8. Assessment of other issues

This chapter provides an assessment of the project's potential impacts that were not identified as key issues by the SSI application or the environmental risk analysis (see **Chapter 10**).

The issues discussed in this chapter have been identified in the SEARs. The level of assessment reflects the fact that these are issues commonly associated with road projects and are appropriately addressed through the design process or by implementing best practice management and mitigation measures.

8.1 Soils and contamination

This section describes the potential soil and contamination impacts that may be generated by construction and operation of the project and presents a proposed approach to the management of these impacts. **Table 8-1** outlines the SEARs that relate to soils and contamination and identifies where they were addressed in this EIS. The full assessment of soil and contamination impacts is provided in **Appendix O**.

Table 8-1 SEARs (soils and contamination)

Secretary's requirement	Where addressed in this EIS
17. Soils	
1. The Proponent must verify the risk of acid sulfate soils (Class 1, 2, 3 or 4 on the Acid Sulfate Soil Risk Map) within, and in the area likely to be impacted by, the project.	Acid Sulfate Soils risk is identified in **Section 8.1.3**
2. The Proponent must assess the impact of the project on acid sulfate soils (including impacts of acidic runoff offsite) in accordance with the current guidelines.	Potential impacts of Acid Sulfate Soils are described in **Section 8.1.4**
3. The Proponent must assess whether the land is likely to be contaminated and identify if remediation of the land is required, having regard to the ecological and human health risks posed by the contamination in the context of past, existing and future land uses. Where assessment and/or remediation is required, the Proponent must document how the assessment and/or remediation would be undertaken in accordance with current guidelines.	Existing contamination is identified in **Section 8.1.3**
4. The Proponent must assess whether salinity is likely to be an issue and if so, determine the presence, extent and severity of soil salinity within the project area.	The presence, extent and severity of soil salinity is described in **Section 8.1.3**
5. The Proponent must assess the impact of the project on soil salinity and how it may affect groundwater resources and hydrology.	Potential impacts of soil salinity on hydrology is described in **Section 7.9.4**, groundwater in **Section 7.10.4** and within **Section 8.1.4**
6. The Proponent must assess the impact on soil and land resources (including erosion risk or hazard). Particular attention must be given to soil erosion and sediment transport consistent with the practices and principles in the current guidelines.	Potential impacts on soil erosion and sediment transport is described in **Section 8.1.4** Additional sediment transport guidelines and impacts are discussed in **Section 7.9.1**and **Section 7.9.4** respectively

8.1.1 Policy and planning setting

The soil and contamination assessment were prepared in accordance with the following guidelines and documents, where relevant:

- Acid Sulfate Soils Assessment Guidelines (Department of Planning 2008)
- Managing Land Contamination: Planning Guidelines SEPP 55 – Remediation of Land (Department of Urban Affairs and Planning and Environment Protection Authority 1998)
- Guidelines for Consultants Reporting on Contaminated Sites (OEH, 2011b).

The following guidelines or other appropriate/endorsed guidelines would be taken into account should further investigations, remediation work and validation be carried out.

Soils

- Acid Sulfate Soil Manual (Acid Sulfate Soils Management Advisory Committee 1998)
- Landslide risk management guidelines presented in Australian Geotechnics Society (2007)
- Soil and Landscape Issues in Environmental Impact Assessment (Gray, 2000)
- Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom, 2004) and Volume 2 (A. Installation of Services; B. Waste Landfills; C. Unsealed Roads; D. Main Roads; E. Mines and Quarries) (DECC, 2008b)
- National Assessment Guidelines for Dredging (Commonwealth of Australia, 2009).

Contamination

- Guidelines on the Duty to Report Contamination under the *Contaminated Land Management Act 1997* (NSW EPA 2015a)
- Urban and regional salinity – guidance given in the Local Government Salinity Initiative booklets which includes Site Investigations for Urban Salinity (DLWC, 2002c)
- Australian Standard (AS 4482.1-2005) Guide to the sampling and investigation of potentially contaminated soil. Part 1: Non-volatile and semi-volatile compounds
- Australian Standard (AS 4482.2-1999) Guide to the sampling and investigation of potentially contaminated soils – Volatile substances
- National Environment Protection (Assessment of Site Contamination) Measure 1999 (as revised 2013) (NEPM, 2013)
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ, 2000)
- NSW EPA (2014a) Waste Classification Guidelines
- Guidelines for the Implementing the Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation 2008 (Department of Environment and Climate Change NSW, 2009b)
- NSW EPA (1995) Contaminated Sites: Sampling Design Guidelines
- NSW EPA (2017b) Contaminated Sites: Guidelines for the NSW Site Auditor Scheme (3rd Edition) (updated from NSW EPA 2006 version)
- Contaminated Sites: Guidelines for the Assessment and Management of Groundwater Contamination (Department of Environment and Conservation NSW [DEC], 2007)
- NSW EPA (2015b) Technical Note: Light Non-Aqueous Phase Liquid Assessment and Remediation
- NSW EPA (2014b) Technical Note: Investigation of Service Station Sites
- NSW EPA (2014c) Best Practice Note: Landfarming
- NSW EPA (2014a) Waste Classification Guidelines
- Information for the assessment of former gasworks sites (DEC, 2005a)

- Vapour Intrusion: Technical Practice Note (DECCW, 2010e)
- NSW EPA (2012a) Guidelines for the Assessment and Management of Sites Impacted by Hazardous Ground Gases
- PFAS - National Environmental Management Plan (HEPA, January 2018)
- Managing asbestos in or on soil (WorkCover NSW, 2014)
- Other guidelines made or approved under section 105 of the *Contaminated Land Management Act 1997*.

8.1.2 Assessment methodology

Overview

The soil and contamination assessment involved the following:

- Desktop assessment, including a review of:
  - NSW Land and Property Management Authority, Land and Property Information (LPI) Division: Historical aerial photographs (1947 to 2002)
  - The NSW EPA Contaminated Sites Register, Record of Notices and POEO Public Register
  - Council websites
  - Geographical and soil mapping (review of the Penrith 1:100,000 geological map (Clarke and Jones, 1991)
  - The Bureau of Meteorology (BoM)
  - The NSW EPA
  - Australian Soil Resource Information System (ASRIS) database
  - The WaterNSW groundwater database (WaterNSW, 2018)
  - Previous contamination site investigations undertaken to inform the project
- Identification of Areas of Environmental Interest (AEIs) that may pose potential contamination or other risks for further investigation, based on results of the desktop assessment
- Site inspection on 18 May 2017 of accessible areas within the construction footprint, and nearby land uses and potential AEIs
- Limited contamination monitoring and sampling investigation
- Photogrammetry survey of the construction footprint using historical and current aerial photography/imagery to ascertain site levels and assess changes in elevation that could indicate areas of filling and/or stockpiling across the construction footprint
- Assessment of potential impacts:
  - Based on the data obtained from the desktop background review, observations from the inspection of the study area, and results from the contamination investigation
  - Expected ground conditions are presented together with potential contamination issues identified and recommendations for further investigations.

These steps in the methodology is described in more detail in the following sections. Further detail on the assessment methodology is provided in **Appendix O**.

Study area

The soils and contamination assessment defined the study area as the construction footprint and about two kilometres radius from the construction footprint (see **Figure 8-1**). This was used for the purpose of selected desktop and historical review components of the assessment, with the site inspection and geographical extent of potential AEIs being carried out in the vicinity of the construction footprint. In addition, the following areas were used to carry out desktop searches:

- Groundwater bore search area
  - For the purpose of the groundwater bore search, the study area comprised the construction footprint and an approximate 500 metre radius from the footprint
- Soils and geology search area
  - For the purpose of the soils and geology desktop assessment, a broader study area (see **Figure 8-1**) was used to encompass regional soil and geological conditions.

Limited contamination monitoring and sampling investigation

A contamination investigation was carried out to support the design component of the project and to further assess the identified AEIs. Limited intrusive investigations were carried out within the construction footprint.

A fieldwork program was carried out commencing 29 November 2017. This involved excavation of a total of 24 soil bores and 34 test pits (see **Figure 8-4**). Boreholes were drilled using a track or truck mounted drilling rig. Test pitting was carried out using a backhoe excavator. The investigations included:

- Soil sampling
  - Carried out from the start of the fieldwork program
  - Soil samples from test pits at depth were collected directly from the undisturbed soil mass within the centre of the excavator bucket
- Groundwater testing
  - Carried out between 21 August and 28 August 2018
  - including drilling boreholes, monitoring well installation, groundwater level gauging, groundwater sampling and hydrogeochemical analysis, were carried out across the study area and is detailed in **Section 7.10.2**
- Landfill gas monitoring
  - The first round of groundwater and gas sampling was carried out between 21 August and 28 August 2018
  - The second round of gas sampling was carried out on 3 October 2018
  - Sampled from installed groundwater monitoring wells using a landfill gas (LFG) monitor.

Soil samples were analysed for the following potential contaminants of concern:

- Heavy metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc)
- Total recoverable hydrocarbons (TRH)
- Benzene, Toluene, Ethylbenzene, Xylenes (BTEX)
- Polycyclic aromatic hydrocarbons (PAH)
- Polychlorinated biphenyls (PCB)
- Organochlorine Pesticides (OCP)
- Organophosphorus Pesticides (OPP)
- Herbicides
- Phenols
- Asbestos (presence/absence).

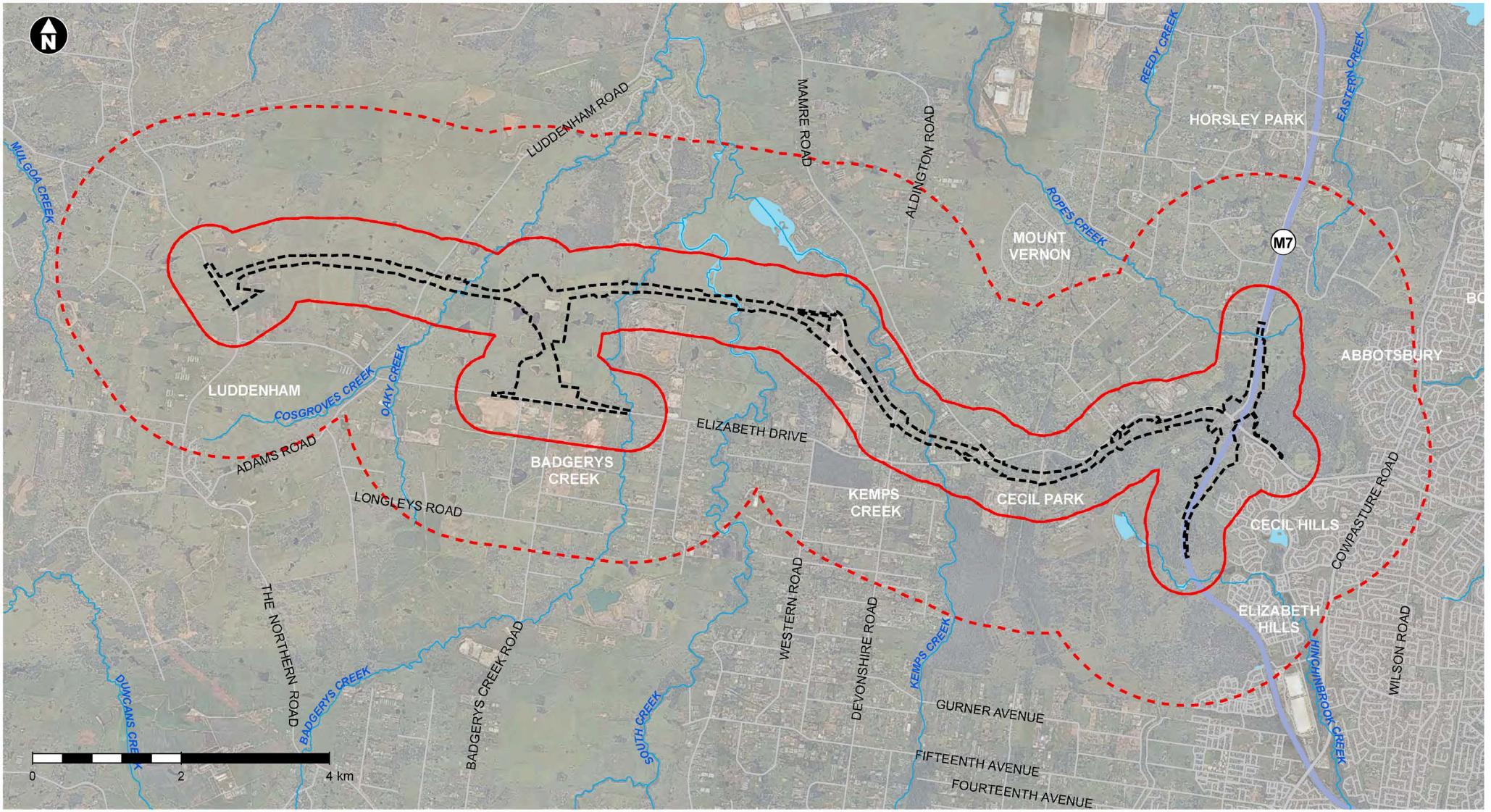

Figure 8-1 Study area for soils and contamination assessment

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The soil, groundwater and gas results were presented against a set of public open space land use exposure risk criteria to assess site contamination in accordance with the National Environment Protection (Assessment of Site Contamination) Measure 1999 (as revised 2013) - Schedule B1 Guideline on Investigation levels for Soil and Groundwater (NEPC 2013).

8.1.3 Existing environment

Topography, geology and soil landscapes

Topography

The project footprint is located within the Cumberland Plain, a subregion of the Sydney Basin which consists of relatively flat and low-lying topography. However, small ridgelines are present around Horsley Park, Orchard Hills and Cecil Hills.

The topography of the study area may be characterised into three general terrain types, as summarised in **Table 8-2**.

Table 8-2 Summary of topography within the study area

Topography	Slopes	Ground surface	Occurrence within study area
Rolling Hills Terrain	5 to 20 degrees	70 to 115 relative level (RL) Australian Height Datum (AHD)	Occurs in the western and eastern portions
Flat to Gently Undulating Terrain	0 to 5 degrees	35 to 70 RL AHD	Occurs in the central portion
Creek Channel/Alluvial Floodplain Terrain	0 to 2 degrees	35 to 50 RL AHD	Dissects the Flat to Gently Undulating Terrain within the central portion

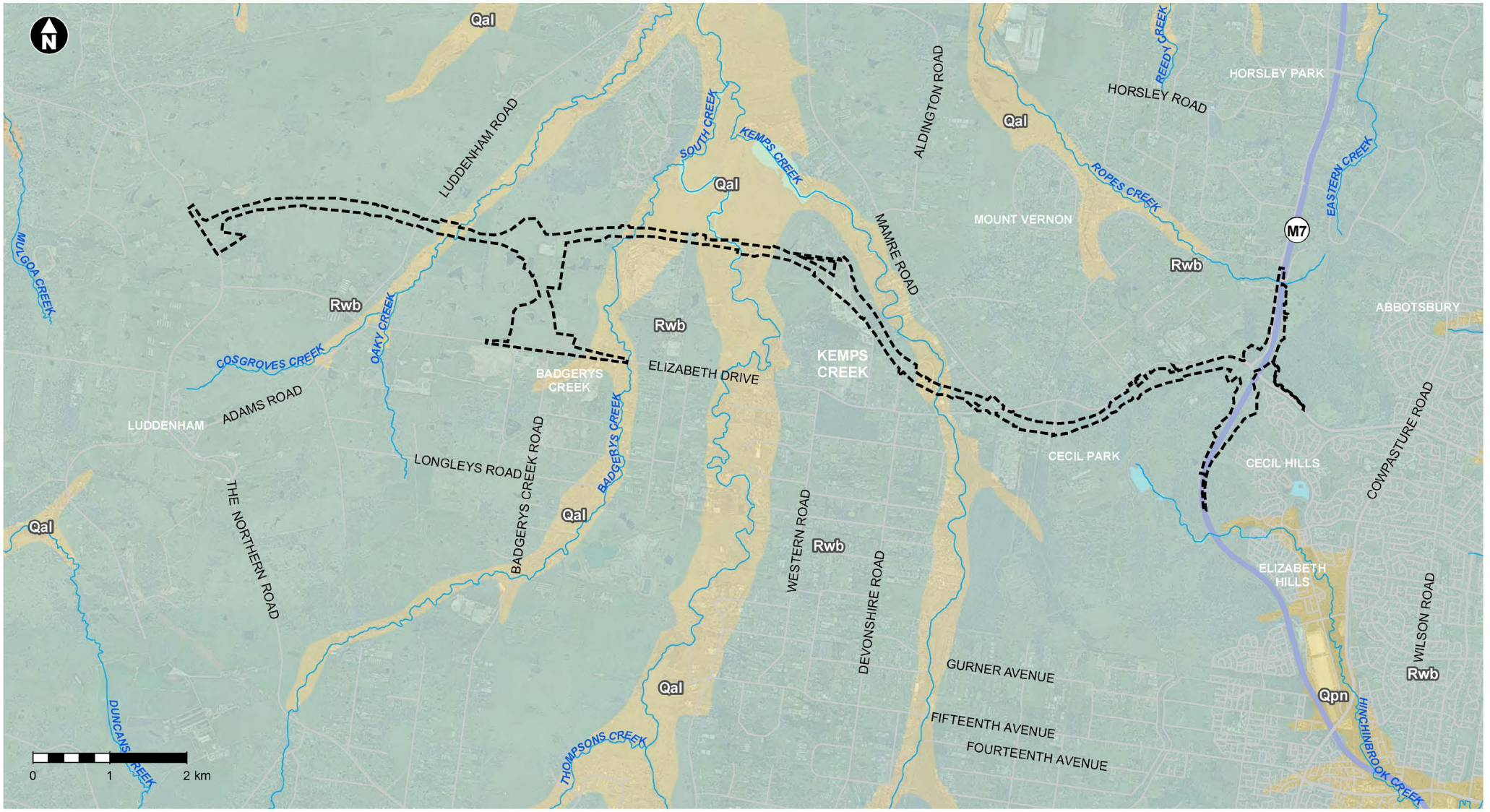
Geology

Based on review of the Penrith 1:100,000 geological map (Clarke and Jones, 1991) and completed project geotechnical borehole logs, the study area includes two surface geological units, illustrated in **Figure 8-2**:

- Quaternary Alluvium (Qal and Qpn)
  - Located in the vicinity of Cosgroves Creek, Badgerys Creek, South Creek and Kemps Creek
  - Consists of fine to medium-grained sand, silt and clay
- Bringelly Shale bedrock (part of Rwb)
  - Upper member of the Wianamatta Group
  - Consists of shale, carbonaceous claystone, claystone, laminate, fine to medium-grained lithic sandstone, rare coal and tuff.

The alluvium deposits are relatively thin, occurring between about 2.5 metres below ground level (BGL) to 7.0 metres BGL (see **Section 7.10.3**).

Project boreholes encountered siltstone, sandstone and interlaminated siltstone, and sandstone at typical depths of about one metre BGL to five metres BGL. Based on project boreholes and regional experience, it is expected that where Bringelly Shale is present near the surface, ground conditions would comprise one metre to five metres of high plasticity, low permeability residual clays over highly weathered bedrock.



Waterways
Motorway
Main roads
The project construction footprint

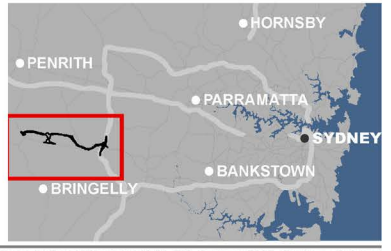
Geology

Qal: Quaternery Alluvium (Fine-grained sand, silt and clay)

Qpc: Quaternery Alluvium (Gravel, sand, silt, clay)

Qpn: Quaternery Alluvium (Medium-grained sand, clay and silt)

Rwb: Bringelly Shale



Data sources
Penrith 1:100 000
Department of Industry: Resources and Energy

Figure 8-2 Geology

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No igneous intrusions are shown in the geological map within the construction footprint. Based on previous experience with rail and road route studies throughout Sydney, however, it is anticipated that two to four igneous dykes/intrusions may be present.

The project footprint may be crossed at two locations by faulting or folding including:

- Narellan Lineament – The overall north/south linearity of South Creek suggests that it may be structurally controlled. In addition to this, there are also a number of north-east trending tributaries into the South Creek channel, such as Cosgroves Creek, which may be an expression of regional faulting trends.
- Rossmore Anticline – This feature is described as a structural high within the Wianamatta Group. The geological map shows this feature ending at Elizabeth Drive, just to the east of the intersection with Luddenham Road. However, this feature may extend further north, crossing the western end of the project footprint. If this is the case, then bedrock bedding dips in the vicinity of such a feature could be altered and potentially dipping to the west on the western side of this structure.

Soil landscapes

Based on a review of the 1:100,000 scale Soil Landscape Map for Penrith (Bannerman and Hazelton 1990), the construction footprint is underlain by four soil landscapes as summarised in **Table 8-3**.

Table 8-3 Summary of soil landscape within the construction footprint

Soil Landscape	Characteristics
South Creek – fluvial deposits located along all four creek channels	• Described as Quaternary alluvium derived from Wianamatta Group shales that comprise deep sandy, sandy clay and clay soils that were deposited as part of the current active South Creek drainage network • A dynamic soil landscape with many areas of erosion and deposition • Relevant limitations for development include high erodibility, shrink-swell potential, salinity, low fertility and localised areas of permanently high-water tables or seasonal waterlogging
Blacktown – residual soils located in the flat to gently undulating terrain between creek channels	• Described as shallow to moderately deep clays and silty clays derived from the Bringelly Shales • Relevant limitations for development include strongly acidic, low fertility, high shrink-swell, low permeability potential for salinity, high erodibility
Luddenham – residual soils located on the low rolling hills at both ends of the project footprint	• Derived from Bringelly Shales and is described shallow to moderately deep, typically comprising clays, and where Minchinbury Sandstone may be present sandy clays • Moderately inclined slopes of 10 to 20 per cent are the dominant landform • Development limitations included high erosion hazards, together with a high shrink-swell potential and low permeability and low fertility
Picton – residual and colluvial soils located at the eastern end of the project footprint	• Occurs on steep sided slopes over Wianamatta Group shales usually with a southern aspect and where there are slope gradients more than 20 per • Described as shallow to deep residual and colluvial clays • There is potential for mass movement and slope instability (ie land sliding).

A small area south of the construction footprint is mapped as Disturbed Terrain. The location and extent of each soil landscape is shown in **Figure 8-3**.

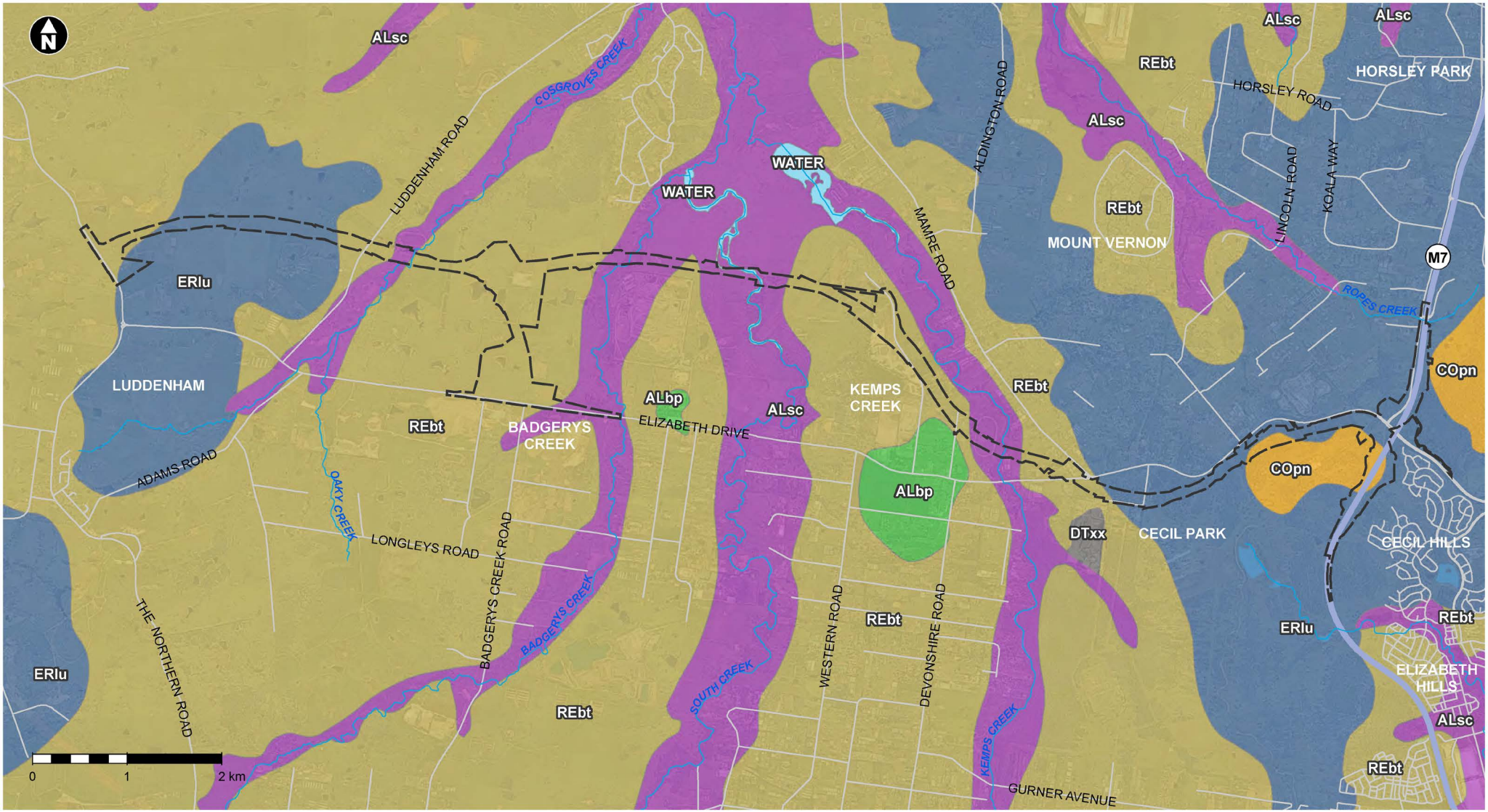

Figure 8-3 Soil landscapes

Data sources
Soil Landscapes of the Penrith 1:100,000 sheet
NSW Department of Environment, Climate Change and Water (DECCW)

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Acid sulfate soils

Acid Sulfate Soils (ASS) is the common name for naturally occurring sediments and soils containing iron sulphides. The exposure of these soils to oxygen by drainage or excavation, oxidises the iron sulphides and generates sulfuric acid. The sulfuric acid can be readily released into the environment, with potential adverse effects on the natural and built environments.

The Australian Soil Resource Information System's (ASRIS, 2018) online ASS risk map indicates the project footprint would be located within an area considered to have an extremely low probability of ASS occurrence. It indicates that there is no known or expected occurrence of ASS within the construction footprint.

Additionally, a search was carried out within Penrith Council (2010) and Liverpool Council (2008) LEPs for ASS risk maps for the construction footprint to determine the probability of ASS occurrence. Council ASS risk maps typically categorise ASS in terms of Class (ie Class 1, 2, 3 or 4). The search found no ASS risk maps exist for the construction footprint and so conclusions can be drawn that there is no known or expected occurrence of ASS within the construction footprint.

Acid rock

Acid rock is defined as rock that contains sulphide or sulfate minerals (commonly pyrite) which has the potential to oxidise when exposed and produce sulfuric acid. Acid rock is potentially an issue where the sulphide bearing rock that has previously been protected from weathering, or is below the water table, becomes exposed such as in deep cuttings.

As of May 2019, no occurrences of acid rock were documented within Bringelly Shales soil landscapes. On this basis, the potential for encountering acid rocks along the project footprint is considered to be extremely low. Impacts associated with acid rock have, therefore, not been assessed further.

Contamination

The construction footprint encompasses large areas of historical and current potentially contaminating activities which may require management or further investigation during the construction phase of the project. Historical and current potentially contaminating activities within the construction footprint include agricultural and rural land use, service stations, landfilling and waste recycling, quarries, potential areas of fill material, illegally dumped material, and industrial land use.

Land Use

The project footprint is located within a range of land use zones identified in the Liverpool Local Environmental Plan 2008, and the Penrith Local Environmental Plan 2010. These include rural landscape (RU2), primary production small lots (RU4), environmental conservation (E2), classified road (SP2) and Western Sydney Parklands. The largest residential areas are the suburbs of Kemps Creek, Mount Vernon and Horsley Park. Agricultural land uses include poultry farms, farms producing tomatoes and cucumbers, Christmas tree farm and wholesale nurseries. Commercial uses are generally located within the Kemps Creek village and include service stations, food stores, hardware and maintenance shops. Industrial uses include landfill and quarry sites (Aurecon 2016b).

The historical aerial photography review Indicated that the construction footprint has remained largely agricultural and rural/residential land use since the 1940s. There was then an increase in rural residential density in suburban pockets until 2002. Since 2002, development was characterised by clearing of bushland, an increase in residential density, and an increase in commercial/industrial activities within surrounding areas.

Potential contamination issues identified during the historical aerial photography review include:

- Diffuse pesticide and herbicide use
- Isolated waste disposal
- Chemical/fuel use and storage
- Degradation and demolition of structures containing hazardous building materials
- Historical and existing landfilling and mining activities
- Historical and existing mining and industrial land use
- Point source contamination of fuel storage and leaks/spills.

Results of register searches

A review of existing lists (eg NSW EPA Contaminated Sites Record of Notices and Environment Protection Licenses (EPLs) and non-compliances) indicate that there are six contaminated sites within 500 metres of the construction footprint. One site was notified to the NSW EPA under section 60 of the CLM Act and five sites are regulated under the POEO Act (see **Table 8-4**, overleaf).

Investigations

Contamination investigations were carried out to further assess the identified AEIs. AEIs were identified based on which sites could pose a potential contamination risk to construction activities and their associated contaminants of concern. A number of locations sampled exceeded the adopted guidelines for environmental and human health criteria. A summary of these exceedances in soils and groundwater samples and gas monitoring are provided in **Table 8-5**, **Table 8-6** and **Table 8-7** respectively.

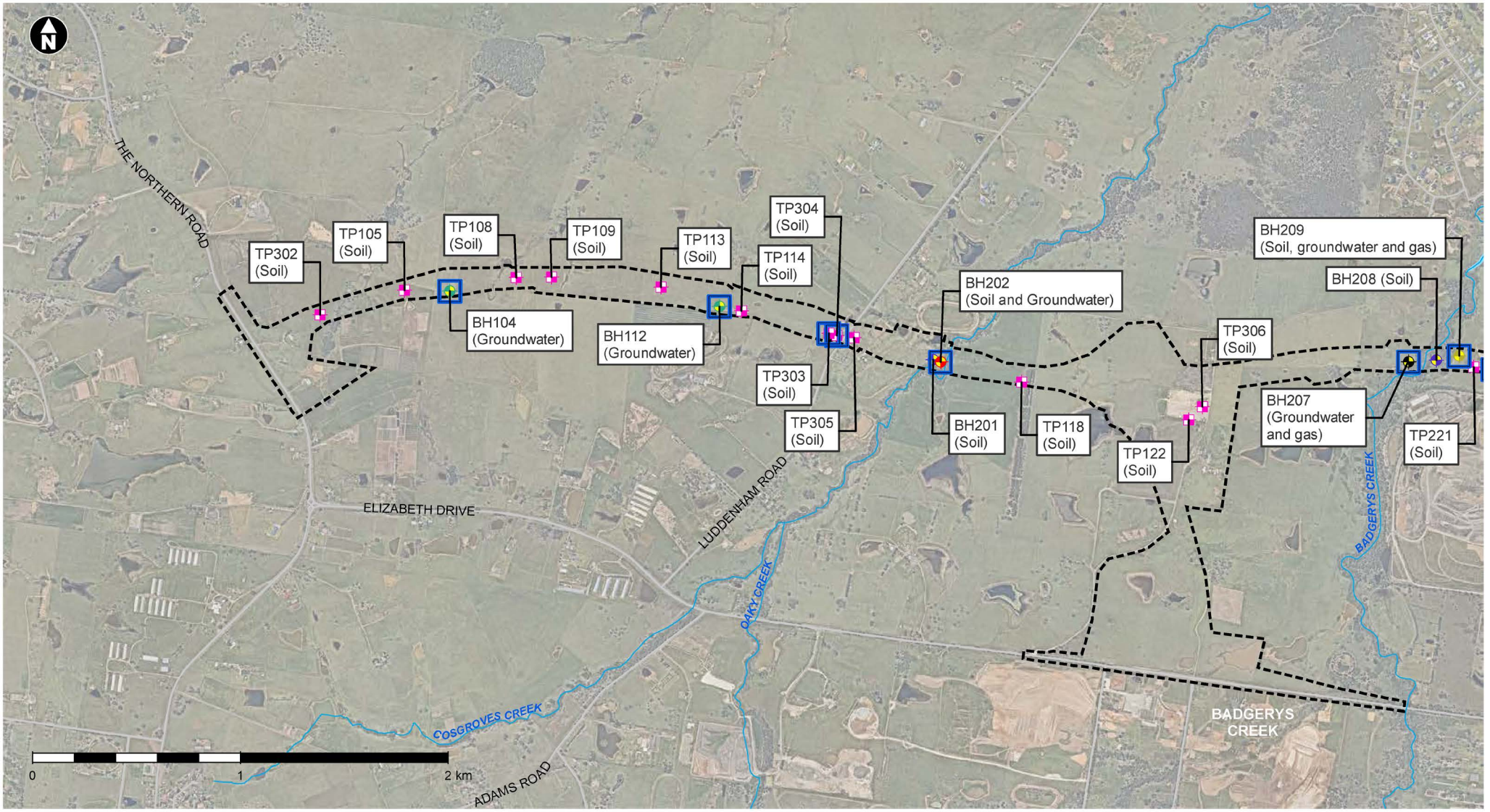
The locations of boreholes and test pits is shown in **Figure 8-4**.

Five of the 58 sampling locations returned test results indicating exceedances of adopted guidelines for soil contamination. This was for Zinc, PAH and Soil Asbestos Containing Material (ACM). **Table 8-5** provides the summary of the exceedances and what element of the project these could potentially impact on.

Groundwater sampling carried out identified copper and zinc concentration that exceeded the ANZECC 2000 FW 95 per cent level and in some instances nickel and nitrogen. Given that zinc and copper exceeded the ANZECC 2000 FW 95 per cent level across many of the other sampled boreholes, these concentrations have the potential to represent background concentrations. A summary of exceedances in groundwater samples are provided in **Table 8-6**.

Table 8-4 Regulated/notified sites within 500 metres of the project footprint

Site	Regulated/ Notified	Site address	Site activity	Contamination status	Location relative to project
1	Notified (section 60)	1163 Mamre Road, Kemps Creek	Caltex Service Station	Regulation under CLM Act not required	300 metres north-east of project
2	Issued Dec 2000 (POEO Act)	Lot 90, Elizabeth Drive, Kemps Creek	Brandown Quarry Land-based extractive activity Waste disposal by application to land	Issued Penalty notice 3085764523: Contravene any condition of licence – not noise – corporation	Next to project to the south
3	Issued June 2000 (POEO Act)	Clifton Avenue, Kemps Creek	Former Kari & Ghossayn Pty Ltd Solid Waste Landfilling grinding or separating	Revoked	Within construction footprint
4	Issued 13 Sep 2001 (POEO Act)	1725 Elizabeth Drive, Kemps Creek	SUEZ Recycling and Recovery Pty Ltd Waste storage – other types of waste Waste disposal by application to land	Issued Clean Up Notice 1025236 Penalty notices 3085764890, 3085769950 and 3085771765: Contravene section by emission of odours Penalty Notice 3085773580: Fail to comply with requirements relating to asbestos waste	Next to project to the south
5	Issued July 2008 (POEO Act)	16-23 Clifton Avenue, Kemps Creek	Sydney Recycling Park Pty Ltd Waste storage - other types of waste Non-thermal treatment of general waste Waste disposal by application to land Land-based extractive activity	Issued Penalty Notice 3085765403 and 3085772425: Contravene any condition of licence - not noise – corporation Penalty notice 3085769592: Contravene emission of odours – Corporation Clean Up Notice 1122702 (s.91 Clean-up notice)	150 metres south-west of project
6	Issued Dec 2016 (POEO Act)	1503-1519 Elizabeth Drive, Kemps Creek	Hi Quality Quarry Land-based extractive activity	Issued POEO licence	350 metres south-west of project



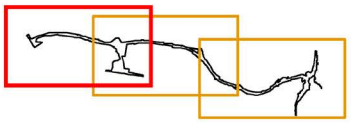
Waterways
Main roads
The project construction footprint
Location of exceedance

Boreholes

Groundwater
Groundwater and gas
Soil
Soil and groundwater
Soil, groundwater and gas

Test pits

Soil



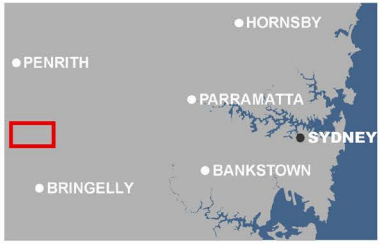


Figure 8-4 Contamination field sampling locations

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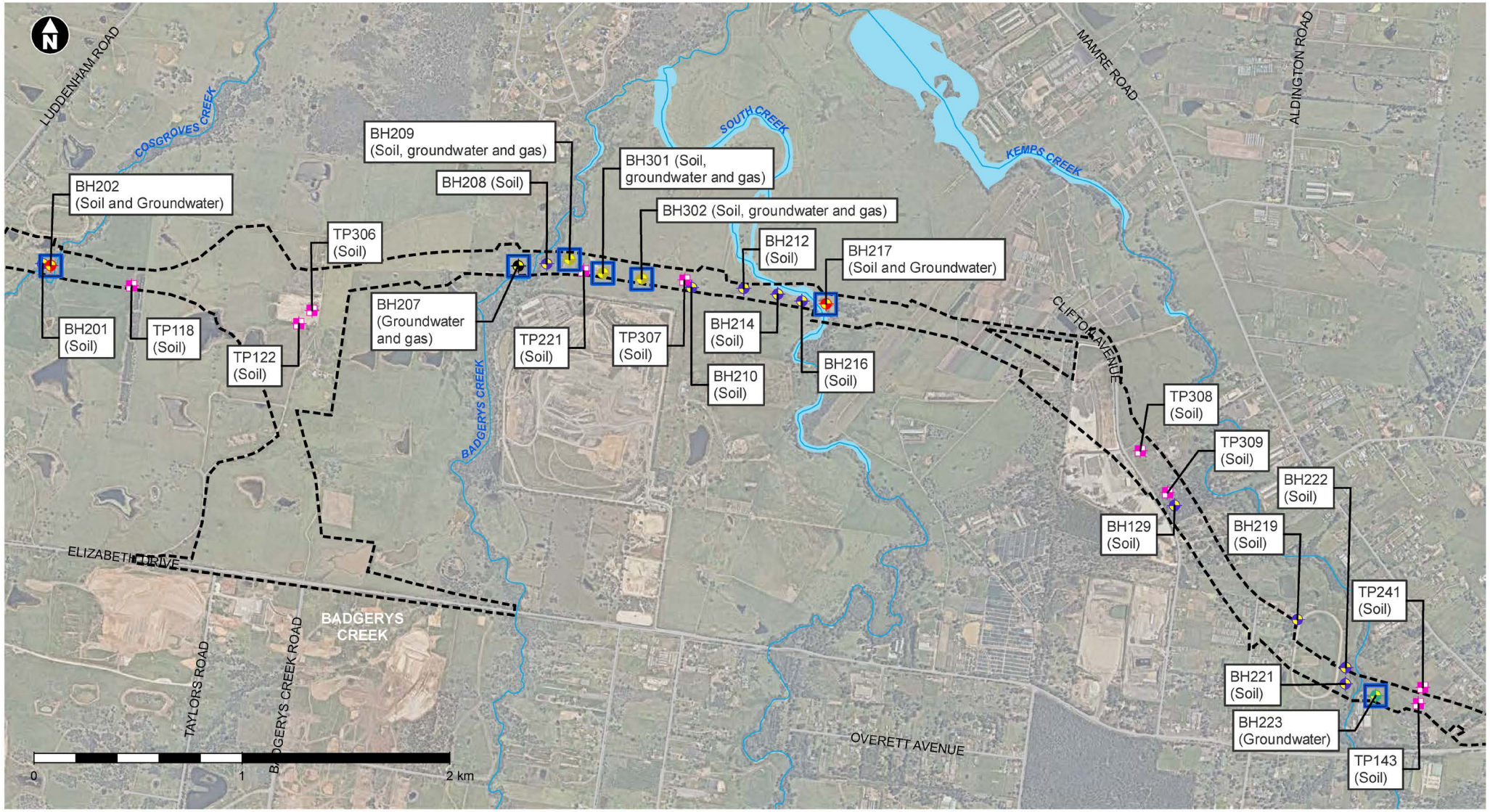

Figure 8-4 Contamination field sampling locations

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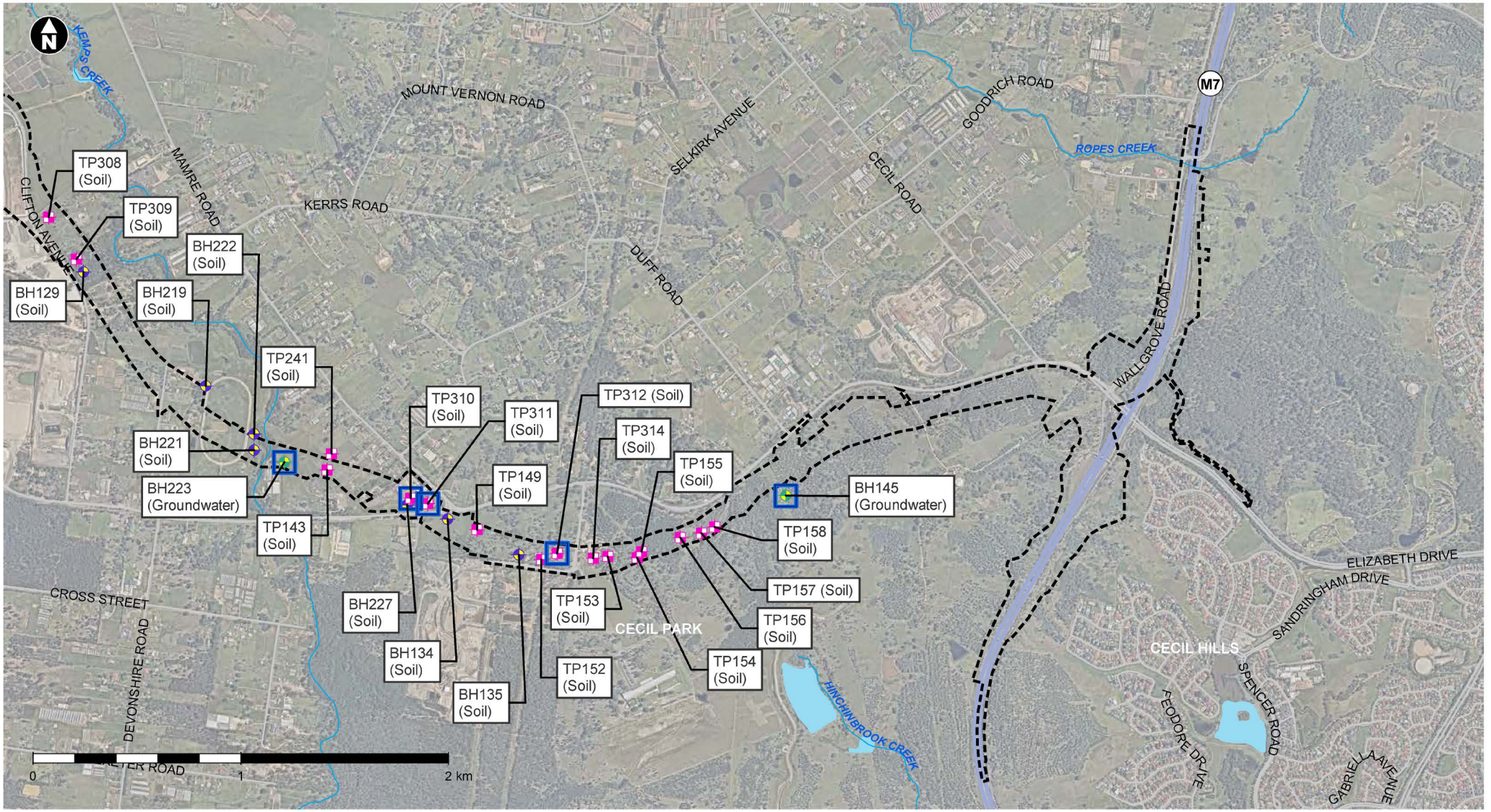

Waterways
Motorway
Main roads
The project construction footprint
Location of exceedance

Boreholes

Groundwater
Groundwater and gas
Soil
Soil and groundwater
Soil, groundwater and gas

Test pits

Soil

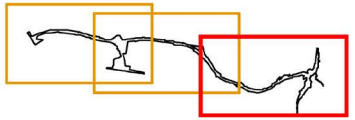

Figure 8-4 Contamination field sampling locations

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Table 8-5 Summary of guideline exceedances from intrusive soil investigations

Sampling location and depth	Analyte/s and results	Adopted guideline and value exceedance	Relevant project element and target AEI
TP310 (0-0.1 mbgl)	Heavy metals (zinc); 1,090 mg/kg	Exceeded the ecological investigation levels (EIL) of 435 mg/kg	• Ancillary facility 5 • Filling construction activity • AEI: stockpiles within Hi-Quality Quarry Group head office
TP303 (0-0.2 mbgl)	PAH (benzo(a)pyrene 9.2 mg/kg and benzo(a)pyrene TEQ); 13 mg/kg)	Exceeded the ecological screening levels (ESL) of 0.7 mg/kg and the health investigation levels (HIL) of 3 mg/kg	• Bridge construction • AEI: miscellaneous construction activities and stockpiles of building materials
TP304a (stockpile)	PAH (benzo(a)pyrene); 0.9 mg/kg	Exceeded the ESL of 0.7 mg/kg	• Bridge construction • AEI: miscellaneous construction activities and stockpiles of building materials
TP311 (0-0.1 mbgl)	PAH (benzo(a)pyrene); 0.9 mg/kg	Exceeded the ESL of 0.7 mg/kg	• Ancillary facility 5 • Filling construction activity • AEI: stockpiles within Hi-Quality Quarry Group head office
TP312 (0.1 mbgl)	Soil ACM – asbestos; present	Presence/absence	• Filling construction activity • AEI: area of illegally dumped material

Table 8-6 Summary of guideline exceedances from intrusive groundwater investigations

Sampling location and depth	Analyte/s and results (exceedance)	Adopted guideline for exceedance	Relevant project element and target AEI
BH104	Heavy metals (copper 10 µg/L and zinc 9 µg/L)	ANZECC 2000 freshwater 95% guideline - 1.4 µg/L for copper and 8 µg/L for zinc	• Cutting construction activity • No associated AEI
BH112	Heavy metals (copper 3 µg/L and zinc 15 µg/L)	As above for copper and zinc	• Cutting construction activity • No associated AEI
BH202	Heavy metals (copper 12 µg/L and zinc 49 µg/L)	As above for copper and zinc	• Bridge construction • AEI: potential area of fill (next to Cosgroves Creek)

Sampling location and depth	Analyte/s and results (exceedance)	Adopted guideline for exceedance	Relevant project element and target AEI
BH207	Heavy metals (copper 18 µg/L and zinc 36 µg/L), nutrients (ammonia 4600 µg/L and nitrogen 4900 µg/L)	As above for copper and zinc ANZECC 2000 freshwater 95% adjusted guideline value of 2.33 mg/L for ammonia (based on site pH) ANZECC 2000 freshwater 99% guideline - 350 µg/L for nitrogen	• Cut/bridge construction • AEI: SUEZ Kemps Creek Resource Recovery Park
BH209	Heavy metals (copper 5 µg/L and zinc 18 µg/L), nutrients (nitrogen 1500 µg/L)	As above for copper, zinc and nitrogen	• Fill/bridge construction • AEI: SUEZ Kemps Creek Resource Recovery Park
BH217	Heavy metals (copper 6 µg/L and zinc 16 µg/L)	As above for copper and zinc	• Fill/bridge construction • AEI: potential area of fill (next to South Creek)
BH223	Heavy metals (zinc 14 µg/L)	As above for zinc	• Filling construction activity • AEI: east of potential area of fill
BH301	Heavy metals (copper 10 µg/L, nickel 14 µg/L, and zinc 25 µg/L)	As above for copper and zinc ANZECC 2000 freshwater 99% guideline -11 µg/L for nickel	• Filling construction activity • AEI: SUEZ Kemps Creek Resource Recovery Park
BH302	Heavy metals (copper 32 µg/L and zinc 57 µg/L), nutrients (nitrogen 1200 µg/L)	As above for copper, zinc and nitrogen	• Filling construction activity • AEI: SUEZ Kemps Creek Resource Recovery Park
BH145	Heavy metals (nickel 33 µg/L)	As above for nickel	• Cutting construction activity • No associated AEI

Gas monitoring carried out at selected locations within the construction footprint indicated that potential soil vapour contamination may be present beneath areas next to the SUEZ Kemps Creek Resource Recovery Park. Methane and carbon dioxide exceeded the NSW EPA (2016a) Environmental Guidelines: Solid Waste Landfills within this area. A summary of the exceedances in the gas monitoring sample is provided in **Table 8-7**.

Table 8-7 Summary of guideline exceedances from gas monitoring investigations

Sampling location and depth	Analyte/s and results (exceedance)	Value exceedance	Relevant project element and target AEI
BH207	Methane (2%) and carbon dioxide (3.3%)	NSW EPA Environmental Guidelines: Solid Waste Landfills - 1.25% for methane; and 1.5% for carbon dioxide	• Filling construction activity • AEI: SUEZ Kemps Creek Resource Recovery Park

Areas of environmental interest

Several potential AEIs and were identified within the study area that could pose a potential contamination risk to construction activities and contain contaminants of concern. Seventeen of the 22 AEIs are considered to represent a low contamination risk due to distance from the project footprint and lack of migration pathways. No further consideration of contamination risk was provided for these 17 AEIs.

Following further assessment and intrusive investigations**,** five AEIs were identified (based on the information review and site inspection) to have a moderate to high exposure risk rankings. In addition to the AEIs, several areas of fill along the construction footprint were also identified as having a moderate to high exposure risk ranking. These areas are presented in **Figure 8-5**. The contaminants of potential concern associated with these areas are presented in **Table 8-8.**

Refer to **Appendix O** for further detail.

