows in a northwesterly direction to Alexandra Canal via the existing drainage network and the Upper Mascot Open Channel. Alexandra Canal is located within the lower reaches of the Cooks River catchment and is owned and operated by Sydney Water.

The Cooks River catchment covers an area of around 10,000 hectares in southeastern Sydney. The catchment is highly urbanised and has a history of intensive land use ranging from residential to heavy industry. Alexandra Canal was constructed through dredging and channelisation of a natural watercourse. It flows into the Cooks River near the northwestern corner of Sydney Airport before it flows into Botany Bay to the west of Sydney Airport. Alexandra Canal is tidally dominated through its connection to the Cooks River. It is around 3.9 kilometres long and 60 metres at its widest.

Surface water features south of the project site

Surface water from the southern 1.6 kilometres of the project site flows to Mill Stream, directly via overland flow or through existing drainage networks. The Mill Stream catchment is a sub catchment of the Botany Bay catchment. The Mill Stream catchment extends from Centennial Park in the north, to its outlet into Botany Bay in the south. Engine Pond and Mill Pond are located near the downstream (southwest) end of Mill Stream catchment. Mill Pond, Engine Pond and the Mill Stream are collectively known as the Sydney Airport Wetlands and are managed by Sydney Airport Corporation.

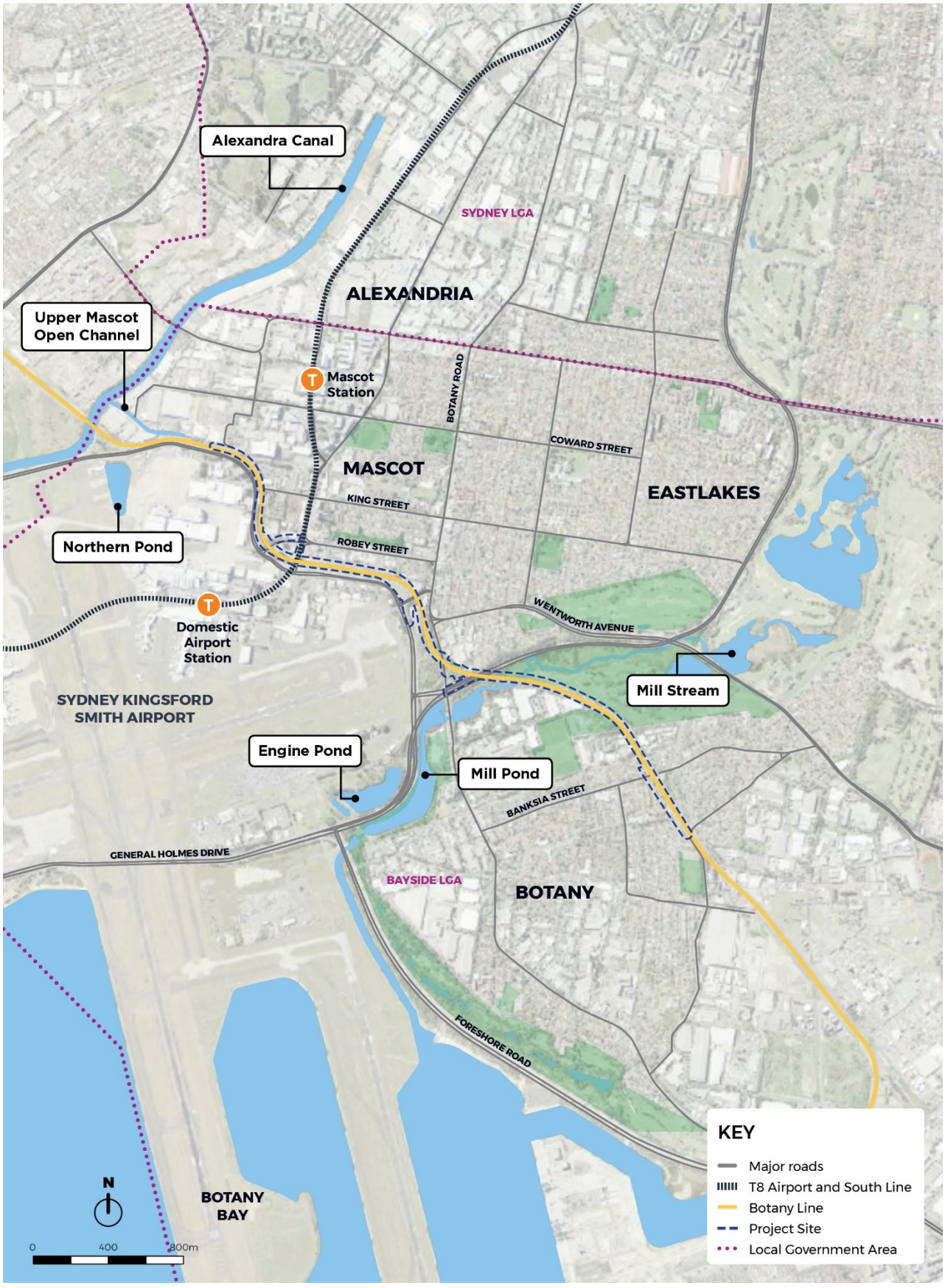


Figure 14.1 Surface water features in the vicinity of the project site

Existing surface water quality

The existing surface water quality within and surrounding the project site is relatively poor due to existing and historical land uses and activities in the area.

The Cooks River is one of the most degraded river systems in Australia, with stormwater identified as a key contributor to water quality and quantity problems. Surface water quality sampling points within the Cooks River and Alexandra Canal frequently exceed the adopted ANZECC (2000) guideline values (which align with the NSW WQOs (see section 14.1.1)) for sulfate, total dissolved solids, TSS, chloride, total nitrogen, aluminium, iron, manganese, zinc and ammonia. As such, the aquatic ecosystems in the Alexandra Canal are considered to be currently 'highly disturbed'. In 2004, the EPA issued a Remediation Order under the CLM Act with specific requirements for the sediments in the Alexandra Canal, citing:

"The bed sediments at the site have been found to be contaminated, in such a way as to present a significant risk to harm human health and the environment."

Surface water quality sampling points in Mill Stream also frequently exceed the adopted ANZECC (2000) guidelines for total nitrogen, aluminium, iron, manganese, zinc, ammonia and turbidity and the limits of accepted contamination specified in Schedule 2 of the Airports (Environment Protection) Regulations 1997.