Table 8-8 Moderate to high ranked AEIs and potential areas of fill

AEI[1]	Site	Location	Potential contaminants of concern
7	Kari & Ghossayn Pty Ltd (Solid Waste Landfill)	Lot 17 Clifton Avenue, Kemps Creek (Within construction footprint)	• TRH • BTEX • Ammonia • PAH • Heavy metals • Organophosphate Pesticides (OPP) • Organochlorine Pesticides (OCP) • Polychlorinated Biphenyls (PCB) • Nutrients • Asbestos
10	SUEZ Kemps Creek Resource Recovery Park	1725 Elizabeth Drive, Kemps Creek (next to project)	• TRH • BTEX • Ammonia • PAH • Heavy Metals • OCP • OPP • PCB • Nutrients • Asbestos
17	Stockpiles within Hi-quality Quarry Group Head Office	Corner Elizabeth Drive and Mamre Road, Kemps Creek (Within construction footprint)	• Heavy metals • TRH • BTEX • Acids • Sulphate • Cyanide

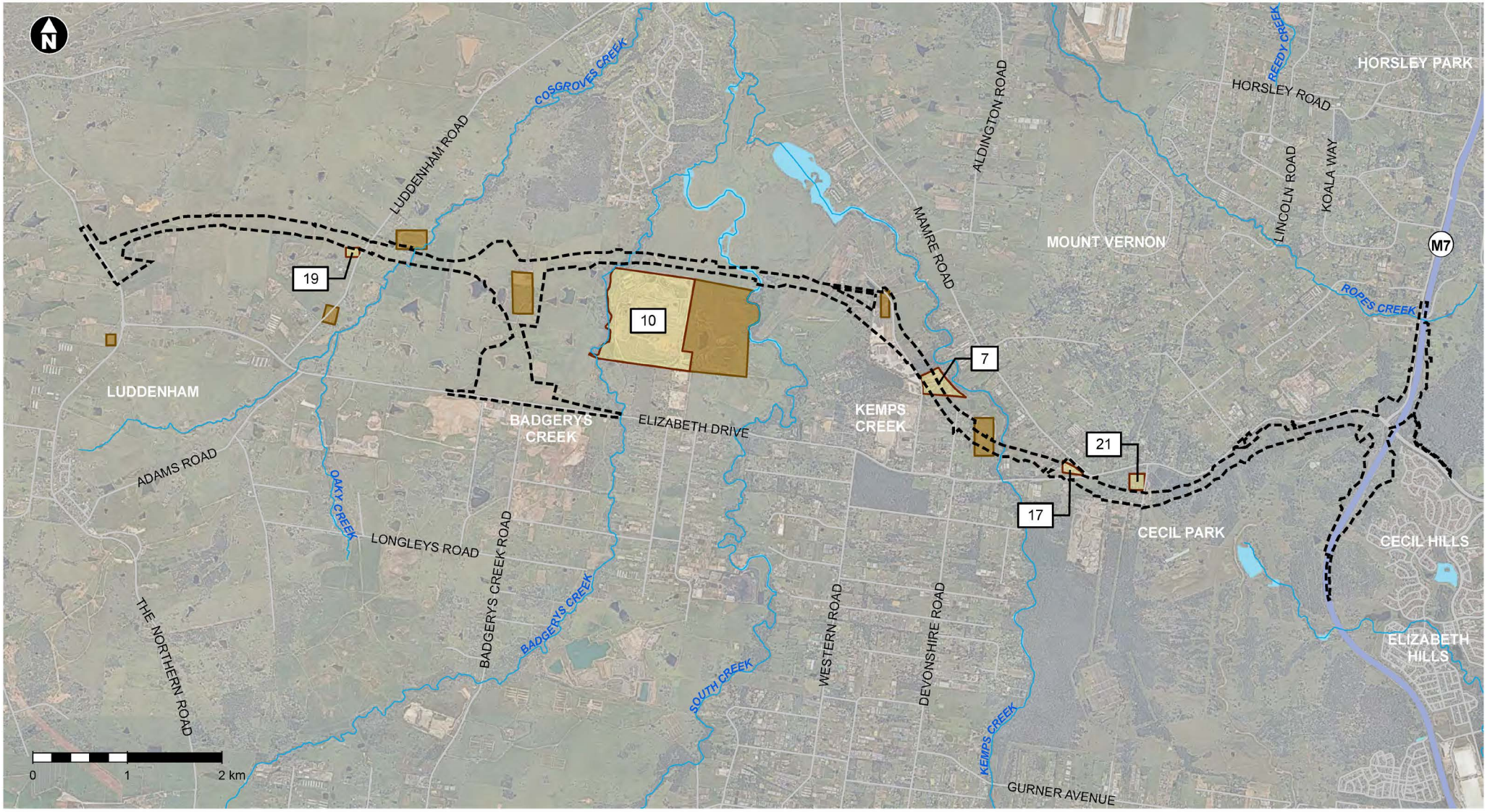
AEI[1]	Site	Location	Potential contaminants of concern
19	Miscellaneous construction activities and stockpiles of building materials	Luddenham Road, Luddenham (within construction footprint)	• Heavy metals • BTEX • Asbestos • TRH • OCP • OPP • PAH
21	Area of significant illegally dumped material	Corner of Elizabeth Drive and Range Road, Kemps Creek (next to project to the north)	• Heavy metals, • BTEX • Asbestos • PAH • OCP • OPP • PCB • TRH
Potential areas of fill			
Generic AEIs[2] along the project	Identified areas of potential fill	Generic AEIs along the project	• Heavy metals, • BTEX • Asbestos • PAH • OCP • OPP • PCB • TRH
	Historical uncontrolled earthworks and building structures containing asbestos previously demolished/ degraded	Generic AEIs along the project	• Asbestos

*[1]AEI figure reference (see **Figure 8-5**) [2]Generic AEIs occur where there is no point source or location for contamination and there is evidence of historical and current agricultural land*

Salinity

Soil salinity refers to the salt content of soil, and is a complex issue relating to salt and water cycles both above and below the ground. Surface and groundwater can dissolve and mobilise salts and cause their accumulation in other areas. Development can cause changes to these water flows and cause salt to accumulate in different areas. Salinity potential is defined as being either known, moderate or high salinity:

- Areas of known salinity – defined as those areas where saline soils were identified or air photo interpretation and field observations have identified visual indicators of land salinity such as bare earth or waterlogging
- Areas of moderate salinity potential – defined as where Wianamatta Group Shales or tertiary alluvial terraces are present
- Areas of high salinity potential – defined as those areas where expected soil, geology, topography and groundwater conditions predispose a site to salinity. These areas are most commonly drainage systems or low lying/flat grounds where there is a high potential for the ground to become waterlogged.



Waterways
Motorway
Main roads
The project construction footprint
Potential areas of existing fill

Areas of environmental interest (moderate to high):

7 - Former Kari & Ghossayn Pty Ltd (Solid Waste Landfill)
10 - SUEZ Kemps Creek Resource Recovery Park
17 - Stockpiles within Hi-quality Quarry
19 - Miscellaneous construction activities and stockpiles of building materials
21 - Area of significant flytipped waste

Figure 8-5 Moderate to high ranked AEIs and potential fill areas

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The Salinity Potential in Western Sydney 2002 Map (DLWC, 2002b) indicates that soils within a majority of the construction footprint have a moderate salinity potential. There are also small areas of known soil salinity to the east of Range Road. In addition, areas of high salinity potential were identified in the following areas:

- Areas of Cosgroves Creek
- Areas of low-lying land to the east and west of Cosgroves Creek
- Areas along Kemps Creek
- Small areas of known soil salinity along the project footprint to the east of Range Road.

Additional saline areas may be present which have not yet been identified or may occur if site conditions change adversely. Areas of current or potential soil salinity are expected along the construction footprint where there is alluvium, waterlogged ground or shallow groundwater.

A soil salinity risk map is presented in **Figure 8-6**.

Areas of identified historical filling

The photogrammetry survey identified historical areas of filling or stockpiling which have taken place within the construction footprint since the 1950s. Areas of explained filling include dams and stockpiles. These were not considered during the walkover given these areas are expected to be of a lower risk of containing contaminants which may exceed adopted soil guidelines.

Uncontrolled filling or stockpiling includes results which cannot be explained through construction of infrastructure. According to the photogrammetry survey, there are about 17 areas of identified historical uncontrolled filling or stockpiling within the construction footprint. Areas of unexplained filling were not sampled during the contamination investigation, however were confirmed during a site walkover.

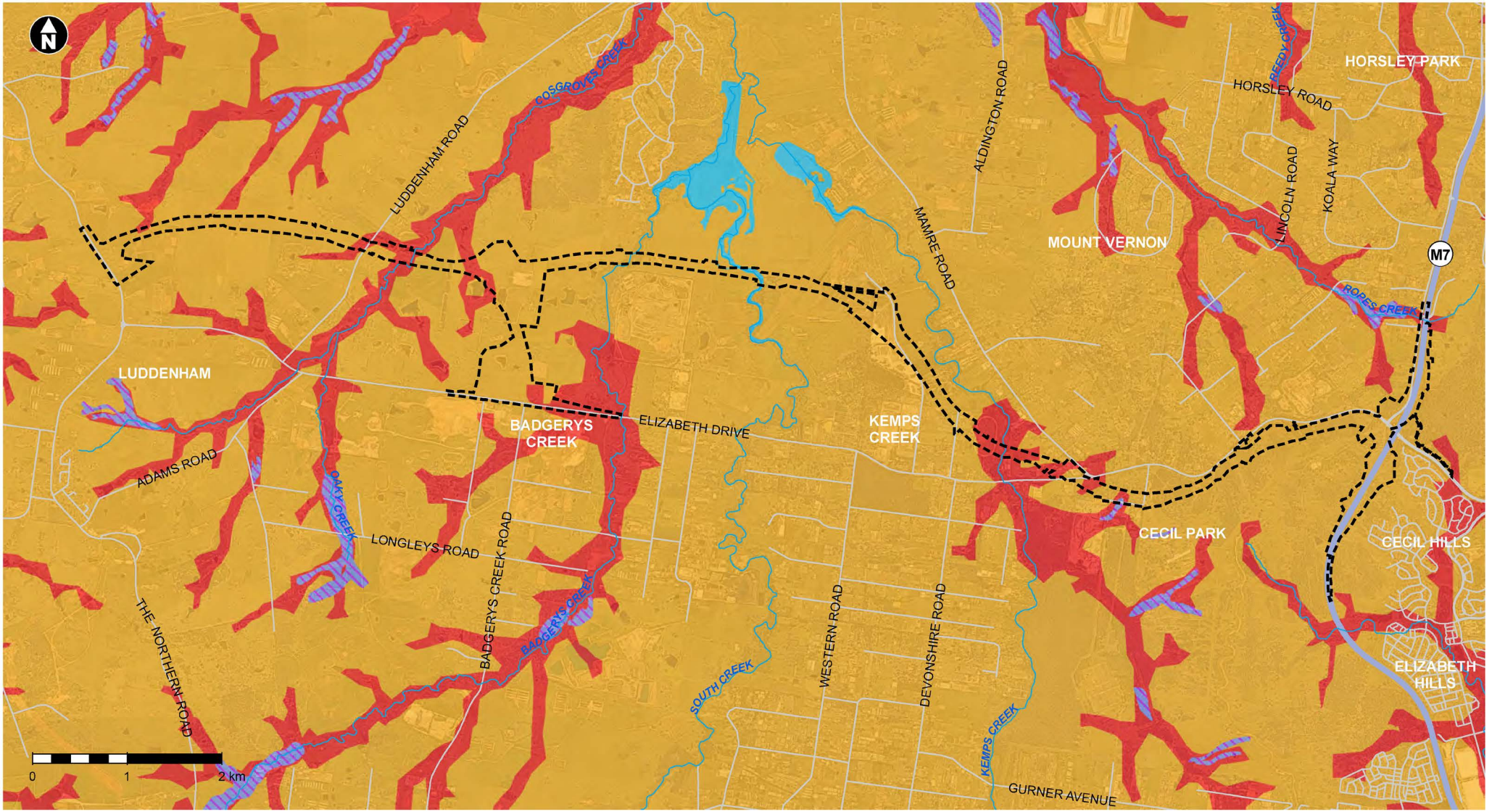
There is the potential that these areas of unexplained and uncontrolled filling and stockpiling contain contaminants which exceed the adopted soil guidelines, including the presence of ACM. These areas would be further investigated before construction to determine the presence of contamination (if any) and would be considered when developing options for waste removal and disposal. Further details relating to proposed investigations are provided in **Section 8.1.4** and **Table 8-9**.

Sensitive receiving environments

Sensitive receiving environments were identified based on the criteria outlined in the environmental values and water quality objectives for the project (see **Section 7.9.1**) and include the following:

- Cosgroves Creek
- Badgerys Creek
- South Creek
- Kemps Creek
- Ropes Creek and unnamed tributaries of South Creek, Cosgroves Creek Badgerys Creek, Kemps Creek and Ropes Creek
- Hinchinbrook Creek and unnamed tributary of Hinchinbrook Creek
- Doujon Lake
- SEPP Coastal Wetlands ID113, ID114 and ID117
- Hinchinbrook Creek at the downstream SEPP coastal wetland ID276.

Sensitive receiving environments are further discussed further in **Section 7.1.3**.



Data sources
Western Sydney Salinity Potential 2002,
Office of Environment and Heritage (OEH)

Figure 8-6 Soil salinity risk map

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8.1.4 Assessment of potential impacts

Construction impacts

Acid sulfate soils and acid rock

Based on the information reviewed in **Section 8.1.3**, there is no known or expected ASS or acid rock occurrence within the construction footprint. Therefore, are no ASS or acid rock impacts are expected in relation to the construction of the project.

Soil contamination

Contamination (where disturbed as part of construction activities), if not managed appropriately, could potentially impact upon the existing environment described in **Section 8.1.3**.

Phase 2 Detailed Site Investigation

Each AEI was assessed for land exposure risk in accordance with the National Environment Protection (Assessment of Site Contamination) Measure 1999 (as revised in 2013), based on potential contaminants and activities. A number of moderate to high risk AEIs were identified within and next to the project (see **Table 8-9**). Limited intrusive investigations have been undertaken within the construction footprint to further quantify the risks of some of these AEIs.

Based on the results of the contamination investigation (JAJV 2018a), further investigations would be carried out in the form of a Phase 2 Detailed Site Investigation (Phase 2 DSI) for the following:

- AEIs identified as having a risk ranking of moderate or high (see **Table 8-9**)
- AEIs where PAH has been identified in soils at concentrations exceeding the respective human health investigation levels, as identified in **Table 8-5**.

No further investigation is proposed within AEIs with a risk ranking of low.

The Phase 2 DSIs would be designed in accordance with the NSW EPA endorsed guidance, including the NEPM (2013) guidelines and the relevant guidelines listed in **Section 8.1.1**. A sampling, analysis and quality plan (SAQP) would be prepared and would include investigations for contaminants, including:

- Hydrocarbons
- Ammonia
- PAH
- Heavy metals
- Pesticides
- PCB
- Asbestos
- Any other identified relevant contaminant.

The Phase 2 DSI would be designed in consideration of the potential and existing contamination identified within **Appendix O** and the proposed construction activities to be carried out on the respective sites (ie investigations would provide lateral and vertical coverage in context of the proposed construction activities within this area).

Table 8-9 Risk ranking of AEIs and consideration of further investigation

AEI[1]	Construction element and anticipated depth	Potential contamination distribution	Risk ranking	Further investigation proposed
7 Former Kari & Ghossayn Pty Ltd (Solid Waste Landfill)	Filling (surface)	Soil, groundwater, gas	**Risk: Moderate** Possible contamination/construction activities within AEI and within potential contamination distribution range (laterally).	The extent of potential contaminants within this AEI is largely unknown. Due to the nature of the site, it is anticipated that some contaminants may be present. In addition, the AEI is located within the construction footprint. As a result, further investigation is proposed.
10 SUEZ Kemps Creek Resource Recovery Park	Shallow cut and filling	Soil, groundwater, gas	**Risk: Moderate** Known contamination/ excavation activities next to project and within potential contamination distribution range (laterally and vertically). Piling from bridge construction in the area is expected to encounter groundwater, and that landfill gas has the potential to impact construction within cuts.	As this AEI is located adjacent to the construction footprint, the main contaminant of further concern is the spread of gas beyond the boundaries of the AEI. Prior to construction activities, further gas investigations would be carried out in this area to assess the extent of high-risk soil gas which could impact upon construction and/or operation of the project.
17 Stockpiles within Hi-quality Quarry Group Head Office	Filling (surface)	Soil	**Risk: Moderate** Known contamination/ construction activities (filling) within project and within potential contamination distribution range (laterally).	Locations sampled within this AEI exceeded the adopted guidelines for environmental and human health criteria. As a result, further investigation is proposed.
19 Miscellaneous construction activities and stockpiles of building materials	Bridge (surface and depth)	Soil	**Risk: High** Known contamination/ excavation activities within project and within potential contamination distribution range (laterally and vertically).	Contamination is known to be present within this AEI which may be disturbed during the construction of a bridge. In addition, locations sampled within this AEI exceeded the adopted guidelines for environmental and human health criteria. As a result, further investigation is proposed.

AEI[1]	Construction element and anticipated depth	Potential contamination distribution	Risk ranking	Further investigation proposed
21 Area of significant illegally dumped material	Filling (surface)	Soil	**Risk: High** Confirmed presence of asbestos in this area Known contamination/ construction activities next to project and within potential contamination distribution range (laterally).	Asbestos has been identified within this AEI which may be disturbed during the construction of a bridge. As a result, further investigation is proposed.
Historical uncontrolled earthworks and building structures containing asbestos previously demolished/ degraded Identified areas of potential fill (Generic AEIs)[2]	Cut and filling (surface and depth)	Soil, groundwater	**Risk: High** Known contamination/ excavation activities below construction footprint and within potential contamination distribution range (laterally and vertically). Asbestos was identified next to the construction footprint.	Within this AEI, the main further concerns are contaminated groundwater during construction and ACM contained within areas of historical or potential fill. As the project has minimal potential to interact with groundwater (see Appendix N), no further investigation is proposed at this time. Unexpected contamination resulting from unexpected interaction with groundwater would be managed in accordance with contaminated land management plan (CLMP). Further investigations within areas of potential or historical fill would be undertaken to determine the presence and/or extent of ACM within these areas.

*[1]AEI figure reference (see **Figure 8-5**)*

[2]Generic AEIs occur where there is no point source or location for contamination and there is evidence of historical and current agricultural land

Remediation Action Plans

The Phase 2 DSIs would identify where remediation would be required due to extensive contamination within the project footprint. The need for remediation would be determined by considering the risks of carrying out construction works associated with the project. If the risks posed to the environment and human health is greater than the contamination remaining in situ, then the need for active remediation would be considered and alternative management options such as capping investigated.

A Remediation Action Plan and/or environmental management plans would be prepared for each area where the detailed site investigations confirm that contamination would have a moderate to a very high risk. This would typically apply where there is more significant, widespread contamination that requires detailed remedial planning,

Remediation Action Plans would be prepared in accordance with the relevant legislation and guidelines listed in **Section 8.1.1** prior to the start of construction.

The process for the preparation and implementation of the Remediation Action Plans are outlined below:

- The plan would be prepared by a suitably qualified and experienced contaminated lands consultant
- Remediation and validation activities would be carried out; typical activities for remediation of sites within the construction footprint may include excavation and off-site disposal or capping and containment
- A validation report would be prepared by the consultant
- The validation report would be reviewed by the appointed independent NSW EPA accredited site auditor.

The Remediation Action Plans would include the assessment of sustainable remediation options and consideration of the *Waste Avoidance and Resource Recovery Act 2001* (NSW).

Use of contaminated material

Heavy metal and PAH contamination was detected at concentrations exceeding ecological investigation levels within surface soils at selected locations (TP303, TP304, TP310 and TP311; see **Table 8-5**). The surface material from these areas cannot be reused within landscaped areas or in areas within and/or adjacent to sensitive environmental receptors.

Asbestos and demolition of structures

Based on the knowledge of the historical land use of the area, and that asbestos was confirmed within one area of the construction footprint (TP312 along Range Road, Cecil Park; see **Table 8-5**), asbestos has the potential to be present within soils of the construction footprint as follows:

- Isolated fragments of fibre cement sheeting in surface soils potentially representing isolated disposal activities or surface water flow driven deposition
- More concentrated scatterings of fibre cement sheet fragments at the surface, likely to be associated with degradation of/damage to building materials and demolition of onsite structures
- Fibre cement sheeting fragments and potentially fibrous material within illegally disposed stockpiles of waste and soil
- Larger areas subject to earthworks with imported fill potentially containing asbestos.

Structures containing hazardous building materials (where present) have the potential to contaminate surrounding environments during demolition via airborne dust and have the potential to impact human health, soils and waterways. Project construction would require the demolition of structures within the project footprint which may impact upon soil contamination if hazardous materials are not managed appropriately. Hazardous building materials (where present) would be managed to reduce the potential for contamination and ensure appropriate handling and waste disposal.

In accordance with Australian Standard (AS 2601-2001): The demolition of structures, a hazardous building materials audit would be carried out before the demolition of any structure and/or building. It is noted that the number of structures to be demolished would be confirmed during detailed design.

Any soil/fill materials surplus to construction needs would be classified in accordance with the NSW EPA (2014a) Waste Classification Guidelines. An additional contamination investigation determined that there are a number of potential scenarios for encountering asbestos containing materials (ACM) within the construction footprint, and that the areas of uncontrolled filling and stockpiling have the potential to contain contaminants which exceed the adopted soil guidelines, including the presence of ACM.

ACM is present as isolated fragments and larger distributions in surface soils throughout the construction footprint. There appears to be a greater concentration of surficial asbestos between the airport interchange and Western Sydney Parklands of the construction footprint where denser residential and commercial/industrial land uses are present. Between the western extent of the construction footprint and the airport interchange, there is a low to moderate potential of encountering surficial asbestos and historical uncontrolled fill. Between the airport interchange and Western Sydney Parklands, there is a high potential of encountering surficial asbestos and historical uncontrolled fill. Between Western Sydney Parklands and the eastern extent of the construction footprint (including the M7 Motorway corridor) there is a low potential of encountering surficial asbestos and historical uncontrolled fill.

Should extensive contamination be identified following further investigations, appropriate remediation action plans and/or environmental management plans would be developed to remove or suitably reduce the contamination risks during construction activities.

Given the implementation of the environmental management measures outlined **in Section 8.1.6**, the project is not anticipated to contribute to any contamination of soil.

Requirements for further investigations are detailed in **Section 8.1.6**.

Groundwater contamination

Based on the findings of the contamination and groundwater investigations, groundwater from identified AEIs poses a low risk to construction of the project. This is because the volumes of groundwater expected to interact with project features during project construction are negligible or are not expected to require management. As a result, while groundwater in the area has exceeded the ANZECC 2000 FW 95 per cent level, the risk of the elevated heavy metals detected in groundwater released from the construction and operation of the project to receiving freshwater environments is low given that the volumes expected are negligible and are likely to represent background concentrations. Additionally, the groundwater quality data from BH104 (bore near the western cut) does not indicate a risk to human health (Australian Drinking Water Guidelines, NHMRC 2011).

Given that zinc and copper concentrations exceeded the ANZECC 2000 FW 95 per cent level at most of the boreholes (see **Table 8-6**), the existing potential baseflow contributions from groundwater to surface water systems is likely currently elevated above the ANZECC 2000 FW 95 per cent level. As a result, drainage of the western cut and discharge to a surface water system is not anticipated to have additional adverse impacts (JAJV 2018b).

If, during construction, volumes of groundwater are encountered which may require management and potential disposal associated with de-watering activities, further investigations would be carried out to confirm the contaminant levels within the groundwater and potential volumes that may need to be managed.

Releases of groundwater offsite into the surrounding environments would be managed through the CEMP to protect surrounding surface and groundwater environments, as discussed in **Section 7.10.4**.

Gas contamination

Gas monitoring indicated that soil vapour contamination may be present beneath areas next to the SUEZ Kemps Creek Resource Recovery Park. Construction activities of filling and cutting are proposed within this area north of the landfill.

Methane and carbon dioxide levels exceeded the NSW EPA (2016a) Environmental Guidelines: Solid Waste Landfills within this area. Methane and carbon dioxide may pose potential asphyxiation and explosion risks, and carbon dioxide may pose potential asphyxiation risk. Monitoring showed levels of methane to be to be below the lower and upper explosive limits where they exceeded the NSW EPA (2016a) guidelines. Potential impacts from gas ingress during construction include explosion and asphyxiation, especially associated with the construction of confined spaces such as service trenches. Before construction activities, further gas investigations would be carried out in this area to assess the extent of high-risk soil gas.

In addition to the above gas investigations, gas hazard mitigation within a Construction Work Health and Safety Plan would detail measures to prevent explosion hazards, remove ignition sources, and prevent gas inhalation of construction workers. If temporary site sheds are proposed within this area, appropriate measures would be implemented to avoid gas ingress into above ground structures (eg breezeways beneath buildings).Requirements for further investigations are detailed in **Table 8-12**.

Salinity

Given the presence of moderate to high risk of saline soils throughout the construction footprint, there is the potential to impact on surface water and/or groundwater (see **Section 7.10.4**), and structures associated with the construction of the project. Additionally, salinity impacts include agricultural production, water quality, ecological health of water bodies, biodiversity and soil erosion. Construction within areas of moderate to high risk saline soils would be managed under a CEMP and be carried out in accordance with the NSW Department of Primary Industries (2014) Salinity Training Handbook (see **Section 7.10.6**).

Soil erosion and sediment transportation

The highest potential for soil erosion would be associated with the disturbance of soils on existing slopes during construction. Given the terrain of the construction footprint includes rolling hills to alluvial floodplains, and that soil disturbance is expected across the length of the construction footprint, soil erosion and the associated sediment transportation is a hazard that could occur as a result of the construction of the project.

High soil erodibility is listed as a limitation of all four soil landscape groups within the study area (see **Section 8.1.3**), particularly Picton soils, within the eastern end of the construction footprint, which have the potential for mass movement and slope instability (ie land sliding).

A number of construction activities have the potential to impact on the soil environment as presented in **Table 8-10**.

The potential for soil erosion and sediment transport during construction is low, subject to standard and suitable erosion control measures being implemented and managed during construction activities. Standard erosion control measures would be consistent with those detailed in Managing Urban Stormwater: Soils and Construction (Landcom, 2004).

Table 8-10 Potential soil impacts resulting from construction activities

Construction activity	Potential impacts on the soil environment
Vegetation removal	There is risk of exposure of soils to weathering processes, increasing the risk of erosion and transportation.
Cut and fill earthworks	Fill requirements have the potential to impact on soils and landform, as loose fill could be eroded during rainfall events by runoff. This can result in sediment transport and sedimentation of downstream drainage lines through mass movement of soils and change soil surface characteristics. In areas of cut, the earthworks have the potential to destabilise the landform. Removal of topsoil can reduce the agricultural and ecological value and impede on the rehabilitation of native ecosystems.
Stockpiling	Excavated material would require stockpiling before being reused on the project. If stockpiles are not adequately stabilised, material could erode during high rainfall or windy events.
Construction of new roads	There is the risk of soil compaction during the construction of new roads from the operation and movement of heavy machinery. This heavy machinery can disturb soil surface, increasing the potential for erosion.
Construction of bridges	The construction of bridges requires piles which supports the bridge foundations. Piling requires excavation and can result in moderate impacts on soils due to disturbance.
Relocation of utilities	The relocation of water mains and telecommunication facilities underground would involve soil disturbance from trenching and underboring. The disturbance of soil by machinery could increase the potential for soil erosion.
Landscaping	Minor earthworks are required during landscaping activities that could result in the erosion of disturbed soils that have not stabilised. These impacts would be temporary as stabilisation and revegetation would act to resist future soil erosion.

Human health

Where disturbed during construction activities, contamination could potentially impact upon human health. It is recommended that further investigations be carried out within the areas where PAH were identified in soils at concentrations exceeding the respective human health investigation levels, as described in **Section 8.1.6**.

Groundwater quality does not pose a risk to human health, as per the Australian Drinking Water Guidelines, (NHMRC, 2011).

Elevated gas concentrations could impact upon human health, including explosion and asphyxiation, especially associated with the construction of confined spaces such as service trenches. While elevated gas concentrations are likely to be relatively localized, further gas investigations would be carried out to assess the extent of high-risk soil gas as described in **Section 8.1.6**.

Operational impacts

Acid sulfate soils

There are no known or expected ASS or acid rock occurrences within the operational footprint. Therefore, no ASS or acid rock impacts are expected in relation to the operation of the project.

Soil contamination

After construction of the project, construction support sites and other areas of soil disturbance would be suitably reinstated. As such, contaminated soils are not expected to impact on the operation of the project.

Given the implementation of the environmental management measures outlined **in Section 8.1.6**, the project is not anticipated to contribute to any contamination of soil.

Groundwater contamination

As discussed in **Section 7.10.4**, groundwater is not expected to impact upon the operation of the project given that anticipated groundwater volumes interacting with the project is negligible.

Gas contamination

Given the project is an aboveground road, landfill gas is not expected to impact on the operation of the project.

Salinity

Saline soils are unlikely to impact upon the operation of the project, however revegetation of construction support sites and other areas of soil disturbance after construction of the project would be carried out to minimise risks to surrounding environments and land uses post construction.

Soil erosion and sediment transportation

After construction of the project, construction support sites and other areas of soil disturbance would be suitably reinstated, including revegetation and plantings where appropriate. As such, soil erosion and sediment transportation hazards are unlikely to result during the operation of the project. Potential water quality risks during the operation would be associated with runoff of pollutants from new road surfaces and increased vehicular traffic, accidental spills, increased impervious areas and permanent structures within waterways.

Human health

The operation of the project and its interaction with soils and contamination is unlikely to have any adverse impacts on human health.

8.1.5 Cumulative impacts

Potential cumulative soil and contamination impacts associated with other nearby projects are presented in **Table 8-11**. Further detail about each of the projects considered in the cumulative impact assessment is provided in **Table 7-3**.

Overall, cumulative impacts of projects that are expected to take place within the same timeframes and/or spatially, would be mainly associated with soil erosion, soil management and in some cases salinity and are more likely associated with the construction periods of the following projects.

Table 8-11 Cumulative soil and contamination impacts

Project and status	Cumulative impacts
Western Sydney Airport Approved. Under construction	Cumulative impacts from the Western Sydney airport and the M12 Motorway are focussed on soil erosion and salinity given that both projects are in areas where the potential for soil erosion and salinity are moderate to high. However, based on the results of the Western Sydney Airport EIS and that impacts of both projects are expected to be managed with the implementation of appropriate control measures, cumulative construction impacts from the Western Sydney Airport and the M12 Motorway projects are expected to be minor. Key risks to soil associated with the irrigation of reclaimed water during operation of the airport include adverse physical or chemical changes of soil, which may lead to ongoing reduction in fertility and potential to grow turf or pasture. Additionally, storage of fuels in the airport present a potential for contamination releases to the environment if not managed appropriately. Given that irrigation of reclaimed water is not proposed during operation of the M12 Motorway, that appropriate storage and handling of fuels are to be implemented at the Western Sydney Airport, and that impacts of the operation of the M12 Motorway are expected to be negligible, similarly, the projects are not expected to contribute to cumulative soil and contamination impacts during operation. It is noted that any contaminated material identified within the Western Sydney Airport site will be the responsibility of the Western Sydney Airport. It is noted that the Western Sydney Airport would be responsible for any off site contamination impacts generated by activities on the Western Sydney Airport site.
Sydney Metro Greater West Not yet approved	Construction timeframes for the Sydney Metro Greater West would overlap with the construction of the project. During any timeframes where construction activities are concurrent, increased soil and contamination impacts may be possible. The magnitude of cumulative construction impacts would be dependent on the specific construction locations, activities and impacts which are yet to be determined for the Sydney Metro Greater West. Cumulative impacts would be likely to be focussed on soil erosion, salinity and waste/soil management. However, given these impacts are expected to be managed by implementing appropriate mitigation controls as well as managing soil/waste within project footprints, the cumulative impacts are expected to be minor. The magnitude of cumulative operational impacts would be dependent on the specific construction locations, activities and impacts which are yet to be determined for the Sydney Metro Greater West. However, due to the minor operational impacts of the M12 Motorway on soil and contamination and the expectation of implementation of appropriate control measures, the project would have a minor contribution to cumulative soil and contamination impacts.
The Northern Road upgrade Approved. Construction has begun	T(here would be no overlap of AEIs during construction of the project (Roads and Maritime, 2017a). Construction activities associated with Stage 5 and 6 may overlap with the project construction. Both projects are in areas of moderate to high salinity potential and both projects have the potential to impact on local soil erosion. During the construction of both projects, construction activities are not expected to increase the potential for salinity impacts along the project footprints. As such, cumulative salinity impacts are not expected.

Project and status	Cumulative impacts
	Similarly, soil erosion and sedimentation are risks posed to surface water quality throughout the construction phase through increased sediment loads entering downstream environments. Soil erosion is expected to be managed with the implementation of appropriate control measures and, therefore, minor cumulative impacts are expected. Cumulative operational contamination impacts of the project and The Northern Road upgrade are expected to be associated with potential contamination associated with increased traffic volumes in the area, including runoff of pollutants, accidental spills, increased impervious areas and permanent structures within waterways. Soil erosion and salinity are not expected to have cumulative impacts by the projects.
Other existing road network upgrades and potential road projects, including: • Elizabeth Drive upgrade • Mamre Road upgrade • Outer Sydney Orbital Not yet approved	The timing for construction of the other road network upgrades presented in **Table 7-3** as not been announced as of May 2019. However, there is potential for overlaps in construction timing between the project and some of these road upgrade works which are in the vicinity of the project. There is the potential for soil management to have a cumulative impact if the project and the other road network upgrades are to be constructed within the same timeframes. Soil management would impact upon transport of soil, disposal costs and locations of disposal. Cumulative impacts would be considered minor however. The timing for operation of the road network upgrades has not yet been announced however it is likely that their operational timeframes will overlap with operation of the project. However, due to the minor operational impacts of the M12 Motorway on soil and contamination and the implementation of appropriate control measures, the projects are expected to have minor cumulative soil and contamination impacts associated with the operation of the projects and the upgrades.
Major land releases, including: • Western Sydney Aerotropolis • South West Growth Area • Western Sydney Employment Area. Future strategic government project	The timing for the construction of developments within the growth areas presented in **Table 7-3** has not yet been announced. There are potential of overlaps in construction timing between some developments and the project. The construction of growth areas and the project may have cumulative soil erosion and soil management impacts. Provided appropriate controls measures are implemented during construction, cumulative impacts are expected to be minor.

8.1.6 Environmental management measures

The environmental management measures that would be implemented to minimise soil and contamination impacts of the project, along with the responsibility and timing for those measures, are presented in **Table 8-12**.

Table 8-12 Environmental management measures (soils and contamination)

Impact	Reference	Environmental management measure	Responsibility	Timing
Salinity	SC01	Construction within areas of moderate to high risk saline soils will be managed in accordance with the CSWMP. Specific measures will also include (but not be limited to): • Ongoing groundwater monitoring of salinity as part of the water quality monitoring program • Identification and management of saline discharge sites • Progressive stabilisation and revegetation of exposed areas following disturbance as soon as is practicable • Testing to confirm the presence of saline soils in areas of high salinity potential prior to disturbance. • Soil salinity management will also be carried out in accordance with the NSW Department of Primary Industries (2014) Salinity Training Handbook.	Contractor	Prior to construction and during construction
	SC02	Testing will be carried out to confirm the presence of saline soils in areas of high salinity potential and to confirm the presence of ASS around creeks prior to disturbance.	Contractor	Prior to construction and during construction
Impacts of soil and groundwater contamination	SC03	A contaminated land management plan (CLMP) will be prepared for the project. The CLMP will include: • Control measures to manage identified areas of contamination, including surface soils in the vicinity of TP303, TP304, TP310 and TP311 containing heavy metal and PAH concentrations • Procedures for unexpected contamination • Measures to manage potential ASS (as required based on testing results) within sediments of the creeks in the construction footprint to minimise impacts to the environment • Requirements for excavation of unexpected contaminants to be carried out in consultation with project Remedial Actions Plans. • Requirements for the disposal of contaminated waste in accordance with the *Protection of the Environment Operations Act 1997* (POEO Act) and the Protection of the Environment Operations (Waste) Regulation 2014.	Contractor	Prior to construction

Impact	Reference	Environmental management measure	Responsibility	Timing
	SC04	An asbestos management plan (AMP) will be prepared as part of the CLMP for the project. The AMP will guide the excavation, handling, storage and disposal of management of asbestos discovered during construction, including procedures for any unexpected asbestos. The AMP will also outline requirements for the encapsulation of asbestos to be carried out in accordance with project Remedial Action Plans.	Contractor	Prior to construction
	SC05	Detailed site (contamination) investigations will be carried out in accordance with the NSW EPA (1995) Sampling Design Guidelines and other NSW EPA endorsed guidance including the NEPM (2013) guidelines within the following AEI locations to confirm the presence of contamination before the start of construction at these locations: • Within AEI 19: the area of miscellaneous construction activities and stockpiles of building materials along Luddenham Road (Lot 1, DP228498) • Within AEI 7: Former Kari and Ghossayn solid waste landfill (Lot 17, Clifton Avenue) • Within AEI 21: Substantial volume of illegally dumped material along Range Road, Cecil Park • Within the 'potential areas of existing fill' identified in the Soils and contamination assessment report (**Appendix O**) for the project. Depending on results of the investigations, or if remediation is deemed required at any site within the construction footprint, a Remedial Action Plan will be prepared before the construction.	Contractor	Prior to construction
	SC06	Further intrusive asbestos investigations throughout the construction footprint will be carried out to assess asbestos risks before the start of construction. The investigations are to include visual assessments and ground truthing along the length of the project.	Contractor	Prior to construction
	SC07	A hazardous building materials management plan will be prepared in accordance with relevant guidelines to manage the removal of known and unexpected hazardous building during demolition activities. Before demolishing structures and/or buildings, a hazardous building materials audit will also be carried out in accordance with Australian Standard (AS 2601-2001) The demolition of structures. Where hazardous building materials are present, they will be managed to reduce the potential for contamination in accordance with the POEO Act and the Protection of the Environment Operations (Waste) Regulation (2014).	Contractor	Prior to construction and during construction
	SC08	All waste will be classified in accordance with the NSW EPA's Waste Classification Guidelines, with appropriate records and disposal dockets retained for audit purposes.	Contractor	Before and during construction

Impact	Reference	Environmental management measure	Responsibility	Timing
Soil gas contamination	SC09	A detailed investigation will be carried out within the area next to the SUEZ Kemps Creek Resource Recovery Park to assess the extent of high-risk soil gas. A report will be prepared to document the outcomes of the investigation and outline measures to manage risks including nuisance odours to the surrounding area during excavation, and prevent the build-up of gases in buildings, basins, and sub-surface trenches and pits, and other enclosed spaces/depressions associated with the project during construction. These investigations will be carried out in accordance (where applicable) with the Guideline for the Assessment and Management of Sites Impacted by Hazardous Ground Gases (NSW EPA 2012a) and Assessing Risks Posed by Hazardous Ground Gases to Buildings Report (C665) (Wilson et al. 2007). This will include undertaking gas monitoring.	Contractor	Prior to construction and during construction
	SC10	Should the further investigations determine that gas concentrations remain elevated near the project footprint, gas monitoring will be carried out during construction within the construction footprint next to the SUEZ Kemps Creek Resource Recovery Park. If excavations are to be carried out within enclosed structures, gas accumulation monitoring will be carried out before and during construction. On site gas monitoring will be carried out in accordance with the NSW EPA (2016a) Environmental Guidelines: Solid Waste Landfills.	Contractor	During construction
	SC11	Should a gas hazard be present (either explosive or asphyxiation hazard), an appropriate gas management plan will be developed and implemented to manage spark generation, explosive environments and confined spaces. This plan will be implemented during construction within gas hazard areas and to manage works within below ground structures such as service trenches during operation. If temporary site sheds and storages are proposed within gas hazard area, appropriate measures will be implemented (eg breezeways) to avoid gas ingress and accumulation into these structures.	Contractor	Prior to construction and during construction

8.2 Air quality

This section describes the potential air quality impacts that may be generated by construction and operation of the project and presents a proposed approach to the management of these impacts. **Table 8-13** outlines the SEARs that relate to air quality and identifies where they were addressed in this EIS. The full assessment of air quality impacts is provided in **Appendix P**.

Table 8-13 SEARs (air quality)

Legislation	Relevance to the project
18. Air quality	
1. The Proponent must undertake an air quality impact assessment (AQIA) for construction and operation of the project in accordance with the current guidelines.	Current guidelines are presented in **Section 8.2.1** and **Section 8.2.2** Assessment of air quality impacts is presented in **Section 8.2.4**
2. The Proponent must ensure the AQIA also includes the following: a. demonstrated ability to comply with the relevant regulatory framework, specifically the *Protection of the Environment Operations Act 1997* and the Protection of the Environment Operations (Clean Air) Regulation (2010); and	Compliance with the relevant regulatory framework is presented in **Section 8.2.1** and Chapter 3 of **Appendix P**
b. a cumulative local and regional air quality impact assessment.	Cumulative impacts are presented in **Section 8.2.5**
19. Health and safety	
2. The assessment must: assess health risks associated with exposure to environmental hazards	Health risks, including health risks from air quality impacts, are presented in **Section 8.3**

8.2.1 Policy and planning setting

In addition to the NSW and Australian strategic planning and policy framework presented in **Section 3.1**, the following federal, state and local policies and plans are relevant to the air quality assessment:

- POEO Act
- National Environment Protection Measure for Ambient Air Quality (AAQ NEPM) (National Environment Protection Council [NEPC], 2016)
- National Environment Protection Measure for Air Toxics (Air Toxics NEPM) (NEPC, 2011)
- Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (Approved Methods) (NSW EPA, 2016b)
- Approved Methods for Sampling and Analysis of Air Pollutants in NSW (NSW Department of Environment and Conservation [DEC], 2005b)
- Air Emissions Inventory for the Greater Metropolitan Region in New South Wales (NSW EPA, 2012b)
- Guidance on the assessment of dust from demolition and construction Version 1.1 (UK IAQM, 2014)
- Assessment and Management of Odour from Stationary Sources in NSW (DEC, 2006b).

Further detail about the above legislation and policies and how they apply to project is provided in Chapter 3 of **Appendix P**.

NSW Protection of the Environment Operations (Clean Air) Regulation 2010

The NSW Protection of the Environment Operations (Clean Air) Regulation 2010 (POEO Clean Air Regulation) contains provisions for the regulation of emissions to air from wood heaters, open burning, motor vehicles and fuels and industry. Although the POEO Clean Air Regulation is referenced in the SEARs issued for the project, its application is limited. This is because the project does not involve any of the four areas of regulation (wood heaters, open burning, motor vehicles and fuels and industry), noting that 'motor vehicles and fuels' refers to emission standard from new and in-services vehicles, and the quality of fuels used in NSW.

8.2.2 Assessment methodology

Overview

In general, the methodology for the assessment of air quality assessment described in this section has included:

- Reviewing details of the project to identify key air quality-related risks during construction and operation
- Determining statutes, policies and guidelines applicable to the project
- Identifying prevailing climate, meteorological and ambient air quality conditions around the project using publicly available data from the Bureau of Meteorology (BoM) and EESG of DPIE, respectively; as well as local terrain characteristics.
- Assessment of potential air quality impacts during construction using the UK IAQM's semi-quantitative risk-based approach
- Predict changes in emissions to air during operations by applying Roads and Maritime's Tool for Roadside Air Quality (TRAQ)
- Reviewing potential cumulative air quality impacts from nearby projects
- Developing measures to mitigation or otherwise effectively manage any potential impacts predicted.

The assessment methodology is described in the following sections. Further detail is provided in Chapter 4 of **Appendix P**.

Air quality considerations

Dust generated during clearing and demolition, excavation, materials handling, stockpiling and compaction activities is expected to be the primary air quality-related risk during construction. When not properly managed, elevated airborne or deposited dust levels have the potential to cause adverse health or nuisance impacts. High dust levels can also cause physical and chemical impacts on vegetation (Farmer, 1993).Exhaust emissions from the combustion of fossil fuels in construction plant and equipment represent another air quality risk during construction, along with odours arising from uncovered contaminated material and/or hazardous materials and airborne hazardous materials. However as dust represents the primary air quality-related risk during construction, it is the focus of the construction air quality assessment.

The key air quality pollutants generated during operation are associated with the combustion of fossil fuels in motor vehicles. In 2018, Roads and Maritime estimated that 14 per cent of fine particulate matter (ie $PM_{2.5}$) and around 62 per cent of nitrogen oxides (NO_x) in Sydney were from the combustion of fossil fuels in motor vehicles (Roads and Maritime, 2018). Further, road traffic emissions are also estimated to contribute 38 per cent of volatile organic compound (VOC) emissions in Sydney, as well as being a major source of carbon monoxide (CO) (DEC, 2005). The pollutants associated with these emissions were linked to a variety of impacts at a local scale, including impacts on human health and amenity, heritage, as well as ecological environmental values; along with impacts at wider regional scales.

Construction impacts

Potential impacts on human health, annoyance and ecology from dust generation represent the primary air quality-related risk during construction. In order to identify the potential for dust impacts on occur during construction, the UK IAQM was followed to identify risks and recommend appropriate environmental management measures. The UK IAQM considers potential dust impacts arising from primary activities during construction and demolition activities:

- Demolition
- Earthworks
- Construction
- 'Track out' or the transport-related handling of construction materials.

The UK IAQM considers potential dust impacts associated with construction and demolition impacts by following a four-step assessment procedure, however the construction air quality assessment methodology is intrinsically linked to the assessment process, so is expanded upon **Section 8.2.4**.

Considering dust is expected to be the primary air quality-related risk during construction (as discussed above), other potential air quality risks including exhaust emissions from construction plant and equipment, odour, and airborne hazardous materials were qualitatively assessed.

Operation impacts

Overview

Changes to local air quality as a result of the project were quantitatively assessed using TRAQ. TRAQ is a tool used to provide 'first-pass screening' of air quality impacts in connection with road-related projects, including exhaust emissions as well as emissions from brake and tyre wear. The model considers conservative, worst-case conditions to determine the potential for impacts and whether more detailed assessment is required.

The key steps in the assessment process included:

- Identifying nearby sensitive receivers with the potential to experience changes in air quality as a result of the project
- Determining relevant impact assessment criteria from the Approved Methods
- Establishing ambient air quality conditions in the local area surrounding the project using publicly available data from the EESG of DPIE
- Determining assessment scenarios and quantitatively predicting emissions to air during operation of the project using TRAQ
- Developing environmental management measures for any potential impacts.

Further details relating to the steps of the impact assessment specific to operation is provided in **Appendix P**.

Study area and sensitive receivers

The study area and sensitive receivers for the operational air quality assessment is shown in **Figure 8-7** and comprises a 200-metre buffer from the edge of the construction footprint. This area is based on the TRAQ operational air quality prediction model that evaluates impacts on a distance of 200 metres from the kerb. Impacts resulting from most surface roads are negligible beyond this distance due to a combination of low release heights, dispersion and barrier effects from terrain features, buildings and other impediments.

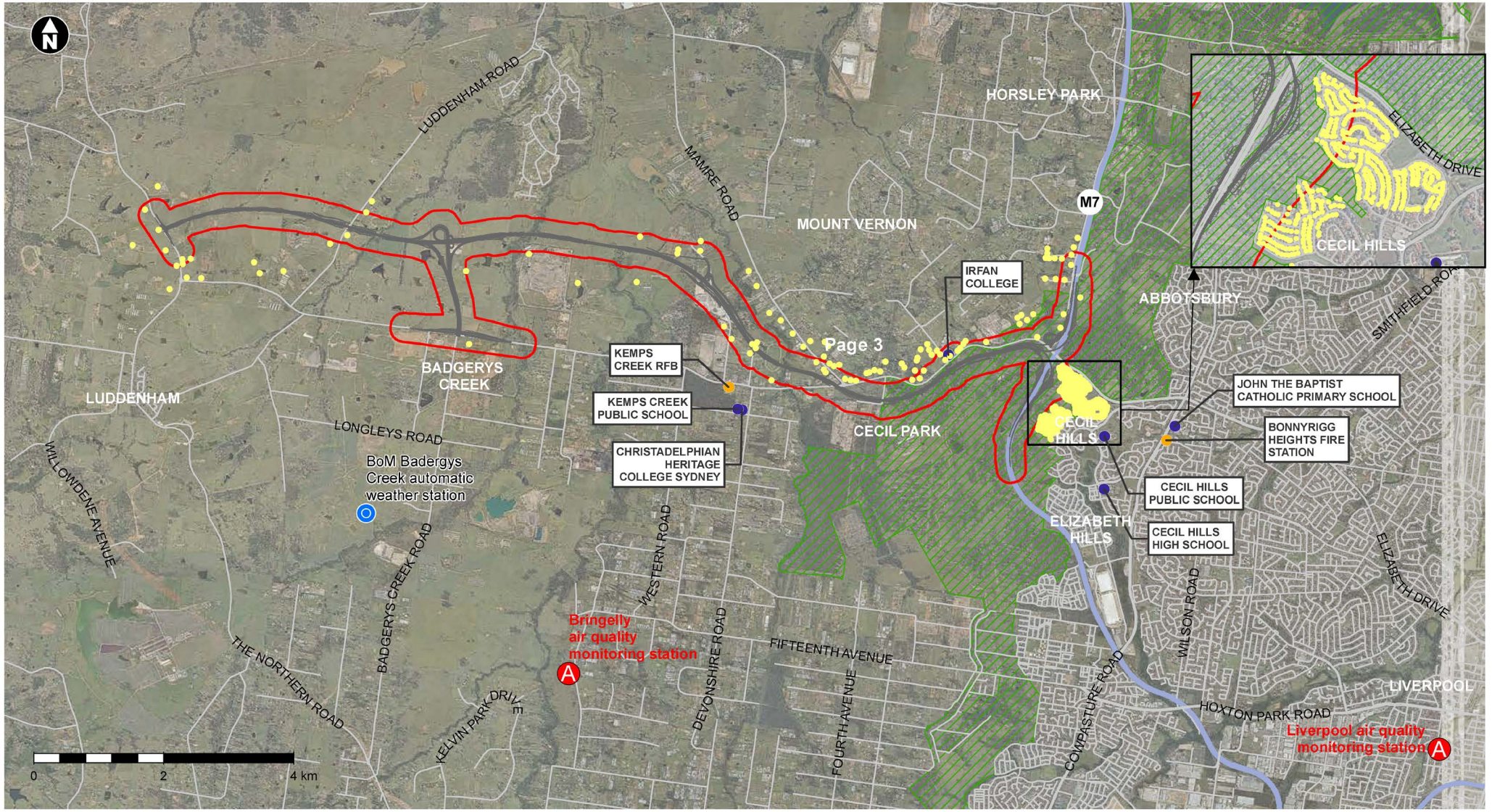

Figure 8-7 Operation air quality study area

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As per the Approved Methods, sensitive receivers are locations where sensitive land uses take place, including residences, schools and hospitals. This definition includes locations where such uses are likely in the future. Sensitive receivers within the operational study area were identified by reviewing aerial imagery and publicly available land use zoning information, as well as the location of future potential sensitive receiver areas.