In addition, PFAS compounds have been detected in surface water samples collected from the Cooks River, Alexandra Canal and Mill Pond. Some PFAS compounds have been globally identified as chemicals of high concern to human health and the environment, particularly due to their persistence and bioaccumulation (see section 2.1.6 in *Technical Report 5 – Contamination Assessment*).

Further information on the surface water quality results from sampling undertaken within and surrounding the project site is provided in section 4.7 in *Technical Report 8 – Surface Water Impact Assessment*.

Sensitive receiving environments

There are a number of sensitive receiving environments surrounding the project site including Mill Stream, Mill Pond, Engine Pond, Cooks River and Botany Bay.

Cooks River and Botany Bay are both identified as key fish habitats under the *Fisheries Management Act 1994.* Key fish habitats are aquatic habitats that are important for the sustainability of the recreational and commercial fishing industries, the maintenance of fish populations generally and the survival and recovery of threatened aquatic species. Commercial fishing is prohibited in Botany Bay and Cooks River, however recreational fishing is not prohibited in or around Mill Stream or in the broader Botany Bay area.

The Botany Bay area provides summer habitat for a number of migratory wading birds that are listed under the EPBC Act, and the ponds may also be used on occasion by these species. In addition, Mill Pond, Engine Pond and Mill Stream are collectively known as the Sydney Airport Wetlands and are considered as environmentally significant areas under the *Sydney Airport Environment Strategy 2019–2024* (SACL 2019b).

14.2.2 Groundwater

Groundwater characteristics

There are two main groundwater systems beneath the project site:

- the Botany Sands aquifer, which is a shallow, unconfined and highly permeable aquifer with variable hydraulic conductivity
- the Hawkesbury Sandstone aquifer, which is a semi-confined, fractured and porous aquifer within the bedrock that extends across the Sydney Basin (see section 14.2.3).

The regional groundwater elevations generally follow the topography of the area, as groundwater is intercepted at higher elevations (up to 35 mAHD) in the northwest of the project site near Centennial Park, and at lower elevations (less than 5 mAHD) to the south of the project site near Botany Bay. Groundwater contours suggest that groundwater passing beneath the project site primarily flows southwest towards Botany Bay.

The Botany Sands aquifer primarily recharges through direct rainfall infiltration at the Centennial Parklands, Botany Wetlands and surrounding golf courses. Previous groundwater monitoring results from registered monitoring wells near the project site (see section 4.7.1 in *Technical Report 7 – Groundwater Impact Assessment*) suggests that the local groundwater elevations are generally stable, with little response to long-term climatic variations. The typical range of the local groundwater elevations is around 1–2 metres (see Figure 4.7 in *Technical Report 7 – Groundwater Impact Assessment*). Spikes in groundwater elevation levels are generally only observed in periods with above average rainfall.

The existing groundwater quality within the Botany Sands Aquifer is poor due to high levels of contamination including elevated concentrations of manganese, arsenic and PFAS exceeding the adopted water quality guidelines (see section 12.2.6 and section 4.14 in *Technical Report 7 – Groundwater Impact Assessment*).

Groundwater uses and restrictions

There are approximately 50 registered groundwater bores within a 500 metre radius of the project site. The majority of these bores are shallow (less than 15 metres in depth) and are screened within the Botany Sands aquifer. These bores are registered for domestic, irrigation, monitoring and commercial and industrial purposes.

However, as discussed in section 12.2.4, the NSW Government has implemented restrictions on groundwater extraction for parts of Botany, due to high levels of contamination in the Botany Sands aquifer. As a result, groundwater from the project site cannot be used for industrial or domestic purposes and can only be extracted for remediation, temporary construction dewatering, testing or monitoring purposes.

GDEs near the project site have also been identified based on a review of the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources* (NSW Government 2011b) and the BOM *Groundwater Dependent Ecosystems Atlas* (BOM 2018) (see section 11.2.1). This includes aquatic and terrestrial GDEs associated with the Botany Wetlands, which are located approximately one kilometre from the project site. Stands of Swamp Oak Forest native vegetation within the project site are also likely to be groundwater dependent, although are not currently mapped as GDEs.

14.2.3 Geology and soils

The 1:100,000 Sydney Region Geological Map (Geological Survey of NSW, 1983) states that the regional geology consists of Triassic Hawkesbury Sandstone and Ashfield Shale overlain by Quaternary sediments (unconsolidated sands with minor peat, silts and clays and hard iron-cemented layers known as waterloo rock). Bedrock is expected to be encountered within the project site between 10 and 15 mAHD. Figure 14.2 shows the geology within and surrounding the project site.

A thin layer of fill is present within the project site, as is commonly encountered in urban areas and associated with infrastructure and roadworks. Areas of thicker fill are present in landfill sites north of the project site comprising dredged estuarine sand and mud, demolition gravels and industrial and household waste. Sydney Airport located west of the project site has been constructed atop mixed Quaternary sediments and manmade fill.

Based on the Soil Landscapes of Sydney Sheet 9130 (Chapman and Murphy, 1989), the project site contains two soil landscapes – Aeolian Tuggerah (AEtg) to the east of the rail corridor, and Disturbed Terrain (DTX) extending across the airport to the west, along the Botany Wetlands, the lower reaches of the Cooks River and up Alexandra Canal to the north. Figure 14.3 shows the locations of the soil landscapes within and surrounding the project site.

There is a low probability of ASS occurrence within the project site, except for the area between Southern Cross Drive bridge to Mill Stream bridge (see section 12.2.2). ASS can result in acidic leachate when exposed to oxygen, which may affect water quality and lead to the death or disease of aquatic organisms.

Chapter 12 discusses the probability of soil salinity within the project site.