Criteria

The Approved Methods contains criteria for assessing whether potential changes in air quality conditions predicted as a result of a project would result in an unacceptable level of impacts. Although these criteria were not developed for road projects and do not specifically apply to road projects, they were considered to provide an indication of the significance of the project's effect on air quality during operations. These criteria are based on the NEPM criteria for general population exposure, as there are no ambient air quality standards with mandatory compliance that relate to any sources of pollution in NSW or Australia, for road projects or otherwise. As a result, the criteria are presented **Table 8-14** were used to determine the significance of the project's effect on air quality during operations.

These criteria apply to the total concentration of the pollutant, comprising the contribution from the source being assessed, as well as ambient background concentrations. Further information about the intent of each of the below criteria is provided in Section 3.6 of **Appendix P**.

Table 8-14 Operation impact assessment criteria for key pollutants

Pollutant	Averaging time	Concentration	Criterion application location
Solid particles (as PM_{10})	24-hour	50 µg/m^3	Nearest existing or likely future offsite sensitive receptors
	Annual	25 µg/m^3	
Solid particles (as $PM_{2.5}$)	24-hour	25 µg/m^3	
	Annual	8 µg/m^3	
Nitrogen dioxide (NO_2)	one-hour	246 µg/m^3	Nearest existing or likely future offsite sensitive receptors
	Annual	62 µg/m^3	
Carbon monoxide (CO)	15 minutes	100 mg/m^3	
	1 hour	30 mg/m^3	
	8 hours	10 mg/m^3	
Benzene	one-hour	29 µg/m^3	At and beyond the site boundary

Source: NSW EPA, 2016b

Background air quality conditions

To review changes in air quality conditions as a result of the project, an understanding of existing (ie background) air quality conditions is required. This is also necessary in order to assess whether impacts may result from any predicted changes. To establish background air quality conditions representative of those at nearby receivers around the project, monitoring data was gathered from nearby monitoring stations managed by EESG of DPIE and processed into the relevant metrics relevant to the respective criteria. These data are presented and explained in **Section 8.2.3**.

Assessment scenarios

To determine whether there would be an "unacceptable" outcome, pollutant concentrations of PM_{10}, $PM_{2.5}$, CO, NO_2 and benzene were predicted from road operations using TRAQ for the following assessment scenarios:

- Scenario 1: Existing operations (2017). Concentrations from existing traffic flows along The Northern Road, the M7 Motorway and Elizabeth Drive were predicted. 2017 was adopted as the existing scenario as the majority of traffic counts were carried out at this time.
- Scenario 2: With M12 Motorway project, at year of opening (2026). Concentrations at the nearest receivers along the new M12 Motorway and The Northern Road, the M7 Motorway and Elizabeth Drive were predicted using traffic predictions for 2026 (nominated year of opening of the new M12 Motorway) with the M12 Motorway being built.
- Scenario 3 - Without the M12 Motorway project, at year of opening (2026). Concentrations at the nearest receivers along the directly and indirectly affected roads including The Northern Road, the M7 Motorway and Elizabeth Drive were predicted using traffic forecast without the addition of the project.
- Scenario 4 - With the M12 Motorway project, 10 years' after opening (2036). Concentrations at the nearest receivers along the new M12 Motorway and The Northern Road, the M7 Motorway and Elizabeth Drive were predicted using traffic information available for these roads for 2036 (10 years' after opening of the new M12 Motorway) with the M12 Motorway being built.
- Scenario 5 - Without the M12 Motorway project, 10 years' after opening (2036). Concentrations at the nearest receivers along the directly and indirectly affected roads including The Northern Road, the M7 Motorway and Elizabeth Drive were predicted using traffic forecast without the new M12 Motorway for 2036.

These scenarios were based on the existing and forecast traffic conditions and scenarios presented in **Section 7.2** and further detailed in **Appendix F**.

Further details relating to the assessment scenarios, including the full details of inputs applied in the TRAQ, are provided in **Appendix P**.

In evaluating potential operational air quality emissions from the scenarios above, for modelling and assessment purposes, the study area was divided into a number of segments. These segments were identified based on where traffic conditions were forecast to change as a result of intersections with other arterial roadways, including the entrance to the Western Sydney Airport, as discussed in **Appendix F**. These segments are shown in **Figure 8-8**.

Model inputs and evaluation of results

TRAQ is a tool used to provide 'first-pass screening' of air quality impacts in connection with road-related projects. The model considers conservative, worst-case conditions to determine the potential for impacts and whether more detailed assessment is required. These assumptions are further discussed below with further details provided in **Appendix P**.

Key inputs that were applied to the model are listed in Annexure A of **Appendix P** The key conservative assumptions include worst-case wind angles, stable atmospheric conditions, and low winds that allow for high air pollutant concentrations to occur. Traffic volumes and characteristics (ie composition of light and heavy vehicle types, speed and distribution) were based on forecasts prepared as part of the Transport and traffic assessment completed for the EIS (**Appendix F**).

Emissions of PM_{10}, $PM_{2.5}$, CO, NO_2 and VOCs as benzene from vehicles were determined using emission factors developed by the NSW EPA from the Greater Metropolitan Motor Vehicle Emissions Inventory (MVEI). Future emissions for 2026 and 2036 scenarios incorporate expected improvements in motor vehicle emissions and fleet composition. Other emission effects including cold starts (ie up-scaling of emissions to account for combustion inefficiencies during cold conditions) were also conservatively incorporated.

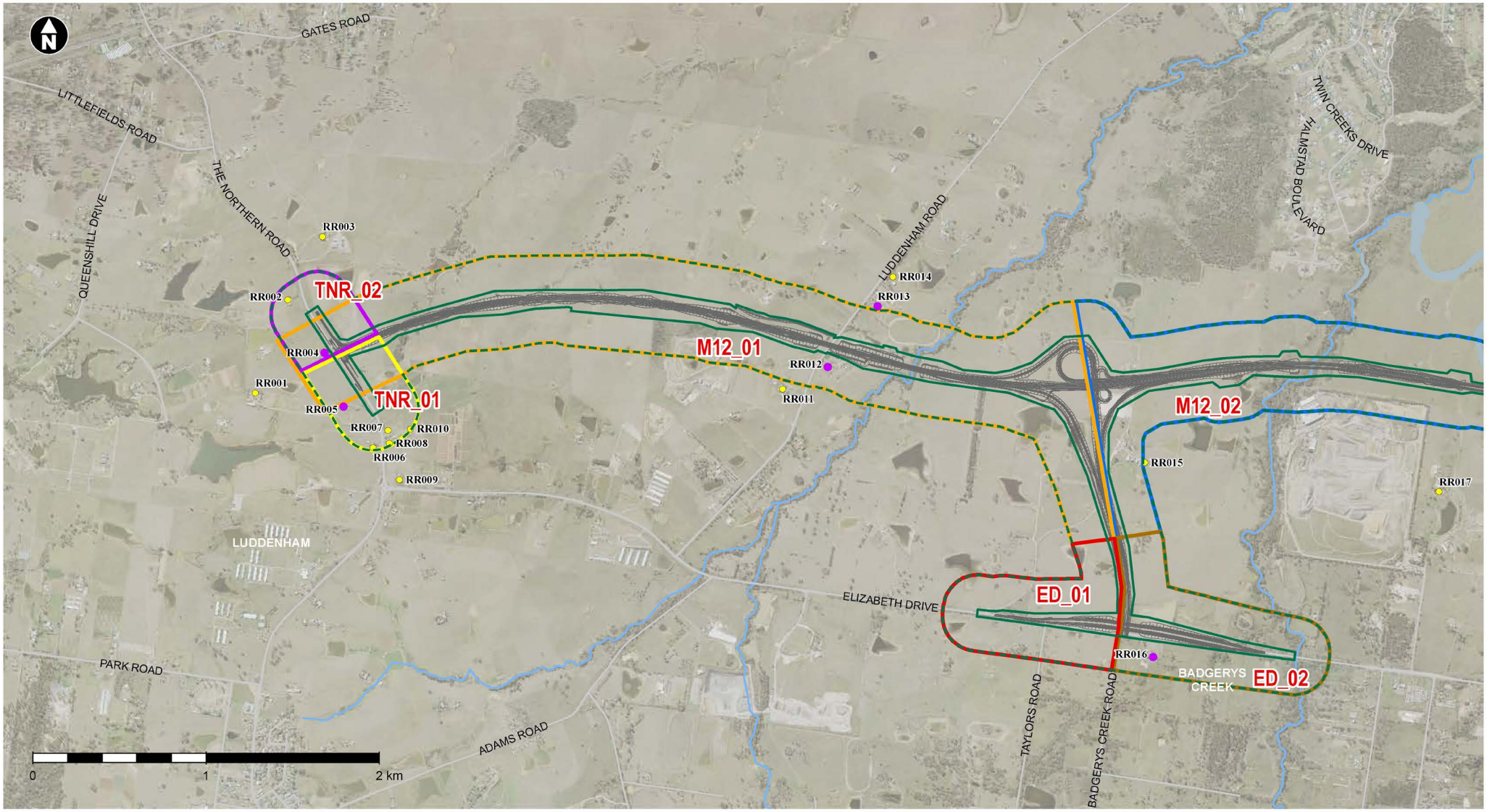

Figure 8-8 Operation air quality study area and assessment segments

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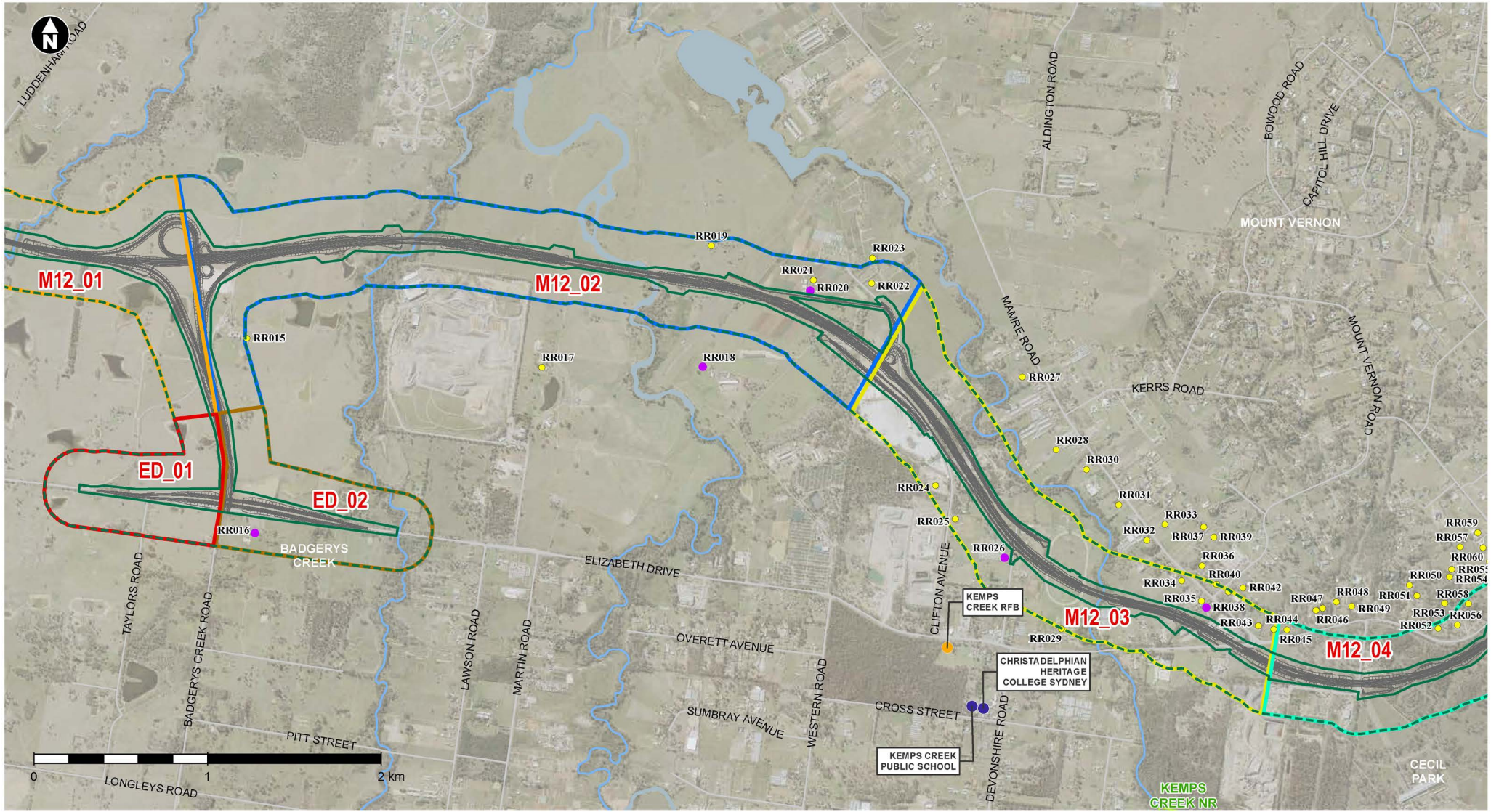

Figure 8-8 Operation air quality study area and assessment segments

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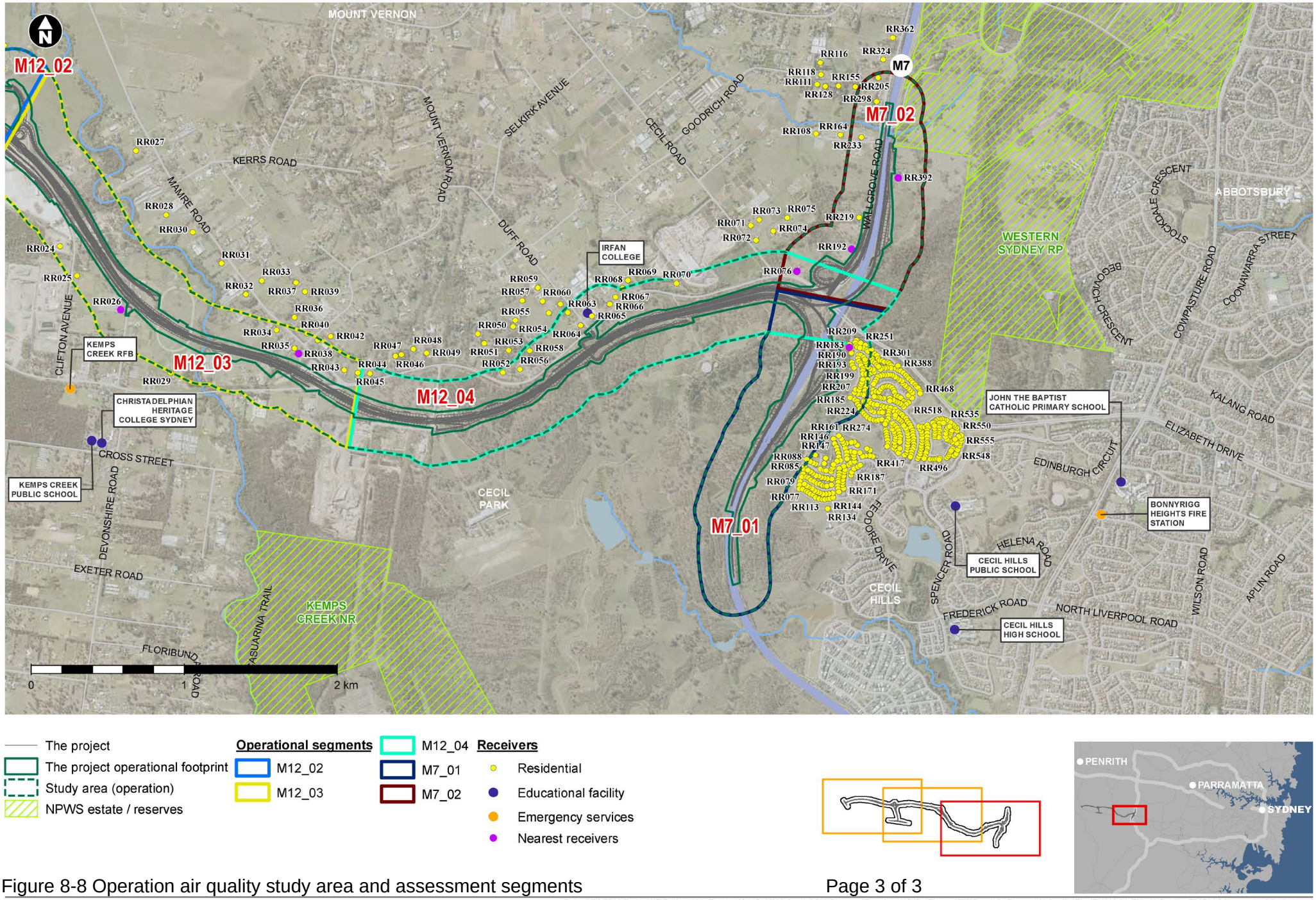


Figure 8-8 Operation air quality study area and assessment segments

To determine impacts on nearby receivers along The Northern Road, the M7 Motorway and Elizabeth Drive, scenarios with the project were compared with scenarios without the project. This was carried out to determine the contributions from the project when compared to the future emissions associated with forecast traffic conditions in the study area that are expected to occur regardless of the project. Changes in air quality conditions at receivers along the new M12 Motorway were evaluated by comparing predictions with existing background concentrations.

Results at the nearest, most-affected sensitive receiver along each segment was first evaluated to determine whether total pollutant concentrations (ie project incremental contribution plus background) would exceed the guidance values in the Approved Methods. Where this was found, further assessment was completed to determine the spatial extent of these changes.

8.2.3Existing environment

Climate

The long-term temperature and rainfall averages recorded at the Badgerys Creek automatic weather station (site 067108) from 1995 to May 2018 are presented in **Table 8-15**. Based on this data, both the construction and operation study areas experience warm and wet summers (December to February) with mean daily maximum temperatures between 28 and 30 degrees Celsius. Early spring is the driest season, with average monthly rainfall from July to September around 31 millimetres per month. The average annual rainfall is 680.9 millimetres over an average of 67.8 rain days per year.

Based on data collected at Badgerys Creek from 2014 to 2018, temperatures were highest for hours in the early afternoon (midday to 3 pm), with average temperatures lowest in early mornings (3 am to 6 am).

Table 8-15 Long-term temperature and rainfall data (Badgerys Creek weather station)

Month	Mean maximum temperature (°C)	Mean minimum temperature (°C)	Mean rainfall (mm)	Mean number of rain days (> 1 mm)
January	30.1	17.1	79.4	7.0
February	28.8	17.1	98.5	7.3
March	26.9	15.3	81.3	7.4
April	24.1	11.5	49.4	5.7
May	20.8	7.7	37.0	3.8
June	17.8	5.6	61.8	5.6
July	17.4	4.1	23.6	3.9
August	19.2	4.7	36.8	3.5
September	22.6	7.7	32.3	4.6
October	24.9	10.4	51.4	5.5
November	26.4	13.5	69.0	6.9
December	28.5	15.5	57.1	6.6
Annual	24.0	10.8	680.9	67.8

Source: BoM, 2018b

Meteorology

Meteorological data collected at Badgerys Creek Automatic Weather Station (AWS) from 2014 to 2018 identified the prevailing seasonal trends:

- Summer – Winds blowing from the east and southwest were most common, with winds from the east occasionally being strong (ie wind speeds six metres per second or more)
- Autumn – Winds from the west-southwest and southwest are most common, with winds from the north also frequent
- Winter – Prevailing winds from west-southwest, southwest and north were most common
- Spring – Winds from the west-southwest and south were recorded as being most common, with the highest.

Local average wind speeds are presented in **Figure 8-9**. In summary, average wind speeds are lowest during night time and early morning periods, pickup up to around 2 m/s at around 9 am and increasing to nearly four m/s at 4 pm, before decreasing back below two m/s at 9 pm.

Long-term morning and afternoon wind conditions are presented in **Figure 8-10**. In summary, winds blowing from the south-west and north are most common in the morning. Winds blowing from the north through to the south-east prevalent in the afternoons. This indicates that receivers to the north-east and south of project would be most likely to experience winds blowing from the direction of the project during mornings; and receivers orientated to the south through to the north–west in the afternoons.

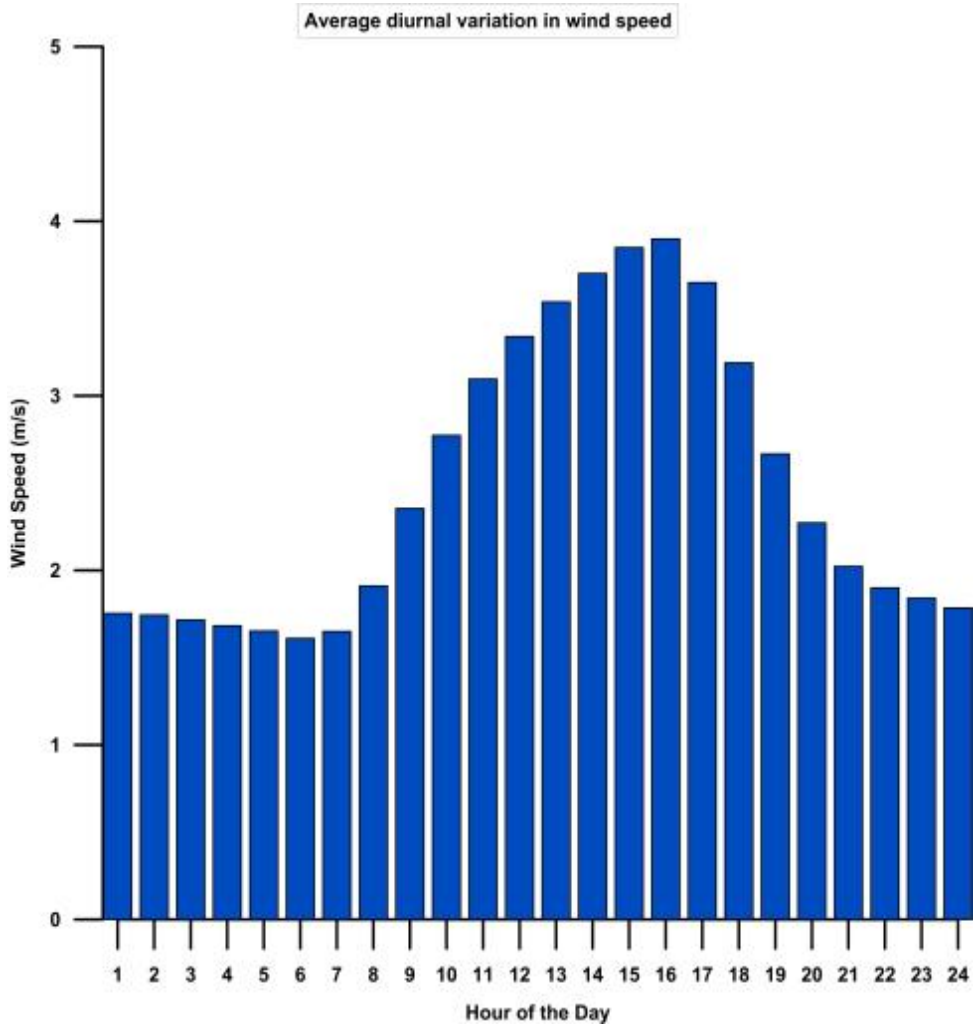
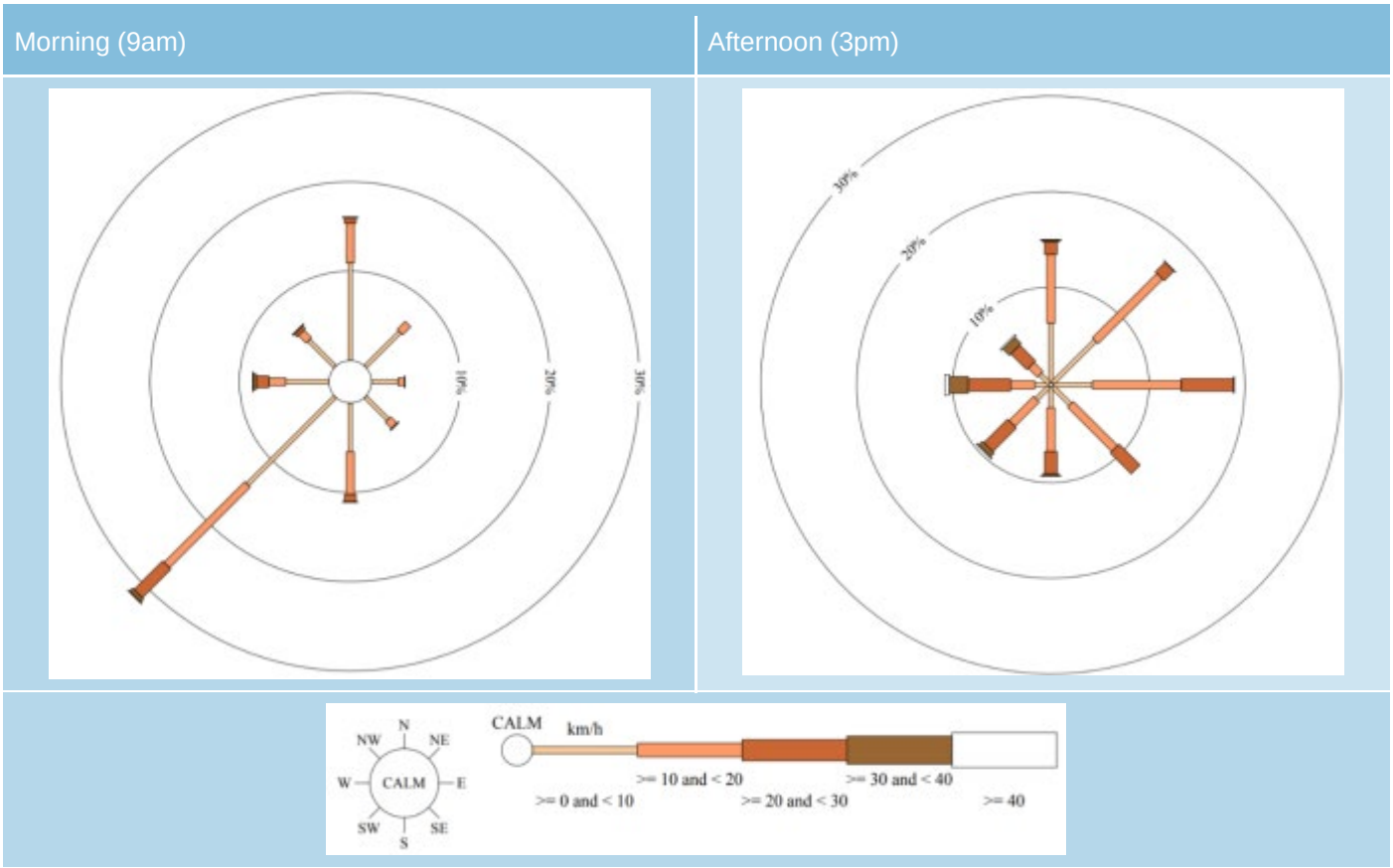


Figure 8-9 Average wind speed per hour (2014 to 2018)



Source: BoM, 2018b

Figure 8-10 Long-term morning and afternoon wind conditions (Badgerys Creek AWS)

Background air quality

Key sources of emissions to air

The air quality in the Greater Sydney region is influenced by a variety of different anthropogenic and natural sources. The NSW EPA's 'Air Emissions Inventory for the Greater Metropolitan Region in New South Wales – 2008 Calendar Year' (2012b) has identified that:

- Human-made sources contributions to PM_{10}, $PM_{2.5}$, CO, NO_x and Total VOCs to air quality in the Sydney Region were all substantially higher (between 75 to 98 per cent) than natural concentrations
- Road traffic is the major source of CO (51 per cent) and NO_x (62 per cent) in the Greater Sydney region when compared to other sources (ie off-road mobile, domestic-commercial, commercial and industrial sources)
- Petrol passenger vehicles were found to be the most dominant source of CO (61 per cent) and NO_x (48 per cent), and evaporation was the key source (contributing 48 per cent) of VOCs
- Key source of particulate matter (PM_{10} and $PM_{2.5}$) emissions to air in the Sydney region was from non-exhaust vehicle-related sources including wearing of tyres, vehicle brakes and the road surface.

General air quality characteristics

Sydney's air quality conditions are comparable with other major cities around Australia and are noted to have improved over the past few decades, mainly because of initiatives and regulations to reduce emissions from industry, motor vehicles, businesses and, more recently, residences.

Air quality is NSW has improved over the past two decades, with annual PM_{10} concentrations across the Sydney South-West Region improving steadily from about 19 µg/m^3 in 2004 to about 15 µg/m^3 in 2016. Over the same period, the frequency of days where the 24-hour averaged concentration value of 50 µg/m^3 in the Sydney South-West Region remained generally consistent. Annually averaged $PM_{2.5}$ concentrations remained steadier in the Sydney South-West Region, with a decrease of less than one µg/m^3 recorded over the period from 1999 to 2016.

Annual concentration trends for NO_2 and CO in the Sydney South-West Region were also measured to have decreased over the period from 1994 to 2016. These increases are noted to have tapered off in recent years, as the balance between efficiencies and population growth was reached.

Population growth, urbanisation, increases in energy and transport demand coupled against technological improvements, higher regulation of emission sources and changes in climate are expected to influence how regional air quality conditions will change in the future.

Local measured air quality conditions

Pollutants of concern measured at EESG of DPIE air quality monitoring stations in the vicinity of the project are presented in **Table 8-16**.

Table 8-16 Summary of pollutants measured at nearby EESG of DPIE air quality monitoring stations

EESG of DPIE air quality monitoring station	Location	Nitrogen dioxide (NO_2)	Carbon monoxide (CO)	Particulate matter PM_{10}	Particulate matter $PM_{2.5}$
Bringelly	Ramsay Road	✓	-	✓	✓
Liverpool	Rose Street	✓	✓	✓	✓

Measured results for NO_2 and CO were well below NSW EPA criterion at both stations.

Monitoring of these pollutants indicate that the maximum 24-hour average PM_{10} concentrations occasionally exceeded the 50 µg/m^3 criterion. The 95th per centile values (the value exceeded five per cent of the time) were about 88 per cent of the criterion or less. Annually averaged PM_{10} concentrations were found to vary between the two stations with the highest value of 24 µg/m^3 recorded at the Liverpool station in 2018. This is still below the 25 µg/m^3 impact assessment criterion. Values were found to typically range between 16 and 21 µg/m^3.

Maximum 24-hour averaged $PM_{2.5}$ concentrations exhibited the same trend as PM_{10}, with the 25 µg/m^3 assessment criterion occasionally being exceeded, but with the 95th per centile values well below. Annually averaged $PM_{2.5}$ concentrations were always in exceedance of the eight µg/m^3 criterion at Liverpool station, but were at or below this limit at the Bringelly station.

Full monitoring results are presented in Annexure C of **Appendix P**.

Application of background air quality conditions and adopted background concentrations

Background concentrations were established for the receiving environment in the construction and operation study areas based on the monitoring data presented above. The values adopted are presented in **Table 8-17**. These values were used instead of the regional default values incorporated into TRAQ for the operational assessment, which are less specific to the project location, and are less current than the measured data reviewed from EESG of DPIE's Bringelly and Liverpool monitoring stations.

Table 8-17 Adopted background concentrations

Pollutant	Averaging time	Adopted background concentration	Justification
PM_{10}	24-hour	38 µg/m^3	Highest 2014 to 2018 95th per centile 24-hour averaged value recorded at Bringelly
	Annual	21 µg/m^3	Highest 2014 to 2018 value recorded at Bringelly
$PM_{2.5}$	24-hour	15 µg/m^3	Highest 2014 to 2018 95th per centile 24-hour averaged value recorded at Bringelly
	Annual	8.0 µg/m^3	Highest 2014 to 2018 value recorded at Bringelly
NO_2	One-hour	74 µg/m^3	Highest 2014 to 2018 value recorded at Bringelly
	Annual	12 µg/m^3	Highest 2014 to 2018 value recorded at Bringelly
CO	One-hour	3 mg/m^3	Highest 2014 to 2018 value recorded at Liverpool
	Eight-hour	2 mg/m^3	Highest 2014 to 2018 value recorded at Liverpool

8.2.4 Assessment of potential impacts

Construction impacts

As outlined in **Section 8.2.2**, the semi-quantitative method developed by the UK IAQM was used to assess the potential for dust impacts during the construction phase of the project.

As shown in **Figure 8-11** the assessment involves the following steps:

- Step 1 Screening review: undertaking a screening review to identify whether there are receivers nearby which have the potential to be impacted by the intended works, and whether a more detailed assessment is required
- Step 2 Risk assessment:
  - 2A – evaluating the potential magnitude of the works
  - 2B – determining receiver sensitivities to dust soiling, human health and ecological dust impacts
  - 2C – estimating the risk of dust soiling, human health and ecological dust impact impacts if no mitigation measures are applied
- Step 3 Mitigation and management – developing mitigation measures for each work location depending on the level of risk determined in Step 2
- Step 4 Residual risks – evaluating any residual dust related risks following the application of the mitigation measures in Step 3 to verify that a suitable level of mitigation was applied to reduce the impact on the extent practicable.

The findings of each step are presented in the following sections.

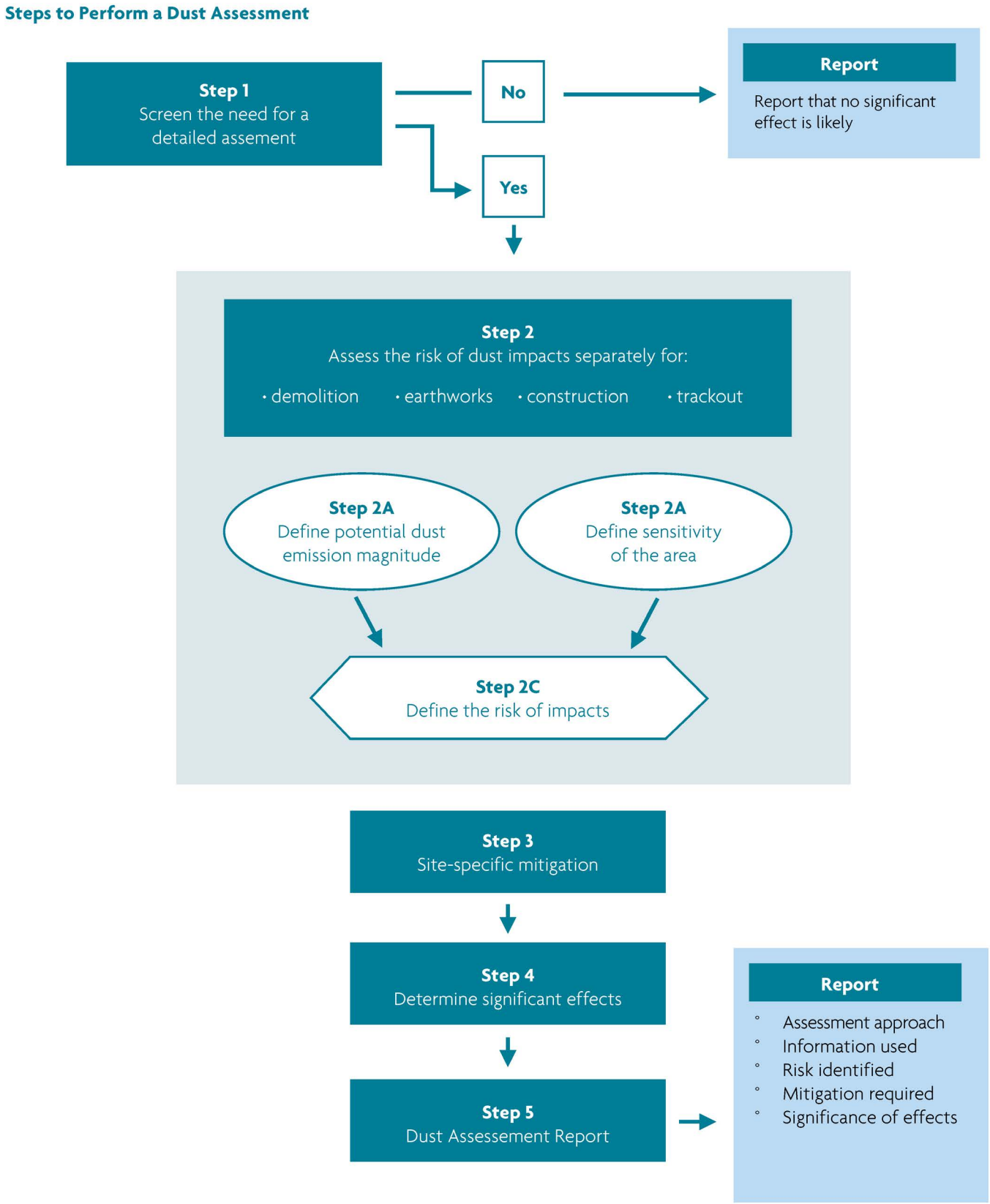


Figure 8-11 UK IAQM construction air quality assessment procedure

Step 1: Screening review

Step 1 of the UK IAQM assessment method involves a screening review to confirm the presence of human and ecological receptors within the vicinity of a project. The UK IAQM considers human receivers as any location where people spend some period of time and where property may be impacted by dust and ecological receivers as any ecological areas that might be sensitive to dust impacts. This definition is considered to include threatened ecological communities (TECs), as well as ecologically sensitive commercial developments.

The UK IAQM advises of a study area of 350 metres from the boundary of the site; or within 500 metres of site egress points for human receivers, and 50 metres from the boundary of the site or within 500 metres of site egress points for ecological receivers. A conservative study area of 500 metres was therefore adopted for the construction assessment. The nearest human and ecological receivers in relation to the project are shown in **Figure 8-12**. For the purpose of the assessment, the study area was divided into a number of segments as shown in **Figure 8-13**. As displayed, there are a number of human and ecological receivers located within the conservatively adopted 500 metre construction assessment study area, as shown in **Figure 8-13**. As such, it was determined that the next stages of the assessment would be required.

Step 2: Risk assessment

Step 2A – Potential for dust emissions

Step 2A involves the estimation of the magnitude of potential dust emissions associated with the project construction activities. The method for evaluating the magnitude of potential emissions considers the scale and nature of the anticipated activities. The objectives used to classify the magnitude of dust emissions arising from demolition, earthworks, construction and trackout activities from the UK IAQM method are presented in **Table 8-18**. The potential dust emission magnitude classifications developed for the project are presented in **Table 8-19**.

Table 8-18 Step 2A - Objectives for classifying the magnitude of potential dust emissions

Construction activity	Potential dust emission magnitude classification		
	Large	Medium	Small
Demolition	Large – Total building volume greater than 50,000 m^3, potentially dusty construction material (eg concrete), on-site crushing and screening, demolition activities greater than 20 metres above ground level	Medium – Total building volume 20,000 to 50,000 m^3, potentially dusty construction material, demolition activities 10 to 20 metres above ground.	Small – Total building volume less than 20,000 m^3, construction material with low potential for dust release (eg metal cladding or timber), demolition activities less than 10 metres above ground, demolition during wetter months.
Earthworks	Large – Total site area greater than 10,000 m^2, potentially dusty soil type (eg clay, which will be prone to suspension when dry due to small particle size), more than 10 heavy earth moving materials active at any one time, formation of bunds greater than eight metres in height, total materials moved exceeding 100,000 tonnes.	Medium – Total site area between 2500 and 10,000 m^2, moderately dusty soil type (eg silt), five to 10 heavy earth moving vehicles active at any one time, formation of bunds four to eight metres in height, total material moved between 20,000 and 100,000 tonnes.	Small – Total site area less than 2500 m^2, soil type with large grain size (eg sand), less than five heavy earth moving vehicles active at any one time, formation of bunds less than four metres in height, total materials moved less than 20,000 tonnes, earthworks during wetter months.

Construction activity	Potential dust emission magnitude classification		
	Large	Medium	Small
Construction	Large – Total building volume greater than 100,000 m^3, on-site concrete batching, sandblasting	Medium – Total building volume between 25,000 and 100,000 m^3, potentially dusty construction material (eg concrete), on-site concrete batching plant.	Small – Total building volume less than 25,000 m^3, construction material with a low potential for dust release (eg metal cladding or timber).
Trackout	Large – More than 50 heavy vehicle movements in any one day, potentially dusty surface material (eg high clay content), unpaved road lengths greater than 100 metres.	Medium – 10 to 50 heavy vehicle movements in any one day, moderately dusty surface (eg high clay content), unpaved road length between 50 and 100 metres.	Small – Less than 10 heavy vehicle movements in any one day, surface material with low potential for dust release, unpaved road length less than 50 metres.

Table 8-19 Dust emission magnitude classifications determined for the project

Construction activity	Potential dust emission magnitude classification
Demolition	Medium
Earthworks	Large
Construction	Large
Trackout	Large

Step 2B – Sensitivity of surrounding local environment

Step 2B involves the evaluation of the sensitivity of the receiving environment around the construction footprint.

Classification of the sensitivity of these receiver areas considered:

- The specific sensitivities of receptors in the area
- The proximity and number of nearby receivers
- Local background air quality conditions characterised based on PM_{10} concentrations
- Site-specific factors such as whether there are natural shelters, to reduce the risk of wind-blown dust (UK IAQM, 2014).

Guidance on how the sensitivity of the receiving environment to these different dust effects were classified is listed in **Table 8-20**. Further detail regarding the methodology used to determine the sensitivities of nearby receivers for each receiver type is provided in Section 6.1.2 of **Appendix P**.

Dust soiling, human health and ecological sensitivity classifications were developed as presented in **Table 8-21** to **Table 8-23** and summarised in **Table 8-24**. These tables also present the number and sensitivity of receivers that would be impacted by construction.

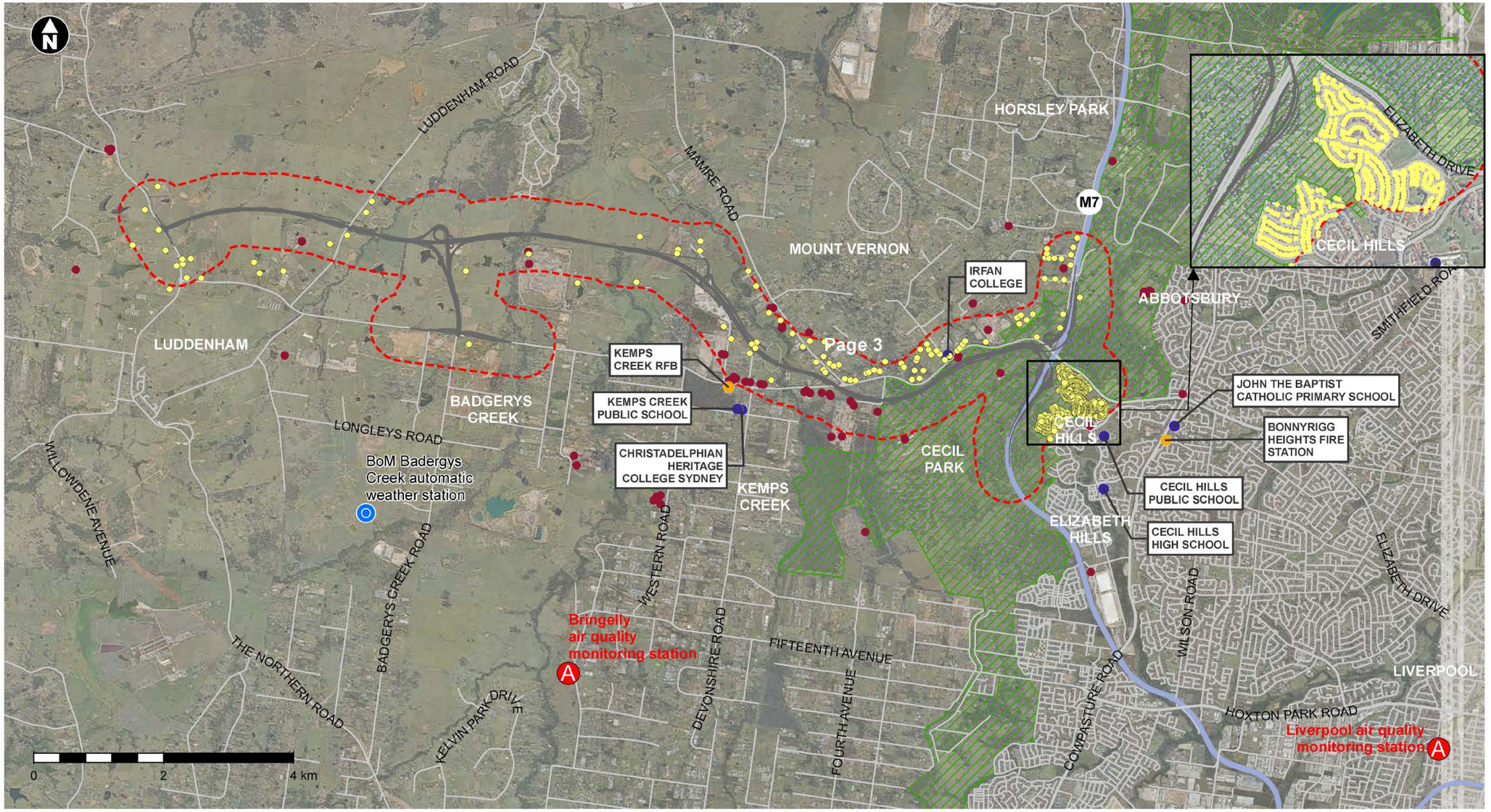


Figure 8-12 Construction air quality study area

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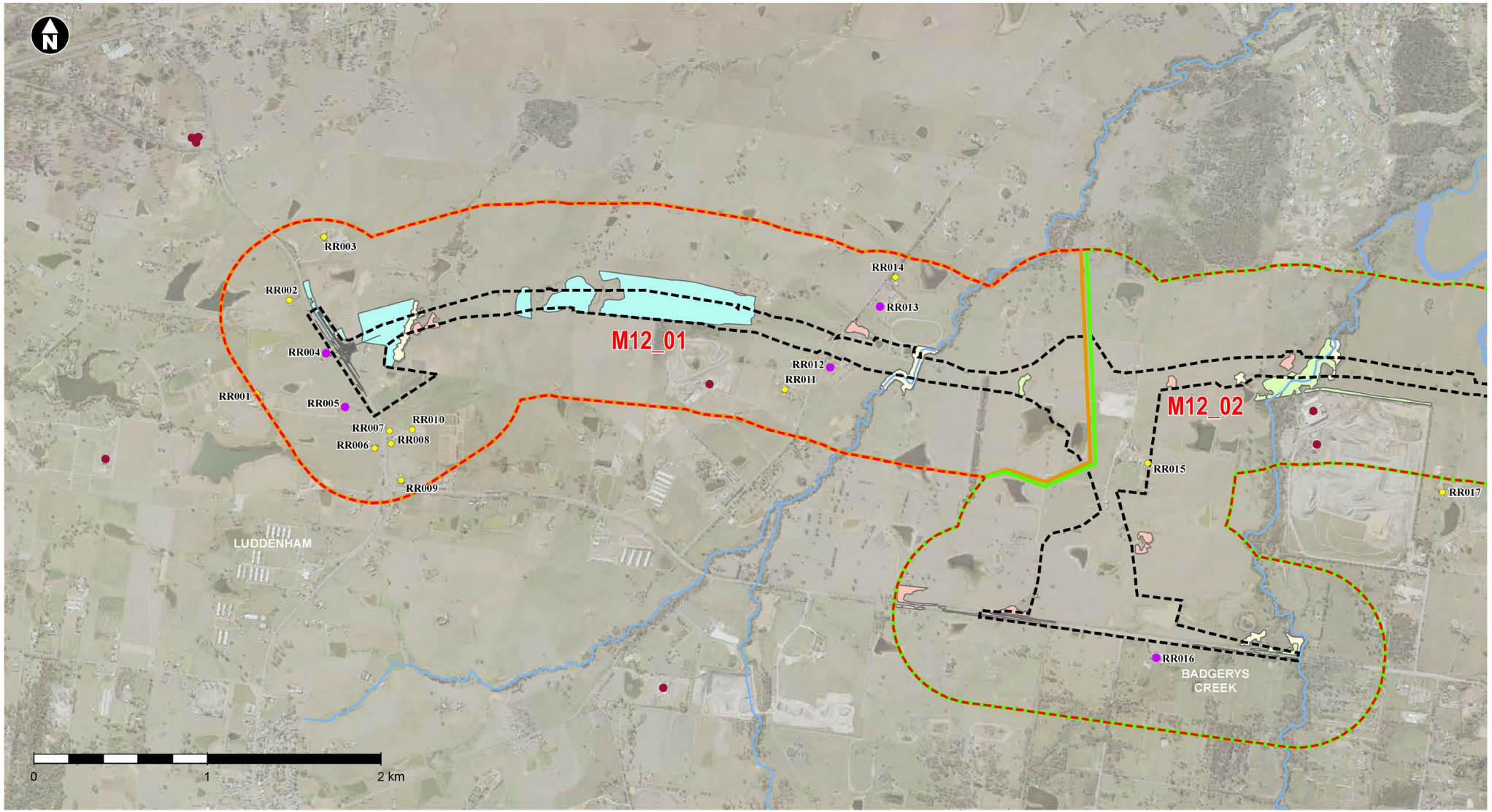