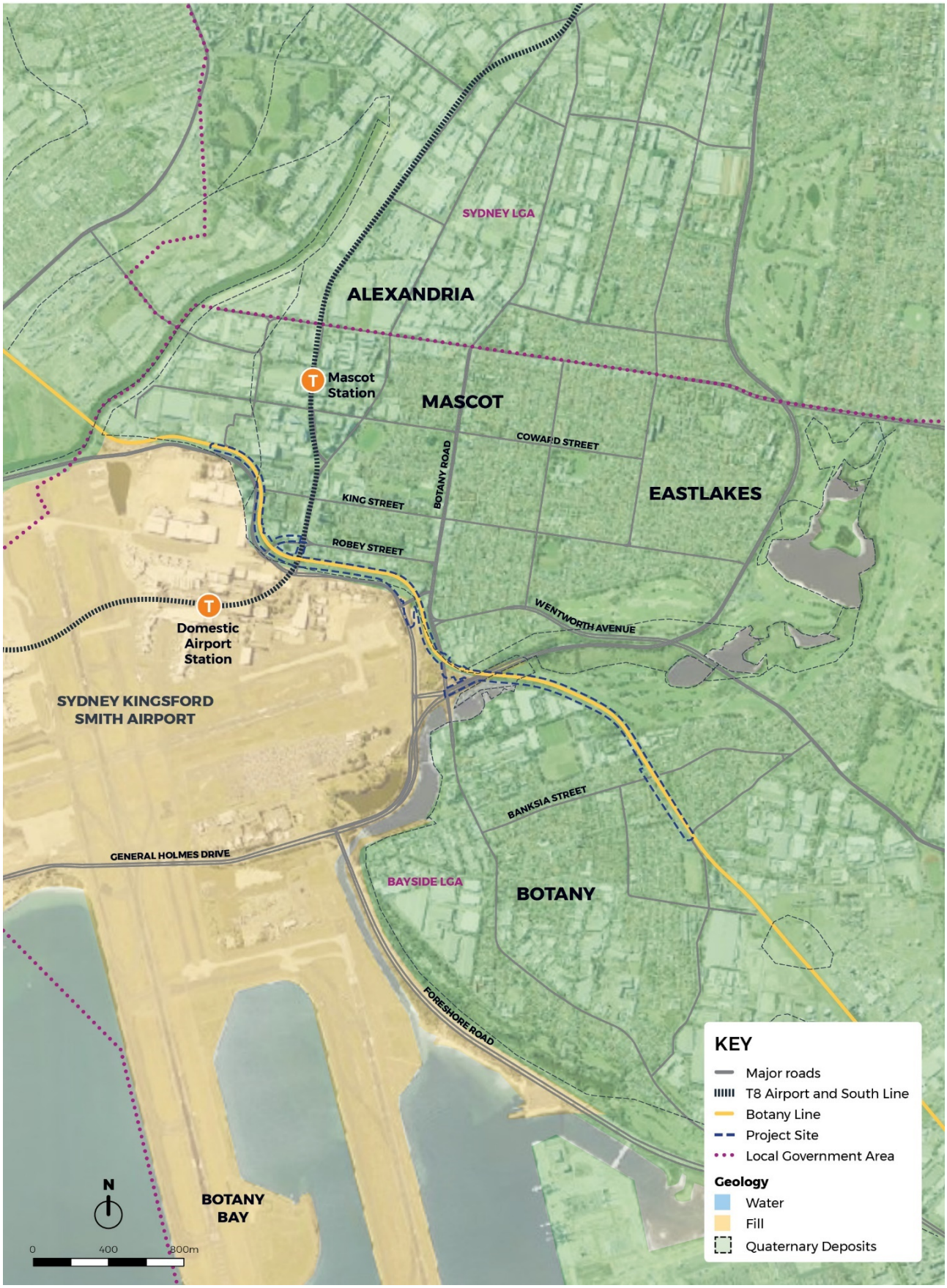


Figure 14.2 Geology within and surrounding the project site

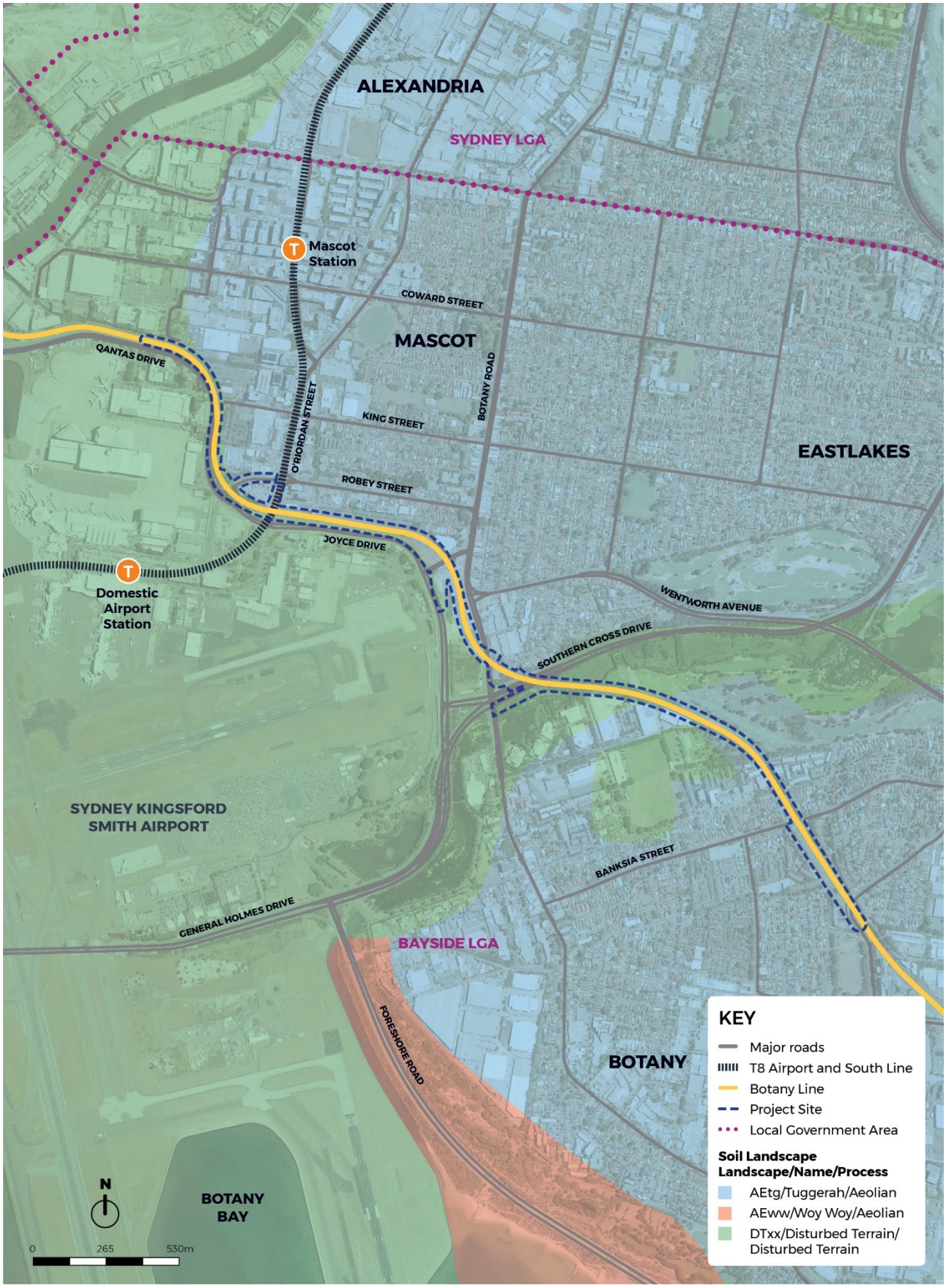


Figure 14.3 Soil classification within and surrounding the project site

14.3 Assessment of construction impacts

14.3.1 Surface water quality and soil impacts

Surface water quality and soil impacts are often interrelated, as soil erosion can result in sedimentation of waterways and increased water runoff can erode soil. Construction of the project has the potential to result in surface water quality and soil impacts from:

- use of water for construction activities including dust suppression and vehicle wash-down, which could result in runoff of polluted or sediment laden water
- vegetation clearing, earthworks and stockpiling of spoil, which would increase the amount of exposed soils that can be transported via runoff and/or erosion into surrounding waterways
- a temporary increase in impervious surfaces such as from the establishment of construction compounds, crane pads and parking areas, which would increase the volume and speed of runoff from the project site
- construction of drainage infrastructure, Mill Stream Bridge and retaining wall works, which could result in increased soil erosion and direct disturbance of waterway beds and banks
- inadequate containment of fuels and chemicals, which could result in spills or leaks of potentially contaminating materials into the surrounding environment
- litter from construction site and activities, which could be transported via runoff and/or erosion into surrounding waterways.