Figure 8-13 Construction air quality study area and assessment segments

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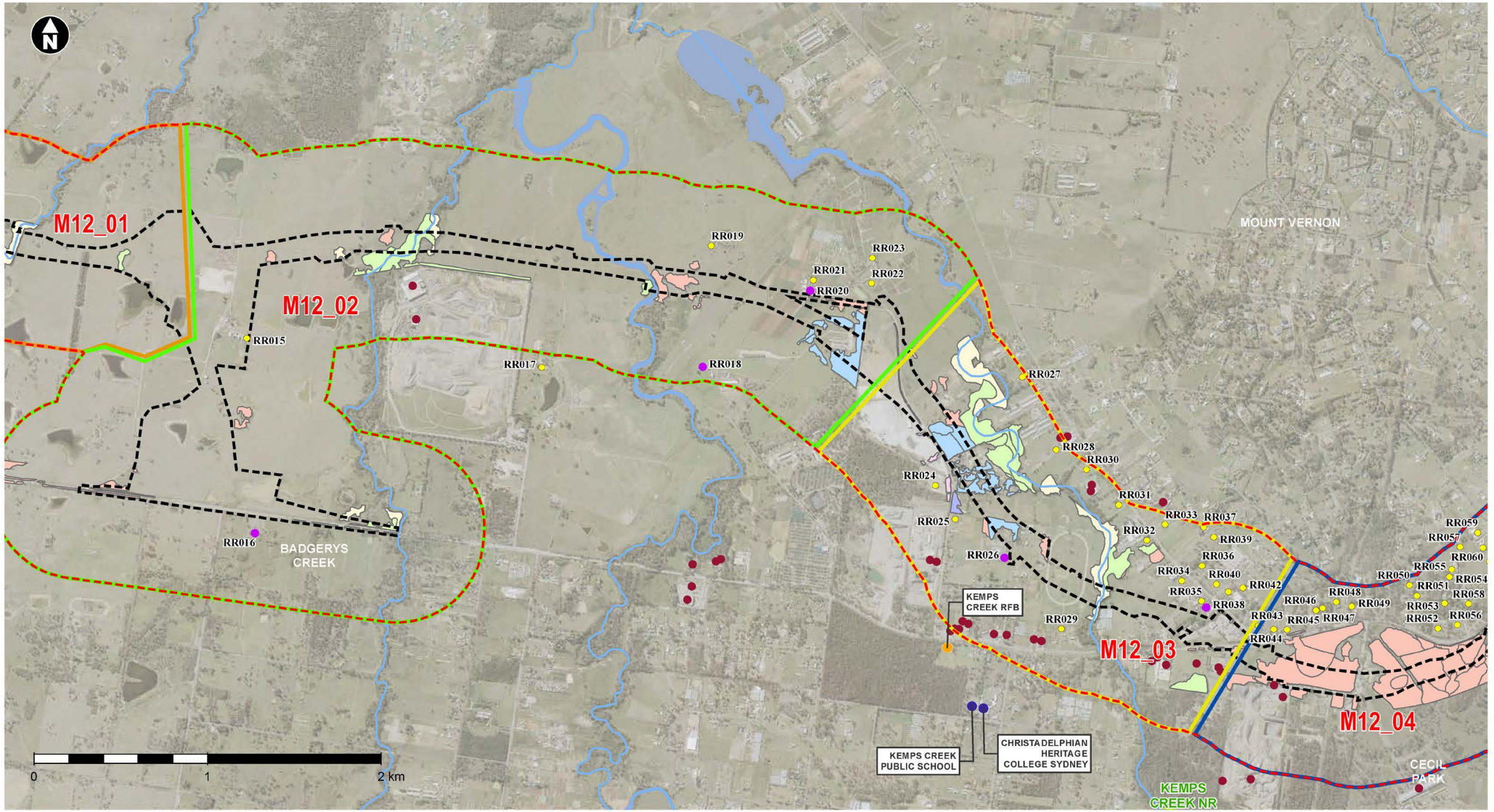

The project construction footprint
Study area (construction)

Construction segments
M12_01
M12_02
M12_03
M12_04

Receivers
Residential
Educational facility
Emergency services
Nearest receivers
Commercial

Threatened Ecological Communities (TEC)
Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion
Cooks River/Castlereagh Ironbark Forest in the Sydney Basin Bioregion
Cumberland Plain Woodland in the Sydney Basin Bioregion
River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
Shale Gravel Transition Forest in the Sydney Basin Bioregion
Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

NPWS estate / reserves

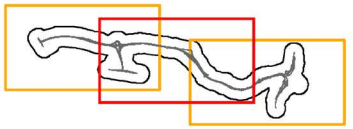

Figure 8-13 Construction air quality study area and assessment segments

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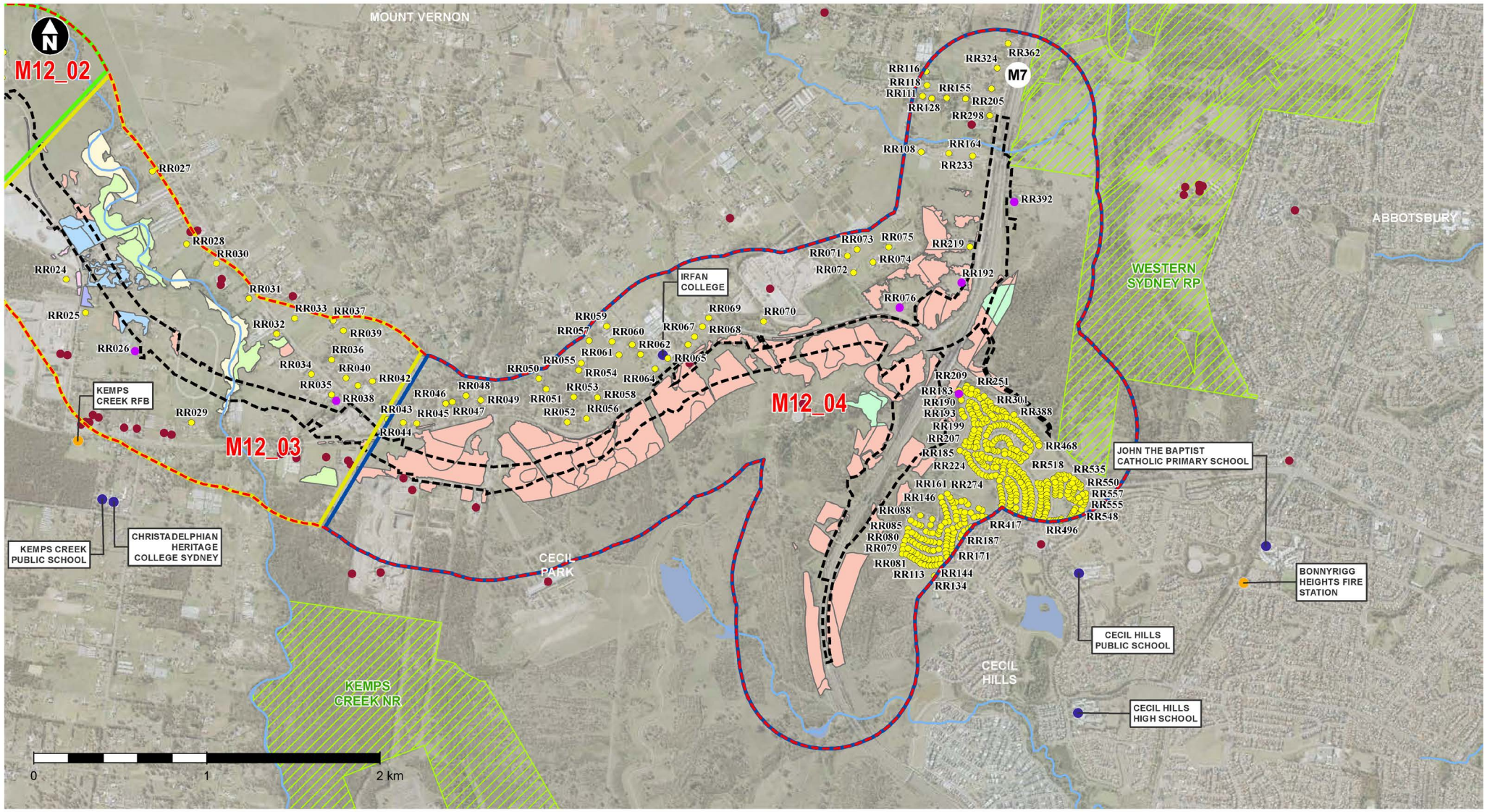

The project construction footprint
Study area (construction)

Construction segments
M12_02
M12_03
M12_04

Receivers
Residential
Educational facility
Emergency services
Nearest receivers
Commercial

Threatened Ecological Communities (TEC)
Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion
Cooks River/Castlereagh Ironbark Forest in the Sydney Basin Bioregion
Cumberland Plain Woodland in the Sydney Basin Bioregion
Moist Shale Woodland in the Sydney Basin Bioregion
River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
Shale Gravel Transition Forest in the Sydney Basin Bioregion
Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

NPWS estate / reserves

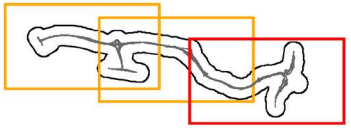

Figure 8-13 Construction air quality study area and assessment segments

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Table 8-20 Receiver sensitivity classifications

Receiver sensitivity	Classification		
	High	Medium	Low
Dust soiling	High – Surrounding land where: users can reasonably expect enjoyment of a high level of amenity the appearance, aesthetics or value of a property would be diminished by soiling the people or property would reasonably be expected to be present continuously, or at least regularly for extended periods, as part of the normal pattern of use of the land. Indicative examples include dwellings, museums and other culturally important collections, medium and long-term car parks and car show rooms.	Medium – Surrounding land where: users would expect to enjoy a reasonable level of amenity, but would not reasonably expect to enjoy the same level of amenity as in their home the appearance, aesthetics or value of a property could be diminished by soiling the people or property wouldn't reasonably be expected to be present here continuously or regularly for extended periods as part of the normal pattern of use of the land. Indicative examples include parks and places of worship.	Low – Surrounding land where: the enjoyment of amenity would not reasonably be expected property would not reasonably be expected to be diminished in appearance, aesthetics or value by soiling there is transient exposure, where the people or property would reasonably be expected to be present only for limited periods of time as part of the normal pattern of use of the land. Indicative examples include playing fields, farmland (unless commercially-sensitive horticultural), footpaths, short-term car parks and roads.
Human health impacts	High: Locations where members of the public are exposed over a time period relevant to the air quality objective for PM_{10}. Indicative examples include residential properties. Hospitals, schools and residential care homes should also be considered as having equal sensitivity to residential areas for the purpose of this assessment.	Medium: Locations where the people exposed are workers, and exposure is over a time period relevant to the air quality objective for PM_{10}. Indicative examples include office and shop workers but will generally not include workers occupationally exposed to PM_{10}, as protection is covered by relevant Health and Safety legislation.	Low: Locations where human exposure is transient. Indicative examples include public footpaths, playing fields, parks and shopping streets.
Ecological effects	High: Locations with an international or national designation and the designated features may be affected by dust soiling Locations where there is a community of particularly dust sensitive species	Medium: Locations where there is particularly important plant species, where dust sensitivity is uncertain or unknown Locations with a national or state designation where the features may be affected by dust deposition.	Low: Locations with a local designation where the features may be affected by dust deposition.

Source: UK IAQM, 2014

In summary:

- Receiver sensitivity to dust soiling would be low around the M12_01 and M12_03 work areas; and receiver sensitivity to dust soiling was determined to have a medium risk around the M12_02 and M12_04 work areas due to the higher density of receivers in closer proximity to the construction footprint
- Receiver sensitivity to human health effects would be medium around all work areas except M12_02, which was determined to have a high risk of human health effects to the higher density of receivers in closer proximity to the identified construction footprint
- The ecological sensitivity around each identified construction footprint was determined to be high for all segments due to the presence of protected ecological habitat areas within 20 metres of the construction footprint.

Table 8-21 Results for sensitivity of areas to dust soiling effects

Construction area	Activity	Receiver sensitivity	Number of receivers by distance from source (m)				Sensitivity to dust soiling impacts
			Less than 20 m	20 to 50 m	50 to 100 m	100 to 350 m	
M12_01 – M12	Demolition	High	<1	1 to 10	1 to 10	10 to 100	Low
	Earthworks	High	<1	1 to 10	1 to 10	10 to 100	Low
	Construction	High	<1	1 to 10	1 to 10	10 to 100	Low
	Trackout	High	<1	1 to 10	1 to 10	10 to 100	Low
M12_02 – M12	Demolition	High	1 to 10	<1	1 to 10	1 to 10	Medium
	Earthworks	High	1 to 10	<1	1 to 10	1 to 10	Medium
	Construction	High	1 to 10	<1	1 to 10	1 to 10	Medium
	Trackout	High	1 to 10	<1	1 to 10	1 to 10	Medium
M12_03 – M12	Demolition	High	<1	1 to 10	1 to 10	10 to 100	Low
	Earthworks	High	<1	1 to 10	1 to 10	10 to 100	Low
	Construction	High	<1	1 to 10	1 to 10	10 to 100	Low
	Trackout	High	<1	1 to 10	1 to 10	10 to 100	Low
M12_04 – M12	Demolition	High	1 to 10	1 to 10	10 to 100	>100	Medium
	Earthworks	High	1 to 10	1 to 10	10 to 100	>100	Medium
	Construction	High	1 to 10	1 to 10	10 to 100	>100	Medium
	Trackout	High	1 to 10	1 to 10	10 to 100	>100	Medium

Table 8-22 Results for sensitivity of areas to human health effects

Construction area	Activity	Receiver sensitivity	Number of receivers by distance from source (m)					Sensitivity to dust soiling impacts
			Less than 20 m	20 to 50 m	50 to 100 m	100 to 250 m	200 to 350 m	
M12_01 – M12	Demolition	High	<1	1 to 10	1 to 10	1 to 10	1 to 10	Medium
	Earthworks	High	<1	1 to 10	1 to 10	1 to 10	1 to 10	Medium
	Construction	High	<1	1 to 10	1 to 10	1 to 10	1 to 10	Medium
	Trackout	High	<1	1 to 10	1 to 10	1 to 10	1 to 10	Medium
M12_02 – M12	Demolition	High	1 to 10	<1	1 to 10	1 to 10	1 to 10	High
	Earthworks	High	1 to 10	<1	1 to 10	1 to 10	1 to 10	High
	Construction	High	1 to 10	<1	1 to 10	1 to 10	1 to 10	High
	Trackout	High	1 to 10	<1	1 to 10	1 to 10	1 to 10	High
M12_03 – M12	Demolition	High	<1	1 to 10	1 to 10	1 to 10	1 to 10	Medium
	Earthworks	High	<1	1 to 10	1 to 10	1 to 10	1 to 10	Medium
	Construction	High	<1	1 to 10	1 to 10	1 to 10	1 to 10	Medium
	Trackout	High	<1	1 to 10	1 to 10	1 to 10	1 to 10	Medium
M12_04 – M12	Demolition	High	<1	1 to 10	10 to 100	10 to 100	10 to 100	Medium
	Earthworks	High	<1	1 to 10	10 to 100	10 to 100	10 to 100	Medium
	Construction	High	<1	1 to 10	10 to 100	10 to 100	10 to 100	Medium
	Trackout	High	<1	1 to 10	10 to 100	10 to 100	10 to 100	Medium

Table 8-23 Results for sensitivity of areas to ecological impacts

Construction area	Activity	Receiver sensitivity	Distance from the source (m)	Ecological sensitivity of area
M12_01 – M12	Demolition	High	<20 m	High
	Earthworks	High	<20 m	High
	Construction	High	<20 m	High
	Trackout	High	<20 m	High
M12_02 – M12	Demolition	High	<20 m	High
	Earthworks	High	<20 m	High
	Construction	High	<20 m	High
	Trackout	High	<20 m	High
M12_03 – M12	Demolition	High	<20 m	High
	Earthworks	High	<20 m	High
	Construction	High	<20 m	High
	Trackout	High	<20 m	High
M12_04 – M12	Demolition	High	<20 m	High
	Earthworks	High	<20 m	High
	Construction	High	<20 m	High
	Trackout	High	<20 m	High

Table 8-24 Surrounding receiver sensitivity classifications determined for the project

Construction area	Sensitivity to potential impact	Surrounding receiver sensitivity rating
M12_01 – M12 Motorway between The Northern Road and Western Sydney Airport entrance/exit	Dust soiling	Low
	Human health impacts	Medium
	Ecological effects	High
M12_02 – M12 Motorway between Western Sydney Airport entrance/exit road and Clifton Avenue	Dust soiling	Medium
	Human health impacts	High
	Ecological effects	High
M12_03 – M12 Motorway between Clifton Avenue and Elizabeth Drive near Mamre Road	Dust soiling	Low
	Human health impacts	Medium
	Ecological effects	High
M12_04 – M12 Motorway between Elizabeth Drive near Mamre Road and the M7 Motorway	Dust soiling	Medium
	Human health impacts	Medium
	Ecological effects	High

Step 2C – Evaluation of the risk of dust impacts

Potential dust emission magnitude ratings determined in Step 2A and the surrounding area sensitivity classifications determined in Step 2B were combined in Step 2C to determine the risk of impacts with no mitigation applied' as per the UK IAQM. The method for determining unmitigated dust impact risks is presented in **Table 8-25**.

The highest unmitigated risk values determined for each dust-related risk (ie dust soiling, human health and ecological impacts) for each of the four types of construction activities around each road segment within the construction footprint are summarised in **Table 8-26**.

In summary, the highest unmitigated risk rating determined for each segment is classified as high risk. This classification relates to the high risk to ecological receivers during earthworks, construction and trackout activities for M12_01, M12_03 and M12_04; with a high risk of human health also determined during earthworks, construction and trackout activities at construction footprint M12_02. Based on this, the project is determined to present a high risk of dust impacts during construction.

Table 8-25 Method for determining unmitigated dust impact risks

Sensitivity of area (from Step 2B)	Dust emission potential (from Step 2A)		
	Large	Medium	Small
Demolition			
High	High risk	Medium risk	Medium risk
Medium	High risk	Medium risk	Low risk
Low	Medium risk	Low risk	Negligible
Earthworks			
High	High risk	Medium risk	Low risk
Medium	Medium risk	Medium risk	Low risk
Low	Low risk	Low risk	Negligible
Construction			
High	High risk	Medium risk	Low risk
Medium	Medium risk	Medium risk	Low risk
Low	Low risk	Low risk	Negligible
Trackout			
High	High risk	Medium risk	Low risk
Medium	Medium risk	Medium risk	Negligible
Low	Low risk	Low risk	Negligible

Table 8-26 Unmitigated construction dust risk values for the project

Construction area	Activity	Potential impact		
		Dust soiling	Human health impacts	Ecological effects
M12_01	Demolition	Low risk	Medium risk	Medium risk
	Earthworks	Low risk	Medium risk	High risk
	Construction	Low risk	Medium risk	High risk
	Trackout	Low risk	Medium risk	High risk
M12_02	Demolition	Medium risk	Medium risk	Medium risk
	Earthworks	Medium risk	High risk	High risk
	Construction	Medium risk	High risk	High risk
	Trackout	Medium risk	High risk	High risk
M12_03	Demolition	Low risk	Medium risk	Medium risk
	Earthworks	Low risk	Medium risk	High risk
	Construction	Low risk	Medium risk	High risk
	Trackout	Low risk	Medium risk	High risk
M12_04	Demolition	Medium risk	Medium risk	Medium risk
	Earthworks	Medium risk	Medium risk	High risk
	Construction	Medium risk	Medium risk	High risk
	Trackout	Medium risk	Medium risk	High risk

Step 3: Mitigation and management

As shown in **Table 8-25**, a ‘high’ potential risk was the highest unmitigated level determined from the review of potential dust deposition, human health and ecological impacts from demolition, earthworks, construction and trackout activities at each of the four construction assessment areas. Based on this, the project was determined to present a ‘high’ risk of dust impacts during construction and measures commensurate to this level of risk were recommended from guidance in the UK IAQM method. These are presented in **Section 8.2.6**.

Step 4: Residual risks

It is expected that with the application of the measures detailed in **Section 8.2.6**, risks from construction (ie residual risks) would be reduced to the extent where impacts could be effectively managed as per the UK IAQM. Significant residual impacts are therefore not anticipated.

Other impacts during construction

In addition to construction dust, there were a range of other potential construction related air quality impacts identified. These included exhaust emission from the combustion of fossil fuels, odours arising from uncovered contaminated and/or hazardous materials, and airborne hazardous materials (eg asbestos and fungal spores). Potential impacts from construction plant and equipment exhaust emissions are not anticipated, owing to the expected intensity of construction activities, setback distances from surrounding sensitive receivers, and the linear nature of the project.

There is potential for odours and airborne hazardous materials to be generated during demolition activities. This potential may also be present during excavation works, as a result of potentially contaminated soils and areas of illegal dumping within the construction study area.

In summary, with the application of the environmental management measures presented in **Section 8.2.6,** it is anticipated that air quality impacts from the project during construction would not result in unacceptable air quality impacts.

Regional air quality

Although the project was determined to present a 'high' risk of dust impacts without the application of mitigation measures, it is expected that construction-related air quality impacts would generally be confined to the study area. The reason for this is that through a combination of their intensity, low height of release of emissions and intervening features mostly limiting the dispersion of dust beyond these distances. As such, it is not expected that emissions during construction would result in wider regional impacts.

Operation impacts

Potential air quality impacts on receivers along the M12 Motorway segments (see **Figure 8-7**) were predicted by identifying any increases in the relevant pollutant relative to existing levels for the following scenarios:

- The difference between:
  - Scenario 1 – existing operations
  - Scenario 2 – with the M12 Motorway, at year of opening (2026)
- The difference between:
  - Scenario 1 – existing operations
  - Scenario 4 – with the M12 Motorway, 10 years after opening (2036).

Potential air quality impacts on receivers along The Northern Road, the M7 Motorway and Elizabeth Drive segments (see **Figure 8-8**) were assessed for the following scenarios:

- The difference between:
  - Scenario 2 – with the M12 Motorway at year of opening (2026)
  - Scenario 4 – with the M12 Motorway, 10 years after opening (2036)
- The difference between
  - Scenario 3 – without the M12 Motorway at year of opening (2026)
  - Scenario 5 – without the M12 Motorway, 10 years' after opening (2036).

This allows for the assessment of increases in the relevant air quality consideration between 2026 and 2036 for project and no-project scenarios. It is noted that, of the two segments of Elizabeth Drive being considered as part of the assessment, there are only sensitive receivers within the operational study area around segment ED_02.

PM_{10} contributions

24-hour and annual averaged PM_{10} contributions from the project at the nearest, most-affected receivers in each segment are presented in the following sections

M12 Motorway segments

24-hour and annually averaged PM_{10} concentrations at the nearest receivers for existing, year of opening (2026) to 10 years after opening (2036) along all four M12 Motorway road assessment segments are displayed in **Figure 8-14** and **Figure 8-15**.

As shown in **Figure 8-14**, the predicted changes in 24-hour averaged PM_{10} contributions from the roadway at the nearest, most-affected receivers are as follows:

- M12_01 – Increases of 1.9 µg/m³ and 3.0 µg/m³ relative to existing with the project in 2026 and 2036 respectively
- M12_02 – Increases of 2.4 µg/m³ and 3.3 µg/m³ relative to existing with the project in 2026 and 2036 respectively
- M12_03 – Increases of 2.8 µg/m³ and 3.8 µg/m³ relative to existing with the project in 2026 and 2036 respectively
- M12_04 – Increases of 2.4 µg/m³ and 3.3 µg/m³ relative to existing with the project in 2026 and 2036 respectively.

24-hour averaged PM_{10} roadway contributions at the nearest, most-affected receivers along the M12 Motorway segments were predicted to increase from year of opening (2026) to 10 years after opening (2036) along all four M12 Motorway road assessment segments. This is attributable to increases in forecast traffic flows between 2026 and 2036. The increase presented and discussed above for M12_03 is the highest of the four segments as a result of a combination of the nearest receiver being nearer along this segment, and high relative traffic flows.

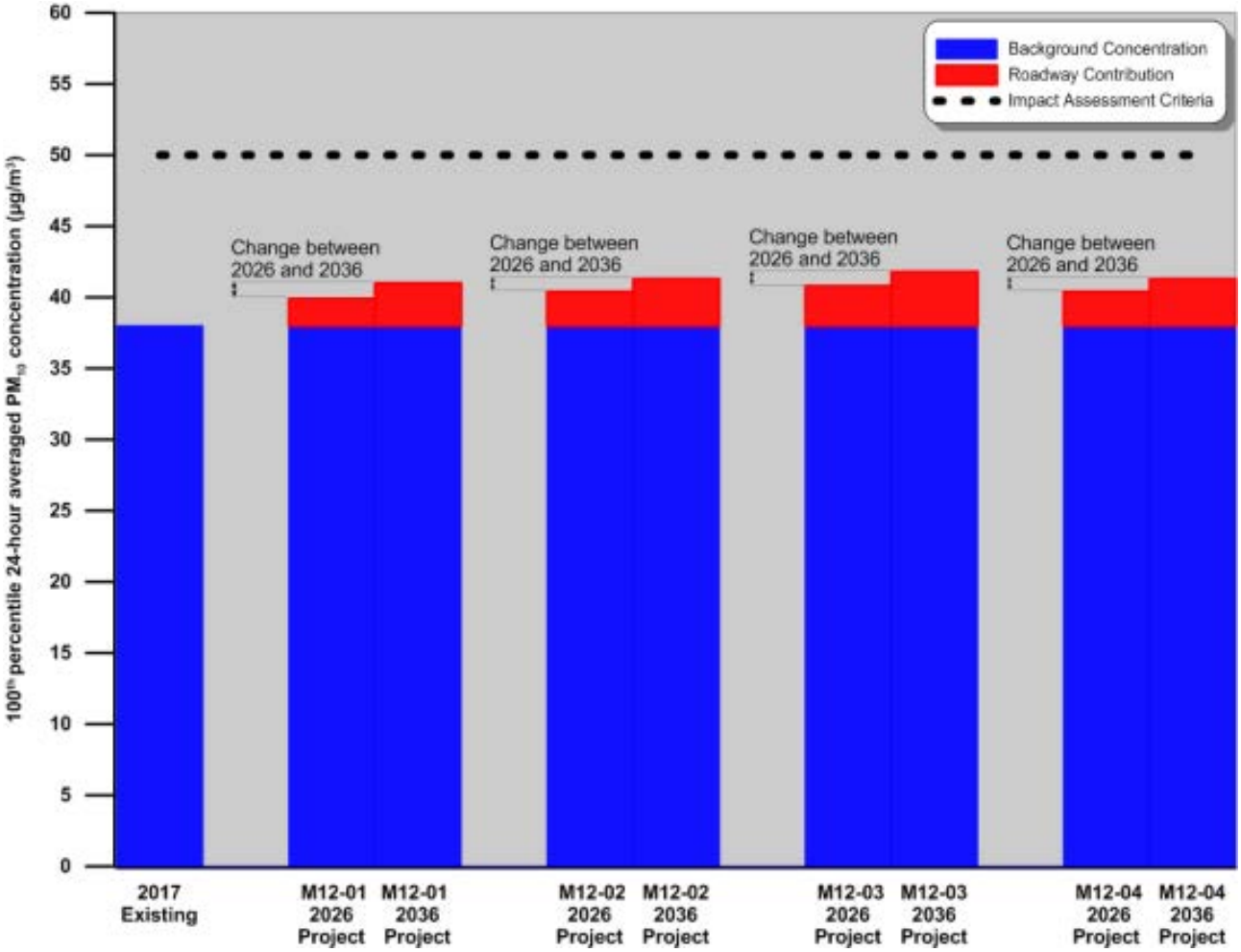

Figure 8-14 Predictions of 24-hour averaged PM_{10} at nearest receivers – M12 Motorway

As shown in **Figure 8-15** annually averaged PM_{10} contributions from the roadway at the nearest, most-affected receivers would change as follows:

- M12_01 – Increases of 0.8 µg/m^3 and 1.2 µg/m^3 relative to existing with the project in 2026 and 2036 respectively
- M12_02 – Increases of 1.0 µg/m^3 and 1.3 µg/m^3 relative to existing with the project in 2026 and 2036 respectively
- M12_03 – Increases of 1.1 µg/m^3 and 1.5 µg/m^3 relative to existing with the project in 2026 and 2036 respectively
- M12_04 – Increases of 1.0 µg/m^3 and 1.3 µg/m^3 relative to existing with the project in 2026 and 2036 respectively.

Annually averaged PM_{10} roadway contributions at the nearest, most-affected receivers along the M12 Motorway segments were predicted to increase from year of opening (2026) to 10 years after opening (2036) along all four M12 Motorway road assessment segments. Again, this is attributable to increases in forecast traffic flows between the 2026 and 2036 traffic scenarios. Similarly for 24-hour averaged PM_{10}, roadway contributions in annually averaged PM_{10} increases at the nearest receiver along M12_03 were highest owing to its proximity and high relative traffic flows compared with the other M12 Motorway segments.

The resulting total (ie background plus road contribution) 24-hour and annually averaged PM_{10} concentrations are predicted to remain below the 50 µg/m^3 and 25 µg/m^3 impact assessment criteria from the NSW EPA's Approved Methods.

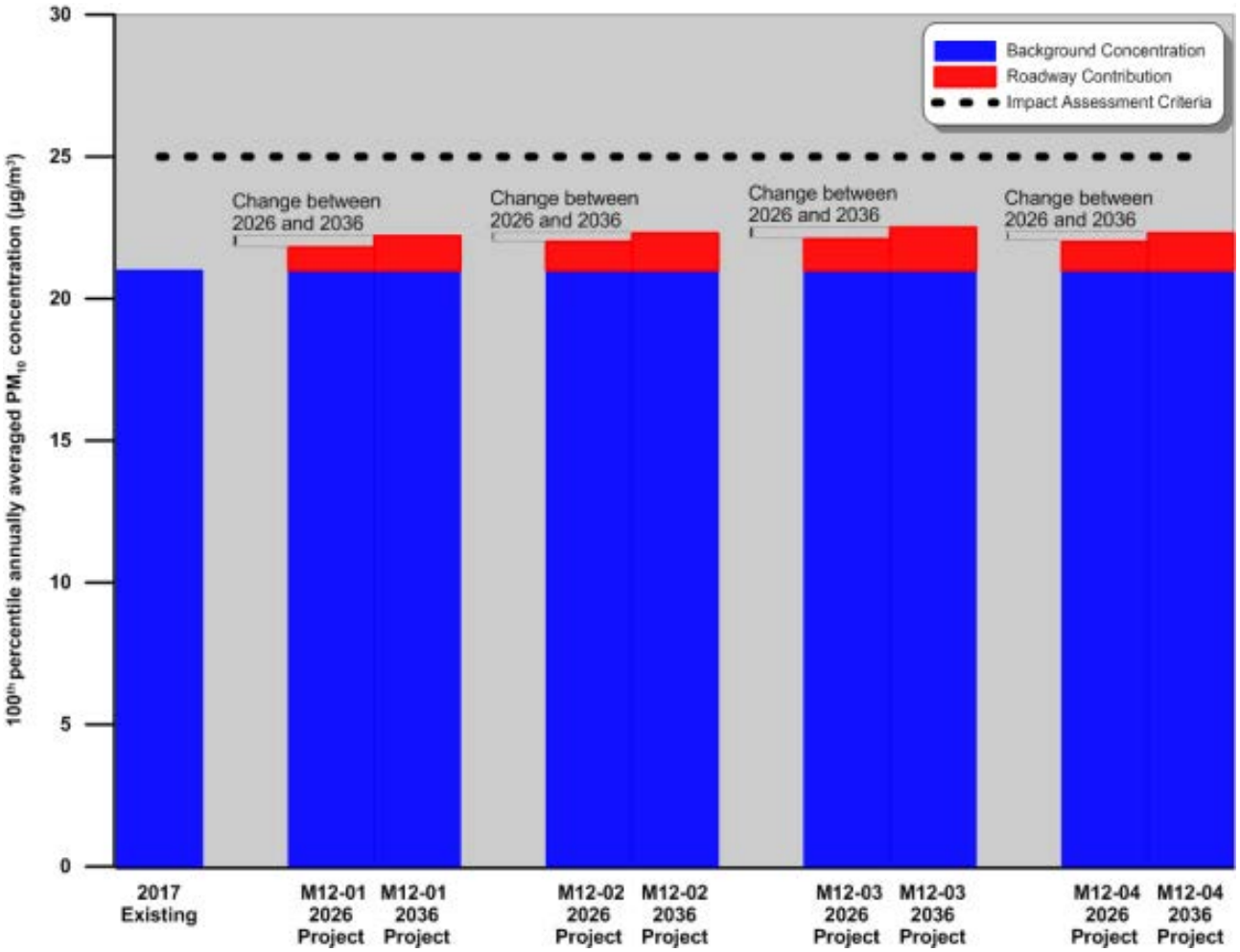

Figure 8-15 Predictions of annually averaged PM_{10} at nearest receivers – M12 Motorway

The Northern Road segments

24-hour and annually averaged PM_{10} concentrations at the nearest receiver along segments of The Northern Road adjoining the new M12 Motorway for existing, project and no project at year of opening (2026), and project and no project for 10 years' after opening (2036) are displayed in **Figure 8-16** and **Figure 8-17**.

As shown in **Figure 8-16**, the predicted changes in 24-hour averaged PM_{10} roadway contributions compared with existing at the nearest, most-affected receivers are as follows:

- TNR_01 – Increases of 1.6 µg/m^3 and 2.9 µg/m^3 relative to existing with the project in 2026 and 2036 respectively
- TRN_02 – Increases of 3.1 µg/m^3 and 4.3 µg/m^3 relative to existing with the project in 2026 and 2036 respectively.

24-hour averaged PM_{10} roadway contributions were predicted to change between 2026 and 2036 project and no project scenarios as follows:

- TNR_01 – A decrease of 0.7 µg/m^3 and increase of 0.7 µg/m^3 between 2026 and 2036 project and no project options respectively
- TNR_02 – Increases of 0.9 µg/m^3 and two µg/m^3 between 2026 and 2036 project and no project options respectively.

As shown in **Figure 8-16**, the predicted changes in annually averaged PM_{10} roadway contributions compared with existing at the nearest, most-affected receivers are as follows:

- TNR_01 – Increases of 0.7 µg/m^3 and 1.2 µg/m^3 relative to existing with the project in 2026 and 2036 respectively
- TRN_02 – Increases of 1.7 µg/m^3 and 1.7 µg/m^3 relative to existing with the project in 2026 and 2036 respectively.

Annually averaged PM_{10} roadway contributions were predicted to change between 2026 and 2036 project and no project scenarios as follows:

- TNR_01 – A decrease of 0.3 µg/m^3 and increase of 0.3 µg/m^3 between 2026 project and no-project options, and 2036 project and no project options respectively
- TNR_02 – Increases of 0.9 µg/m^3 and 0.8 µg/m^3 between 2026 project and no-project options, and 2036 project and no project options respectively.

It was predicted that the resulting total 24-hour and annual concentrations associated with the project scenarios would remain below the 50 µg/m^3 and 25 µg/m^3 impact assessment criteria from the NSW EPA's Approved Methods respectively.

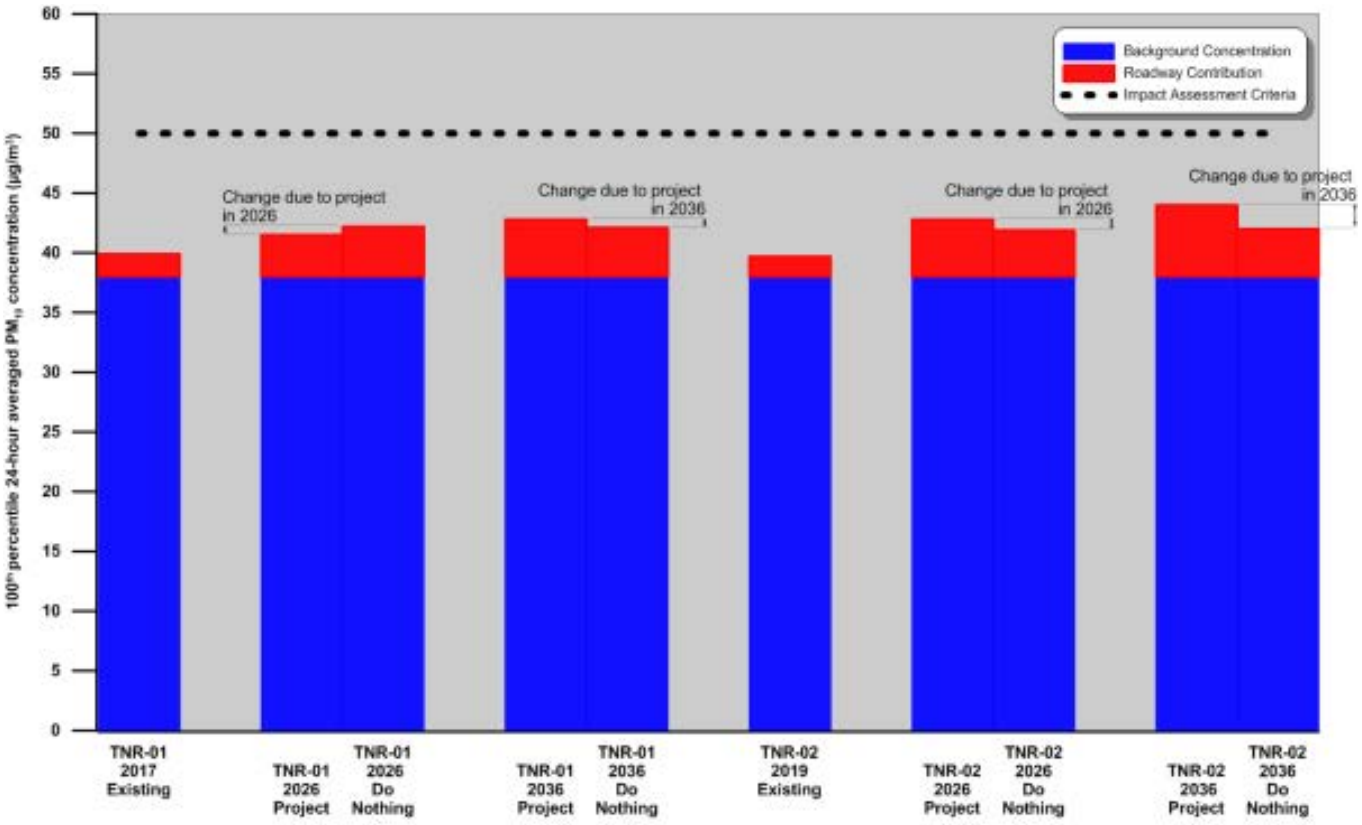

Figure 8-16 Predictions of 24-hour averaged PM_{10} at nearest receivers – The Northern Road

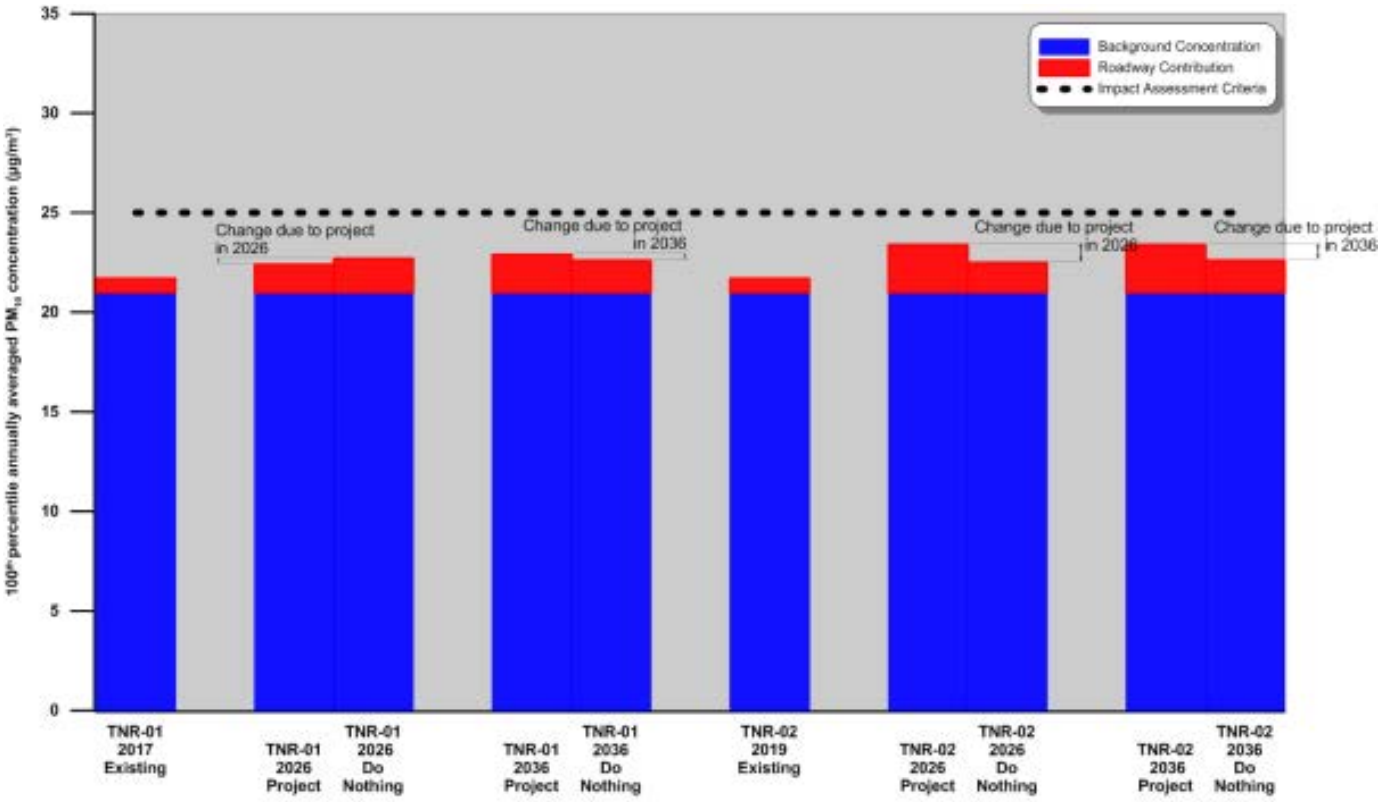

Figure 8-17 Predictions of annually averaged PM_{10} at nearest receivers – The Northern Road

M7 Motorway segments

24-hour and annually averaged PM_{10} concentrations at the nearest receiver along segments of the M7 Motorway segments adjoining the new M12 Motorway for existing, project and no project at year of opening (2026), and project and no project for 10 years' after opening (2036) are shown in **Figure 8-18** and **Figure 8-19**.

As shown in **Figure 8-18**, changes in 24-hour averaged PM_{10} roadway contributions compared with existing at the nearest, most-affected receivers are as follows:

- M7_01 – A decrease of 1.1 µg/m^3 and increase of 0.6 µg/m^3 relative to existing with the project in 2026 and 2036 respectively
- M7_02 – A decrease of 3.0 µg/m^3 and 0.5 µg/m^3 relative to existing with the project in 2026 and 2036 respectively.

24-hour averaged PM_{10} roadway contributions were predicted to change between 2026 and 2036 project and no project scenarios as follows:

- M7_01 – A decrease of 0.4 µg/m^3 and 0.4 µg/m^3 between 2026 and 2036 project and no project options respectively
- M7_02 – A decrease of 1.3 µg/m^3 and 0.6 µg/m^3 between 2026 and 2036 project and no project options respectively.

As shown in **Figure 8-19**, the predicted changes in annually averaged PM_{10} roadway contributions compared with existing at the nearest, most-affected receivers are as follows:

- M7_01 – A decrease of 0.4 µg/m^3 and increase of 0.3 µg/m^3 relative to existing in 2026 and 2036 respectively
- M7_02 – A decrease of 1.2 µg/m^3 and 0.2 µg/m^3 relative to existing in 2026 and 2036 respectively.

Annually averaged PM_{10} roadway contributions were predicted to change between 2026 and 2036 project and no project scenarios as follows:

- M7_01 – A decrease of 0.1 µg/m^3 and 0.1 µg/m^3 between 2026 and 2036 project and no-project options respectively
- M7_02 – A decrease of 0.5 µg/m^3 and 0.2 µg/m^3 between 2026 and 2036 project and no-project options respectively.

It was predicted that the resulting total 24-hour and annual concentrations associated with the project scenarios would remain below the 50 µg/m^3 and 25 µg/m^3 impact assessment criteria from the NSW EPA's Approved Methods respectively.

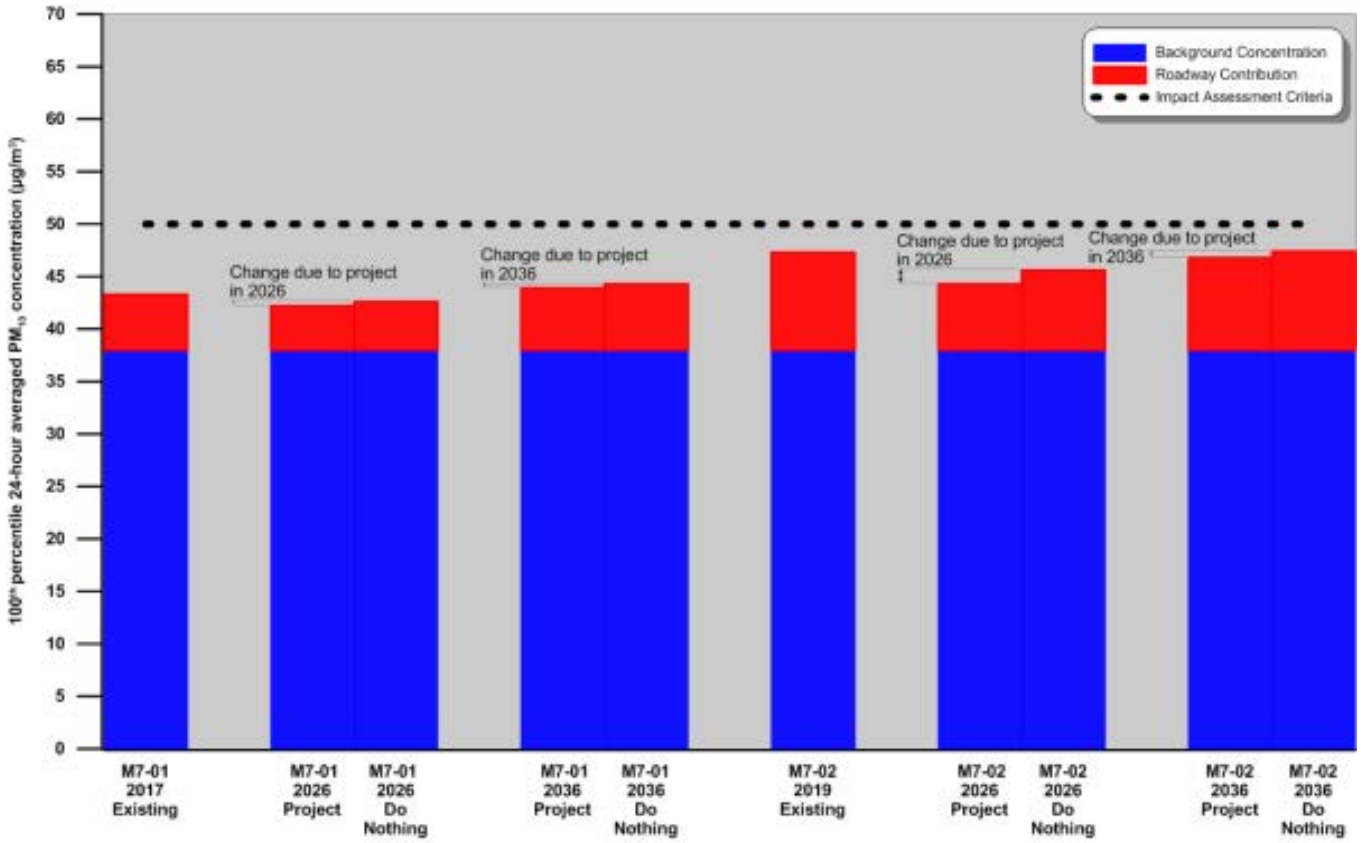

Figure 8-18 Predictions of 24-hour averaged PM_{10} at nearest receivers – M7 Motorway

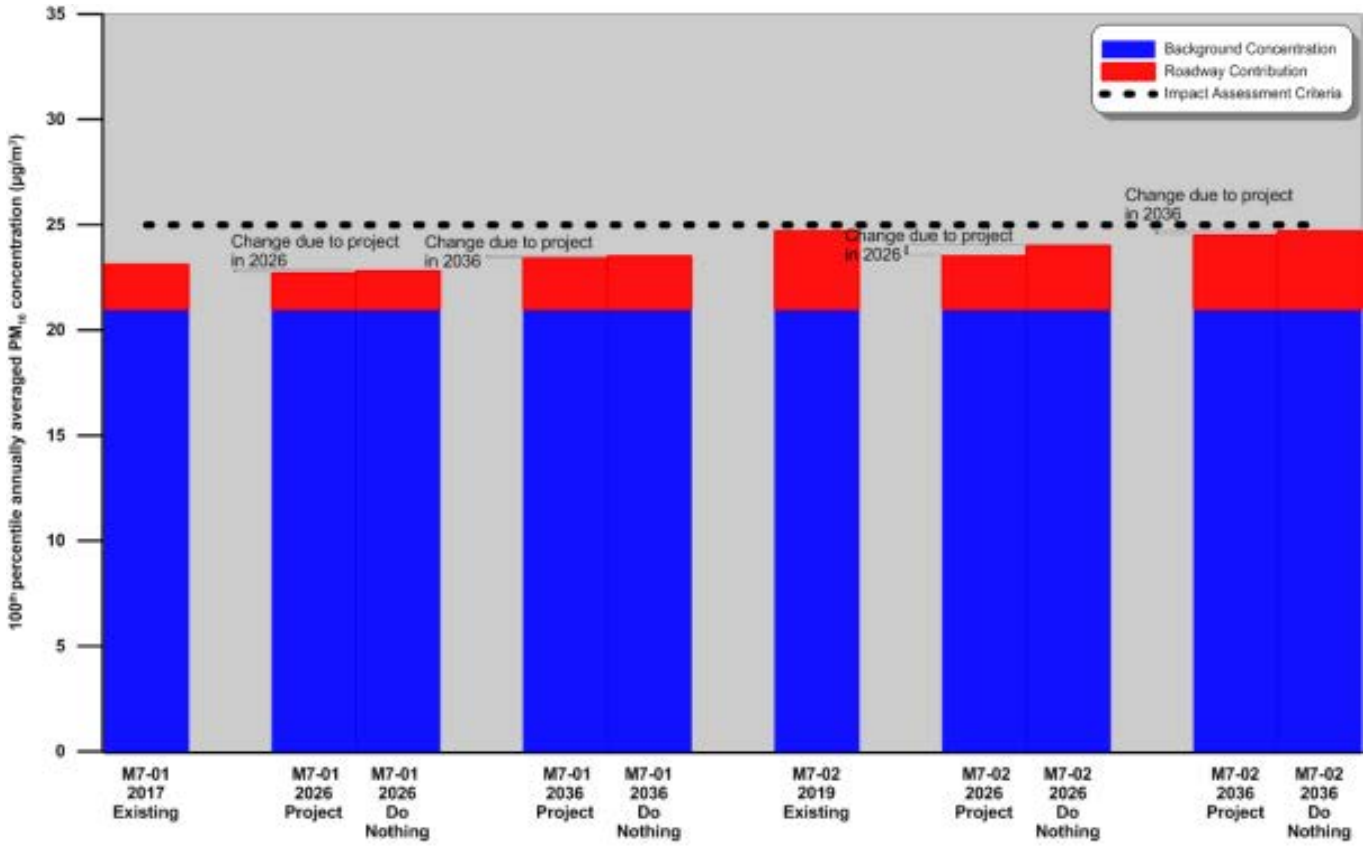

Figure 8-19 Predictions of annually averaged PM_{10} at nearest receivers – M7 Motorway

Elizabeth Drive segments

24-hour and annually averaged PM_{10} concentrations at the nearest receiver along segments of The Elizabeth Drive segments for existing, project and no project at year of opening (2026), and project and no project for 10 years' after opening (2036) are shown in **Figure 8-20** and **Figure 8-21**. Of the two segments of Elizabeth Drive (ED_01 and ED_02) there is only one receiver location within the operational study area around segment ED_02.

As shown in **Figure 8-20**, 24-hour averaged PM_{10} roadway contributions at this receiver were predicted to change compared with existing as follows:

- ED_02 – Increases of 0.1 µg/m^3 and 0.7 µg/m^3 relative to existing with the project in 2026 and 2036 respectively.

24-hour averaged PM_{10} roadway contributions were predicted to change between 2026 and 2036 project and no project scenarios as follows:

- ED_02 – A decrease of 0.4 µg/m^3 and 1.2 µg/m^3 between 2026 project and no-project and 2036 project and no-project options respectively.

As shown in **Figure 8-21**, annually averaged PM_{10} roadway contributions were predicted to change compared with existing as follows:

- ED_02 – No change and an increase of 0.3 µg/m^3 relative to existing with the project in 2026 and 2036 respectively.

Annually averaged PM_{10} roadway contributions were predicted to change between 2026 and 2036 project and no project scenarios as follows:

- ED_02 – A decrease of 0.2 µg/m^3 and 0.5 µg/m^3 between 2026 project and no-project and 2036 project and no-project options respectively.

It was predicted that the resulting total 24-hour and annual concentrations associated with the project scenarios would remain below the 50 µg/m^3 and 25 µg/m^3 impact assessment criteria from the NSW EPA's Approved Methods respectively.

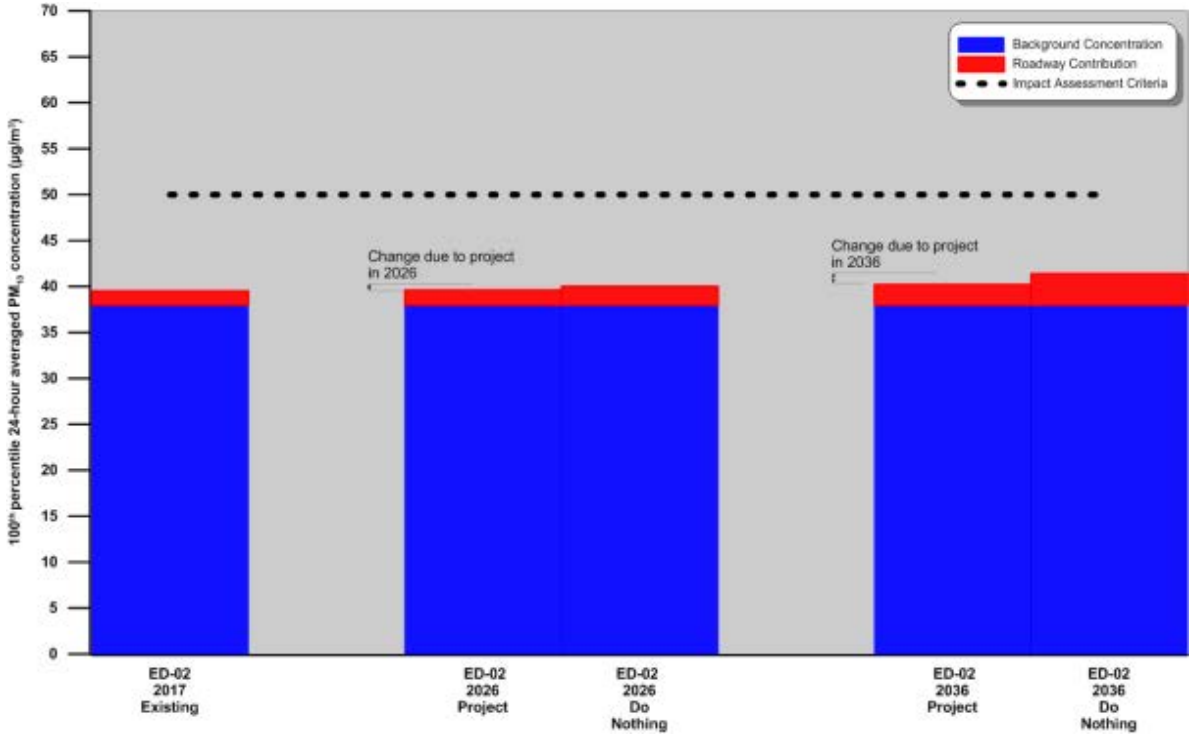

Figure 8-20 Predictions of 24-hour averaged PM_{10} at nearest receiver – Elizabeth Drive

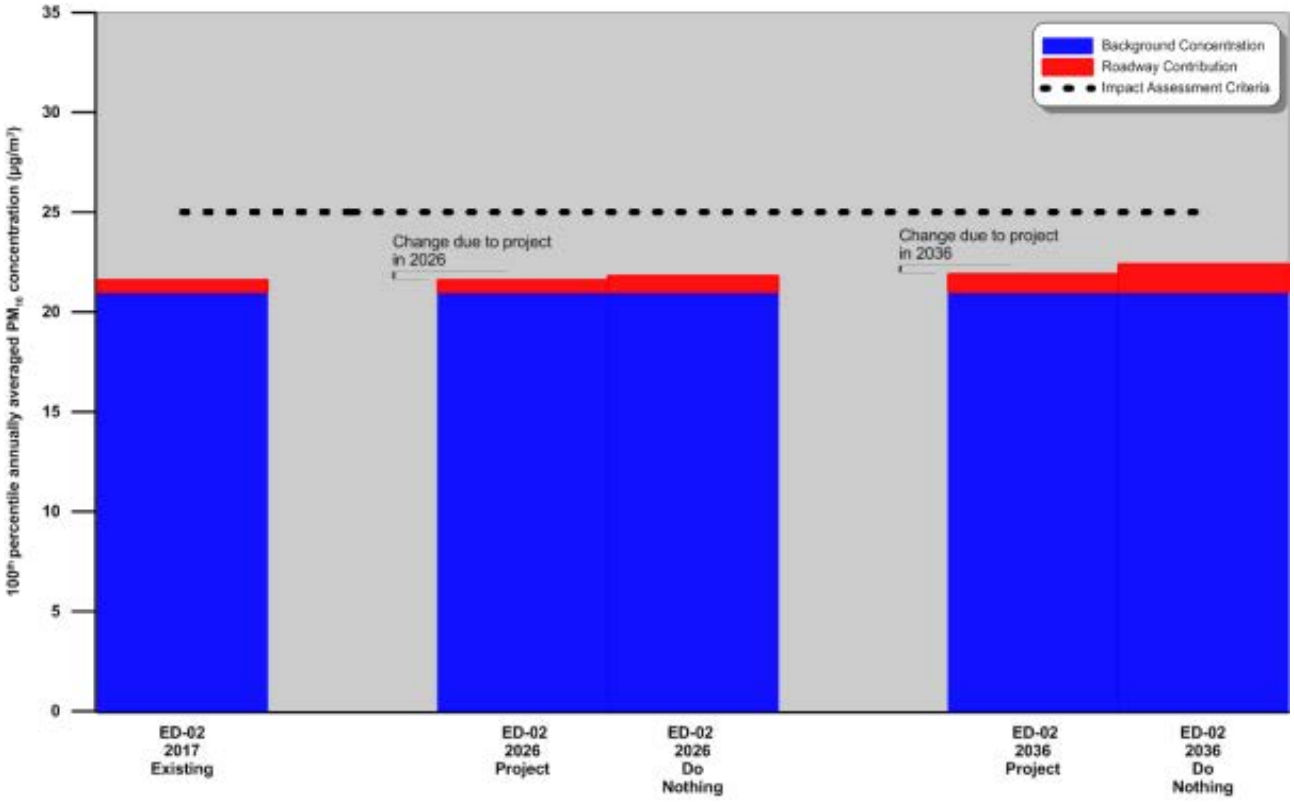

Figure 8-21 Predictions of annually averaged PM_{10} at nearest receiver – Elizabeth Drive

24-hour averaged $PM_{2.5}$ contributions

24-hour averaged $PM_{2.5}$ contributions from the project at the nearest, most-affected receivers in each segment are presented in the following sections.

M12 Motorway segments

24-hour and annually averaged $PM_{2.5}$ concentrations at the nearest receiver along segments of the M12 Motorway segments for existing, project and no project at year of opening (2026), and project and no project for 10 years' after opening (2036) are shown in **Figure 8-22** and **Figure 8-23**.

As shown in **Figure 8-22**, 24-hour averaged $PM_{2.5}$ contributions from the roadway at the nearest, most-affected receivers were predicted to change as follows:

- M12_01 – Increases of 1.9 µg/m^3 and 3.0 µg/m^3 relative to existing with the project in 2026 and 2036 respectively
- M12_02 – Increases of 2.4 µg/m^3 and 3.3 µg/m^3 relative to existing with the project in 2026 and 2036 respectively
- M12_03 – Increases of 2.8 µg/m^3 and 3.8 µg/m^3 relative to existing with the project in 2026 and 2036 respectively
- M12_04 – Increases of 2.4 µg/m^3 and 3.3 µg/m^3 relative to existing with the project in 2026 and 2036 respectively.

24-hour averaged $PM_{2.5}$ roadway contributions at the nearest, most-affected receivers along the M12 Motorway segments were predicted to increase from year of opening (2026) to 10 years after opening (2036) along all four M12 Motorway road assessment segments. This is due to increases in forecast traffic flows between 2026 and 2036.

The increase presented for M12_03 is highest of the four segments as a result of a combination of the nearest receiver being nearer along this segment, and high relative traffic flows. However the highest resulting total (ie background plus road contribution) 24-hour averaged $PM_{2,5}$ concentration were predicted to be about 19 µg/m^3. This would be below the 25 µg/m^3 impact assessment criteria from the NSW EPA's Approved Methods.

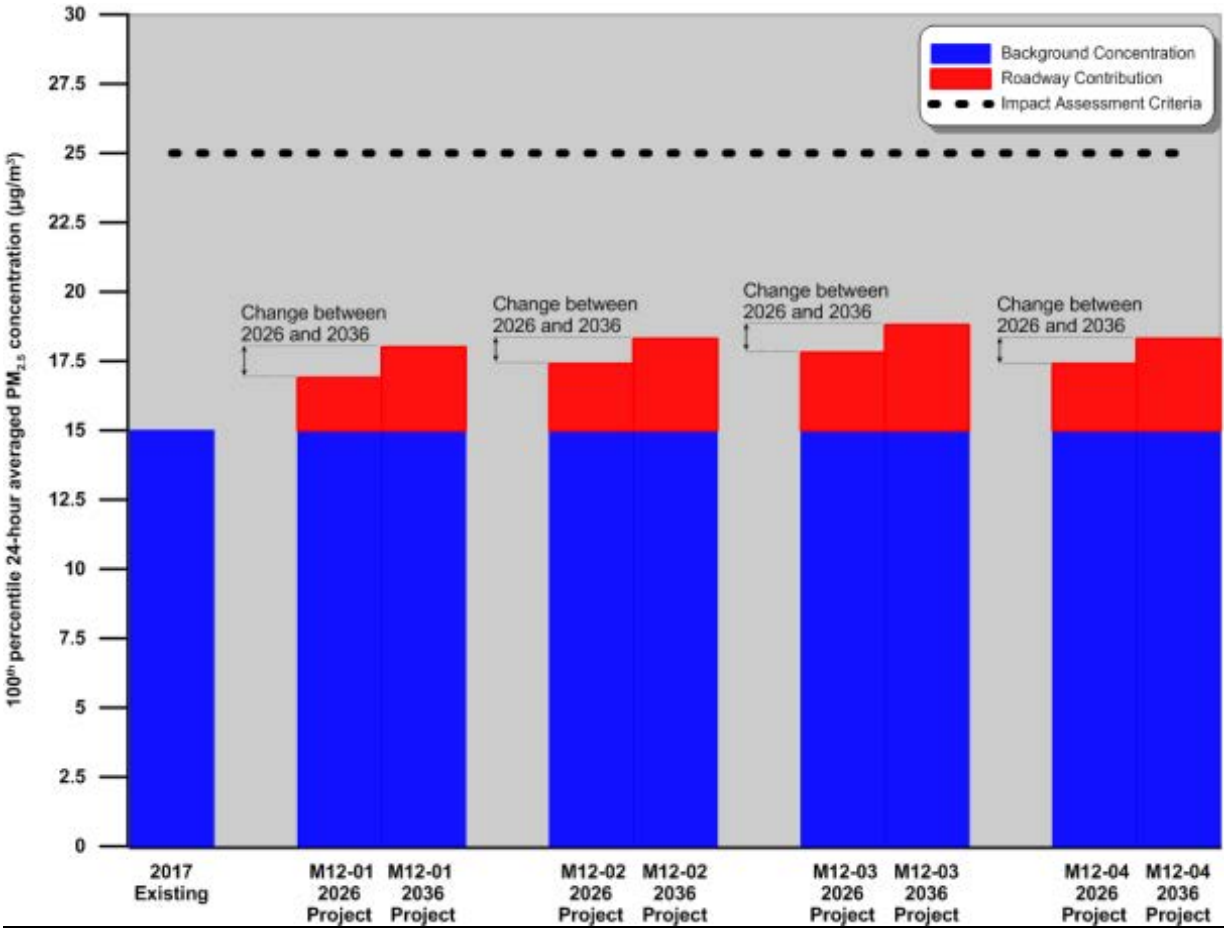

Figure 8-22 Predictions of 24-hour averaged $PM_{2.5}$ at nearest receivers – M12 Motorway

The Northern Road segments

24-hour and annually averaged $PM_{2.5}$ concentrations at the nearest receiver along segments of The Northern Road adjoining the new M12 Motorway for existing, project and no project at year of opening (2026), and project and no project for 10 years' after opening (2036) are shown in **Figure 8-23**.

As displayed in **Figure 8-23**, 24-hour averaged $PM_{2.5}$ roadway contributions were predicted to change compared with existing at the nearest, most-affected receivers as follows:

- TNR_01 – Increases of 1.6 µg/m^3 and 2.9 µg/m^3 relative to existing with the project in 2026 and 2036 respectively
- TRN_02 – Increases of 3.1 µg/m^3 and 4.3 µg/m^3 relative to existing with the project in 2026 and 2036 respectively.

24-hour averaged $PM_{2.5}$ roadway contributions were predicted to change between 2026 and 2036 project and no project scenarios as follows:

- TNR_01 – A decrease of 0.7 µg/m^3 and increase of 0.7 µg/m^3 between 2026 project and no-project options and 2036 project and no project options respectively
- TNR_02 – Increases of 0.9 µg/m^3 and two µg/m^3 between 2026 and 2036 project and no project options respectively.

It was predicted that the resulting total concentrations associated with the project would remain below the 25 µg/m^3 impact assessment criteria from the NSW EPA's Approved Methods.

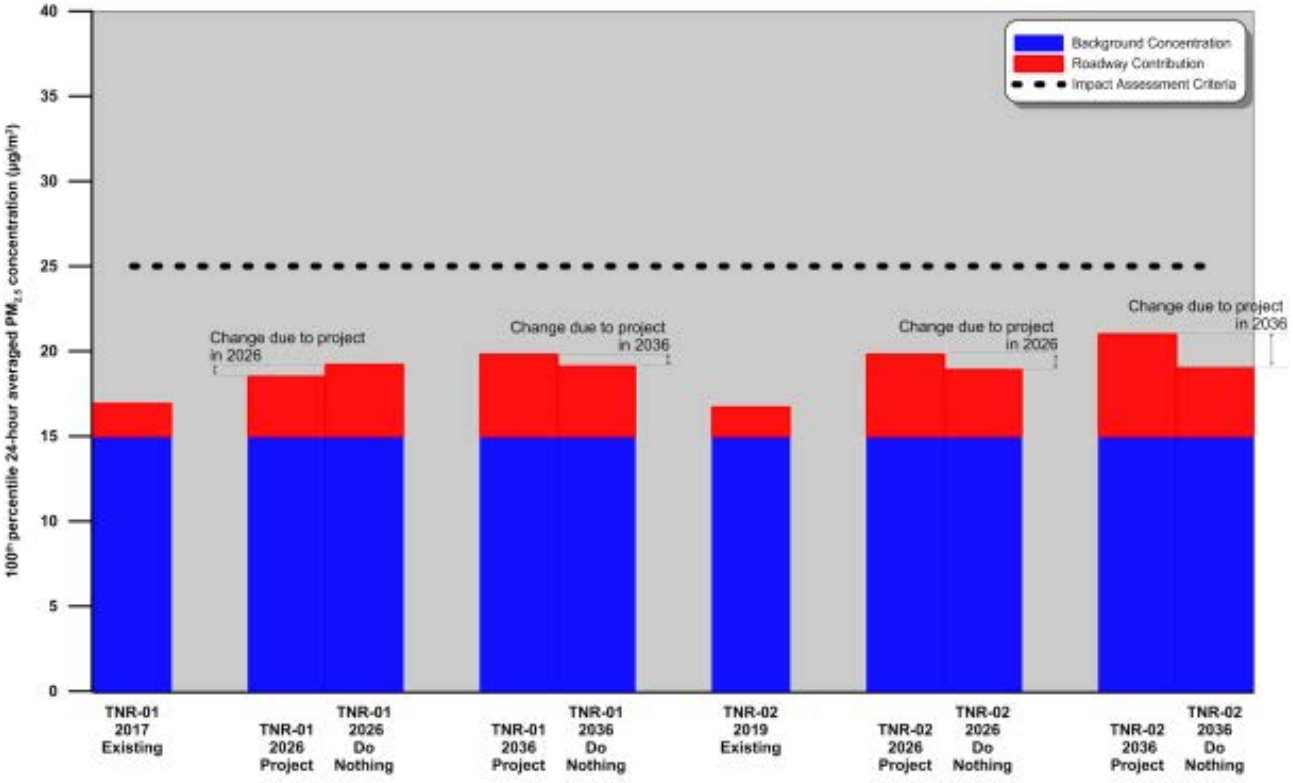

Figure 8-23 Predictions of 24-hour averaged $PM_{2.5}$ at nearest receivers – The Northern Road

M7 Motorway segments

24-hour and averaged $PM_{2.5}$ concentrations at the nearest receiver along segments of the M7 Motorway segments adjoining the new M12 Motorway for existing, project and no project at year of opening (2026), and project and no project for 10 years' after opening (2036) are shown in **Figure 8-24.**

As shown, 24-hour averaged $PM_{2.5}$ roadway contributions were predicted to change compared with existing at the nearest, most-affected receivers as follows:

- M7_01 – A decrease of 1.1 µg/m^3 and increase of 0.6 µg/m^3 relative to existing in 2026 and 2036 respectively
- M7_02 – A decrease of 3.0 µg/m^3 and 0.5 µg/m^3 relative to existing in 2026 and 2036 respectively.

24-hour averaged $PM_{2.5}$ roadway contributions were predicted to change between 2026 and 2036 project and no project scenarios as follows:

- M7_01 – A decrease of 0.4 µg/m^3 and 0.4 µg/m^3 between 2026 and 2036 project and no-project options respectively
- M7_02 – A decrease of 1.3 µg/m^3 and 0.6 µg/m^3 between 2026 and 2036 project and no-project options respectively.

It was predicted that the resulting total concentrations would remain below the 25 µg/m^3 impact assessment criteria from the NSW EPA's Approved Methods.

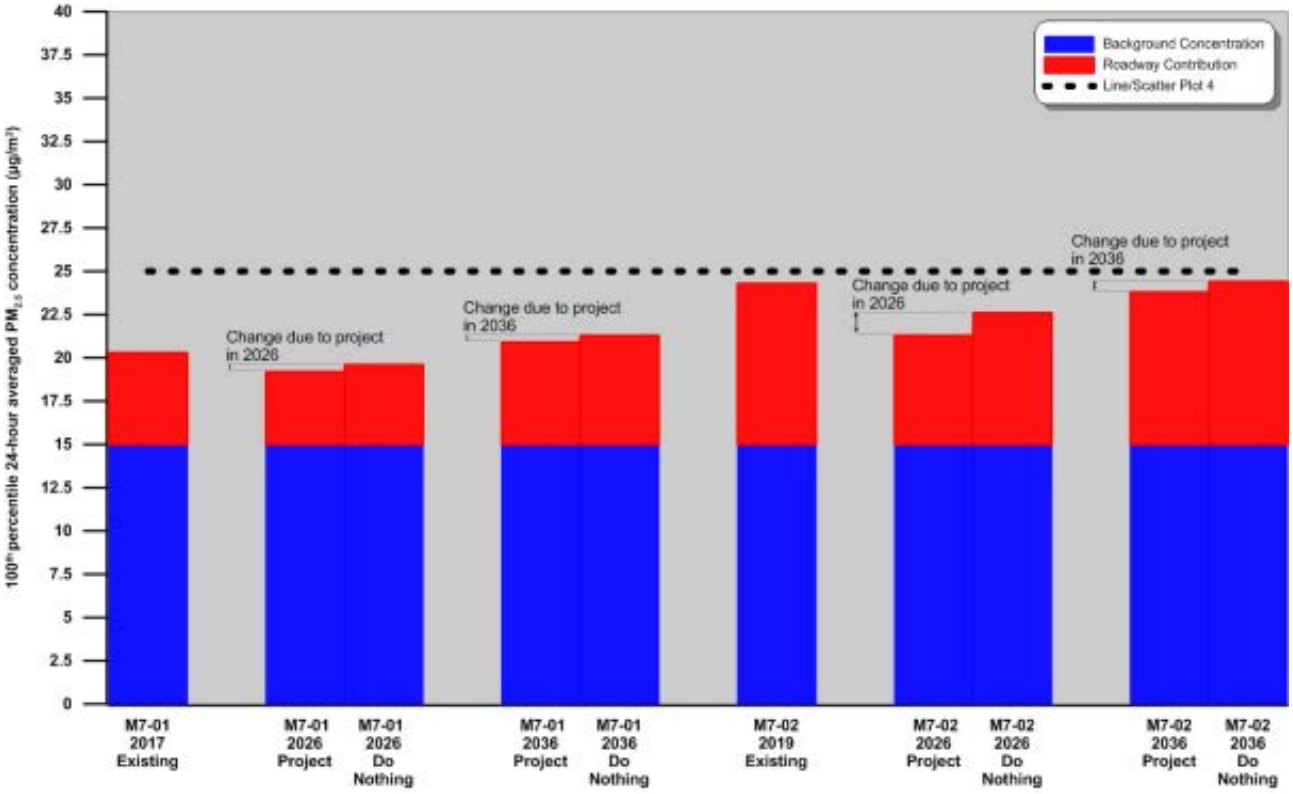

Figure 8-24 Predictions of 24-hour averaged $PM_{2.5}$ at nearest receivers – M7 Motorway

Elizabeth Drive segments

24-hour and averaged $PM_{2.5}$ concentrations at the nearest receiver along segments of Elizabeth Drive segments for existing, project and no project at year of opening (2026), and project and no project for 10 years' after opening (2036) are shown in **Figure 8-25**.

As presented, 24-hour averaged $PM_{2.5}$ roadway contributions at this receiver were predicted to change as follows:

- ED_02 – Increases of 0.1 µg/m^3 and 0.7 µg/m^3 relative to existing with the project in 2026 and 2036 respectively.

24-hour averaged $PM_{2.5}$ roadway contributions were predicted to change between 2026 and 2036 project and no project scenarios as follows:

- ED_02 – A decrease of 0.4 µg/m^3 and 1.2 µg/m^3 between 2026 project and no-project and 2036 project and no-project options respectively.

It was predicted that the resulting total concentrations associated with the project would remain below the 25 µg/m^3 impact assessment criteria from the NSW EPA's Approved Methods.

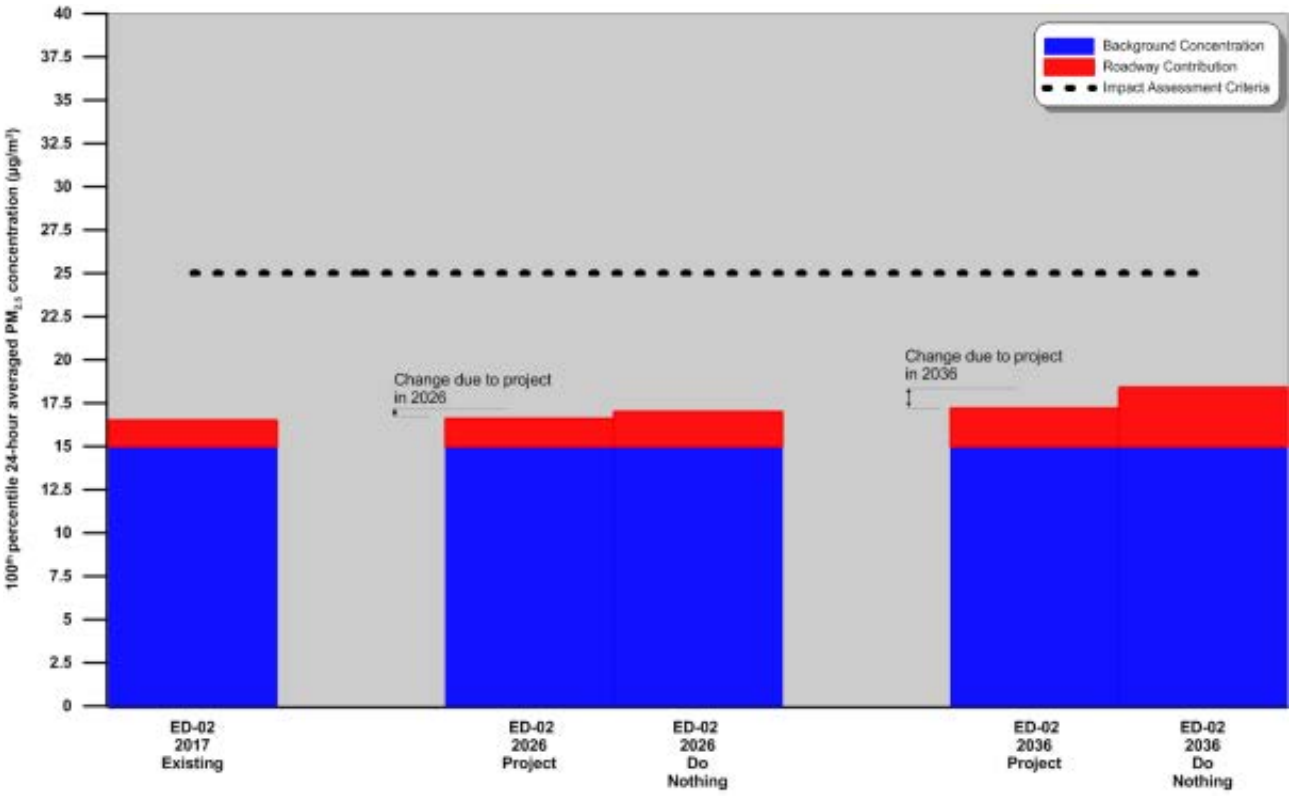

Figure 8-25 Predictions of 24-hour averaged $PM_{2.5}$ at nearest receiver – Elizabeth Drive

Annually averaged $PM_{2.5}$ contributions

Annually averaged $PM_{2.5}$ concentrations at the nearest receivers along all segments existing operations (Scenario 1) and year of opening (2026) (Scenario 2) and future design year (2036) (Scenario 4) are shown in **Figure 8-26** to **Figure 8-29**.

Annually averaged $PM_{2.5}$ background levels were already predicted to be at the eight µg/m^3 impact assessment criteria for all segments, as defined in the Approved Methods. Results for each segment are discussed below.

As shown in **Figure 8-26**, increases ranging from 0.8 µg/m^3 to 1.1 µg/m^3 were predicted at the nearest, most-affected receivers along the four M12 Motorway segments at year of opening (2026). These contributions were predicted to increase further in 2036, ranging from 1.2 µg/m^3 to 1.5 µg/m^3 at the nearest sensitive receiver locations over the four segments. The highest total (ie background plus roadway contribution) concentration of 9.5 µg/m^3 was predicted at the nearest receiver along segment M12_03 in 2036. As explained above, this occurs at this location because the nearest receiver along M12_03 is closest to the project, with high relative traffic flows compared with the other segments.

As shown in **Figure 8-27**, changes in roadway contributions for The Northern Road segments between the 2026 project and no project options were predicted to have a decrease of 0.3 µg/m^3 at the nearest receiver along segment TRN_01, and an increase at the nearest receiver along segment TNR_02 of about 0.9 µg/m^3. For the 2036 assessment scenarios, concentrations increased with the project by 0.3 µg/m^3 compared with the no project option at the nearest receivers along both assessment scenarios. The highest total (ie background plus roadway contribution) concentration at the most-affected receiver for the project options assessed was of 10.4 µg/m^3.

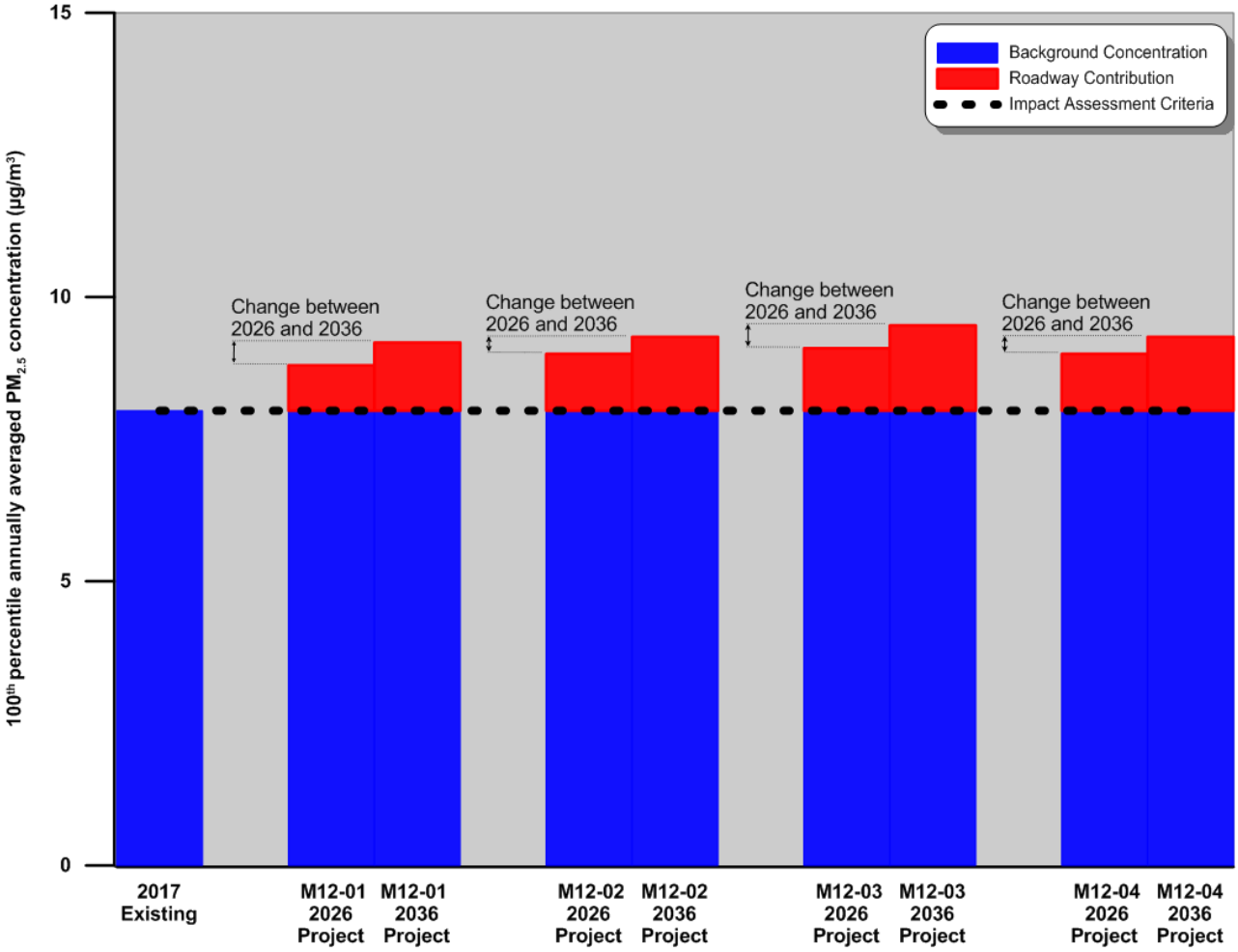

Figure 8-26 Predictions of annually averaged $PM_{2.5}$ at nearest receivers – M12 Motorway (Design)

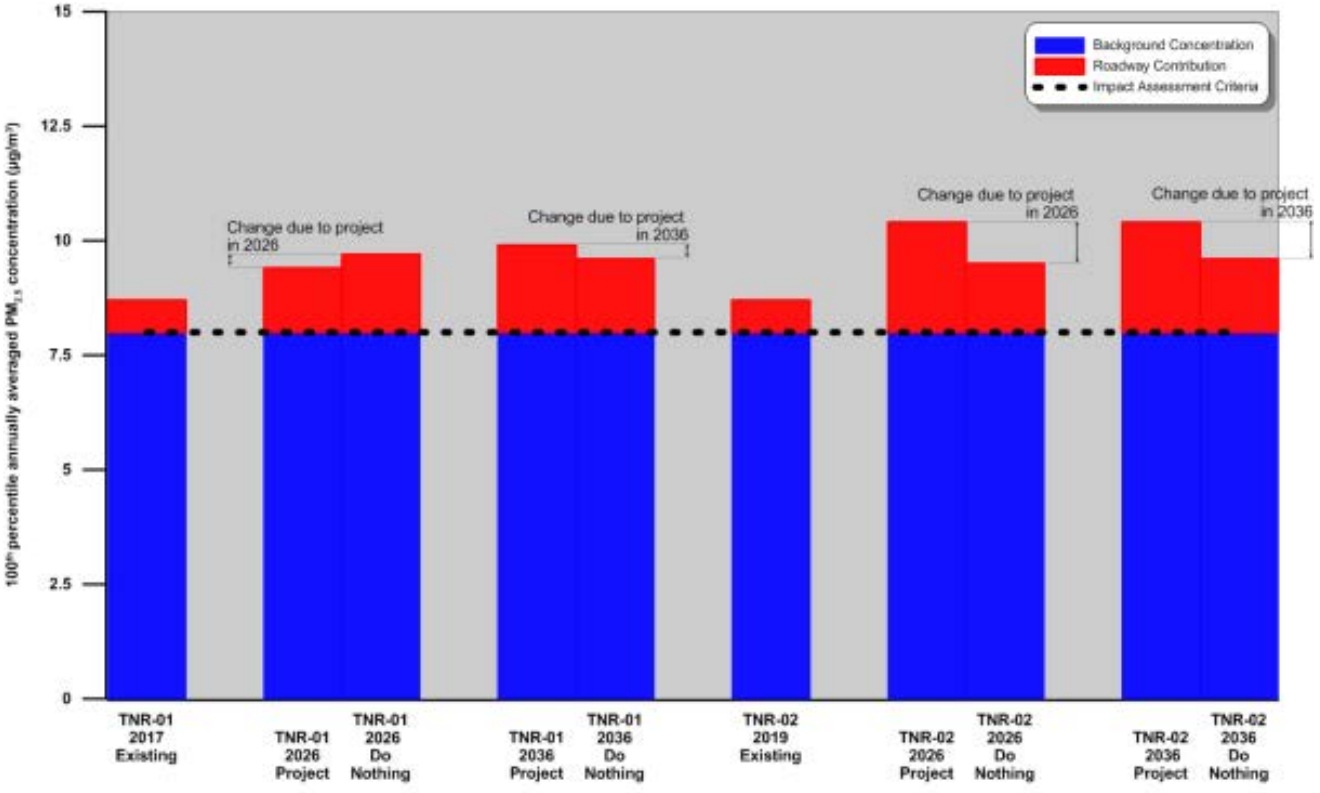

Figure 8-27 Predictions of annually averaged $PM_{2.5}$ at nearest receivers – The Northern Road (Design)

As shown in **Figure 8-28**, contributions from 2026 project at the nearest receivers along segments M7_01 and M7_02 were predicted to decrease by 0.1 µg/m^3 compared with the no project option. For 2036, contributions at the nearest receiver along segment M7_01 decreased by 0.5 µg/m^3. Along segment M7_02 this reduction between the project and no project options was 0.2 µg/m^3. The highest total (ie background plus roadway contribution) concentration at the most-affected receiver for the project options assessed was of 11.5 µg/m^3.

As shown in **Figure 8-29**, contributions with the project for Elizabeth Drive segments were predicted to decrease by 0.2 µg/m^3 in 2026 and 0.5 µg/m^3 in 2036 between no-project and project scenarios. The highest total (ie background plus roadway contribution) concentration at the most-affected receiver for the project options assessed was of 8.9 µg/m^3.

While the impact assessment criteria of eight µg/m^3 from the Approved Methods does not strictly apply to road projects, it was used as the basis for triggering further investigation of the spatial extent of changes when exceeded at the nearest, most-affected receiver for each segment. However, noting that there is only one sensitive receiver within the study area around Elizabeth Drive, which has already been reviewed above, no further assessment for this segment was identified as necessary.

Given the total concentrations would be higher than the criteria defined in the Approved Methods, the sensitive receivers predicted to experience changes in annually averaged $PM_{2.5}$ concentrations were identified. The number of these receivers, and the magnitude of change that would be experienced, are presented in **Table 8-28** and **Table 8-29**.

These receivers were identified by first predicting how concentrations of $PM_{2.5}$ would vary with distance from the roadway in each segment, under each scenario. Figures that show how the concentrations vary over distance are presented in Section 6.2.4 of **Appendix P**. Aerial imagery was then used to identify the number of sensitive receivers predicted to experience a change in annually averaged $PM_{2.5}$ concentrations.

As shown in **Table 8-28**, no sensitive receivers in the M12 Motorway segments were predicted to experience changes more than two µg/m^3 above existing levels. However, 11 receivers are predicted to experience an increase (still within one to two µg/m^3) of annually averaged $PM_{2.5}$ road contributions from 2026 to 2036.

As shown in **Table 8-29**, the project was predicted to result in one additional sensitive receiver within the operational study area experiencing annually averaged $PM_{2.5}$ contributions that are greater than two µg/m^3 along segment TNR_02, compared with the no project option. For segment TNR_01, in 2026 there was no change in the number of receivers between these categories. For 2036, there was one additional receiver that would experience road contributions ranging from one to two µg/m^3 compared with the no project option.

The project would result in one less receiver experiencing annually averaged $PM_{2.5}$ contributions of more than two µg/m^3 compared with the no project scenario in 2036 for the M7 Motorway segments; indicating a small improvement as a result of the project.

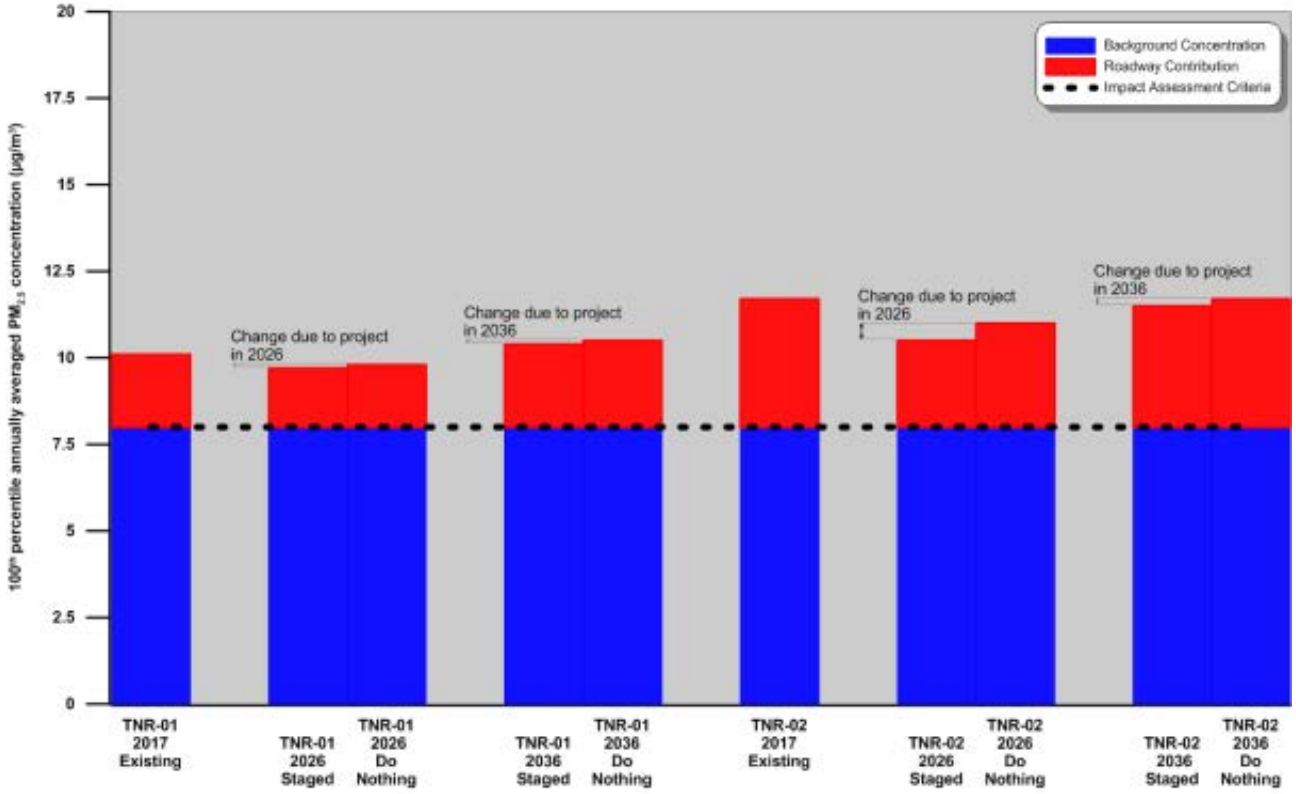

Figure 8-28 Predictions of annually averaged $PM_{2.5}$ at nearest receivers – M7 Motorway (Design)

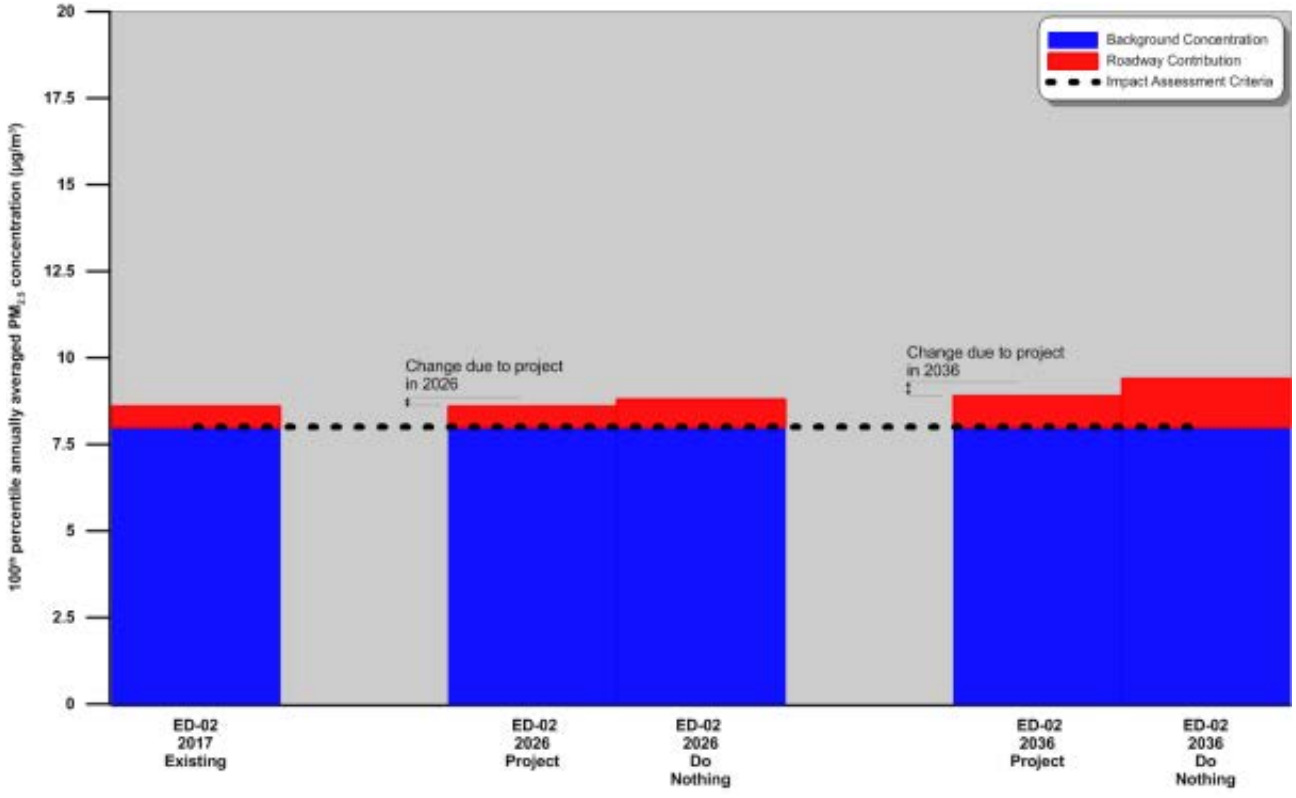

Figure 8-29 Predictions of annually averaged $PM_{2.5}$ at nearest receiver – Elizabeth Drive (Design)

Table 8-27 Number of receivers predicted to experience different magnitudes of change in annually averaged $PM_{2.5}$ concentrations as a result of the project – M12 Motorway

Road segment	Number of sensitive receivers in operational study area predicted to experience change					
	Greater than 2 µg/m³		1 to 2 µg/m³		Less than 1 µg/m³	
	2026	2036	2026	2036	2026	2036
M12_01	0	0	1	1	1	1
M12_02	0	0	1	2	3	2
M12_03	0	0	4	7	6	3
M12_04	0	0	5	12	10	3
Total	0	0	11	22	20	9

Table 8-28 Number of receivers predicted to experience different magnitudes of change in annually averaged $PM_{2.5}$ concentrations as a result of the project – The Northern Road and the M7 Motorway

Road segment	Number of sensitive receivers in operational study area predicted to experience change											
	Greater than 2 µg/m³				1 to 2 µg/m³				Less than 1 µg/m³			
	2026		2036		2026		2036		2026		2036	
	Without project	With project	Without project	With project	Without project	With project	Without project	With project	Without project	With project	Without project	With project
TNR_01	0	0	0	0	1	1	1	2	4	4	4	3
TNR_02	0	1	0	1	2	1	2	1	0	0	0	0
M7_01	10	10	55	55	45	45	0	0	0	0	0	0
M7_02	4	4	6	5	2	2	0	1	0	0	0	0
Total	14	15	61	61	50	49	3	4	4	4	4	3

Carbon Monoxide

M12 Motorway segments

Existing and project-contributed 1-hour and 8-hour averaged carbon monoxide concentrations at the nearest, most-affected receivers along the M12 Motorway segments are presented in **Table 8-29**. In summary, road contributions of carbon monoxide at the nearest, most-affected receivers along the M12 Motorway segments are typically in the range of 0.2 to 0.4 mg/m³. The total carbon monoxide concentrations resulting from the project would be well below the 1-hour 30 mg/m³ and 8-hour 10 mg/m³ impact assessment criteria, as defined in the Approved Methods.

Table 8-29 Summary of predictions of CO at nearest receivers – M12 Motorway

Averaging period	Segment	Existing 2017 (mg/m^3)	2026, project (mg/m^3)		2036, project (mg/m^3)	
			Road contribution	Background + Road contribution	Road contribution	Background + Road contribution
1-hour	M12_01	3	0.2	3.2	0.4	3.4
	M12_02		0.3	3.3	0.5	3.5
	M12_03		0.4	3.4	0.6	3.6
	M12_04		0.3	3.3	0.5	3.5
8-hour	M12_01	2	0.2	2.2	0.3	2.3
	M12_02		0.2	2.2	0.3	2.3
	M12_03		0.3	2.3	0.4	2.4
	M12_04		0.2	2.2	0.3	2.3

The Northern Road, M7 Motorway and Elizabeth Drive segments

Existing and project-contributed 1-hour and 8-hour averaged carbon monoxide concentrations at the nearest, most-affected receivers along The Northern Road, the M7 Motorway and Elizabeth Drive segments are presented in **Table 8-30**.

For the nearest, most-affected receivers along The Northern Road segments, increases of 1-hour averaged carbon monoxide levels between 0.2 mg/m^3 and 0.3 mg/m^3 relative to existing levels are predicted in 2026 and 2036, with minimal (maximum increase of 0.1 mg/m^3) changes between the project and no-project scenarios.

For the nearest, most-affected receivers along The Northern Road segments, increases of 8-hour averaged carbon monoxide levels of between 0.1 mg/m^3 and 0.2 mg/m^3 relative to existing levels are predicted in 2026 and 2036, with no change between the project and no-project scenarios.

For the nearest, most-affected receivers along the M7 Motorway segment, increases of 1-hour averaged carbon monoxide levels between 0.1 mg/m^3 and 0.4 mg/m^3 relative to existing levels are predicted in 2026 and 2036, with increases of between 0.1 mg/m^3 and 0.4 mg/m^3 between the project and no-project scenarios.

For the nearest, most-affected receivers along the M7 Motorway segment, increases of 8-hour averaged carbon monoxide levels between 0.1 mg/m^3 and 0.2 mg/m^3 relative to existing levels are predicted in 2026 and 2036, with increases of between 0.1 mg/m^3 and 0.2 mg/m^3 between the project and no-project scenarios.

For the nearest, most-affected receivers along the Elizabeth Drive segment, increases of 1-hour averaged carbon monoxide levels of 0.1 mg/m^3 relative to existing levels are predicted in 2026 and 2036, with minimal (maximum increase of 0.1 mg/m^3) positive changes to carbon monoxide air quality resulting from the project when compared to the no-project scenario.