In addition, the project site includes several areas of known contaminated soil (see section 12.2.5), including PFAS, hydrocarbon, heavy metal and asbestos contamination. If this contaminated soil is disturbed during construction and not appropriately managed, it could be transported via wind or water into the surrounding waterways. ASS is also likely to be encountered in the area of the project site between Southern Cross Drive bridge to the Mill Stream Bridge (see section 12.3.1), which has the potential to result in acidic runoff into Mill Stream and Mill Pond.

As a result, if mitigation measures are not implemented during construction of the project, the surface waterbodies surrounding the project site may experience increased sedimentation, erosion, pollutants and contaminants, which could reduce the existing water quality and harm the aquatic ecosystems. However, these potential surface water impacts are likely to be temporary and minor, and minimised through the implementation of management and mitigation measures (see section 14.6). Additionally, no construction water discharges to local receiving waterways are proposed during construction of the project.

Moreover, as discussed in section 14.2.1, the surface water features surrounding the project site, including Cooks River, Alexandra Canal and Mill Stream, are already highly contaminated and frequently exceed the adopted ANZECC 2000 guidelines for water quality. Therefore, there would be negligible additional water quality impacts from construction of the project to those already affecting the surrounding waterways. As such, the construction of the project is unlikely to have an influence on whether the NSW WQOs are met at downstream receivers.

14.3.2 Groundwater impacts

Construction activities such as excavation and piling may intersect groundwater at isolated locations within the project site. However, this is only likely to occur during wet weather, as rainfall can recharge the Botany Sands aquifer and reduce the depth to groundwater beneath the site.