For the nearest, most-affected receivers along the Elizabeth Drive segment, increases of 8-hour averaged carbon monoxide levels of 0.1 mg/m^3 relative to existing levels are predicted in 2026 and 2036, with no change between the project and no-project scenarios.

In summary, resulting total 1-hour and 8-hour concentrations at the most affected receiver would be below the 1-hour 30 mg/m^3 and 8-hour 10 mg/m^3 impact assessment criteria for all segments, as defined in the Approved Methods.

Table 8-30 Summary of predictions of CO at nearest receivers – The Northern Road, M7 Motorway and Elizabeth Drive

Averaging period	Segment	Existing 2017 (mg/m^3)		2026, project (mg/m^3)		2026, no project (mg/m^3)		2036, project (mg/m^3)		2036, no project (mg/m^3)	
		Road	Bg + Road	Road	Bg + Road	Road	Bg + Road	Road	Bg + Road	Road	Bg + Road
1-hour	TNR_01	0.1	3.1	0.3	3.3	0.3	3.3	0.3	3.3	0.3	3.3
	TNR_02	0.2	3.2	0.5	3.5	0.4	3.4	0.5	3.5	0.5	3.5
	M7_01	0.3	3.3	0.4	3.4	0.3	3.3	0.4	3.4	0.3	3.3
	M7_02	0.5	3.5	0.9	3.9	0.5	3.5	0.9	3.9	0.7	3.7
	ED_02	0	3.0	0.1	3.1	0.1	3.1	0.1	3.1	0.2	3.2
8-hour	TNR_01	0.1	2.1	0.2	2.2	0.2	2.2	0.2	2.2	0.2	2.2
	TNR_02	0.1	2.1	0.3	2.3	0.3	2.3	0.3	2.3	0.3	2.3
	M7_01	0.2	2.2	0.3	2.3	0.2	2.2	0.3	2.3	0.2	2.2
	M7_02	0.4	2.4	0.6	2.6	0.4	2.4	0.6	2.6	0.5	2.5
	ED_02	0	2.0	0.1	2.1	0.1	2.1	0.1	2.1	0.1	2.1

Nitrogen Dioxide

M12 Motorway segments

Existing and project-contributed 1-hour and annually averaged nitrogen dioxide concentrations at the nearest, most-affected users along the M12 Motorway segments are presented in **Table 8-31**. In summary, 1-hour averaged road contributions of nitrogen dioxide at the nearest, most-affected receivers along the M12 Motorway segments are typically in the range of six mg/m^3 to eight mg/m^3, while annually averaged road contributions of nitrogen dioxide are typically in the range of one mg/m^3 to two mg/m^3. The total nitrogen dioxide concentrations resulting from the project would be below the 1-hour 246 mg/m^3 and annually averaged 62 mg/m^3 impact assessment criteria, as defined in the Approved Methods.

Table 8-31 Summary of predictions of NO_2 at nearest receivers – M12 Motorway

Averaging period	Segment	Existing 2017 (mg/m^3)	2026, project (mg/m^3)		2036, project (mg/m^3)	
			Road contribution	Background + Road contribution	Road contribution	Background + Road contribution
1-hour	M12_01	74	6	80	6	80
	M12_02		7	81	6	80
	M12_03		8	82	7	81
	M12_04		7	81	6	80

Averaging period	Segment	Existing 2017 (mg/m^3)	2026, project (mg/m^3)		2036, project (mg/m^3)	
			Road contribution	Background + Road contribution	Road contribution	Background + Road contribution
Annual	M12_01	12	1	13	1	13
	M12_02		1	13	1	13
	M12_03		2	14	1	13
	M12_04		1	13	1	13

The Northern Road, M7 Motorway and Elizabeth Drive segments

Existing and project-contributed 1-hour and annual averaged nitrogen dioxide concentrations at the nearest, most-affected receivers along The Northern Road, the M7 Motorway and Elizabeth Drive are presented in **Table 8-32**.

For the nearest, most-affected receivers along segment TNR_01, decreases of 1-hour averaged nitrogen dioxide levels of two mg/m^3 relative to existing levels are predicted in 2026 and 2036. There would be a decrease of four mg/m^3 in 2026 between the respective no-project and project scenarios; and an increase of two mg/m^3 between the respective no-project and project scenarios in 2036. This would result in an overall improvement in nitrogen dioxide air quality.

For the nearest, most-affected receivers along segment TNR_02, increases of 1-hour averaged nitrogen dioxide levels of seven mg/m^3 relative to existing levels are predicted in 2026 and 2036, with increases of six mg/m^3 and 11 mg/m^3 between the respective no-project and project scenarios.

For the nearest, most-affected receivers along segment TNR_01, maximum decreases of annually averaged nitrogen dioxide levels of one mg/m^3 relative to existing levels are predicted in 2026 and 2036, with a maximum decrease of one mg/m^3 between the 2026 and 2036 respective no-project and project scenarios. This would result in an overall slight improvement in nitrogen dioxide air quality.

For the nearest, most-affected receivers along segment TNR_02, increases of annually averaged nitrogen dioxide levels of one mg/m^3 relative to existing levels are predicted in 2026 and 2036, with increases of one mg/m^3 and two mg/m^3 between the respective project and no-project scenarios.

For the nearest, most-affected receivers along the M7 Motorway segments, decreases of 1-hour averaged nitrogen dioxide levels of between 32 mg/m^3 and 15 mg/m^3 relative to existing levels are predicted in 2026 and 2036 for both project and no-project scenarios. This would result in an overall improvement in nitrogen dioxide air quality relative to existing levels. However for segment M7_01, an increase of 1-hour nitrogen dioxide levels of one mg/m^3 and six mg/m^3 between the respective project and no-project scenarios is predicted. For segment M7_02, a decrease of 1-hour nitrogen dioxide levels of two mg/m^3 and an increase of six mg/m^3 between the respective project and no-project scenarios is predicted.

For the nearest, most-affected receivers along the M7 Motorway segments, decreases of annually averaged nitrogen dioxide levels of between three mg/m^3 and seven mg/m^3 relative to existing levels are predicted in 2026 and 2036. This would result in an overall improvement in nitrogen dioxide air quality relative to existing levels. There would also be a maximum decrease of one mg/m^3 between the 2026 and 2036 respective project and no-project scenarios. This would also result in an overall slight improvement in nitrogen dioxide air quality.

For the nearest, most-affected receivers along the Elizabeth Drive segment, decreases of 1-hour averaged nitrogen dioxide levels of one mg/m^3 relative to existing levels are predicted in 2026 and 2036, with decreases of up to one mg/m^3 between the project and no-project scenarios.

For the nearest, most-affected receivers along the Elizabeth Drive segment, no change in annually averaged nitrogen dioxide levels was predicted relative to existing in 2026 and 2036, and no change was predicted between the 2026 and 2036 project and no-project scenarios. This would result in no change to existing nitrogen dioxide air quality.

In summary, the total nitrogen dioxide concentrations resulting from the project were predicted to be below the 1-hour 246 mg/m^3 and annual averaged 62 mg/m^3 impact assessment criteria, as defined in the Approved Methods. Additional results are summarised below.

Table 8-32 Summary of predictions of NO_2 – The Northern Road, M7 Motorway and Elizabeth Drive

Averaging period	Segment	Existing 2017 (mg/m^3)		2026, project (mg/m^3)		2026, no project (mg/m^3)		2036, project (mg/m^3)		2036, no project (mg/m^3)	
		Road	Bg + Road	Road	Bg + Road	Road	Bg + Road	Road	Bg + Road	Road	Bg + Road
1-hour	TNR_01	8	82	6	80	10	84	6	80	4	78
	TNR_02	8	82	15	89	9	83	15	89	4	78
	M7_01	31	105	16	90	15	89	16	90	22	96
	M7_02	54	128	22	96	24	98	22	96	26	90
	ED_02	4	78	3	77	4	78	3	77	4	78
Annual	TNR_01	2	14	1	13	2	14	1	13	1	13
	TNR_02	2	14	3	15	2	14	3	15	1	13
	M7_01	6	18	3	15	3	15	3	15	4	16
	M7_02	11	23	4	16	5	17	4	16	5	17
	ED_02	1	13	1	13	1	13	1	13	1	13

Volatile organic compounds

1-hour averaged VOCs (as benzene) concentrations predicted at the nearest receivers along the M12 Motorway, The Northern Road, the M7 Motorway and Elizabeth Drive are presented in **Table 8-33**.

VOCs are not presently measured at any EESG air quality monitoring stations. As outlined in the Western Sydney Airport EIS, (Pacific Environment Limited, 2016), two historical studies have previously been completed by the NSW EPA to investigate baseline concentrations of air toxics:

- Air Toxics Monitoring Program (ATMP) involving the collection of 24 hour-averaged measurements at the Sydney CBD, Rozelle, St Marys and Blacktown from 1996 to 2001
- Ambient Air Quality Monitoring and Fuel Quality Testing Project (AAQMFQTP) where 24 hour-averaged measurements were collected from October 2008 to October 2009 at Turrella and Rozelle.

During the ATMP study, annual and 24 hour-averaged benzene concentrations of 1.4 µg/m^3 and 4.2 µg/m^3 were measured at St Marys respectively. Annual benzene concentrations of 1.4 µg/m^3 were measured at Turrella during the AAQMFQTP study. one-hour averaged concentrations would generally be higher and modifying the formula provided in the 'AUSPLUME Gaussian Plume Dispersion Model Technical User Manual', (Victorian EPA 2000) for estimating sub-hourly concentrations from hourly data a one-hour concentration of 7.9 µg/m^3 was estimated from the 24 hour-averaged concentration measured at St Marys in the ATMP study. Compared with this value, roadway contributions were predicted to be small.

The results presented in **Table 8-33** indicate that the project would only result in increases in road-related benzene concentrations relative to no project scenarios for both assessment horizons (ie 2026 and 2036) of up to one µg/m^3, and that contributions would be well below the 29 µg/m^3 criteria, as defined in the Approved Methods

Table 8-33 Summary of predictions for VOCs as benzene

Averaging period	Segment	Roadway contribution (µg/m^3)				
		Existing 2017	2026, project	2026, no project	2036, project	2036, no project
1-hour	M12_01	-	0.2	-	0.3	-
	M12_02	-	0.2	-	0.3	-
	M12_03	-	0.3	-	0.4	-
	M12_04	-	0.2	-	0.3	-
	TNR_01	0.1	0.5	0.4	0.5	0.4
	TNR_02	0.2	0.6	0.4	0.6	0.4
	M7_01	0.5	0.6	0.5	0.6	0.6
	M7_02	0.9	0.9	0.8	0.9	0.9
	ED_02	0.2	0.2	0.2	0.2	0.3

Regional air quality

Concentrations due to emissions from vehicle exhausts, wearing of tyres, vehicle braking, the road surface, and re-entrainment exhibit a pronounced spatial decline with distance from the roadway. Given the distance (four and seven kilometres respectively) emissions from the project would not lead to concentration contributions at levels that would adversely affect measured air quality conditions at the nearest Bringelly and Liverpool EESG of DPIE air quality monitoring stations. As such it could be concluded that the project is unlikely to have a measurable effect on background air quality conditions.

However, as presented in **Appendix F**, the project could result in changes in traffic conditions at other locations around the Sydney Region, beyond the operational study area. These changes in traffic conditions could also result in changes in air quality conditions at nearby sensitive receivers. Where the number of vehicles increases and/or flow conditions deteriorate (ie congestion increases), there is the potential for localised increases in road-related pollutant contributions. There is also the potential for improvements, where traffic volumes decrease, and/or the degree of congestion is indirectly reduced as a result of the project. These regional changes beyond the operational study area would be attributable to the project.

8.2.5 Cumulative impacts

Infrastructure and urban development projects that are planned or under construction in the vicinity of the project are presented in **Table 7-3**.

Specifically, a range of other transport infrastructure and urban development projects have started or are planned in or near the primary study area. These include major road infrastructure upgrades associated with the WSIP, the Western Sydney Airport, upgrade of The Northern Road, transport projects such as the Sydney Metro Greater West, and the planned future development of the Western Sydney Aerotropolis.

Cumulative impacts were reviewed by considering the impacts predicted in publicly available environmental impact assessments for the above projects, in conjunction with those predicted for the M12 Motorway. Operational cumulative impacts have already been considered for several projects in the area, with traffic associated with upgrades along The Northern Road, Elizabeth Drive and Mamre Road; as well as traffic from the operation of the Western Sydney Airport having already been included in the traffic inputs applied in the assessment.

Interaction with these projects may change the air quality impacts of the project as presented in **Table 8-34.** These projects are in varying stages of delivery and planning.

Table 8-34 provides a qualitative assessment of the potential for cumulative local and regional air quality impacts based on the predictions for the M12 Motorway presented throughout this section, and the most current and publicly available information on the projects presented in **Table 8-34**.

A high-level qualitative assessment was carried out for projects as limited information is presently available. A quantitative assessment has however been carried out to assess for the potential for cumulative impacts in conjunction with the operation of the Western Sydney Airport (noting that traffic from the airport have already applied in the assessment). This was assessed separately below.

Table 8-34 Cumulative air quality impacts

Project and status	Cumulative impacts
Sydney Metro Greater West Not yet approved	During any timeframes where construction activities are concurrent, increased air quality impacts may be likely. This would be dependent on the specific construction locations and the different construction activities. it is likely that the primary construction-related air quality risk would also be dust emissions. It is anticipated that air quality management measures for the construction of the Sydney Metro Greater West would be developed and implemented, in addition to the air quality management measures presented in **Section 8.2.6**. Although there would be the potential for cumulative, localised dust impacts when both projects are being constructed, emissions from both projects are expected to be adequately controlled. As such, it is considered that there is the potential for cumulative local dust impacts during construction of both projects, but that emissions from both projects would be effectively controlled so that the potential for cumulative impacts at receivers would be limited. There is also the potential for localised increases in other emissions associated with the construction activities (ie exhaust emissions, odours, airborne hazardous materials). This risk is also considered to be limited. It is not expected that cumulative regional, construction-related air quality issues would occur as a result of the M12 Motorway and the Sydney Metro Greater West. Sydney Metro Greater West would use electrified trains, which have no local emissions. The Sydney Metro Greater West would not contribute any air emissions locally, as these emissions would occur where the electricity used is generated (ie a coal-fired power station). As a result, negligible cumulative operation air quality impacts are anticipated.
The Northern Road upgrade Approved. Construction has begun	Where The Northern Road construction activities occur around the vicinity of the intersection with the M12 Motorway there is the potential for some receivers to be affected by dust from cumulatively occurring activities under certain meteorological conditions. The scale of the impacts would be dependent on the timing and location of concurrent construction activities for both projects as well as meteorological conditions.

Project and status	Cumulative impacts
	As such, there would be moderate potential for cumulative air quality impacts associated with the construction of the M12 Motorway and The Northern Road upgrade Stage 5 and 6. The scale of the impacts would be dependent on the timing and location of concurrent construction activities for both projects. It is anticipated that air quality management measures for the construction of The Northern Road upgrade would be developed and implemented, in addition to the air quality management measures presented in **Section 8.2.6**. Controls for both projects were designed to ensure that localised impacts during construction would be minimised. As such, cumulative regional, construction-related air quality are not expected. Changes in future traffic along The Northern Road are already considered in the operational air quality assessments completed for the M12 Motorway.
Other existing road network upgrades and potential road projects, including: • Elizabeth Drive upgrade • Mamre Road upgrade • Outer Sydney Orbital Not yet approved	Where works take place at the same time and location, there would be some potential for cumulative air quality impacts during construction of the M12 Motorway and other road projects. Contributions from the M12 Motorway and these other projects could be equivalent but would depend on the relative location and intensity of works being completed, and meteorology at the time of the concurrent works. It is anticipated that controls for all these projects would be developed to ensure that localised impacts during construction would be minimised. Considering this, significant cumulative regional, construction-related air quality are not expected. Changes in traffic as a result of upgrades along Elizabeth Drive and Mamre Road are already considered in the traffic inputs applied in the assessment. Changes in traffic as a result of the Outer Sydney Orbital project would be dependent on changed traffic conditions for the M12 Motorway and the proposed Orbital, and are unknown at the time of writing.
Major land releases, including: • Western Sydney Aerotropolis • South West Growth Area • Western Sydney Employment Area. Future strategic government project	Where works take place at the same time and location, there would be some potential for cumulative air quality impacts during construction of the project and these projects. Contributions from the project and these other projects could be equivalent but would depend on the relative location and intensity of works being completed, and meteorology at the time of the concurrent works. It is anticipated that air quality management measures for these projects would be developed and implemented, in addition to the air quality management measures presented in **Section 8.2.6**. As a result, significant cumulative regional, construction-related air quality impacts are not anticipated. Over time, there is the potential that the M12 Motorway and these land releases may influence local air quality conditions around the project, resulting in cumulative impacts. The extent of the impacts of the operational air quality would depend on changed traffic conditions, and are unknown at the time of writing.

Western Sydney Airport

Construction

The potential for impacts from construction activities for the Western Sydney Airport was assessed quantitatively, whereas the UK IAQM risk-based approach was applied for the project. This means that it isn't possible to directly compare the predicted impacts from the two projects.

However, a high risk of dust impacts during construction at receivers within the construction study area was determined for the project (see **Section 8.2.4**). It is estimated that the magnitude of emissions from bulk earthwork activities at the Western Sydney Airport also represent a high risk of impacts on receivers within the M12 Motorway construction study area. It is considered that the scale of contributions at surrounding receivers from the two projects would be comparable. Controls for the project below in **Section 8.2.6** were developed so that residual (ie post-mitigation) dust-related risks from construction activities would be reduced to the extent where they could be effectively managed. The same level of control is expected from activities during the construction of the Western Sydney Airport. The same level of control is also to be applied for other emissions associated with the construction activities (ie exhaust emissions, odours, airborne hazardous materials) from both projects.

As such, it is considered that there would be a high potential for cumulative dust-related impacts during the concurrent construction of both projects. However, measures were committed for both projects to minimise risks associated with emissions during construction. Therefore, although both projects represent a high unmitigated risk of air quality impacts during construction and hence a high potential for cumulative impacts, measures were committed to reduce these risks to the extent where they could be effectively managed. Considering this, there would be some potential for local cumulative impacts at sensitive receivers within the construction study area, although it is expected that these would be controlled to a level that they would present a limited level of risk. Wider regional cumulative impacts during construction would not be expected from both projects.

Operation

The Western Sydney Airport and the project would be operational at the same time. A summary of predicted pollutant contributions from the 'airport only' from the 'Western Sydney Airport EIS – Local Air Quality and Greenhouse Gas Assessment', (Pacific Environment Limited, 2016) at receivers around the project, and the values from the project are listed in **Table 8-35**.

Table 8-35 Approximate concentrations for each project during operations

Pollutant	Western Sydney Airport		M12 Motorway
	Stage 1 operations (around 2030)	Longer term operations (around 2063)	10 years' after opening (2036)
24-hour averaged PM_{10}	2 to 0.5 µg/m^3	8 to 4 µg/m^3	Up to 4 µg/m^3
Annually averaged PM_{10}	0.2 to 0.05 µg/m^3	0.8 to 0.2 µg/m^3	Up to 1.8 µg/m3
24-hour averaged $PM_{2.5}$	2 to 0.5 µg/m^3	8 to 4 µg/m^3	Up to 4 µg/m^3
Annually averaged $PM_{2.5}$	0.2 to 0.05 µg/m^3	0.8 to 0.2 µg/m^3	Up to 1.5 µg/m^3
1-hour averaged NO_2	70 to 150 µg/m^3	220 to 520 µg/m^3	Up to 8 µg/m^3
Annually averaged NO_2	11 to 13 µg/m^3	20 to 40 µg/m^3	Up to 2 µg/m^3
1-hour averaged CO	0.2 to 1.5 mg/m^3	Not presented	Up to 0.6 mg/m^3
8-hour averaged CO	0 to 0.2 mg/m^3	Not presented	Up to 0.4 mg/m^3
1-hour averaged VOCs	0.1 to 0.3 µg/m^3	Not presented	Up to 0.4 µg/m^3

These results indicate that maximum particulate matter contributions at nearby receivers from the operation of the project and the Western Sydney Airport would be comparable. This would also be the case for CO and VOCs as benzene. NO_2 contributions would be around an order of magnitude higher from the Airport than the project.

Together it is expected that the concurrent operation of the project and the Western Sydney Airport may result in cumulative local operational impacts at receivers within the operational study area. This could result in some receivers occasionally experiencing 24-hour and lower averaging time pollutant concentrations approaching or exceeding the impact assessment criteria, and a higher frequency of these instances. Annually averaged concentrations are also likely to increase.

At a regional scale, the potential for operational impacts from the project was determined to be limited as discussed previously. Emissions to air from operations at the Western Sydney Airport are expected to be much more significant regionally. As such, it is not expected that the project would change or materially affect the potential for regional operational impacts from operations at the Western Sydney Airport.

Conclusion

It was concluded that the project would not lead to unacceptable air quality impacts, and that the need for more detailed assessment would not be required. This conclusion is based on the determination of potential local and regional impacts on air quality during both construction and operational stages, including potential cumulative impacts. With the application of the appropriate safeguards it is anticipated that air quality impacts from the project during construction would be effectively managed.

8.2.6 Environmental management measures

Using the UK IAQM method, as described above in **Section 8.2.4**, it was determined that the project presents a 'high' risk of dust impacts during construction. Based on this level of risk, the method recommends the implementation of specific and other standard measures which are listed in Table 8-1 and Table 8-2 of **Appendix P**. These measures would be reviewed by the construction contractor once detailed design was completed and updated as necessary.

The environmental management measures that would be implemented to minimise the air quality impacts of the project, along with the responsibility and timing for those measures, are presented in **Table 8-36**.

Table 8-36 Environmental management measures (air quality)

Impact	Reference	Environmental management measure	Responsibility	Timing
General air quality impacts during construction	AQ01	A construction air quality management plan (CAQMP) will be developed and implemented for the project to manage potential air quality impacts associated with construction. The CAQMP will identify activities that may results in air quality impacts and associated mitigation measures to avoid or minimise these impacts. The CAQMP will provide: • Measures to minimise dust generation associated with earthworks and other activities that disturb the ground surface, stockpiles, and haulage routes • Measures to minimise emissions from machinery and vehicles associated with the project • Procedures for inspection, monitoring and addressing any impacts where required. The CAQMP will be implemented for the duration of construction.	Contractor	Prior to construction and during construction

Impact	Reference	Environmental management measure	Responsibility	Timing
Dust impacts during construction	AQ02	Dust generation will be minimised during construction where possible. Where practicable, specific measures will include (but not be limited to): • Regularly watering exposed and disturbed areas including stockpiles, especially during inclement weather conditions • Adjusting the intensity of activities based on measured and observed dust levels, weather forecasts and the proximity of and direction of the works in relation to the nearest surrounding receivers • Ensuring loads are covered, and any loose materials/debris are removed before vehicles exit the site • Minimising the number of stockpiles and amount of material stockpiled where practicable • Positioning stockpiling areas as far as possible from surrounding receivers, including potentially ecologically sensitive receivers • Limiting stockpiling activities during conditions where winds are blowing strongly in the direction(s) from the stockpiling location to nearby receivers • Consultation with nearby developers to co-ordinate and plan activities where practicable to minimise the potential for cumulative dust-related impacts • The planning and undertaking of demolition activities, including the removal of hazardous building materials in a manner that minimises dust generation. This will also include the removal of hazardous building materials before the start of general demolition works.	Contractor	During construction
Odours during construction	AQ03	Odorous materials identified on site will be excavated in a staged process and exposed areas of odorous material will be kept to a minimum to reduce the total emissions from the site where feasible.	Contractor	During construction

8.3 Health and safety

This section describes the potential health and safety impacts that may be generated by the construction and operation of the project and presents a proposed approach to managing these impacts. **Table 8-37** outlines the SEARs that relate to health and safety and identifies where they were addressed in this EIS.

Table 8-37 SEARs (health and safety)

Secretary's requirement	Where addressed in this EIS
19. Health and safety	
1. The Proponent must assess the potential health impacts of the project, in accordance with the current guidelines.	The policy and planning setting, including current guidelines, is presented in **Section 7.4.1** and **Section 8.3.1** Impacts on community values, including community health and wellbeing, are presented in **Section 7.4.4** Further discussion of health impacts is presented in **Section 8.3.4**
2. The assessment must: a. describe the current known health status of the affected population;	The existing health environment, including the current health status of the affected population, is presented in **Section 8.3.3**
b. assess health risks associated with exposure to environmental hazards;	Potential health risks associated with exposure to environmental hazards are assessed in **Sections 8.3.4**
c. assess the effect of the project on other relevant determinants of health such as the level of physical activity and access to social infrastructure;	Potential impacts of the project during both construction and operation are described in **Section 8.3.4**
d. assess opportunities for health improvement;	Opportunities for health improvement are assessed in **Section 8.3.5**
e. assess the distribution of the health risks and benefits; and	Distribution of health risks and potential benefits during construction and operational are described in **Section 8.3.4**
f. discuss how, in the broader social and economic context of the project, the project will minimise negative health impacts while maximising the health benefits.	**Section 7.4.3** discusses the social and economic context of the project, including community health and wellbeing Additional detail regarding negative health impacts and health benefits are discussed in **Section 8.3.4** and **Section 8.3.5**
3. The Proponent must assess the likely risks of the project to public safety, paying particular attention to pedestrian safety, subsidence risks, bushfire risks and the handling and use of dangerous goods.	Likely risks to public safety during both construction and operation are described in **Section 8.3.4** The project is not located in the vicinity of any mine subsidence developments or mine subsidence districts, and as a result subsidence risks are not further considered

8.3.1Policy and planning setting

The health and safety assessment was prepared in accordance with national and international legislation, policy and guidance that is endorsed or accepted by Australian health and environmental authorities. This includes, but is not limited to:

- *Environmental Planning and Assessment Act 1979*
- *Work Health and Safety Act 2011*
- *Rural Fires Act 1997*
- Environmental Health Risk Assessment: Guidelines for Assessing Human Health Risks from Environmental Hazards: 2012 (enHealth 2012)
- Health Impact Assessment Guidelines (enHealth 2017)
- Health Impact Assessment: A Practical Guide (NSW Health 2007)
- Fairfield, Penrith and Liverpool Local Environmental Plans (LEPs)
- Planning for Bush Fire Protection (NSW Rural Fire Service, 2006).

In addition, the following was considered:

- Methodology for Valuing the Health Impacts of Changes in Particle Emissions (NSW EPA, 2013)
- NSW Health, Building Better Health, Health considerations for urban development and renewal in the Sydney Local Health District (LHD) (NSW Health, 2016)
- NSW Health, Healthy Urban Development Checklist, A guide for health services when commenting on development policies, plans and proposals, 2009
- State Environmental Planning Policy No. 33 (SEPP 33) – Hazardous and Offensive Development (NSW)
- Planning for Bush Fire Protection (NSW Rural Fire Service, 2006).

8.3.2 Assessment methodology

The project has the potential to impact on the health and safety of the construction workforce and the communities around the project. An assessment was carried out in accordance with the policies and guidance presented in **Section 8.3.1** and using the methodology described in this section.

Where relevant, risks to health and safety were assessed through qualitative risk assessment techniques. In general, the assessment identified potential health and safety impacts, assessed the likelihood and consequences of occurrence of the impacts, and provided an estimate of the risk levels for people who could be exposed.

Existing environment

The existing environment was reviewed and described by undertaking a desktop review of the following databases:

- NSW Ministry of Health's NSW Population Health Survey (Secure Analytics for Population Health Research and Intelligence (SAPHaRI))
- Australian Bureau of Statistics (ABS) Census of Population and Housing Basic Community Profile
- ABS National Health Survey: First Result, 2014-2015
- ABS Participation in Sport and Physical Recreation
- ABS Work-Related Injuries (ABS, 2014)
- Roads and Maritime Interactive Crash Statistics

- NSW Government's Planning Portal: Mine Subsidence Development areas and Mine Subsidence Districts
- LGA and Council Bushfire Prone Land Maps.

Where relevant, the existing environment for the Greater Western Sydney Area was also assessed for comparison purposes.

Study area

The study area for this health and safety assessment comprises communities closest to the project and includes communities likely to experience the greatest health and safety impacts from the project's location, construction and operation. The health and safety study area is the same as the primary socio-economic study area (see **Section 7.4**), and includes the ABS Statistical Area Level 2 (SA2) geographies of:

- Cecil Hills SA2
- Austral-Greendale SA2
- Horsley Park-Kemps Creek SA2
- Mulgoa-Luddenham-Orchard Hills SA2
- Badgerys Creek SA2.

The health and safety study area is presented in **Figure 8-30**.

Information on community health status and health risk factors is collected by the NSW Ministry of Health and the ABS. The study area is covered by two local health districts (LHD), for the SAPHaRI (**Figure 8-30**):

- South-western Sydney LHD – covers the LGAs of Fairfield, Liverpool, Bankstown, Camden, Campbelltown, Wollondilly and Wingecarribee
- Nepean Blue Mountains LHD – covers the LGAs of Penrith, Blue Mountains, Hawkesbury and Lithgow.

Additional data regarding the current known health status of the population within the study is provided by the ABS according to statistical areas and LGAs. Those covered by the study area are:

- Austral-Greendale SA2
- Mulgoa-Luddenham-Orchard Hills SA2
- Badgerys Creek Statistical Area Level 2 SA2
- Horsley Park-Kemps Creek SA2
- Cecil Hills SA2.

In some cases, where local data for these statistical areas is not available, information was obtained (or compared with) data from larger populations in areas of Sydney and/or NSW, including the LGAs of Fairfield, Penrith and Liverpool. Where relevant, the health status of the existing population was compared to the Greater Sydney Area in order to determine any communities that may be more significantly impacted than anticipated.

Health and safety impacts

Assessment of health risks associated with exposure to environmental hazards was conducted in accordance with the methodology for assessing health impacts as defined by NSW Health (2007):

- Identification of hazards which may lead to or contribute to human health and public safety risks, through desktop analysis, based on typical hazards encountered for the construction and operation of a new motorway
- Qualitative risk assessment to ascertain the level of risk associated with the identified hazards.

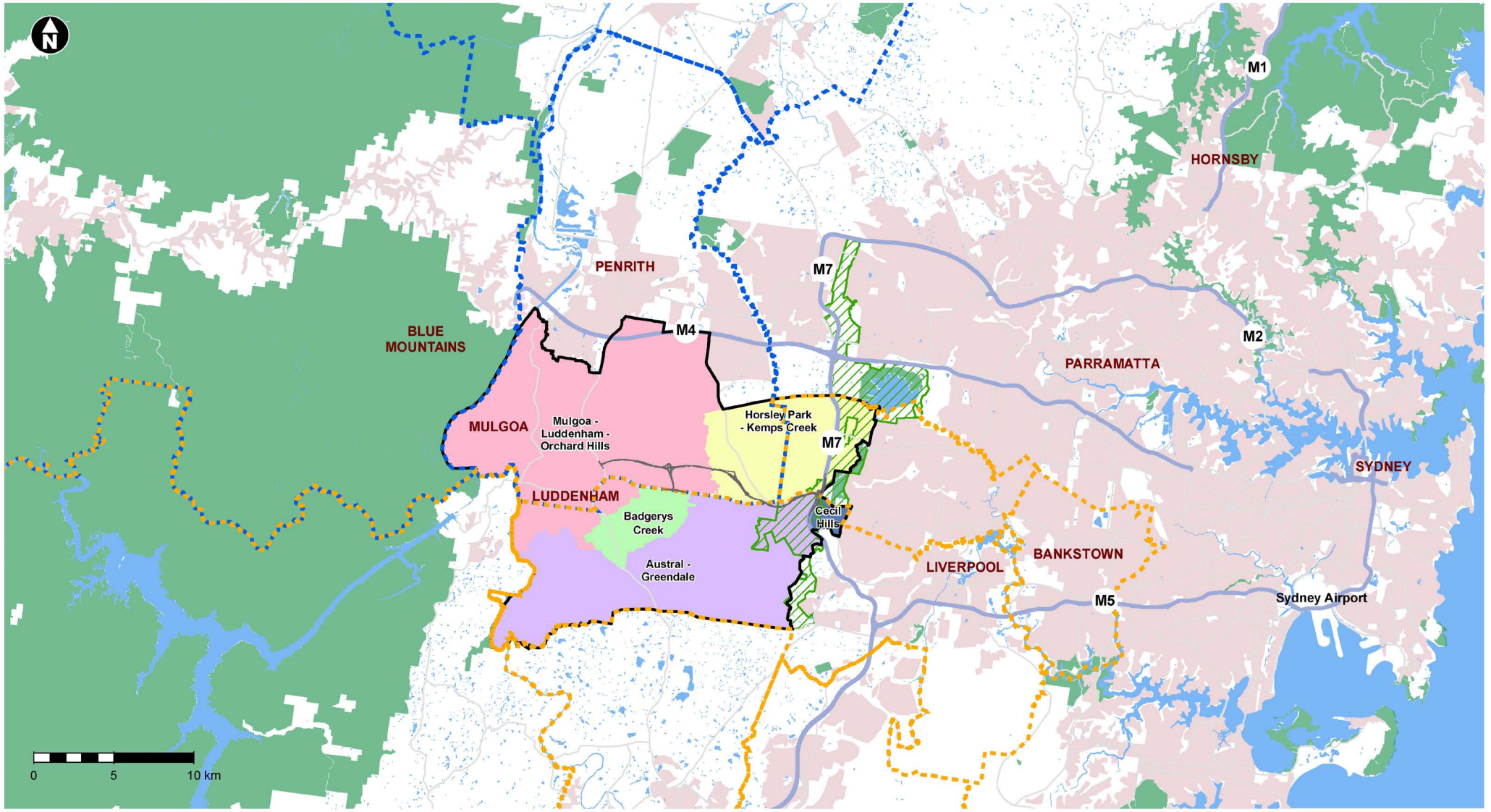

Figure 8-30 Health and safety assessment study area

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Transport and traffic, noise and vibration and air quality assessments are presented in **Section 7.2, Section 7.7** and **Section 8.2** respectively, and summarised where relevant throughout this section.

In addition, the following qualitative assessments were carried out to determine the health and safety impacts of the project:

- Assessment of the effect of the project on relevant determinants of health such as the level of physical activity and access to social infrastructure
- Assessment of opportunities for health improvement
- Assessment of the distribution of the health risks and benefits
- Assessment of the likely risks of the project to public safety, paying particular attention to pedestrian safety, subsidence risks, bushfire risks and the handling and use of dangerous goods
- Identification of the management measures to minimise the impacts on human health and public safety while maximising the health benefits.

8.3.3Existing environment

Health status of affected population

The social and income demographics of an area have some influence on the health of the existing population. **Table 8-38** compares the social and income demographics of the populations in the study area to the Greater Sydney Area. In summary, the study area generally has a higher median total income and lower employment rate than the Greater Sydney Area, with household sizes and mortgage and rental payments varying depending on whether the area is urban or rural.

Table 8-38 Social and income demographics of the study area (2016)

	Greater Sydney Area[1]	Austral-Greendale	Mulgoa-Luddenham	Badgerys Creek	Horsley Park-Kemps Creek	Cecil Hills
Median total income[2]	$45,267	$45,326	$56,930	$38,657	$51,460	$50,845
Average household monthly mortgage repayment	$2,384	$2,377	$2,579	No data	$2,730	$2,260
Average household monthly rental payment	$1,996	$1,658	$1,921	$553	$1,684	$2,185
Average household size	2.8	3.3	3.2	2.2	3.4	3.7
Unemployment rate	6%	5.2%	3.8%	No data	3.7%	5.7%

1 As represented by the ABS Greater Capital Statistical Area of Sydney
2 Excluding government pensions and allowances

Source: ABS (2017a) and ABS (2017b)

General health and wellbeing of Australians living in New South Wales is good with an average 80.4 per cent adults aged 16 years or over who rated their health as being ‘excellent, very good or good’. The Ministry of Health and the ABS collect data on the health of residents in the study area (see **Section 8.3.2**), which is summarised in **Table 8-39.**

Table 8-39 Health of the residents of the study area

Health aspect	Area	Existing environment
Self-rated health – proportion of adults (aged 16 years or over) with ratings of 'excellent, very good or good' (NSW Ministry of Health, 2017)	Nepean Blue Mountains LHD	Below the NSW average About 77.3 % compared to the NSW average of 79.9 % in 2017
	South-western Sydney LHD	**About the same as NSW average** About 78.2 % compared to the NSW average of 79.9 % in 2017
People needing assistance – refers to people who need help in one or more of the three core activity areas of self-care, mobility or communication due to disability, a long-term health condition or old age (Australian Bureau of Statistics, 2017b)	Study area	**Below the NSW average** About 5.1 % compared to the NSW average of 5.4 %
	Austral-Greendale statistical area	Highest statistical area out of the study area, 6.9 % compared to the NSW average of 5.4 %
People receiving aged pension or, disability or sickness benefits (2010) (NSW Ministry of Health, 2017)	Nepean Blue Mountains LHD	52,712 total recipients in 2010 77.7 % of eligible population (above the NSW average of 71.7 per cent) receiving a pension 10 % of eligible population (below the 10.5 % NSW average) receiving disability and/or sickness benefits
	South-western Sydney LHD	156,984 total recipients in 2010 82.9 % of eligible population (above the NSW average) receiving a pension 13.5 % of eligible population (above the NSW average) receiving disability and/or sickness benefit

Physical activity

A lack of physical exercise or journeys made by active travel modes (walking or cycling) can lead to long-term health conditions such as cardiovascular disease, high blood pressure and Type 2 diabetes (Brown et al, 2012). Research has shown that physical activity reduces the relative risk of mortality in both men and women, and that active commuting to and from work, through walking or cycling, is also associated with reductions in mortality risks (Brown et al, 2012).

Indicators of population health and physical activity are presented in **Table 8-40**. Where practicable, statistics were provided for the health and safety study area. Where these are not available, statistics were provided to major Australian cities, NSW or all of Australia as appropriate. The per centage of people in the study area walking or cycling to work is likely to be below the NSW average due to the more rural nature of the study area and distance to employment centres.

Table 8-40 Indicators of population health and physical activity

Physical indicator	Measure	Area
Overweight or obese	63.4 per cent of people aged 18 years and over	Australia wide
	61.1 per cent of people aged 18 years and over	Major Australian cities
Walks or cycles to work	About 2 per cent of people aged 15 years or over	Study area
	3.9 per cent of people aged 15 years or over	NSW
Sufficiently active (participated in over 150 minutes of moderate physical activity or more than 75 minutes of vigorous physical activity, or an equivalent combination of both in the week before survey)	55.5 per cent of 18-64 year old Australian adults	Australia wide
Insufficiently active in the week before the survey	29.7 per cent of 18-64 year old Australian adults	Australia wide
No exercise in the week before the survey	14.8 per cent of 18-64 year old Australian adults	Australia wide
Participated in sport and physical recreation at least once during the 12 months before the survey	60 per cent aged 15 years and over	Australia wide
Walking for exercise	19 per cent of people aged 15 years and over walking for exercise at least once in the 12 months prior	Australia wide
Participate in cycling and BMXing	8.5 per cent of females aged 15 years and over	Australia wide
	4 per cent of males aged 15 years and over	Australia wide
Participate in organised sport	26 per cent of persons aged 15 years and over (4.7 million people)	Australia wide

Source: National health Survey (Australian Bureau of Statistics, 2015a), (Australia Bureau of Statistics, 2015b), ABS (2017c) and TfNSW (2017b)

Access to social infrastructure

Land uses throughout the health and safety study area are described in **Section 7.4**. In summary, existing land uses mainly comprise a mix of:

- Urban uses
- Environmental areas
- Rural and agricultural uses
- Mining and extractive resources uses
- Infrastructure and utilities
- The future Western Sydney Airport.

There are also a range of local, regional and state level community services and infrastructure located within or servicing the health and safety study area, including:

- Major hospitals, including:
  - Fairfield Hospital
  - Nepean public and private hospitals (Penrith)
  - Liverpool Hospital
- Tertiary education facilities, including:
  - University of Western Sydney campuses at Kingswood and Werrington North and South
  - TAFE Western Sydney Institute – Nepean College campuses at Kingswood and Penrith
  - TAFE South-western Sydney Institute – Liverpool College
- Schools, including:
  - Kemps Creek Public School
  - Christadelphian Heritage College Sydney
  - St Dominic's College
  - Irfan College, Cecil Park
  - Penrith High School
  - Penrith South Public School
  - Kingswood High School
  - Jamison High School
  - York Public School
  - Mary Mackillop Primary School
  - Orchard Hills Public School
  - Surveyors Creek Public School
  - Penrith Anglican College
- Regional, state and national sport and recreation facilities, including:
  - Western Sydney Parklands
  - Sydney International Shooting Centre
  - Sydney Motorsport Park at Eastern Creek and Sydney International Equestrian Centre
  - Penrith Lakes Regional Park, which incorporates Sydney International Regatta Centre and Penrith Whitewater Stadium
  - Nepean Aquatic Centre
  - Penrith Park
  - Fairfield Showground
  - Chipping Norton Lakes
  - Luddenham Showground
  - Luddenham Raceway
- Other community facilities such as the Orchard Hills Masonic Centre.

A comprehensive description of the existing land use of the study area, including the surrounding available social infrastructure is provided in **Section 7.4** and **Appendix H**.

The surrounding existing active transport network is provided in **Section 7.2**. In summary, existing active transport includes:

- Recreational cycleways within the Western Sydney Parklands
- An off-road separated pedestrian/cycle shared user path that runs adjacent to the M7 Motorway with numerous points of entry and exit, and connecting to a shared user path into the Western Sydney Parklands
- The Wylde mountain bike trail that runs through the Western Sydney Parklands

A new shared user path would also be constructed between Narellan and the M4 Motorway as part of The Northern Road upgrade.

Road and pedestrian safety

Existing road safety performance is provided in **Section 7.2**. A summary of the crash history for the five-year period between July 2012 and June 2018 is provided in **Table 7-38**.

Pedestrian safety statistics for NSW for the years 2013 to 2017 are presented in **Table 8-41**. In summary, while 6.1 per cent of safety incidents result in the injury of a pedestrian, 15.4 per cent of safety incidents result in the death of a pedestrian, meaning that pedestrian deaths are over-represented at a State level.

Table 8-41 Summary of pedestrian safety statistics between 2013 and 2017

Safety statistics	Road user	Total incidents	Average number of incidents per year	Proportion of incidents involving pedestrians
Injuries	Pedestrians	7221	1444.2	6.1 %
	All road users	117,475	23,495	
Fatalities	Pedestrians	271	54.2	15.4 %
	All road users	1759	351.8	

Bushfire risk

The identification of bushfire prone areas in NSW is required under section 146 of the EP&A Act. The Rural Fire Service has set guidelines on what constitutes a bushfire prone area and how it is to be mapped. Each council then prepares a map in accordance with the guidelines as set out in **Section 8.3.1**. Section 79BA of the EP&A Act requires that a consent authority shall not grant approval for a development application for any purpose on bushfire prone land, unless it:

- Is satisfied that the development conforms to the specifications and requirements of Planning for Bush Fire Protection (Rural Fire Service 2006); or
- Consults with the Rural Fire Service concerning measures to be taken to protect persons, property and the environment from danger that may arise from a bushfire.

The project is located within the Cumberland and Macarthur Rural Fire Service districts. Bushfire prone land mapping was carried out throughout NSW to inform development and control inappropriate land uses in bush fire prone areas. The bushfire prone land near the project is displayed in the following maps:

- Fairfield City Council – Bush Fire Prone Land Map (2017)
- Liverpool City Council – Bushfire Prone Land Map (2014)
- Penrith City Council LGA – Bushfire Prone Land Map (2014).

An assessment of these maps confirmed that the project would be partly located within and near bushfire prone land (see **Figure 8-31**). In summary, Vegetation Category 1 is considered to be the highest risk for bushfire and is surrounded by a 100 metre buffer where practicable. The majority of the construction footprint is surrounded by Vegetation Category 2, which is considered to be a lower bushfire risk than Category 1. Consultation with the Rural Fire Service is further discussed in **Chapter 6**.

Distribution of health risks and benefits

The potential health and safety impacts associated with the project are not anticipated to be equally distributed across the study area community.

The study area contains a number of populations that may be more sensitive to environmental changes, including children, elderly people, people with disabilities and/or chronic illnesses, and people who suffer from asthma or other conditions. A comparison of these populations is presented in **Table 8-42**. In summary, the study area contains higher numbers of children and lower numbers of elderly people than NSW as a whole. The South-western Sydney LHD contains a higher proportion of people on disability and/or sickness benefit than the Nepean Blue Mountains LHD and NSW as a whole, while the Nepean Blue Mountains LHD contains a higher proportion of adults with asthma than the South-western Sydney LHD and NSW as a whole. These demographics were further considered in **Sections 8.3.4**.

Table 8-42 Summary of sensitive populations within the study area

Indicator	Nepean Blue Mountains LHD (%)	South-western Sydney LHD (%)	NSW (%)
People aged 65 and over	13.9	12.7	15.7
Disability and/or sickness benefit (% of eligible population)	10.0	13.5	10.5
Adults with asthma (% of eligible population)	12.5	10.7	10.9
Children aged 0 to 14 (% of population)	20.4	21.5	18.8

Additional discussion of the distribution of environmental impacts is presented as follows:

- Traffic impacts considered in **Section 7.2** and **Appendix F**
- Noise impacts considered in **Section 7.7** and **Appendix K**
- Air quality impacts described in **Section 8.2** and **Appendix P**.

8.3.4 Assessment of potential impacts

Construction impacts

The following potential impacts on the local population's health and safety may occur during the construction of the project.

- Workplace hazards
- Environmental hazards
- Impacts on public health and ability to carry out physical activity and/or complete journeys using active modes of travel
- Road and pedestrian safety
- Bushfire risks
- Dangerous goods handling risks.

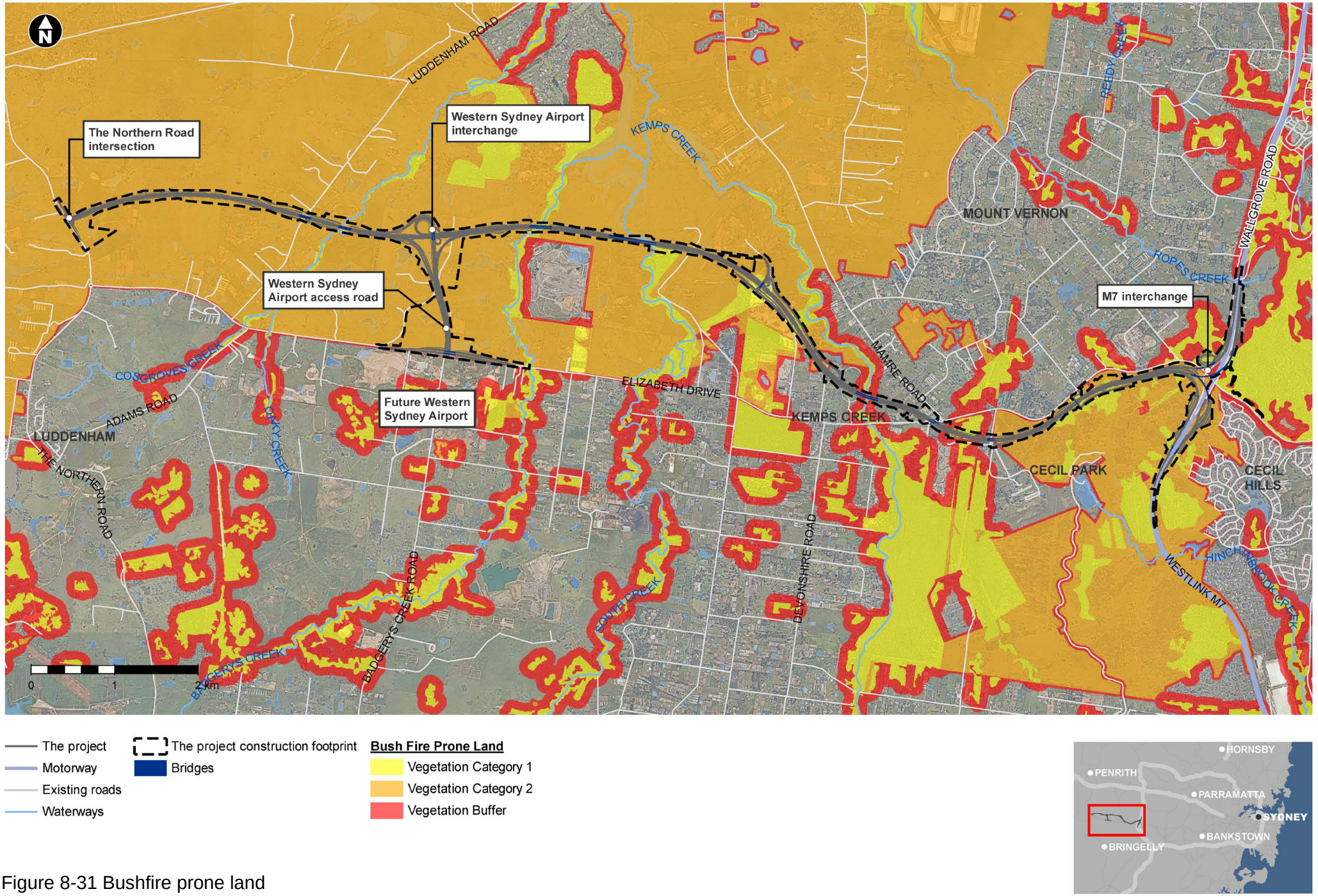

Figure 8-31 Bushfire prone land

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Construction workplace hazards

A number of workplace hazards could occur during the construction of the project. Given the nature of the construction site, potential risks to human health and safety include the following:

- Slips and trips from walking around site
- Falls from height
- Rock falls
- Fire or explosion
- Personnel struck by dropped or swinging loads or other objects
- Manual handling injuries
- Accidents involving vehicles, equipment and people
- Accidents involving vehicle to vehicle collisions
- Asbestos containing material
- Mobile plant interaction
- Electrocution or fire hazards
- Working near or over water.

Construction workplace hazard impacts would be limited to the construction work sites and immediate vicinity. Generally, the risk is limited to the construction workforce.

Overall, the construction workplace risk would be moderate, considering the implementation of mitigation measures set out in **Table 8-45**.

Environmental hazards

Health risks associated with the project may be present due to exposure to the following environmental hazards:

- Air quality impacts
- Noise impacts
- Lighting and vibration impacts
- Electrocution or fire hazards
- Exposure to hazardous materials such as asbestos
- Gas contamination
- Contaminated land exposure.

Impacts on amenity may be experienced by users of community services and facilities located close to construction works and ancillary facilities due to the following:

- Construction noise impacts as a whole are relatively low. High impacts would be likely at the nearest receivers to the project when noise intensive equipment such as rock-breakers or concrete saws are in use. However, noise intensive equipment would generally only be required for relatively short periods. Noise levels and impacts during typical construction works would result in either compliant noise levels or minor impacts. Sensitive receivers are generally sparsely distributed along the project resulting in the number of receivers with the highest impacts being relatively low. Construction noise impacts across the project are described in detail in **Section 7.7**.
- There would be a low to moderate risk of dust impacts during construction, including temporarily increased levels of PM_{10} and $PM_{2.5}$. Construction dust impacts are described in detail in **Section 8.2.4**.

Amenity impacts would be most likely to occur where night-time work results in sleep disturbance over extended periods of time or where construction activities create extended periods of high noise or dust levels. Construction noise impacts, including sleep disturbance levels, are presented in **Section 7.7.6**, while dust levels are presented in **Section 8.2.4**. Environmental management measures, as described in **Sections 7.7.9** and **8.2.6** would be implemented to minimise these potential impacts. Overall, potential impacts would be short-term and are not expected to be significant.

Hazardous materials including asbestos may be encountered during earthworks, demolition works and utility relocations. Microscopic asbestos fibres that become airborne can become a health risk if inhaled into the lungs, potentially causing asbestosis, lung cancer and mesothelioma to workers or nearby residents WorkCover NSW (2014). Areas that potentially include asbestos, and the management of asbestos are described in **Section 8.1**. In summary, intrusive asbestos investigations would be carried out along the construction footprint to assess asbestos risks before construction. As a result, asbestos exposure to workers or nearby residents are not anticipated.

Construction activities, as well as the use of hazardous materials, have the potential to expose contaminated land to the local community. **Section 8.1** provides a qualitative risk assessment to assess the potential risk of these construction activities to human health and environments. Further detailed investigation of areas of environmental interest are recommended to determine if there are concentrations of polycyclic aromatic hydrocarbons or the presence of asbestos that could be harmful to human health.

As described in **Section 8.1.4**, there is a moderate risk of gas contamination from excavation activities in the vicinity of landfills. Potential impacts from gas ingress during construction include explosion and asphyxiation, especially associated with the construction of confined spaces such as service trenches. Elevated gas concentrations are likely to be relatively localised and would be further investigated before construction of the project.

Following the implementation of mitigation measures set out in **Table 8-45**, a low impact is anticipated as a result of environmental hazard exposure.

Detailed assessment of noise, dust and construction traffic impacts is provided in **Section 7.7**, **Section 8.2** and **Section 7.2** respectively.

Physical activity

The construction footprint of the project would encroach into the Western Sydney Parklands and is near Kemps Creek Nature Reserve. The parklands contain the Wylde Mountain Bike Trail. Range Road is the main access road to the Wylde Mountain Bike Trail, while Kemps Creek Nature Reserve is accessed via Devonshire Road and managed by National Parks and Wildlife. During construction, access into the Parklands and Kemps Creek Nature Reserve would be maintained in consultation with the Western Sydney Parklands Trust and National Parks and Wildlife Service. The community would therefore have continuous access to the physical activity and recreation opportunities offered by both parks.

Construction of the project would impact on a number of walking and cycling paths. These impacts and the measures to be put in place to minimise them are detailed in **Table 8-43**.

Table 8-43 Impacts on walking and cycling paths – construction

Walking/cycling track	Summary of potential impacts
Wylde Mountain Bike Trail	The Wylde Mountain Bike Trail would be directly impacted by the project corridor, including the jump run, pump track, kids loop, sections of the three-kilometre, six-kilometre and 12 kilometre trails and associated facilities, including shelters. The project would result in the permanent loss of facilities and sections of trails within the operational footprint, requiring the redesign and relocation of these facilities. As described in **Section 7.4**, the trail is an important attraction within the Western Sydney Parklands and disruption to these facilities and sections of trails has potential to impact on recreational riders and disrupt national, state and local mountain bike events. During construction, increased noise and dust from construction activities has potential to reduce the amenity of meeting places near construction works and cause temporary disruptions to facilities such as Wylde Mountain Bike Trail. This may temporarily impact people's use and enjoyment of these places, and possibly deter some people from using these facilities. Environmental and traffic management measures would be implemented during construction to manage potential impacts on users of the trail. As a result, impacts during construction would be short-term and minimal.
Cecil Hills Walking Track	During construction, temporary disruptions would occur to the access track west of the M7 Motorway during construction of the northbound on-ramp from the M7 Motorway. This access would be reinstated following construction, minimising ongoing impacts. The construction compound AF7 would be located next to the walking track within the Parklands. Potential disruption to local amenity from construction activities and presence of construction activities may impact on the use and enjoyment of the track and perceptions of safety for some users, potentially deterring some people from using this facility during the construction phase. Environmental and traffic management measures would be implemented during construction to manage potential impacts on Parklands users. As a result, impacts during construction would be short-term and minimal.
Jaquetta Close pedestrian pathway	The operational footprint would directly impact on a section of pathway east of the M7 Motorway connecting to the Jacquetta Close overpass. During construction, temporary disruptions would occur to this pedestrian pathway during construction of the southbound off-ramp to the M7 Motorway. This access would be reinstated following construction, minimising any ongoing impacts. As a result, impacts during construction would be short-term and minimal.
M7 Motorway Shared Path	The M7 Motorway southbound off-ramp and northbound on-ramp would directly impact on sections of the M7 Motorway shared user path at Horsley Park and Cecil Hills, requiring realignment and reconstruction of these sections. During construction, temporary disruptions would be required to the shared user path disrupting access for users. Potential disruptions to local amenity from construction activities, presence of construction activities and increased construction traffic may also impact on the use and enjoyment of the shared user path and perceptions of safety for some users. This may deter some people from using this facility during the construction phase. Environmental and traffic management measures would be implemented during construction to manage potential impacts on path users. Following completion of the realigned path, ongoing impacts are not expected. As a result, impacts during construction would be short-term and minimal.

In summary, access would be maintained for tracks during construction, which may include temporary diversions. These temporary disruptions would lead to minimal impacts on the community's ability to access physical activity opportunities.

Access to social infrastructure

The construction of the project is not anticipated to significantly disrupt access to social infrastructure (eg medical centres and schools) in the local area. While there would be a number of temporary road closures, detours and other temporary traffic management measures, Elizabeth Drive would remain open throughout the construction period. Journeys along Elizabeth Drive may increase in travel time during construction, however this is not anticipated to significantly delay access to medical centres presented in **Section 8.3.3**.

Similarly, pedestrians wishing to access medical centres in Cecil Hills using the footbridge south of the M7 Motorway junction, may experience slightly longer routes as a result of construction in the Parklands, however, this is not anticipated to be significant as it is not anticipated that pedestrians are likely to wish to access medical centres by foot.

The project's construction footprint would adjoin the Kemps Creek Sporting and Bowling Club. Operation of and access to the club would be maintained during the construction phase.

A driveway off Range Road which provides access to Sydney International Shooting Centre would be subject to some access adjustments during construction. Access would be maintained to Range Road and to the shooting centre. However, temporary disruptions for staff and visitors may result from local access changes to the shooting centre's access road. Disruptions may also result from increased construction traffic on Range Road. Impacts on amenity for staff and visitors to the centre associated with increased dust, noise and traffic are expected to be minor given the distance between the construction works and facilities.

During construction there would be impacts on roads in and adjacent to the construction footprint including reduced speed limits and modified arrangements. This may delay response times and/or access for emergency services. Staging of construction activities would be developed to minimise impacts on the road network. During construction, emergency vehicle access would be maintained at all times.

Road safety

Construction traffic impacts are described in detail in **Section 7.2.5** and would include construction vehicles using the surrounding road network, surface roadworks requiring temporary traffic diversion and/or road closures, and temporary changes to speed limits.

Construction of the project would result in an increased number of vehicles, including heavy vehicles, in the study area. This, along with changed traffic conditions (eg altered speed limits and temporary traffic lane closures), could result in an increased risk of vehicular accidents during construction.

A construction traffic management plan (TMP) would be implemented to manage traffic safety. The TMP would also manage pedestrian and cyclist safety. With the effective implementation of a traffic management plan, road safety impacts would be low and temporary in nature.

Pedestrian safety

Construction of the project would impact on pedestrian tracks in the study area (see **Table 8-43**). Pedestrian access would be maintained near construction works, although temporary changes would be required to some pathways for safety of pedestrians. This, along with the increased construction traffic and changed traffic conditions, could potentially impact on safety for pedestrians and cyclists. As mentioned above, altered traffic conditions could result in an increased risk of vehicular accidents, including increased risks to pedestrians and cyclists.

A construction traffic management plan would be implemented to manage traffic safety, as well as pedestrian and cyclist safety. With the effective implementation of the plan, the risk of pedestrian and cyclist safety impacts occurring during construction would be low.

Bushfire risks

As the project would be partially located within and near bushfire prone land (see **Section 8.3.3**), the project has the potential to increase bushfire risk in the study area from accidental ignition from the use of mobile equipment, fuels and chemicals during construction. Measures to mitigate and manage bushfire would be developed and included as part of a site-specific hazard and risk management plan within the project CEMP.

Temporary ancillary facilities and construction infrastructure would generally be less sensitive to bushfire than operational facilities, given the temporary nature of the construction compounds and the absence of critical infrastructure within the compounds. In addition, the clearing of vegetation for the project would create a fire break between residential areas of Mount Vernon, Kemps Creek, Cecil Park, Cecil Hills and Abbotsbury. This would reduce the risk of bushfire, allowing for better containment.

Temporary construction compounds would be maintained in a tidy and orderly manner to minimise potential fuel loads should they be affected by fire.

Construction activities involving flammable materials and ignition sources would be managed to ensure that the potential for fire is minimised. High risk construction activities such as welding and metal work would be subject to a risk assessment on total fire ban days and restricted or ceased as appropriate. Construction personnel would be inducted into the requirement to operate safely to minimise risk of fire.

During construction, there would be impacts on roads in and adjacent to the construction footprint including reduced speed limits and modified arrangements. This may delay response times and/or access for emergency services including fire crews, in the event of a bushfire.

Construction personnel would be made aware of the potential for bushfire before working on the project. Measures to protect personnel and the local community during construction were identified in **Table 8-45**.

Handling and use of dangerous goods

The types of hazardous substances that would be transported to the site and used within the construction footprint during construction would include, but are not limited to:

- Diesel fuels
- Oils, greases and lubricants
- Explosives (Class 1)
- Gases (oxy-Acetylene) (Class 2.1)
- Bitumen (Class 3 PGIII)
- Paints and epoxies (Class 3 PGII and Class 3 PGIII)
- Herbicides (class 6.1 PGII)
- Hydrated lime (non-dangerous good)
- Cement and concrete
- Curing compounds (non-dangerous good).

The storage, handling and use of dangerous goods and hazardous substances would be carried out in accordance with the *NSW Work Health and Safety Act 2011*, the Storage and Handling of Dangerous Goods Code of Practice (WorkCover NSW, 2005) and relevant Australian Standards.

The location and purpose of each temporary ancillary facility is detailed in **Section 5.24.3**. The types of dangerous goods and hazardous substances that would be stored and used within ancillary facilities would be confirmed by the construction contractor and addressed in the CEMP for the project. A register and inventory of the dangerous goods and hazardous substances to be stored at each temporary ancillary facility would be kept as part of an incident response management plan developed for the project. Safety Data Sheets would also be obtained for each relevant material.

The principles of Applying State Environmental Planning Policy 33 (SEPP 33): Hazardous and Offensive Development Application Guidelines (Department of Planning and Environment, 2011) were reviewed to identify potential hazards associated with the project.

Potential inadvertent contaminant impacts (see **Section 8.1**), fire and explosions resulting from the handling, storage and transportation of hazardous materials may adversely impact human safety, either directly through contact, or indirectly through damage to the local environment. This may impact construction workers and residents surrounding the construction footprint and haulage routes. However, the potential for such incidents to occur is low in view of the following factors:

- Hazardous substances would be transported in accordance with relevant legislation and codes
- The likelihood of a crash occurring during the transportation of hazardous substances to and from work sites and spillage to the receiving environment is low
- Implementation of environmental management measures such as those identified in **Table 8-45** would reduce the likelihood of impact on the environment, construction personnel and the public.

Overall, the hazards and risks associated with construction of the project are low and would be managed with the implementation of the standard management and mitigation measures such as those identified in **Table 8-45.**

Distribution of health risks and benefits

As described in the above sections, construction activities have the potential to negatively impact on the health and wellbeing of the sensitive populations described in **Section 8.3.3**.

The health and safety risks associated with construction of the project would be concentrated on land within and close to the project construction boundary. As a result, health risk impacts on workers and the community in the wider study area would be minimal during construction due to the limited scope and relatively short length of construction.

Public safety

Accidental contact with underground services when excavating could give rise to hazards in the form of electrocution, gas or fire. This could affect workers, residents and other members of the public in close proximity to the hazard. The likelihood of impacts associated with these hazards would be minimised by undertaking utility searches (such as dial before you dig, surveys and potholing) to identify locations of utilities, consulting with the relevant utility provider and if required, relocating and/or protecting utilities within the construction footprint before the start of construction.

Hazards are also present when working in the vicinity of high voltage 330 and 500 kV transmission lines located in the construction footprint.

The utility searches and consultation with providers is ongoing and described in more detail in **Section 5.20**.

As the project is not located near any mine subsidence developments or mine subsidence districts, subsidence risks have not been further considered.

Operational impacts

Operation workplace hazards

The workplace health and safety hazards that could occur during the operation of the project are related to road maintenance activities.

These hazards include:

- Exposure to hazards associated with road safety –collisions while performing maintenance activities near live traffic areas
- Exposure to hazards associated with utilities – such as exposure of workers, pedestrians and nearby residents to electrocution and fire risks
- Exposure to hazards associated with working in or near confined spaces.

Roads and Maritime have experience in road maintenance and have developed effective safety guidelines and procedures for all maintenance activities. With the effective implementation of these guidelines and procedures, the impacts on operational workplace hazards would be low.

Exposure to environmental hazards

Environmental hazards in the form of noise impacts were considered in **Section 7.7**. In summary, during operation the project would result in increased noise impacts resulting from the movement of traffic, and during maintenance activities. These impacts would be minor in nature and are not anticipated to constitute an environmental hazard.

Air quality environmental hazards were considered in **Section 8.2**. In summary, during operation the project would produce the following air quality outcomes:

- 24-hour and annually averaged PM_{10} and $PM_{2.5}$ concentrations at the nearest sensitive receivers along the M12 Motorway were not predicted to change materially from existing conditions
- One-hour and eight-hour average CO and NO_2 concentrations at the nearest sensitive receivers along the M12 Motorway would increase, though this would be below relevant impact assessment criteria
- Volatile organic compounds in the form of benzene would increase relative to no-project scenarios, though this increase would be below relevant impact assessment criteria.

Contamination and asbestos hazards were considered in **Section 8.1**. In summary, once operational the contamination hazards of the project would be minor in nature and are not anticipated to constitute an environmental hazard.

Physical activity

The project would result in the permanent loss of land in the Western Sydney Parklands and the redesign of the Wylde Mountain Bike Trail, with associated change in recreation opportunities. Roads and Maritime is in discussions with Western Sydney Parklands Trust to relocate the Wylde Mountain Bike Trail, and Western Sydney Parklands Trust will endeavour to complete the relocation before the start of construction. Consultation would continue during the detailed design and construction phases of the project.

In addition, the project would impact a number of walking and cycling tracks. These impacts are detailed in **Table 8-44**.

Table 8-44 Impacts on walking and cycling paths during operation

Walking/cycling track	Summary of potential impacts
Wylde Mountain Bike Trail	Part of this trail would be directly impacted by the operational footprint for the project corridor, and the trail would be redesigned and relocated as a result as a result. Once redesigned and relocated, the trail would continue to be used, minimising any ongoing impacts.
Cecil Hills Walking Track	A section of this track would be directly impacted by the operational footprint for the project corridor. Specifically, the project would impact on a section of the track connecting to the Jaquetta Close overpass of the M7 Motorway. The Jaquetta Close overpass would be retained, while the realignment of the Cecil Hills Walking track would be determined during detailed design.
Jaquetta Close pedestrian pathway	The operational footprint would directly impact on a section of pathway east of the M7 Motorway connecting to the Jacquetta Close overpass. This access would be reinstated following construction, minimising any ongoing impacts.
M7 Shared Path	The M7 Motorway southbound off-ramp and southbound on-ramp would directly impact on sections of the M7 Motorway shared user path at Horsley Park and Cecil Hills, requiring realignment and reconstruction of these sections. Following completion of the realigned path, ongoing impacts are not expected.

As part of the project, a new shared user path would be constructed alongside the M12 Motorway, from The Northern Road up to Range Road at the Western Sydney Parklands. The shared user path would connect to the existing shared user path along the M7 Motorway, either by extending through the Western Sydney Parklands, along the M12 Motorway or along Elizabeth Drive as described in **Section 5.23**. The shared user path would also extend along the airport access road and would tie-in to Elizabeth Drive. The shared user path is described in more detail in **Section 5.21**.

The two existing pedestrian bridges crossing the M7 Motorway south of Elizabeth Drive, Cecil Hills, would be retained and modified as part of the project. With the implementation of the shared user path, opportunities for the local population to carry out physical exercise and active travel would be improved because of the project.

Pedestrian crossings would also be provided at upgraded intersections, which would also support improved access and safety outcomes for pedestrians and cyclists. With improved opportunities for walking and cycling, as well as improvements to pedestrian safety at key intersections, the project is expected to generate positive benefits for health of the community.

Access to social infrastructure

The operation of the project would improve access to social infrastructure in the local and wider western Sydney area by improving access and connectivity to regional, State and national level community services and facilities within the primary and secondary study areas through improved travel time savings and improved travel time reliability. This would include community services and facilities, such as:

- Education facilities such as the University of Western Sydney and TAFE Western Sydney Institute
- Major medical and health care facilities, including hospitals and facilities at the Nepean Hospital campus
- Regional open space, sport and recreation facilities at and surrounding Western Sydney Parklands and within central Penrith
- The Western Sydney Airport
- Community support services and service organisations.

Improved access would have long-term beneficial impacts for local communities as well as communities across the western Sydney region.

While, the project would result in the permanent loss of land in the Western Sydney Parklands, wider access to the Parklands would be improved for pedestrians and cyclists. Road access to the Western Sydney Parklands would continue to be provided by Elizabeth Drive. Access to Sydney International Shooting Centre via Range Road would be maintained. There would be no change in access to the Kemps Creek Nature Reserve, with Devonshire Road remaining open.

The project may present a perceived barrier to local access and connectivity. In particular, changes to local access may discourage some people from making some local trips. While these impacts would be permanent, they would be balanced by safer access for motorists and other road users and are not expected to be significant.

Road safety

The design of the project was developed with a focus on providing a realistic, constructible, high standard design that aims to deliver optimised road user safety, as described in **Chapter 5**.

Road Safety Audits were completed for strategic design (Aurecon, 2016) and concept design (JAJV, August 2018). These safety audit findings and proposed mitigations were reviewed and considered in the Design as set out in this document.

The project would provide a more direct, alternative route to the Western Sydney Airport than Elizabeth Drive and the local road network. As a result, the safety of motorists, pedestrians and cyclists would be enhanced, with a beneficial impact anticipated. The project is also expected to result in the following improvements to road safety:

- Reduce the number of heavy vehicles that would need to use Elizabeth Drive for access to the Western Sydney Airport or for travelling between the M7 Motorway and The Northern Road. This would improve road safety by reducing opposing-lane overtaking of heavy vehicles and the associated risk of head-on crashes
- Provide cyclists with a safe off-road facility and remove the risks associated with cycling on road adjacent to general traffic on Elizabeth Drive
- Reduced congestion at the M7 Motorway/Elizabeth Drive Interchange is expected to reduce the likelihood of vehicle crashes, especially rear-end type crashes.

Pedestrian safety

The shared user path would be grade–separated at all road crossings along the M12 Motorway and would underpass the airport access road, while the crossing at The Northern Road would be at grade. The shared user path would run adjacent to the motorway from The Northern Road to the Western Sydney Airport interchange, separated by a barrier. As a result, the project would provide safer access for pedestrians and cyclists.

Emergency facilities

As discussed in **Section 5.18**, Emergency crossovers and heavy vehicle stopping bays would be provided at required intervals and would be appropriately located where road geometry allows for suitable visibility and sufficient space for vehicles.

Emergency telephone bays would be provided at each integrated speed limit and lane use sign location. Each bay would be designed to allow a car to park clear of the motorway shoulder and safely access the emergency telephone.

The proposed locations of dedicated emergency cross overs and breakdown bays are shown in **Figure 5-1**.

Bushfire risks

The operational infrastructure of the project is largely invulnerable to bushfire due to its incombustible nature (road surface materials, retaining walls, road barriers). The new road surfaces would create a buffer between vegetated areas, particularly in the Western Sydney Parklands. As such the project is not expected to be a significant bushfire hazard during operation.

In addition, the project would create an effective bushfire buffer between residential areas north and south of the M12 Motorway.

Access for emergency services would be improved by the operation of the project.

Handling and use of dangerous goods

It is not anticipated that significant volumes of hazardous substances would be used by Roads and Maritime during operation of the project. However, dangerous goods would be transported along the M12 Motorway in significant quantities for the operation of the Western Sydney Airport. The nature of the project means that there is an inherent risk of vehicle collision associated with its operation.

Contaminants either directly associated with a spill or hazardous material clean-up may enter the receiving environment from both paved and unpaved surfaces. However, the potential for such a spill and consequential impacts is considered to be low in view of the following factors:

- The high road design standard of the project would reduce the potential for road crashes relative to the existing situation
- The existing legislative controls on the transport of dangerous goods is anticipated to reduce the likelihood of impacts
- In the unlikely event of a traffic crash involving a vehicle carrying hazardous substances, any spills would typically be managed by the emergency services and the permanent water quality basins, which have a 20,000 litre spill containment capacity.

As a result, hazards and risks associated with handling and use of dangerous goods during operation are considered to be low and would be managed with the implementation of standard management and mitigation measures identified in **Table 8-45**. Inspections and maintenance processes would be developed and followed to identify ongoing hazards, investigate all reported incidents and implement identified corrective actions.

Distribution of health risks and benefits

The operation of the project would generally have a positive benefit to health and safety – both for the immediate community and the wider western Sydney.

Health risks associated with the operation of the project are anticipated to be contained to the immediate motorway, associated pedestrian access and nearby sensitive receivers, as discussed in the assessment of impacts of transport and traffic (**Section 7.2**), noise and vibration (**Section 7.7**), soils and contamination (**Section 8.1**) and air quality (**Section 8.2**).

Public safety

As described in **Section 5.5.5**, the project is located partially within a PSA. Potential interaction between the project design and the PSA would be the subject of ongoing consultation during detailed design to ensure that the relevant guidelines from the NASF are considered appropriately, minimising risks to public safety.

Bird strikes

The proposed permanent water quality treatment measures for the project include permanent basins. The proposed permanent basins are operational water quality basins. The presence of operational water quality basins within a 13 kilometre zone of the Western Sydney Airport presents a potential risk for aeroplane bird strike, which could lead to aviation accidents. The NASF has a number of recommendations regarding wildlife strike risk, including consultation with airport operators and where necessary, identifying and managing potential wildlife and wildlife attractants within 13 kilometres of runways (NASF, Guideline C). As such, the type and design of permanent water quality basins for the project should be further investigated during detailed design to confirm their suitability and develop appropriate mitigation measures.

8.3.5 Opportunities for health improvement

This section summarises the beneficial health and safety impacts presented in **Section 8.3.4.**

Once operational, the project would contribute to improved access and connectivity to regional, State and national level community services and facilities within or near the study area through improved travel time savings and improved travel time reliability. This includes major medical and health care facilities, including hospitals and facilities at Fairfield Hospital, Nepean public and private hospitals (Penrith), and Liverpool Hospital, as well as regional open space, sport and recreation facilities at Western Sydney Parklands and within central Penrith.

The project would provide additional opportunities for people to increase levels of physical exercise and journeys made by active travel modes. With the implementation of the shared user path, opportunities for the local population to carry out physical exercise and active travel would be improved. Opportunities for surrounding residents to walk or cycle to work and use the shared user path for recreation and exercise would help to reduce the incidence of long-term health conditions and reduce the per centage of Australians classified as overweight and obese. As the shared user path would be grade-separated, this would also reduce the risk of pedestrian and cyclist traffic accidents.

The project would reduce bushfire health risks by creating an effective bushfire buffer between the residential areas of Mount Vernon, Kemps Creek, Cecil Park, Cecil Hills and Abbotsbury. There would also be a bushfire buffer created by the project.

8.3.6 Environmental management measures

The environmental management measures that would be implemented to minimise the health and safety impacts of the project, along with the responsibility and timing for those measures, are presented in **Table 8-45**.

A Work Health and Safety Plan would be developed and implemented during construction of the project. This would support the management measures and procedures included in the CEMP for the project, including site and activity-specific Safe Work Method Statements.

Monitoring of risk control measures would occur regularly as part of routine site management procedures, and would include monitoring of movement of hazardous goods, safe workplace practices, and regular testing and monitoring of any fire and life safety systems.

Table 8-45 Environmental management measures (health and safety)

Impact	Reference	Environmental management measure	Responsibility	Timing
General	HS01	A work health safety management plan (WHSMP) will be prepared for the project. The WHSMP will include: • Details of the hazards and risks associated with construction activities • Risk management measures • Procedures to comply with all legislative and industry standard requirements • Use of appropriate personal protective equipment • Contingency plans, as required • An incident response management plan • Training for all personnel (including subcontractors) including site inductions, the recognition and awareness of site hazards and the locations of relevant equipment to protect themselves and manage any spills. All staff would have the relevant training and certificates.	Contractor	Prior to construction
Bushfire	HS02	Measures to mitigate and manage bushfire risk will be developed and included as part of site-specific hazard and risk management measures within the WHSMP. Measures will include the maintenance of ancillary facilities in a tidy and orderly manner and the storage and management of dangerous goods and hazardous materials in a safe location.	Contractor	Prior to construction
Incident response	HS03	An incident response management plan will be developed and implemented. The response to incidents within the road will be managed in accordance with the memorandum of understanding between Roads and Maritime and the NSW Police Service, NSW Rural Fire Service, NSW Fire Brigade and other emergency services.	Contractor	Prior to construction
Storage of dangerous goods and hazardous substances	HS04	Storage, handling and use of dangerous goods and hazardous substances would be in accordance with the *Work Health and Safety Act 2011* and the *Storage and Handling of Dangerous Goods Code of Practice* (WorkCover NSW, 2005).	Contractor	During construction and operation
	HS05	Secure, bunded areas will be provided around storage areas for oils, fuels and other hazardous liquids.	Contractor	During construction
	HS06	Safety Data Sheets will be obtained for dangerous goods and hazardous substances stored onsite prior to their arrival.	Contractor	During construction
Contamination from transportation of hazardous good	HS07	All hazardous substances will be transported in accordance with relevant legislation and codes, including the Road and Rail Transport (Dangerous Goods) (Road) Regulation 1998 and the 'Australian Code for the Transport of Dangerous Goods by Road and Rail' (National Transport Commission, 2008).	Contractor	During construction

8.4 Sustainability

This section presents an assessment of the project against the principles of sustainability and demonstrates how sustainability was integrated into the project design.

Sustainable development refers to “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (World Commission on Environment and Development, 1987).

The Australian Government refers to ecologically sustainable development as “using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased” (Ecologically Sustainable Development Steering Committee, 1992).

The Infrastructure Sustainability Council of Australia (ISCA) provides a definition specific to sustainable infrastructure development within the Australian context, being that which is “planned, designed and delivered to meet the needs of society whilst enhancing our environment and economy.” (Infrastructure Sustainability Council of Australia, 2018).

Table 8-46 outlines the SEARs that relate to sustainability and identifies where they were addressed in this EIS.

Table 8-46 SEARS (sustainability)

Secretary's requirement	Where addressed in this EIS
20.Sustainability	
1. The Proponent must assess the sustainability of the project in accordance with the Infrastructure Sustainability Council of Australia (ISCA) Infrastructure Sustainability Rating Tool and recommend an appropriate target rating for the project.	The project was assessed in accordance ISCA and an appropriate target rating identified within **Section 8.4.1** and **Section 8.4.2**.
2. The Proponent must assess the project against the current guidelines including targets and strategies to improve Government efficiency in use of water, energy and transport.	Current guidelines and strategies are identified in **Section 8.4.1** and **Section 8.4.2**.

8.4.1 Policy and planning setting

The following sections outline the relevant aims and objectives of key legislation, policies and guidelines that have directed the consideration and integration of sustainability into the project design and assessment. These include relevant targets and strategies to improve Government efficiency in use of water, energy and transport.

This sustainability policy and planning setting is made up of the following documents:

- United Nations Sustainable Development Goals (United Nations, 2015)
- EP&A Act
- Transport Environment and Sustainability Policy Framework and Statement (TfNSW, 2015)
- NSW Sustainable Design Guidelines Version 4.0 (TfNSW, 2017a)
- Roads and Maritime Environmental Sustainability Strategy 2015-19 (Roads and Maritime, 2016g)
- Infrastructure Sustainability rating tool Version 1.2 (Infrastructure Sustainability Council of Australia, 2016)

- Future Transport Strategy 2056 (NSW Government, 2018a)
- A Metropolis of Three Cities – the Greater Sydney Region Plan (Greater Sydney Commission, 2018a)
- Western City District Plan (Greater Sydney Commission, 2018b)
- NSW Freight and Ports Strategy (TfNSW, 2013b)
- NSW Climate Change Policy Framework (OEH, 2016d)
- NSW Government Resource Efficiency Policy (OEH, 2019)
- NSW Waste Avoidance and Resource Recovery Strategy 2014-21 (NSW EPA, 2014d)
- Aboriginal participation in construction policy (APiC) (NSW Government, 2018b)
- Training Management Guidelines (NSW Government, 2009)
- Transport Social Procurement Policy (TfNSW, 2016).

A discussion of the broader legislative and strategic framework relevant to the project is presented in **Chapter 2**. Specific objectives and aims of these plans in relation to sustainability are outlined below.

Sustainable Development Goals

World leaders adopted 17 Sustainable Development Goals (SDGs) of the United Nations (UN) 2030 Agenda for Sustainable Development, which came into effect January 2016. These 17 goals are a collection of global goals addressing various social, environmental and economic issues, with the aim of meeting each goal and target by 2030. The project would contribute directly to three of the goals:

- Goal 8 Decent work and economic growth: Goal 8 focuses on sustaining economic growth that allows people to have quality jobs while not adversely harming the environment. The project is anticipated to create about 600 to 800 jobs during construction and stimulate economic growth in the Western Sydney region and across Sydney (see **Section 5.24.13**). The project would create a necessary transport link to the new Western Sydney Airport, particularly for freight movements, which would generate economic growth opportunities for Sydney. Environmental management measures were identified to minimise the potential for the project to harm the environment (see **Chapter 9**)
- Goal 9 Industry, innovation and infrastructure: Goal 9 acknowledges that investment in infrastructure, including transport infrastructure, is crucial to achieving sustainable development and empowering communities. The project is a state significant infrastructure project, which is required to provide transport connectivity to Western Sydney and the new Western Sydney Airport.
- Goal 11 Sustainable cities and communities: Goal 11 identifies congestion and declining infrastructure as common urban challenges. The project would provide access to the Western Sydney Airport and support the Western Sydney region's significant projected population and economic growth, which would emanate from a number of major urban and infrastructure developments including the Western Sydney Aerotropolis (see **Chapter 3**).

Transport Environment and Sustainability Policy Framework and Statement

The Transport Environment and Sustainability Policy Framework and Statement (TfNSW, 2015) gives a collective and coordinated approach to deliver the NSW Government's environmental and sustainability agenda across the transport network. The framework outlines the commitment of TfNSW and key transport agencies to deliver transport projects and services in a manner that balances economic, environmental and social issues.

The Policy Framework and Statement is based around eight environment and sustainability themes, against which are a number of performance indicators. The themes are:

- Energy management: Energy use and greenhouse gas emissions were estimated for the project (see **Section 8.6**). A project-specific objective (see **Table 8-48**) was set to minimise energy use and greenhouse gas emissions generated by the project.
- Pollution control: The potential for the project to result in pollution impacts was assessed as part of this EIS. Measures to minimise the potential for the project to result in air quality, noise, contamination and water quality impacts were identified and are summarised in **Chapter 9**. A project-specific objective (see **Table 8-48**) was set to minimise pollution generated by the project.
- Climate change resilience: Risks from climate change to the project, and measures to minimise these risks and enhance the resilience of the project, were assessed as part of this EIS (see **Section 8.6**) , and a project-specific objective (see **Table 8-48**) was set to maximise the resilience of the project to climate change impacts.
- Resource management: Key waste streams that would be generated, and measures to minimise waste quantities, were identified for the project (see **Section 8.5**). The volume of materials that would be used to construct the project, and the embodied energy within these materials, is identified in **Section 8.5**). A project-specific objective (see **Table 8-48**) was set to optimise resource efficiency and waste management.
- Biodiversity: Biodiversity impacts, and measures to minimise impacts on biodiversity, were identified for the project (see **Section 7.1**). A project-specific objective (see **Table 8-48**) was set to minimise impacts caused by the project on biodiversity.
- Heritage: Assessment of Aboriginal heritage (see **Section 7.5**) and non-Aboriginal heritage (see **Section 7.6**) impacts and opportunities for interpretation was carried out as part of this EIS. A project-specific objective (see **Table 8-48**) was set to enhance liveability of local communities for the project.
- Liveable communities: A socio-economic impact assessment was carried out which identifies potential impacts and benefits from the project on the community (see **Section 7.4**) Urban and landscape design features were incorporated into the project design (see **Section 7.3**). Landscape treatments are described in **Appendix G**. A project-specific objective (see **Table 8-48**) was set to enhance liveability of local communities for the project.
- Corporate sustainability: Which relates to internal sustainability governance within TfNSW and has therefore not been considered applicable to the project.

Sustainable Design Guidelines v4.0

The Sustainable Design Guidelines v4.0 (TfNSW, 2017a) are aimed at embedding sustainability initiatives, across seven key themes, into the planning, design, construction, operations and maintenance of infrastructure projects as follows:

- Energy and greenhouse: Energy use and greenhouse gas emissions were estimated for the project (see **Section 8.6**). A project-specific objective (see **Table 8-48**) was set to minimise energy use and greenhouse gas emissions generated by the project.
- Climate resilience: Risks from climate change to the project, and measures to minimise these risks and enhance the resilience of the project, were assessed as part of this EIS (see **Section 8.6**), and a project-specific objective (see **Table 8-48**) was set to maximise the resilience of the project to climate change impacts.
- Materials and waste: Key waste streams that would be generated, and measures to minimise waste quantities, were identified for the project (see **Section 8.5**). The volume of materials that would be used to construct the project, and the embodied energy within these materials, are identified in **Section 8.6**).
- Water: A water balance was prepared for the project to identify potential sources of water supply and total estimated water use for the construction of the project (see **Section 7.9**).

- Pollution control: The potential for the project to result in pollution impacts was assessed as part of this EIS. Measures to minimise the potential for the project to result in air quality, noise, contamination and water quality impacts were identified and are summarised in **Chapter 9**.
- Biodiversity: Biodiversity impacts, and measures to minimise impacts on biodiversity, were identified for the project (see **Section 7.1**).
- Community benefit: A socio-economic impact assessment was carried out which identifies potential impacts and benefits from the project on the community (see **Section 7.4**).

The guideline and its sustainability initiatives are together a key tool in helping to realise sustainable transport outcomes. Project specific objectives and targets (see **Table 8-48**) were identified to contribute to each of these above focus areas and intent of these guidelines.

The above key themes broadly align with the focus areas presented in the Roads and Maritime Environmental Sustainability Strategy 2015-2019 (Roads and Maritime, 2016g). A discussion of how the project meets these focus areas is provided below.

Roads and Maritime Environmental Sustainability Strategy 2015-19

The Roads and Maritime Environmental Sustainability Strategy 2015–2019 (Roads and Maritime, 2016g) aligns with the Transport Environment and Sustainability Policy Framework and outlines nine specific focus areas for integrating sustainability into Roads and Maritime projects and services as follows:

- Energy and carbon management, which aims to minimise energy use and reduce greenhouse gas emissions without compromising the delivery of services. Energy use and greenhouse gas emissions were estimated for the project (see **Section 8.5**) and a project-specific objective (see **Table 8-48**) was set to minimise energy use and greenhouse gas emissions generated by the project.
- Climate change resilience, which aims to design and construct transport infrastructure to be resilient to climate change impacts. A climate change risk assessment was completed for the project (**Section 8.5**) and a project-specific objective (see **Table 8-48**) was set to maximise the resilience of the project to climate change impacts.
- Air quality, which aims to minimise the air quality impact of road projects and support initiatives that aim to reduce transport related air emissions. An air quality impact assessment was completed for the project and measures to minimise impacts on air quality were identified (see **Section 8.2**). A project-specific objective (see **Table 8-48**) was set to minimise pollution generated by the project.
- Resource use and waste management, which aims to minimise the use of non-renewable resources and the quantity of waste disposed to landfill. Key waste streams that would be generated, and measures to minimise waste quantities, were identified for the project (see **Section 8.5**). The volume of materials that would be used to construct the project, and the embodied energy within these materials, is identified in **Section 8.6.** A project-specific objective (see **Table 8-48**) was set to optimise resource efficiency and waste management.
- Pollution control, which aims to minimise noise, water and land pollution from road and maritime construction, operation and maintenance activities. The potential for the project to result in pollution impacts was assessed as part of this EIS. Measures to minimise the potential for the project to result in air quality, noise, contamination and water quality impacts were identified and are summarised in **Chapter 9**. A project-specific objective (see **Table 8-48**) was set to minimise pollution generated by the project.
- Biodiversity, which seeks to improve outcomes for biodiversity by avoiding, mitigating or offsetting the potential impact of road and maritime projects on plants, animals and their environments. Biodiversity impacts, and measures to minimise impacts on biodiversity, were identified for the project (see **Section 7.1**). A project-specific objective (see **Table 8-48**) was set to minimise impacts caused by the project on biodiversity.

- Heritage, which seeks to ensure cultural heritage is conserved and managed according to its heritage significance and that it contributes positively to awareness of the past. Assessment of Aboriginal heritage (see **Section 7.5**). and non-Aboriginal heritage (see **Section 7.6**). impacts and opportunities for enhancement was carried out as part of this EIS. A project-specific objective (see **Table 8-48**) was set to enhance liveability of local communities for the project.
- Liveable communities, which aims to produce high quality urban design outcomes that contribute to the liveability of communities in NSW. A socio-economic impact assessment was carried out which identifies potential impacts and benefits from the project on the community (see **Section 7.4**). Urban and landscape design features were incorporated into the project design (see **Section 5.3**). Landscape treatments are described in **Section 7.3**. A project-specific objective (see **Table 8-48**) was set to enhance liveability of local communities for the project.
- Sustainable procurement, which aims to procure infrastructure, goods and services that over their lifecycle deliver value for money and contribute to the environmental, social and economic wellbeing of the community. Procurement would largely be considered in future stages of the project.

Project specific objectives and targets (see **Table 8-48**), referenced above, were identified to align with these focus areas and ensure that sustainability opportunities are identified and that the project contributes to the reduction of environmental footprints for a more sustainable NSW transport system.

Infrastructure Sustainability rating tool Version 1.2

The Infrastructure Sustainability (IS) rating tool Version 1.2 was developed by ISCA as a comprehensive process for evaluating sustainability across the design, construction and operation of infrastructure. The IS rating tool is a comprehensive Australia and New-Zealand rating system used to evaluate sustainability performance across the planning, design, construction and operational phases of infrastructure programs, projects, networks and assets.

ISCA released the new Planning, Design and As-Built IS rating tool Version 2.0 in August 2018. This update provides a number of altered and additional categories and credits, with the aim of further enhancing the sustainability performance of major infrastructure projects. Roads and Maritime registered the project for a Design and As-Built IS rating under Version 1.2 before the release of Version 2.0. Therefore, Version 1.2 would continue to be used for the remainder of the project and options to selectively apply Version 2.0 criteria would be considered where reasonable and feasible.

There are three types of ratings that can be adopted using the IS rating tool. A ‘Design’ rating achieved at the end of the planning and design phase, an ‘As Built’ rating achieved at the end of construction and an ‘Operations’ rating achieved after 24 months of operation. The project would seek to achieve a minimum ‘Excellent’ IS rating for both ‘Design’ and ‘As Built’ ratings under Version 1.2 of the IS rating tool ensuring that sustainability is fully integrated into the project delivery.

The IS rating tool incorporates a number of requirements that are specific to either the detailed design phase or construction phase of a project. Considering sustainability early provides the greatest opportunity to influence and achieve sustainable outcomes. Although the majority of the IS rating tool would not be implemented until future stages of the project, integration of sustainability, and implementation of the IS rating tool requirements, was achieved to date through the assessment of environmental impacts and the identification of relevant environmental management measures (see **Chapter 9**).

Requirements of the IS rating tool have also been considered within the design development for the project. Indicative objectives and targets were set (see **Table 8-48**) to ensure future stages of the project consider the themes and requirements of the IS rating tool. The construction contractor would be responsible for ensuring that enough credits are achieved to meet the IS 'Excellent' rating.

Version 1.2 of the IS rating tool comprises 15 categories, which are described below together with a description of project elements under each category:

- Management systems: During the detailed design and construction phase management systems would be established to maximise delivery of sustainability solutions. A sustainability management plan would be prepared during the detailed design phase to outline how sustainability initiatives would be managed and implemented (see **Section 8.4.4**)
- Procurement and purchasing: Procurement and purchasing would mostly be considered within future stages of the project, in particular during the construction phase. The sustainability management plan (see **Section 8.4.4**) would outline key objectives for procurement and purchasing.
- Climate change adaptation: A climate change risk assessment was completed for the project (see **Section 8.6**). A project-specific objective (see **Table 8-48**) was set to maximise the resilience of the project to climate change impacts.
- Energy and carbon: Energy use and greenhouse gas emissions were estimated for the project (see **Section 8.6**). A project-specific objective (see **Table 8-48**) was set to minimise energy use and greenhouse gas emissions generated by the project.
- Water: A water balance was prepared for the project to identify potential sources of water supply and total estimated water use for the construction of the project (see **Section 7.9**). A project-specific objective (see **Table 8-48**) was set to efficiently manage water.
- Materials: The volume of materials that would be used to construct the project, and the embodied energy within these materials, is identified in **Section 8.6**). A project-specific objective (see **Table 8-48**) was set to optimise resource efficiency and waste management.
- Dischargers to air, land and water: The potential for the project to result in discharges to air, land and water was assessed as part of this EIS. Measures to minimise the potential for the project to result in air quality, noise, contamination and water quality impacts were identified and are summarised in **Chapter 9**). A project-specific objective (see **Table 8-48**) was set to minimise pollution generated by the project.
- Land: The project has the potential to result in land use changes (assessed in **Section 7.4**), changed flood regimes (assessed in **Section 7.8**), and generation or disturbance of contaminated material (assessed in **Section 8.1**). Measures to minimise impacts on the land were identified and are summarised in **Chapter 9**).
- Waste: Key waste streams that would be generated by the project, and measures to minimise waste quantities, were identified for the project (see **Section 8.5**). A project-specific objective (**Table 8-48**) was set to optimise resource efficiency and waste management.
- Ecology: Biodiversity impacts, and measures to minimise impacts on biodiversity, were identified for the project (see **Section 7.1**). A project-specific objective (**Table 8-48**) was set to minimise impacts caused by the project on biodiversity.
- Community health, wellbeing and safety: A socio-economic impact assessment was carried out which identifies potential impacts and benefits from the project on the community (see **Section 7.4**). A project-specific objective (see **Table 8-48**) was set to enhance liveability of local communities for the project.
- Heritage: Assessment of Aboriginal heritage (see **Section 7.5**) and non-Aboriginal heritage (see **Section 7.6**) impacts and opportunities for enhancement was carried out as part of this EIS. A project-specific objective (see **Table 8-48**) was set to enhance liveability of local communities for the project.
- Stakeholder participation: **Chapter 6** identified the consultation activities that were carried out for the project as part of this EIS. Consultation would continue to be carried out as the project progresses.
- Urban and landscape design: Urban and landscape design features were incorporated into the project design (see **Section 7.3**). Landscape treatments are described in **Appendix G**.
- Innovation: Opportunities for innovation would mostly be considered during future stages of the project.

Initiatives were implemented within the delivery of this EIS and the design of the project to address the requirement of the IS rating tool (see **Section 8.4.2**).

Project specific objectives and targets (see **Table 8-48**), referenced above, were identified to align with the themes and focus areas comprising the IS rating tool. Sustainability initiatives, aimed at achieving the requirements of the IS rating tool, would largely be implemented during future stages of the project and would broadly be governed by the sustainability strategy described in **Section 8.4.2.** Consideration of the requirements of the tool were considered within this EIS to the extent possible given the current stage of the project.

Future Transport Strategy 2056

The Future Transport Strategy 2056 (NSW Government, 2018a) is a 40-year vision to use transport to contribute to long-term economic, social and environmental outcomes and to the NSW Government's aspirational target to achieve net-zero emissions by 2050. While it is recognised that a growing transport investment is critical to the wellbeing of communities, doing so in an unsustainable way risks the government's ability to respond to community needs. As a result, the sixth outcome of the Strategy's vision includes a series of sustainability objectives, including achieving an affordable network that is financially sustainable and responsive to change.

A Metropolis of Three Cities – the Greater Sydney Region Plan and Western City District Plan

A Metropolis of Three Cities – the Greater Sydney Region Plan (Three Cities Plan) (Greater Sydney Commission, 2018a) serves as the vision for Sydney where the three cities: Western Parkland, Central River and Eastern Harbour; serve to allow residents to live within 30 minutes of their jobs, education, health facilities and services. This vision aims to utilise land use and transport patterns to boost Sydney's liveability, productivity and sustainability. A series of district plans support the Three Cities Plan. The *Western City District Plan* (Greater Sydney Commission, 2018b), sets out planning priorities and actions for improving the quality of life for residents in Western Sydney. The Three Cities Plan and Western City District Plan include three directions for sustainability, which are to create:

- A city in its landscape by valuing green spaces and landscapes. urban and landscape design, including incorporation of urban design objectives (see **Section 7.3**). were incorporated into the project design. Landscape treatments are described in **Appendix G**.
- An efficient city by using resources wisely. The project's potential to generate GHG emissions (see **Section 8.6**), use water refer **Section 7.9**) and produce waste (see **Section 8.5**) were assessed as part of this EIS. Measures to minimise production of GHG emissions and waste and to minimise water use are summarised in **Chapter 9**.
- A resilient city by adapting to a changing world. A climate change risk assessment was completed for the project (see **Section 8.6**). A project-specific objective (see **Table 8-48**) was set to maximise the resilience of the project to climate change impacts.

NSW Freight and Ports Strategy

The NSW Freight and Ports Strategy (TfNSW, 2013b) provides a 20–year road map that will ensure freight is at the forefront of NSW's economy. Two main objectives are outlined in the plan:

- Delivery of a freight network that efficiently supports the projected growth of the NSW economy
- Balancing of freight needs with those of the broader community and the environment.

The Strategy gives three strategic action programs on network efficiency, network capacity and network sustainability. Strategic Action Program 3 on Network Sustainability offers four actions which detail the need for a sustainable freight network that balances efficient freight movements with community expectations on safety, good neighbourhood amenity and positive environmental outcomes. The four actions are to embed freight requirements in planning schemes, manage congestion, noise and emission impacts of freight transport, prioritise safety of freight transport and support the growth of the transport and logistics workforce.

Chapter 3 outlines the benefits of the project in improving efficiency of the freight network. The project would provide increased road capacity and reduce congestion and travel times in the future, and would also improve the movement of freight in and through western Sydney.

NSW Climate Change Policy Framework

The NSW Climate Change Policy Framework (OEH, 2016d) aims to maximise the economic, social and environmental wellbeing of NSW in the context of a changing climate. The framework outlines policy directions for implementing the government's long-term objectives of achieving net zero emissions by 2050 and improving the resilience of NSW to a changing climate, including:

- Creating a certain investment environment by working with the Commonwealth to manage transition
- Boosting energy productivity to put downward pressure on household and business energy bills
- Capturing co-benefits and manage unintended impacts of external policies
- Taking advantage of opportunities to grow new industries in NSW
- Recuing risks and damage to public and private assets in NSW arising from climate change
- Reducing climate change impact on health and wellbeing
- Managing impact on natural resources, ecosystems and communities.

A climate change risk assessment was completed for the project (see **Section 8.6**). A project-specific objective (see **Table 8-48**) was set to maximise the resilience of the project to climate change impacts.

NSW Government Resource Efficiency Policy

The NSW Government Resource Efficiency Policy (OEH, 2019) aims to drive resource efficiency, with a focus on energy, water and waste, and a reduction in harmful air emissions. The policy aims to ensure that NSW Government agencies show leadership by incorporating resource efficiency in decision-making. The policy includes specific measures, targets and minimum standards to drive resource efficiency aligned to energy, waste, clean air and water. Project specific objectives and targets (see **Table 8-48**) to ensure the project sustainability manages energy, waste, clean air and water.

NSW Waste Avoidance and Resource Recovery Strategy 2014-21

The NSW Waste Avoidance and Resource Recovery Strategy 2014-21 (NSW EPA, 2014d) gives long-term objectives and targets across six key result areas. The key result areas are to avoid and reduce waste generation, increase recycling, divert more waste from landfill, manage problem wastes better, reduce litter and reduce illegal dumping. The corresponding targets are to reduce the rate of waste generation per capita by 2021-22, increase recycling rates for municipal solid waste, commercial and industrial waste and construction and demolition waste, increase the waste diverted from landfill by 2021-22, establish or upgrade.

An assessment of the potential waste impacts associated with the project is presented in **Section 8.5**. A project-specific objective was set to optimise resource efficiency and waste management (see **Table 8-48**).

Aboriginal Participation in Construction Policy (APiC)

The Aboriginal Participation in Construction Policy (APiC) (NSW Government, 2018b) was developed to support greater participation and opportunities for Aboriginal people in government construction projects across NSW. It specifically aims to increase the number of Aboriginal people employed under the NSW Government plan for Aboriginal Affairs by encouraging Aboriginal training. A project-specific objective (see **Table 8-48**) was set to maximise employment and training opportunities for young people, Aboriginal and Torres Strait Islanders, disadvantaged groups, long-term unemployed and people who live along the project's alignment.