The types of groundwater impacts that may occur during construction of the project include:

- groundwater drawdown impacts, due to groundwater extraction and dewatering activities
- groundwater quality impacts, due to contaminants potentially being introduced into the groundwater.

No groundwater drawdown impacts are expected as a result of construction activities, as no significant groundwater extraction or dewatering of excavations are proposed. This is because construction techniques that do not require groundwater dewatering systems would be adopted for the project, such as cast in situ techniques for the bridge piling works. Incidental and very localised displacement of groundwater for bridge and retaining piling works are expected to occur but this would not result in groundwater drawdown. As a result, groundwater drawdown impacts are expected to be negligible.

During construction, intersection of groundwater may result in groundwater quality impacts by exposing the aquifer to new contaminants. This could impact the beneficial use potential of the groundwater at down-gradient industrial water supply wells. However, with implementation of the management and mitigation measures recommended in section 14.6.2, including the proposed groundwater monitoring program, the potential for adverse impacts under the AIP criteria is low. In addition, the Botany Sands Aquifer has high levels of existing contamination (see section 14.4.2), and therefore any additional groundwater quality impacts from construction of the project are expected to be negligible.

14.4 Assessment of operational impacts

14.4.1 Surface water quality and soil impacts

The project is located within an existing operational rail corridor. Surface water quality and soil impacts within and surrounding the project site may occur during operation as a result of:

- formation failure, which can result in increased pollutant, sediment load or organic matter entering waterways
- rail accidents, use of grease pots and friction modifiers and/or poor maintenance of equipment resulting in accidental spills or leaks of chemicals, oils and fuels, which can cause contamination of soil and waterways
- runoff from the rail corridor, which can result in soil contaminants entering the surrounding waterways.

These events represent potential sources of pollution that could flow into the waterways surrounding the site, including Mill Stream or Alexandra Canal. However, the operation of the project would involve similar maintenance and rail activities within the project site to the existing scenario. It would also not result in any substantial change to the existing surface water catchment areas, so any increase in flow volumes are expected to be minimal. Additionally, runoff from rail tracks is typically filtered by rocks and other material in the ballast, reducing the potential for pollutants to be transported beyond the rail corridor. Therefore, the operation of the project is not expected to result in additional surface water quality and soil impacts within and surrounding the project site.

However, the operation of the project may slightly increase the magnitude or frequency of the existing surface water quality and soil impacts. This would be due to the additional train movements within the project site, which would slightly increase the potential for spills or leaks, and the increased impervious surface area from the duplication of the rail track and new capping material, which would result in a minor increase in the runoff from the rail corridor. These potential impacts are expected to be negligible compared to the existing water quality impacts on Alexandra Canal and Mill Stream from current and historical land uses and activities, and would be minimised through the implementation of mitigation measures (see section 14.6.2).

As a result, the project would result in a negligible change in the quantity of pollutants in surrounding waterways and would have limited ability to influence the water quality at downstream receivers. Therefore, it is expected that where the NSW WQOs are currently being met, they would continue to be protected. However, the project is unlikely to result in the achievement of the NSW WQOs where they are not currently being met, such as at Mill Stream and Alexandra Canal (see section 14.2.1).

The overall track drainage system would continue to drain to existing drainage systems surrounding the project. At Mill Stream, there would be a new drainage pipe and headwall that would either replace or supplement the existing 1200 millimetre diameter drainage pipe and headwall. All cess drainage and final outfalls that are installed or modified as part of the project would have appropriate scour protection. Therefore, operation of the project would not result in any notable change to the existing hydrological behaviour of the catchments surrounding the project.

14.4.2 Groundwater impacts

During operation, groundwater quality impacts may result from infiltration of contaminants due to spills or leaks. However, the existing Botany Sands aquifer is also already highly contaminated and the occurrence of spills and leaks is expected to be low. The upgraded drainage system and reduced permeability across the site would further minimise the potential for infiltration of contaminants to groundwater. Therefore, the operation of the project would result in negligible groundwater quality impacts.

The project would increase the impervious surface area within the project site, which would slightly reduce rainfall infiltration and therefore groundwater recharge within the project site. However, any minor decreases in recharge within the project site are expected to be negligible compared to the overall recharge volumes, as the majority of groundwater recharge for the Botany Sands aquifer occurs at the Centennial Parklands, Botany Wetlands and surrounding golf courses. Therefore, groundwater recharge impacts during operation of the project are expected to be negligible and have no measurable effect on groundwater elevations.

There may be permanent intersection of groundwater by new infrastructure from the project (such as bridge piles), however the depth of this infrastructure would be minor relative to overall aquifer thickness. Therefore, there would be no change to groundwater elevations from subsurface barriers.

14.5 Cumulative impacts

14.5.1 Overview

The methodology of the cumulative impact assessment and details of other projects considered are detailed in Chapter 24. A summary of the predicted cumulative impacts which relate to water quality and soil are described below.

14.5.2 Cumulative construction impacts

Simultaneous construction of the Botany Rail Duplication, the Sydney Gateway road project and Airport East upgrade works has the potential to result in cumulative surface water quality impacts on Alexandra Canal and Mill Stream including increased sedimentation and potential for contaminated runoff. However, these cumulative water quality impacts would be temporary and minor, and minimised through standard construction management and mitigation measures.

Construction of other major developments within the Cooks River and Georges River catchments (such as the WestConnex M4-M5 Link, WestConnex New M5, Sydney Metro City & Southwest and Airport North projects) may also have cumulative impacts on water quality in the receiving waterways surrounding the project site. Increases in impervious area during construction and operation of other major projects may contribute to the volume and pollutant loading of surface runoff in the area. However, if mitigation requirements are applied consistently across projects, no adverse cumulative surface water impacts are anticipated. As such, the residual risk to the environment from cumulative surface water quality impacts is expected to be low.

No cumulative groundwater impacts are expected to occur, due to the negligible adverse groundwater impacts expected during construction of the project.

14.5.3 Cumulative operational impacts

The surface water and soil impacts during operation of the Botany Rail Duplication project are expected to be similar to the existing conditions. Therefore, no cumulative impacts are expected.

No cumulative groundwater impacts are expected to occur, due to the negligible adverse groundwater impacts expected during operation of the project.

14.6 Management of impacts

14.6.1 Approach

A Soil and Water Management Plan (SWMP) would be developed to manage all soil and water risks during construction of the project and included as part of the CEMP. The SWMP would be prepared in accordance with the Blue Book (Landcom, 2004) and include:

- water quality objectives for the project as outlined in Appendix C of *Technical Report 8 – Surface Water Impact Assessment*
- an erosion and sediment control plan that allows for site-specific erosion and sediment controls at all work sites. Physical controls may include sediment fences and basins, containment bunds, silt traps, turbidity barriers and diversions, dust suppression and earth compaction around stockpiles and earthworks area
- specific plans required to address identified contamination risks including an AMP and ASSMP (see section 12.6).

It is noted that there is no sediment storage capacity currently included in the construction phase design, as there is limited space within the rail corridor and project site. Physical constraints immediately adjacent to the project site also limits the ability to provide on-site sediment storage. As such, all controls would be designed to minimise the on-site erosion risk and maintain the annual sediment export rate to below 150 cubic metres of sediment at each outlet, to avoid the need for sediment basins (Landcom, 2004).

While discharge is not currently proposed during construction, in the event that the contractor determines through its construction planning that this may be necessary, a discharge impact assessment and discharge management plan would be developed. This would detail the relevant mitigation measures and monitoring program required, specific to the discharge activities proposed.

Further details on the overall approach to management of impacts is provided in Chapter 24.

14.6.2 List of mitigation measures

The mitigation measures that would be implemented to address potential water quality and soil impacts are listed in Table 14.1. This table also outlines which mitigation measures (during the construction stage) would be implemented during the enabling works and main construction works. As discussed in section 14.6.3, additional contamination specific mitigation measures may also minimise water quality and soil impacts.

Table 14.1 Mitigation measures

STAGE	IMPACT	MEASURE	ENABLING WORKS	MAIN CONSTRUCTION
Design	Formation failure	The formations and integrated drainage will be designed to prevent formation failure. This would include designing the longitudinal drainage to direct surface water runoff away from formations.	N/A – Design phase	N/A – Design phase
	Soil erosion	Batter slope gradients, surface treatments and the construction program will be designed to minimise erosion risk so the annual sediment export rate is below 150 cubic metres at each outlet to avoid the need for sediment basins in accordance with the Blue Book.	N/A – Design phase	N/A – Design phase
	Use of water during construction	Requirements for construction water (volumes, quality, demand curves, approvals requirements and lead times) will be defined during detailed design.	N/A – Design phase	N/A – Design phase
	Potential scour and erosion impacts	Suitably designed scour and erosion control measures will be included in the detailed design where required, including at the Mill Stream drainage outlets.	N/A – Design phase	N/A – Design phase
		The detailed design of Mill Stream bridge will be optimised to minimise upstream or downstream scour effects on the existing watercourse.	N/A – Design phase	N/A – Design phase
	Groundwater impacts	A baseline groundwater monitoring program will be implemented to characterise baseline groundwater conditions as per Chapter 8 of *Technical Report 7 – Groundwater Impact Assessment*.	N/A – Design phase	N/A – Design phase
Construction	Spills and leaks causing soil or water contamination	Procedures to store, handle and use materials and equipment appropriately to prevent spills and leaks will be included in the SWMP.		✓
		Leakage of fuels, oils, chemicals and other hazardous liquids will be immediately cleaned up in accordance with the Safety Data Sheet and relevant emergency response procedures.	✓	✓
		Adequately stocked spill kits will be readily accessible to site personnel during all refuelling activities.	✓	✓
		Construction plant and equipment will be regularly inspected and maintained to prevent leaks.	✓	✓
		All potentially contaminating substances will be stored in secure, bunded and impervious locations away from surface water features and outside of the extent of the 20 year ARI design flood wherever practicable.	✓	✓

STAGE	IMPACT	MEASURE	ENABLING WORKS	MAIN CONSTRUCTION
		Impervious and bunded areas will be established for the on-site maintenance of construction plant and equipment.	✓	✓
	Erosion and sediment impacts	The area of exposed soils within the project site will be minimised through staging vegetation clearing and ground disturbing works across the project site. Disturbed areas and all long-term stockpiles will be protected or stabilised during periods of inactivity. Areas disturbed by construction activities will be rehabilitated and restored as soon as possible after completion of works in the area.	✓	✓
		Where feasible, construction activities will be scheduled to avoid ground disturbance works or in-stream works during periods of heavy or prolonged rainfall.	✓	✓
		Protect stockpiles of loose material from erosion due to rain and wind.	✓	✓
		Erosion and sediment control measures will be implemented prior to soil disturbance in accordance with *Managing Urban Stormwater: Soils and Construction Volume 1* (Landcom, 2004) and included in the SWMP. Erosion and sediment controls throughout the project site will be regularly inspected and maintained.	✓	✓
		Remove all material from the site as soon as practical at the completion of work.	✓	✓
		Specific measures and procedures for works within waterways, such as the use of silt barriers will be implemented where necessary.		✓
		Instruct site workers on the need to prevent materials from washing or blowing into the stormwater system.	✓	✓
		Infiltration trenches will be installed to allow for potentially contaminated water to be collected and infiltrated back into groundwater rather than flowing to surface water.	✓	✓

STAGE	IMPACT	MEASURE	ENABLING WORKS	MAIN CONSTRUCTION
	Groundwater and surface water impacts during construction	A groundwater construction monitoring program will be prepared and implemented as per Chapter 8 of *Technical Report 7 – Groundwater Impact Assessment*. This monitoring program will verify the effectiveness of construction activities at preventing changes in the beneficial use potential of the aquifer system. A surface water quality monitoring program will be prepared and implemented for specific construction works (see section 6.2.3 of *Technical Report 8 Surface Water Impact Assessment*).		✓
	Litter polluting waterways	Bins will be provided on-site for litter. All general litter and waste collected on-site will be transported off-site to an appropriate waste facility.	✓	✓
Operation	Formation failure	Regular inspections of formation and any necessary repairs will be undertaken in accordance with ARTC's Safety Management System procedures.	N/A – Operation	N/A – Operation
	Water or soil impacts from maintenance works	The existing ARTC Standard Environmental Management Measures (under the Environment Management System) will be implemented to manage impacts from maintenance works, including potential litter.	N/A – Operation	N/A – Operation

14.6.3 Consideration of the interaction between measures

In addition to the measures for water quality and soil described above, there are interactions between the mitigation measures for biodiversity (Chapter 11), contamination (Chapter 12), hydrology and flooding (Chapter 13) and resources and waste management (Chapter 20), which would also help to minimise impacts on water quality and soil from the project.

All mitigation measures for the project are consolidated in Chapter 25 to ensure consistency in implementation.

14.6.4 Managing residual impacts

A residual risk analysis was undertaken taking into account the impact assessment summarised in this chapter and implementation of the mitigation measures as recommended in section 14.6.2. The results of the residual risk analysis are provided in Appendix B. Residual risks with an assessed level of medium or above include:

- increased erosion and sedimentation due to excavation activities and vehicle movement.

The reduction in risk levels are primarily due to the implementation of the erosion and sediment control measures and the SWMP during construction and ARTC Standard Environmental Management Measures during operation.