Training Management Guidelines

The Training Management Guidelines (NSW Government, 2009) provide a strategic approach to training and skills opportunities and development in the construction industry at both the enterprise and project level. This is done by integrating training and skills development into planning and management. A project-specific objective (see **Table 8-48**) was set to maximise employment and training opportunities for the project's workforce.

Transport Social Procurement Policy

The Transport Social Procurement Policy (TfNSW, 2016) aims to promote strategic procurement practices within the delivery of transport infrastructure projects that generate environmental and social benefits beyond the goods and services required. The key outcomes the policy aims to achieve include avoiding unnecessary consumption, minimising environmental impacts from goods and services procured, supporting markets for sustainable product markets and driving innovation. Procurement will largely be considered in future stages of the project.

8.4.2 Sustainability implementation

Section 8.4.1 describes the policy and planning setting for the project. To the greatest extent possible, as summarised in **Section 8.4.1**, the sustainability themes and objectives within the outlined guidelines were considered within the design of the project and within the preparation of this EIS. Sustainability outcomes would largely be achieved within future stages of the project; namely construction and operation. Sustainability implementation was considered for all stages of project delivery to ensure that the project can contribute to the desired outcomes outlined within the relevant guidelines for the project.

Implementation during the EIS

Implementation of sustainability during the preparation of the design as set out in this document and the EIS has included:

- Avoidance of environmental impacts where possible during the site/route selection process and preparation of the design as set out in this document (see **Chapter 4**).
- Assessment of environmental impacts and identification of measures to minimise adverse impacts was carried out (this EIS)
- Consideration of the requirements of the IS rating tool to the extent possible at this stage of the project during the delivery of the project
- Consideration of sustainability principles within the development of the design for the project
- Environmental management measures were identified to ensure sustainability continues to be integrated into the delivery of the project in future stages (see **Section 8.4.4**).

Sustainability workshops and meetings were held during EIS development with the planning and design teams to implement the sustainability strategy. Opportunities for future detailed design developments suggested in these workshops were also taken into account as part of the development of the design as set out in this document and preparation of this EIS.

Sustainability initiatives were identified under the following headings:

- Adaptation to climate change (see **Section 8.6**), including initiatives to improve the resilience of the project to future extreme climate events. Climate change adaptation measures were developed for the project and are presented in **Table 8-69**.
- Energy and carbon reduction (see **Section 8.6**), including measures to minimise greenhouse gas emissions that would be produced by the construction and/or operation of the project. For example, design refinements were made to minimise the volume of fill required, minimising transport emissions associated with haulage of imported fill
- Materials, including opportunities to reduce total material quantities, reuse materials and select materials with a lower embodied energy content where possible. For example, the asphalt specification that would be used for the project allows for the incorporation of a proportion of recycled asphalt into the pavement mixture (see **Section 5.9**)
- Water quality and water use, including initiatives for achieving efficiencies in water use and reduction of potable water use. For example, opportunities to use non-potable water from sediment basins were considered (see **Section 7.9.4**)
- Noise and vibration (see **Section 7.7**), including measures to minimise and/or mitigate noise and vibration during construction and operation. Measures were developed to minimise noise during construction and operation of the project and are outlined in **Section 5.19**.
- Flooding design (see **Section 7.8**), The project was designed to ensure flood immunity up to, and including, a one in 100 year event
- Crime prevention (see **Section 7.3**), including the implementation of 'Crime Prevention through Environmental Design' principles for the project. For example, the proposed shared user path underpass at the airport access road would have end to end visibility to promote natural surveillance, and lighting would be provided along the shared user paths.
- Urban and landscape design (see **Section 7.3**), including incorporation of urban design objectives (see **Section 5.3**) into the project design. Landscape treatments are described in **Appendix G**. With the disjointed existing landscape areas, opportunities to accentuate the existing natural patterns through revegetation and reinforce the previous landscape patterns throughout the project were considered.
- Biodiversity (see **Section 7.1**), including measures to avoid and minimise impacts on biodiversity, such as provision of bridges for all creek crossing to assist in maintaining wildlife connectivity. Biodiversity formed a key consideration within the site/route selection process for the project to ensure impacts on biodiversity would be avoided and minimised to the greatest extent feasible.
- Innovation, including the creation of better or more effective products, processes, services, technologies, or ideas that are accepted by markets, governments and society.

A number of actions were identified for consideration in planning and design, in order to develop specific sustainability commitments and targets for the project to be implemented by the construction contractor.

Implementation across future stages of the project

The policy and planning setting, outlined in **Section 8.4.1,** describes the sustainability themes and objectives that are generally applicable to the project. Many of the themes and objectives are most applicable to future stages of the project and the desired outcomes of the relevant policies would be achieved as the project is delivered in future. For example, the requirements of the IS rating tool are largely applicable to the detailed design and construction phases of a project. The development of the design for the project and preparation of this EIS have considered the targets and strategies within the relevant policies and guidelines in order to position the project to achieve sustainability outcomes as it progresses and to ensure sustainability opportunities are identified and considered early.

A strategy was established to ensure that the desired sustainability outcomes outlined within applicable guidelines (described in **Section 8.4.1**) can be implemented in future stages of the project when they are most applicable and to ensure that the project can achieve an “Excellent’ IS rating.

The steps followed to develop the sustainability strategy for the project were:

- Review current guidelines and sustainability policy applicable to the project
- Align the project to its applicable sustainability policy
- Establish sustainability objectives and targets for the project.

Review of current guidelines

Section 8.4.1 describes the policy and planning setting for the project with a focus on 15 relevant guidelines and documents. To the greatest extent possible, as summarised in **Section 8.4.1**, the sustainability themes and objectives within the outlined guidelines were considered within the design as set out in this document and within the preparation of this EIS. Sustainability outcomes would largely be achieved within future stages of the project; namely construction and operation. To ensure that the project supports the relevant guidelines in future stages a strategy was developed to align with applicable sustainability focus areas within each of the guidelines. Each guideline was reviewed to identify sustainability focus areas, objectives and targets that should form the basis of the project’s strategy for addressing sustainability. The review identified that a broad range of different sustainability focus areas, and numerous objectives and targets are identified across each of the guidelines. **Table 8-47** shows a summary of the sustainability themes and which guidelines contain sustainability objectives and targets that were considered most relevant to the project.

The purpose of mapping the themes, objectives and targets outlined within each of the 15 applicable guidelines was to inform the key sustainability themes that the project should endeavour to minimise impact on or contribute positively to. Based on the recurring themes and the objectives and targets identified within the applicable guidelines, and summarised in **Table 8-47**, objectives and targets for the project were set.

Sustainability policy

The sustainability strategy was developed based on the sustainability policy relevant for the project (see **Figure 8-32**). The sustainability policy sets the overall direction for implementing sustainability initiatives during the delivery of the project. The policy acknowledges the need to deliver services and infrastructure that benefit the community and minimise negative environmental, social and economic impacts while maximising positive outcomes.

Establish objectives and targets

Objectives and targets for the project are being set based on the recurring sustainability focus areas, and the objectives and targets already contained within relevant guidelines. The purpose of setting objectives and targets is to ensure that the project can comply with the intent of the current guidelines applicable to the project and to position the project to be able to achieve an ‘Excellent’ IS Rating. **Figure 8-33** identifies the key steps taken to identify the objectives and targets for the project.

The outcomes from this EIS, including any relevant conditions that may be applied to the project by the Minister for Planning and Public Spaces, would be used to finalise the sustainability objectives and targets for the project. Indicative objectives and targets for current phase of the project are outlined in **Table 8-48**.

Table 8-47 Relevant guideline's sustainability principles, objectives and targets

✓ Principle ✓ Objective ✓ Target	Sustainable Development Goals	Environmental Planning and Assessment Act 1979	Transport Environmental and Sustainability Framework	TfNSW Sustainable Design Guidelines	Roads and Maritime Sustainability Strategy	Infrastructure Sustainability Council of Australia	Future Transport Strategy 2056	A Metropolis of Three Cities and Western City District Plan	NSW Freight and Ports Strategy	NSW Climate Change Policy Framework	NSW Government Resource Efficiency Policy	NSW Waste avoidance and resource recovery strategy	Aboriginal Participation consultation Guidelines	NSW Government Training Management Guidelines	Transport Social procurement Policy
Management and participation			✓ ✓	✓ ✓	✓ ✓	✓ ✓									✓
Energy, carbon and materials	✓ ✓	✓ ✓	✓ ✓	✓ ✓	✓ ✓	✓ ✓	✓ ✓	✓ ✓	✓ ✓	✓ ✓ ✓	✓ ✓				✓
Resources and waste	✓ ✓	✓	✓	✓ ✓	✓	✓ ✓		✓			✓	✓ ✓ ✓			
Climate change	✓ ✓		✓	✓ ✓	✓ ✓	✓ ✓	✓ ✓	✓		✓ ✓					
Communities and liveability	✓ ✓		✓ ✓	✓ ✓ ✓	✓ ✓	✓ ✓	✓	✓							✓
Water	✓ ✓		✓ ✓	✓ ✓	✓	✓ ✓					✓				
Pollution and emissions	✓ ✓	✓ ✓	✓ ✓	✓ ✓	✓ ✓ ✓	✓ ✓	✓		✓		✓				
Ecology	✓ ✓	✓	✓	✓ ✓	✓	✓ ✓		✓							
Employment and opportunities	✓ ✓						✓		✓				✓ ✓ ✓	✓ ✓ ✓	

Environment and Sustainability Policy

Transport for NSW

Transport is essential to the economic and social development of NSW. It provides access to jobs, housing, goods and services. It provides for the movement of people in their daily lives to improve their quality of life.

Transport for NSW, together with its key agencies NSW Trains, Sydney Trains, Roads and Maritime Services and State Transit Authority are committed to delivering transport services, projects, operations and programs in a manner that balances economic, environmental and social issues to ensure a sustainable transport system for NSW. We work towards achieving this by:

- Minimising impacts on the environment, whether through transport operations, infrastructure delivery, maintenance or corporate activities
- Procuring, delivering and promoting sustainable transport options that promote value for money
- Complying with relevant legislation
- Developing, expanding and managing the transport network in a sustainable and climate change resilient way.

We will continuously improve our performance in line with this Environment and Sustainability Policy by:

- Implementing sound governance practices to set, apply and monitor the policy across the portfolio
- Setting objectives and targets to improve management and performance in line with best practice
- Reporting on our performance
- Raising the awareness and capacity of our staff to build the policy into their day-to-day business
- Forming constructive partnerships with government, industry and the community on environment and sustainability issues
- Contributing to and influencing the strategic environment and sustainability agenda of the NSW Government.

The Environment and Sustainability Policy flows from our obligations under the *Transport Administration Act* 1988 for "the delivery of transport services in an environmentally sustainable manner" and is reflected in our Corporate Plan "Connections - Towards 2017".

I commend the policy to all within the Transport cluster agencies.

Tim Reardon
Secretary
August 2015

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Figure 8-32 Sustainability policy (TfNSW, 2015)

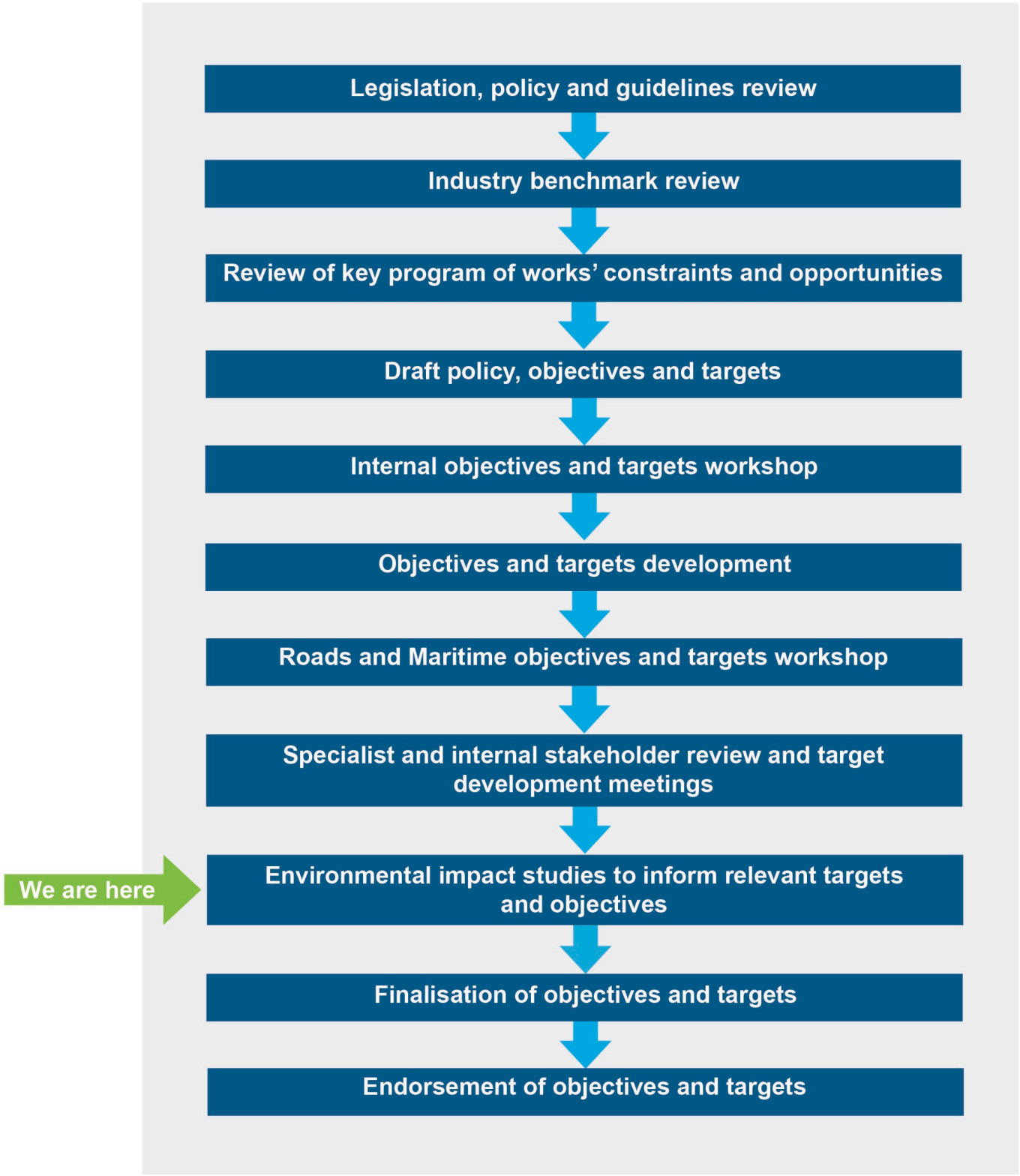


Figure 8-33 M12 Motorway sustainability objectives and targets development process

Table 8-48 Indicative sustainability objectives and target themes

Objective	Target themes
Maximise sustainability knowledge and awareness	• Sustainability commitments (including procurement commitments) • Sharing of sustainability outcomes with the community/stakeholders and industry
Minimise energy use and greenhouse gas emissions	• Operational greenhouse gas emissions • Construction greenhouse gas emissions • Embodied energy within construction materials
Optimise resource efficiency and waste management	• Resource recovery of virgin excavated natural material (VENM) and a range of other materials • Reuse of topsoil • Diversion of office waste from landfill
Maximise resilience to climate change impacts	• Climate change risk mitigation and/or adaptation measures
Enhance liveability of local communities	• Heritage values • Community benefit initiatives • Public open space
Maximise employment and training opportunities for young people, Aboriginal and Torres Strait Islanders, disadvantaged groups, long-term unemployed and people who live along the project's alignment	• Apprenticeships • Training and development • Workforce participation
Efficiently manage water	• Water use during construction • Water use during operation • Use of non-potable water
Minimise pollution generated by the project	• Air quality • Noise and vibration • Water quality • Contamination
Minimise impacts on biodiversity	• Ecological value and biodiversity

8.4.3 Ecologically sustainable development

Ecologically sustainable development (ESD) is development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends (Ecologically Sustainable Development Steering Committee, 1992). The principles of ESD were considered throughout the development of the project as per Schedule 2 of the Environmental Planning and Assessment Regulation 2000.

ESD requires the effective integration of economic and environmental considerations in decision-making processes. The four main principles supporting the achievement of ESD are:

- The precautionary principle
- Inter-generational equity
- Conservation of biological diversity and ecological integrity
- Improved valuation and pricing and incentive mechanisms.

These principles are discussed in **Section 11.1.3**.

8.4.4 Environmental management measures

The overarching sustainability objectives for the project would be met through the implementation of a sustainability management plan and project specific sustainability initiatives. The sustainability management plan would be prepared during the detailed design phase for the detailed design and construction phase of the project.

The purpose of the sustainability management plan would be to confirm the sustainability strategy (policy, objectives and targets) that would be adopted for the project and identify measures and activities to ensure that sustainability is embedded into project delivery.

The sustainability management plan will outline:

- Ratified project sustainability objectives and targets
- Activities and responsibilities to achieve the project sustainability objectives and targets
- Governance structures, processes and systems for implementing sustainability
- Description of the IS rating process and the proposed timeframes for achieving an IS rating
- Credits within the IS rating tool that will be targeted by the project in order to obtain an 'Excellent' Design and As Built IS rating, and how these credits will be achieved
- Roles and responsibilities for ensuring sustainability is embedded in the design and construction of the project
- A process of continual improvement and ongoing review for the plan and the implementation of sustainability initiatives.
- The implementation of these initiatives would contribute to the project achieving an IS rating of 'Excellent'.

Environmental management measures relating to sustainability are outlined in **Table 8-49**.

Table 8-49 Environmental management measures (sustainability)

Impact	Reference	Environmental management measures	Responsibility	Timing
Project sustainability outcomes	SU1	A sustainability management plan for the project will be developed and implemented during detailed design, to give effect to the sustainability strategy for the project. The management plan will detail measures to meet the sustainability objectives and targets and IS rating tool credit requirements.	Contractor	Throughout detailed design, construction, and operation

8.5 Waste

This section describes the potential waste that may be generated by construction and operation of the project and presents a proposed waste management approach for the project. **Table 8-50** outlines the SEARs that relate to waste and identifies where they were addressed in this EIS.

Table 8-50 SEARs (waste)

Secretary's requirement	Where addressed in this EIS
21. Waste	
1. The Proponent must assess predicted waste generated from the project during construction and operation, including: a. classification of the waste in accordance with the current guidelines;	Potential construction waste streams are presented in **Section 8.5.3** in **Table 8-51**, while potential operational waste streams are presented in **Section 8.5.4** in **Table 8-55**
b. estimates/ details of the quantity of each classification of waste to be generated during the construction of the project, including bulk earthworks and spoil balance;	Quantities of waste anticipated to be generated during construction are presented in **Section 8.5.3** in **Table 8-51**
c. handling of waste including measures to facilitate segregation and prevent cross contamination;	Handling of construction waste is presented in **Section 8.5.3**. Handling of operational waste is presented in **Section 8.5.4** The environmental management measures associated with handling of waste are summarised in **Section 8.5.6** Measures relating to potentially contaminated materials are addressed in **Section 8.1**
d. management of waste including estimated location and volume of stockpiles;	Management of construction waste, including stockpile management, is discussed in **Section 8.5.3** Management of operational waste is discussed in **Section 8.5.4** The environmental management measures associated with management of waste are summarised in **Section 8.5.6**
e. waste minimisation and reuse;	Minimisation and reuse of construction waste is discussed in **Section 8.5.3**. Minimisation and reuse of operational waste is discussed in **Section 8.5.4** **The** environmental management measures associated with management of waste are summarised in **Section 8.5.6**
f. lawful disposal or recycling locations for each type of waste; and	Recycling locations are presented in **Section 8.5.3** in **Table 8-54**
g. contingencies for the above, including managing unexpected waste volumes.	Contingencies and management measures are presented in **Section 8.5.6**
2. The Proponent must assess potential environmental impacts from the excavation, handling, storage on site and transport of the waste particularly with relation to sediment/leachate control, noise and dust.	General waste-related potential environmental impacts are presented in **Section 8.5.3** and **Section 8.5.4** Measures relating to sediment/leachate control are addressed in **Section 8.1** Measures relating to noise are addressed in **Section 7.7** Measures relating to dust control are addressed in **Section 8.2**

8.5.1 Policy and planning setting

The key legislative instruments which manage waste in NSW are described below.

Waste Avoidance and Resource Recovery Act 2001

The *Waste Avoidance and Resource Recovery Act 2001 (NSW)* promotes waste avoidance and resource recovery, and establishes the following waste management hierarchy:

- Avoidance – minimise the potential for waste generation by avoiding unnecessary consumption of resources, including materials and materials that have excessive packaging
- Recovery – reuse, reprocess or recycle waste products to minimise the amount of waste requiring disposal
- Disposal – as a last resort, dispose of resources that cannot be recovered.

Protection of the Environment Operations Act 1997

The POEO Act is the key piece of environment protection legislation administered by the NSW EPA, and sets the statutory framework for:

- Specification of requirements for licences and the regulation of various activities that have the potential to pollute or harm the environment. Activities listed under Schedule 1 of the POEO Act require an Environment Protection Licence (EPL)
- Integration with NSW EPA licensing with the development approval procedures under the EP&A Act
- Provision for the issuing of clean-up notices, prevention notices and environment protection notices
- Classification of environment protection offences and penalties
- Allowance for mandatory audits and provision for authorised officers with the power to carry out investigations.

Protection of the Environment Operations (Waste) Regulation 2014

The Protection of the Environment Operations (Waste) Regulation 2014 (NSW) (Waste Regulation) sets out the provisions related to the following:

- Storage and transportation of waste
- Reporting and record-keeping requirements for waste facilities
- Special requirements for the management of certain special waste including asbestos
- Payment of waste contributions (referred to as a waste levy) by the occupiers of licensed waste facilities
- Exemption of certain occupiers or types of waste from paying waste contributions and from requiring an EPL under Part 9 of the Waste Regulation.

Part 9 of the Waste Regulation provides for exemptions to some of the requirements of the POEO Act and Waste Regulation for certain activities where it can be demonstrated that waste reuse would not cause harm to human or environmental health.

There are a number of Resource Recovery Orders and Exemptions allowing specified reuse of waste streams that are relevant to road construction projects, including:

- Excavated natural material
- Recovered aggregate
- Excavated public road material
- Treated drilling mud

- Reclaimed asphalt pavement
- Mulch
- Pasteurised garden organics
- Stormwater.

Clause 71 of the Waste Regulation prohibits the transport of waste for disposal more than 150 kilometres from the place of generation. Further discussion on waste facilities that may be utilised for the project is provided in **Section 8.5.3**.

Environmentally Hazardous Chemicals Act 1985

This Act provides the NSW EPA with the authority to declare chemicals as chemical waste, and to make a Chemical Control Order to appropriately manage the potential risk associated with any such waste to human and environmental health. In addition, a licence may be required under the Act for certain activities relating to manufacturing, processing, keeping, distributing, conveying, using, selling or disposing of an environmentally hazardous chemical or a declared chemical waste. Construction of the project may require the use and storage of chemicals onsite that may generate chemical waste.

Guidelines

Guidelines which were considered for this assessment include:

- Waste Classification Guidelines: Part 1 Classifying Waste (NSW EPA, 2014a), which prescribe the process for the classification of waste into groups that pose similar risks to the environment and human health
- NSW Sustainable Design Guidelines Version 4.0 (TfNSW, 2017a), which includes targets to achieve waste diversion in accordance with the waste management hierarchy
- Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom, 2004) and Volume 2 (A. Installation of Services; B. Waste Landfills; C. Unsealed Roads; D. Main Roads; E. Mines and Quarries) (DECC, 2008b), which outline waste management practices that should be applied during the design and construction phases of a project
- Technical Guide – Management of road construction and maintenance wastes (Roads and Maritime, 2016h), which identifies typical waste types produced during the construction of roads and measures to manage these waste types.

8.5.2 Assessment methodology

Waste streams that have the potential to be generated during the construction and operational stages of the project were identified via a desktop assessment. Potential waste types and quantities that may be generated by the projects were estimated by reviewing the construction and operational activities for the project (as outlined in **Chapter 5**), their scale and extent, as well as by reviewing relevant guidelines and waste generated on similar projects.

Management and mitigation measures were identified with respect to the relevant legislation and guidelines to manage waste as outlined below.

8.5.3 Construction waste

Potential waste generated during project construction would be managed using the waste hierarchy approach; whereby avoiding the generation of waste and reusing materials are prioritised over waste disposal. All waste would be managed in accordance with the waste provisions contained within the POEO Act and the Waste Regulation. Where waste would be reused offsite, relevant NSW EPA Resource Recovery Orders and Exemptions would be followed. As discussed below, construction of the project would require a greater quantity of fill than the quantity of excavation material generated, and all material that is suitable for reuse would be used for construction activities. The total quantity of fill required for the project is about 3,413,000 cubic metres (see **Table 8-52**).

Should waste be found to be unsuitable for reuse or recycling, disposal methods would be selected based on the classification of the waste material in accordance with the Waste Classification Guidelines: Part 1 Classifying Waste (NSW EPA, 2014a). The Waste Classification Guidelines provide direction on the classification of waste, specifying requirements for management, transportation and disposal of each waste category.

Resource recovery would be applied to the management of construction waste and would include:

- Recovery of resources for reuse - reusable materials generated by the project would be segregated for reuse onsite, or offsite where possible, including the reuse of the major waste streams
- Recovery of resources for recycling - recyclable resources (such as metals, plastics and other recyclable materials) generated during construction and demolition would be segregated for recycling and sent to an appropriate recycling facility for processing
- Recovery of resources for reprocessing - cleared vegetation would be mulched or chipped onsite and used for landscaping, in the absence of a higher beneficial use being identified.

Waste would be managed in accordance with the statutory requirements presented in **Section 8.5.1**, and the management measures presented in **Table 8-56**. A construction waste and resource management plan (CWRMP) would be prepared and implemented as part of the CEMP for the project. As a result, the overall impact of construction waste is considered to be manageable and acceptable.

Waste generated during construction would primarily be from works associated with clearing, stripping, demolition of existing structures, earthworks and construction of road carriageways, retaining soil structures and/or walls, bridges and drainage infrastructure. **Table 8-51** outlines the likely waste streams that have the potential to be generated by each of the key construction activities (described in **Section 5.24**) for the project; grouped together based on the potential waste streams they would generate. Reuse options and waste management measures for each potential waste stream are described in **Table 8-51.** The potential waste quantity requiring removal off site, following implementation of reuse options and waste management measures, were estimated in **Table 8-51.** Potential waste quantities requiring removal would be highly dependent on site conditions and the suitability of potential waste streams for reuse. Predicted waste quantities are therefore indicative only. The waste management approach would be refined and incorporated within the CWRMP to be developed for the project (detailed further in **Section 8.5.6**).

Excavated material

The project would generate topsoil and other excavated material (eg excavated soil, sediment, rock, gravel, clay, sand etc) during bulk earthworks. This includes any potentially contaminated earthworks material.

Table 8-51 Potential waste streams (construction)

Activity	Potential waste streams produced	Expected classification	Reuse options and waste management approach	Potential waste quantity requiring removal offsite
Early works (including site establishment activities, installation of office accommodation, utilities, and other facilities and minor earthworks. * Note that other activities may also be carried out as early works including demolition works and removal/relocation of farm infrastructure, and vegetation removal (see **Section 5.24.4**). These are discussed below.	Surplus construction material including fencing, geofabrics sediment, concrete, steel, timber, and sand bags	General solid waste (non-putrescible)	Materials that are potentially recyclable would be disassembled and removed carefully to maximise reuse and recycling. To ensure diversion from landfill, materials would be clearly separated and stored temporarily onsite for reuse or removal to a recycling facility. Stockpiled materials would be monitored and managed in accordance with the CEMP. As a priority, surplus construction materials are to be stored by the contractor for reuse on the project or be transferred to other sites for use in other Roads and Maritime projects. Stockpiling is further discussed under 'stockpile management' in the following sections. Onsite assessment/treatment of surplus construction materials, such as visual assessment, screening/removal of oversized material, mixing and moisture conditioning, would facilitate the potential reuse of this material in the project In the second instance, surplus construction materials may be recycled where possible. Sending of surplus materials to landfill is to be avoided where possible.	Minimal Surplus construction material would be reused onsite or reused at alternate Roads and Maritime projects
	Excavated materials including spoil	General solid waste (non-putrescible), restricted solid waste, hazardous waste and/or special waste	Excavation associated with establishment of ancillary facilities is to be minimised through selection of suitable ancillary facility locations that are as flat as possible (see **Section 5.24.3**). Excavated materials suitable for reuse are to be appropriately segregated and stored for future use on the project. Onsite assessment/treatment of these surplus construction materials, such as visual assessment, screening/removal of oversized material, mixing and moisture conditioning, would facilitate the potential reuse of this material as general fill or for landscaping. Earthworks waste is discussed further in the section below.	Minimal surplus excavated material is anticipated, as the project would reuse excavated material where feasible * Note that quantities of contaminated spoil are specified together under earthworks below

Activity	Potential waste streams produced	Expected classification	Reuse options and waste management approach	Potential waste quantity requiring removal offsite
Earthworks, drainage works and creek adjustment (including topsoil stripping, cut and fill preparation, and vegetation clearance) * Note these activities would not necessarily be carried out concurrently	Vegetation waste from the removal of trees, shrubs and ground cover	General solid waste (putrescible)	Where possible, vegetation clearing is to be minimised through project design. Vegetation that is cleared would be mulched and reused where possible, including consideration of the Mulch Order and Exemption allowing for reuse on other Roads and Maritime projects. This may include the reuse of timber for fauna habitat and root balls in the rehabilitation of waterways. Remaining vegetation that is not reused be sent to an approved facility for sale or disposal. Weeds would be disposed of offsite at an appropriate licensed disposal facility (waste disposal locations are discussed in the following sections below under 'waste disposal locations'). Onsite assessment/treatment of these surplus construction materials, such as visual assessment, screening/removal of oversized material, mixing and moisture conditioning, would facilitate the potential reuse of this material as general fill or for landscaping.	Minimal A majority of cleared vegetation is expected to be reused onsite or on other Roads and Maritime projects, other than weed species.
	Excavated spoil unsuitable for reuse (including contaminated spoil)	General solid waste (non-putrescible), restricted solid waste, hazardous waste, and/or special waste	Material that is identified as contaminated is to be segregated from uncontaminated material onsite to prevent cross-contamination and removed offsite to a licensed disposal facility. Onsite assessment/treatment of surplus excavated materials, such as visual assessment, screening/removal of oversized material, mixing and moisture conditioning, would facilitate the potential reuse of this material as general fill or for landscaping. If asbestos or other hazardous materials are identified, they are to be disposed offsite to a licensed facility or managed in accordance with a Remedial Action Plan (described in **Section 8.1**). Where reasonable and feasible, asbestos may be emplaced under the road pavement in accordance with a Remedial Action Plan. Waste disposal locations are discussed in the following sections below under 'waste disposal locations'. The excavation, handling, storage, movement and disposal of waste material that is identified as being contaminated would be carried out in accordance with the procedures detailed in the CEMP in accordance with the Work Health and Safety Regulation 2011 (NSW).	Minimal excavated material is anticipated, as the project would reuse excavated material where feasible. As an estimate, about 19,668 m^3 of contaminated material may need to be removed from site. In addition, areas of historical fill (totalling about 10,535 m^3) will be further investigated to determine if there is any contaminated material that would require excavation.

Activity	Potential waste streams produced	Expected classification	Reuse options and waste management approach	Potential waste quantity requiring removal offsite
			Spoil and stockpile management are discussed further in the following sections.	
	Contaminated water (eg generated by a spill leading to contamination of surface water or encountering (already) contaminated groundwater)	Liquid waste	Erosion and sediment controls, appropriate bunding of any chemicals and use of water quality control measures would be implemented (as described in **Section 8.1**) to minimise potential risk of surface water contamination. Contaminated water quantities are anticipated to be negligible or minor and are to be collected and disposed of by a suitably licensed contractor. Where contaminated water can be treated, it may be reused onsite for construction activities, including dust suppression, where possible.	Minimal
Demolition of existing structures on acquired/leased land and farm structures	Demolition materials including concrete, bricks, road base, tiles, timber (untreated and treated), metals, plasterboard, carpets, electrical and plumbing fittings and furnishing (doors, windows). May also include tyres, asbestos and lead paint.	General solid waste (non-putrescible), special waste and/or hazardous waste	Concrete and bricks are to be demolished using low impact techniques where practicable, so as to maintain the structure of the material, and thus its reusability. Materials are to be disassembled and removed carefully to maximise the potential for reuse and recycling. Where practical, removed road pavement is to be re-processed and used to provide sub-pavement layers for the project or another Roads and Maritime project under a waste order or exemption where applicable. Where practical, concrete is to be recycled. Remaining material is to be disposed of at an offsite facility. Waste disposal locations are discussed in the following sections below under ‘waste disposal locations’. Hazardous waste is to be removed by a qualified handler for recycling or recovery of energy where possible. If asbestos or other hazardous materials are identified, they are to be managed in accordance with a Remedial Action Plan (described in **Section 8.1**) or disposed of offsite at a licenced facility.	About 6436 tonnes (This was calculated from house composition information provided in DECCW (2010f)

Activity	Potential waste streams produced	Expected classification	Reuse options and waste management approach	Potential waste quantity requiring removal offsite
Construction of pavements and bridges, retaining structures, including finishing works (eg line marking, installation of roadside furniture, landscaping and demobilisation and rehabilitation of construction facilities and disturbed areas)	General construction waste including timber formwork, scrap metal, steel, concrete, plasterboards, and packaging material (crates, pallets, cartons, plastics and wrapping material)	General solid waste (non-putrescible)	Materials that are potentially recyclable are to be disassembled and removed carefully to maximise further reuse and recycling. To ensure diversion from landfill, waste materials are to be clearly separated and temporality stored onsite for reuse or removal to a recycling facility. Stockpiled materials would be monitored and managed in accordance with the CEMP. Where possible, the amount of packaging waste is to be minimised by avoiding the ordering of unnecessary or excess supplies and by buying in bulk. Where reasonable and feasible, cost-effective suppliers that use sustainable, recycled and/or recyclable material are to be used. Packaging waste generated is to be sorted for recycling or disposal at an approved facility. In the event of excess supplies due to accidental over-ordering or design changes, excess material would be reused, returned to the supplier or recycled where feasible. Remaining material would be disposed of at a licenced facility.	Minimal
	Surplus construction material including fencing, sediment, gravel/crushed rock, asphalt, concrete, steel, aggregate, formwork, asphalt, landscaping material and sand bags.	General solid waste (non-putrescible)	Materials that are potentially recyclable would be disassembled and removed carefully to maximise further reuse and recycling. To ensure diversion from landfill, waste materials would be clearly separated and stored temporarily onsite for reuse or removal to a recycling facility. Stockpiled materials would be monitored and managed in accordance with the CEMP. As a priority, surplus construction materials may be transferred to other sites for use or stored by the contractor for future use. In the second instance, surplus construction materials may be recycled where possible. Surplus materials would be diverted from, landfill where possible. Onsite assessment/treatment of surplus construction materials, such as visual assessment, screening/removal of oversized material, mixing and moisture conditioning, would facilitate the potential reuse of this material in the project In the second instance, surplus construction materials may be recycled where possible. Sending surplus materials to landfill is to be avoided where possible.	Minimal Surplus construction material would be reused onsite or reused at an alternate Roads and Maritime project where possible

Activity	Potential waste streams produced	Expected classification	Reuse options and waste management approach	Potential waste quantity requiring removal offsite
Temporary works including the construction of work platforms, hardstand areas, and sediment basins	General construction waste including timber formwork, scrap metal, steel, concrete, plasterboards and packaging material (crates, pallets, cartons, plastics and wrapping material)	General solid waste (non-putrescible)	To ensure diversion from landfill, waste materials would be clearly separated and stored onsite, monitored and managed in accordance with the CEMP. Where possible, the amount of packaging waste would be minimised by avoiding the ordering of unnecessary or excess supplies and by buying in bulk. Where reasonable and feasible, cost-effective suppliers that use sustainable, recycled and/or recyclable material would be used. Packaging waste generated would be sorted for recycling or disposal at an approved facility. In the event of excess supplies due to accidental over-ordering or design changes, excess material would be reused, returned to the supplier or recycled where feasible. Materials that are potentially recyclable would be disassembled and removed carefully to maximise further reuse and recycling.	Minimal
	Sediment and sludge within sediment basins	General solid waste (non-putrescible)	Sediment removed from basins would be dewatered and may be reused onsite (eg in landscaping works) or in non-structural fill embankments. If the material cannot be reused onsite, it would be disposed of at an appropriately licensed facility.	Minimal Any sediment/ sludge is expected to be treated and reused onsite
Activities at site offices	General waste from site office including putrescibles, paper, cardboard, e-waste plastics, glass, site litter, cigarette butts, printer cartridges and sewage waste	General solid waste (non-putrescible)	Waste and recycling generated by the site offices would be source-separated into dedicated bins, such as: • General waste • Co-mingled recycling • Paper/cardboard • Toner/cartridges • E-waste. The segregation of recyclables from the general waste stream would maximise resource recovery and minimise materials sent to landfill. Bins would be clearly labelled and coloured to reflect the correct stream. Staff would be trained about the internal office waste management system to ensure adequate understanding across all employees. Sewage would be directed to the sewage mains or pumped out for disposal at an appropriately licensed facility.	Minimal Volumes of waste produced would be dependent on the number of workers onsite at any one time

Activity	Potential waste streams produced	Expected classification	Reuse options and waste management approach	Potential waste quantity requiring removal offsite
Operation of plant and equipment	Waste from operation and maintenance of construction vehicles and machinery including adhesives, lubricants, waste fuels, cleaning products and chemicals, and oils, engine coolant, batteries, hoses and tyres	Hazardous waste, special waste, liquid waste	Liquid waste would be collected and transferred to a dedicated recycling facility where possible, to ensure diversion from landfill. Batteries would be collected and recycled by a qualified handler.	Minimal
	Clean up waste in the event of an accidental spill of fuel or chemicals	Hazardous waste, Liquid waste	Materials collected during clean up would be disposed of at an appropriately licensed facility.	Minimal Any waste from spills would be dependent on the size and nature of the spill

Table 8-52 presents the expected quantities and types of excavated materials to be generated by the project. About 1,426,000 cubic metres of material would be excavated during construction of the project, however, the total quantity of fill required for the project is about 3,413,000 cubic metres. No surplus excavated material is anticipated to be produced by the project, and therefore the only waste resulting during earthworks would comprise excavated material that is unsuitable for reuse. The potential to encounter contaminated material during earthworks, along with a management approach for any contaminated materials encountered during construction, is discussed in **Section 8.1**.

Table 8-52 Expected types and quantities of excavated material

Type of material	Status	Approximate quantity (cubic metres)
Topsoil	Suitable for reuse	205,000
	Unsuitable for reuse	minimal
Other excavated material	Suitable for reuse	1,426,000
	Contaminated or otherwise unsuitable for reuse	19,668
	Surplus excavated material	minimal

Wherever possible, excavated material would be stockpiled onsite (further discussed below under 'Stockpile management') and reused for project construction. The ability to reuse excavated material would depend on the physical properties of the excavated material and require that the material is of suitable quality.

A contamination assessment completed as part of this EIS identified areas of potential and confirmed contamination as outlined in **Section 8.1**. If previously unidentified contaminated material is discovered during construction, the contaminated material would be managed in accordance with an unexpected contaminated finds procedure, as outlined in the Guideline for the Management of Contamination (Roads and Maritime, 2013b).

Where excavated material cannot be reused onsite, it would be managed in the following order of priority:

- Transfer to other Roads and Maritime projects for reuse in accordance with the NSW EPA's excavated public road resource recovery exemption
- Transfer to an approved Roads and Maritime stockpile site for reuse on a future project only if a specific project was identified before stockpiling and statutory/regulatory requirements under the POEO Act are met. If a project cannot be identified the material would not be stockpiled
- Transport off site for reuse by a third party in accordance with relevant NSW EPA resource recovery exemption or to a NSW EPA licensed waste recovery facility
- Dispose at an accredited materials recycling or waste disposal facility.

Where excavated material is deemed unsuitable for reuse or emplacement due to contamination, it would be taken to a waste facility licensed to accept the waste.

Stockpile management

Stockpiles may be located along the alignment and within all ancillary facilities. Large stockpiles are expected at the following ancillary facilities:

- AF 1 – east of The Northern Road
- AF 2 – north of Elizabeth Drive opposite the Elizabeth Drive/Badgerys Creek Road intersection
- AF 3 – north of Elizabeth Drive between proposed Airport Access Road and rail line.

Table 8-53 presents the anticipated stockpile volumes within each of these ancillary facilities (see **Section 5.24.3**). The project would aim to reuse materials onsite to the greatest extent possible, and as a result material and earthworks stockpiles would not necessarily constitute stored volumes of waste. The estimated stockpile volumes provided below were calculated based on the maximum quantity of waste that would be stored, which is estimated to be towards the beginning of construction when the highest volumes of construction and demolition waste and vegetation waste would be stored. The volume of waste stockpiled at each ancillary facility would likely gradually be reduced as construction progresses.

Table 8-53 Estimated stockpile volumes

Stockpiled waste	Estimated stockpile volume (cubic metres)
Construction and demolition waste	67,000
Vegetation waste	1,467,000
Excavated material (including material unsuitable for reuse onsite such as contaminated spoil)	333,000

Stockpile management procedures for segregating waste, preventing cross-contamination of clean and contaminated spoil and odour management would be included in the CEMP. Management measures for the stockpiling of potential waste streams would be dependent on the type and quantity of waste to be stockpiled would be in accordance with the Roads and Maritime Stockpile Site Management Guideline (Roads and Maritime 2015e) (see **Section 8.5.6**).

Where possible, ancillary facilities identified in this EIS were nominated in locations that would minimise the potential for stockpiled waste to result in environmental impacts (such as contamination of waterways) and that would minimise the generation of waste (such as by not requiring vegetation waste). Characteristics of the ancillary facilities that would minimise potential impacts from waste would be that they are, where possible:

- More than 50 metres from a waterway
- Within or adjacent to land where the project is being carried out
- Have ready access to the road network
- Are on relatively level land
- Do not require vegetation clearing beyond that already required for the project
- Are above the one in 20–year ARI flood level unless a contingency plan to manage flooding is prepared and implemented
- Provide sufficient area for the storage of raw materials to minimise, to the greatest extent practical, the number of deliveries required outside standard construction hours.

Spoil would be transported between ancillary sites along the length of the project and to offsite reuse or disposal locations. The location of ancillary sites on or adjacent to land where the project is being carried out and that have ready access to the road network would minimise potential impacts associated with the transportation of earthworks. Construction traffic impacts were assessed in **Section 7.2.4.**

Potential impacts from runoff and sedimentation would be further minimised through the implementation of the environmental management measures described in **Section 7.9** and **Section 8.1**. Potential impacts related to dust and noise associated with the management of stockpiles are discussed in **Section 8.2** and **Section 7.7** respectively.

Waste disposal locations

The project would require a greater quantity of fill material than the quantity of excavation material that would be generated during construction. It is therefore anticipated that all excavated material that is suitable for reuse would be used within the project. The remaining material that is determined unsuitable for reuse would be transported offsite for reuse, recycling or disposal at an appropriately licensed facility.

A number of waste facilities throughout Sydney are licensed to accept each type of waste that may be generated by the project. Specific facilities and collection contractors for the disposal of waste would be identified and engaged during the detailed design and delivery of the project.

Table 8-54 identifies potential waste disposal and recovery facilities that may receive waste generated by the project. The selection of one or more of the below facilities, or any other facility, would be dependent on the nature and volume of waste streams generated and the capacity of the receiving facilities at the time of the waste generation.

In addition, further capacity is being added to the resource recovery industry, with multiple facilities expanding and new waste management facilities being created, including:

- St Marys Resource Recovery Facility
- Wetherill Park Waste Transfer Station: SUEZ Wetherill Park Resource Recovery Facility
- Widemere Resource Recovery Facility (Boral)
- Bettergrow Resource Recovery Facility, Wetherill Park
- St Marys Chemical Waste Facility
- Glendenning Liquid Waste Treatment Facility
- Ingleburn Battery Recycling Facility
- Bingo Minto - Resource Recovery Facility.

Potential impacts

The mismanagement of waste generated by the project has the potential to result in the following impacts:

- Excessive materials being directed to landfill due to inadequate collection, reuse, and recycling
- Impacts on human health resulting associated with various types of waste being generated and stored onsite, with the potential for misclassification or mishandling resulting in potential cross contamination
- Environmental impacts from the incorrect storage, classification, transport and disposal of waste
- Dust impacts due to incorrect storage, handling, transport and disposal of spoil (see **Section 8.2**)
- Noise impacts associated with waste disposal and stockpile management (see **Section 7.7**)
- Traffic impact associated with the inadequate removal and transport of waste offsite (see **Section 7.2**).

Given that the management measures presented in **Section 8.5.6** would be implemented, the risk of the above impacts would be minor during construction of the project.

Table 8-54 Potential waste disposal facilities

Facility	Relevant waste streams accepted	Annual waste throughput limit	Location	Distance from the project by road
St Marys Resource Recovery Facility	• Construction and demolition waste • VENM, ENM and soils	250,000 tonnes per annum (tpa)	Dunheved Circuit, St Marys	20 km
Cleanaway Erskine Park Resource Management Facility	• Construction and demolition waste • VENM, ENM and soils • General solid waste (non-putrescible) • Commercial and industrial	300,000 tpa	Raffles Glade, Erskine Park	15 km
Boral Widemere Resource Recovery Facility, Wetherill Park	• General solid waste (non-putrescible) • Construction and demolition • ENM • Tiles and masonry • Quarry products (> 20mm) • Wet concrete batching plant stirrer waste (liquid)	1,000,000 tpa	Windemere Road, Wetherill Park	20 km
Lucas Heights Resource Recovery Park	• Asbestos • Construction and demolition waste • E-waste • Gas bottle • Lead acid batteries • Liquid waste • Metal • Mixed putrescible • Non-putrescible • Paper and cardboard • Soil • Tyres • Organic waste • Waste oil	850,000 tpa (landfill) 80,000 tpa (organics) 200,000 tpa (resource recovery)	Little Forest Road, Lucas Heights	50 km
No Fuss Waste Water Treatment Plant (Oily Waste Water Treatment Facility)	• Liquid waste	100,000 litres	Smith Street, Emu Plains	25 km
St Marys Chemical Waste Facility	• Dangerous goods (liquid and solid)	Various based on type of dangerous good	Links Road, St Marys	25 km

Facility	Relevant waste streams accepted	Annual waste throughput limit	Location	Distance from the project by road
SUEZ Wetherill Resource Recovery Facility/transfer station	• Asbestos • Batteries • Paper and cardboard • E-waste • Garden and food waste • Gas bottles • Hazardous waste • Metal • Mixed putrescible • Non-putrescible • Plastic • White goods • Wood waste	230,000 tpa	Davis Road, Wetherill Park	25 km
SUEZ Kemps Creek Resource Recovery Park	• Garden waste • Mixed waste • Biosolids from sewage plants	120,000 tpa (mixed and garden waste) 14,400 tpa (biosolids from sewage treatment plans)	Elizabeth Drive, Kemps Creek	5 km
SUEZ Eastern creek waste management centre	• Household (general waste, organics) • Garden waste • Sand and timber (VENM)	220,000 tpa (resource recovery) 50,000 tpa (source separated organic materials	Wallgrove Road, Eastern Creek	20 km

8.5.4 Operational waste

Waste generated by the operation of the project would be limited. Waste generated during operation would be from maintenance and minor repair works. Major repair work or upgrade work, beyond standard maintenance, would be subject to separate assessment and any waste generated by those activities would be assessed separately. **Table 8-55** outlines the likely waste streams generated during operation and the proposed management approach for each waste type. It is expected that only minimal amounts of each waste stream would be generated.

The routine maintenance requirements for the project would be carried out as agreed by Roads and Maritime and the relevant local council. Where evident, waste materials would be managed in accordance with the waste management hierarchy (see **Section 8.5.1**) and either reused if appropriate or disposed of at an appropriately licensed waste facility.

Table 8-55 Potential waste streams (operation)

Waste streams produced	Likely waste classification	Waste management approach
Surplus maintenance material including fencing, sediment, concrete, steel, aggregate, formwork, asphalt, and sand bags	General solid waste (non-putrescible)	As a priority, surplus maintenance materials are to be transferred to other sites for reuse or stored for future use. In the second instance, surplus materials may be recycled where possible. Surplus materials should avoid being sent to landfill where possible. Any remaining surplus material that could not be reused or recycled would be disposed of at an appropriately licenced facility.
Waste from operation and maintenance of vehicles and machinery including adhesives, lubricants, waste fuels, cleaning products and chemicals, and oils, engine coolant, batteries, hoses and tyres	Hazardous waste, special waste, liquid waste	Liquid waste is to be collected and transferred to a dedicated recycling facility where possible, to ensure diversion from landfill. Batteries would be collected and recycled by a qualified handler. All identified waste that cannot be recycled would be disposed of at an appropriately licenced facility.
Clean up waste in the event of an accidental spill of fuel or chemicals	Hazardous waste, Liquid waste	Materials collected during clean up would be disposed of at a suitably licenced waste facility, depending on the type of material involved.
Landscaping and vegetation waste, from the pruning/maintenance of trees, shrubs and ground cover that are unable to be mulched and reused within the project, including weeds, timber and logs	General solid waste (putrescible)	The quantity of vegetation that is mulched for reuse onsite would be maximised, including consideration of the Mulch Order and Exemption allowing for reuse. Remaining vegetation that is not reused be sent to an approved facility for sale or disposal. Weeds would be disposed of offsite at an appropriate disposal facility.
Sediment and sludge within water quality basins, drains, basins and culverts	General solid waste (non-putrescible)	Sediment removed from basins may be dewatered and reused onsite (eg in landscaping works). If the material is not suitable for reuse onsite, it would be disposed of at an appropriately licensed facility.
Waste grit and soil from road sweepers	General solid waste (non-putrescible)	Soil may be reused onsite (eg in landscaping works). If the material is not suitable for reuse onsite, it would be disposed of at an appropriately licensed facility.
Contaminated water	Liquid waste	Captured water would be discharged to the local stormwater system in accordance with POEO requirements or treated and discharged. Contaminated water which cannot be reused or discharged would be taken offsite and disposed of at an appropriately licensed facility. Further information is provided in **Section 7.9**.

Potential impacts

The overall impact of operational waste is expected to be minimal and would be managed through the application of standard Roads and Maritime and Council operating and maintenance Environmental Management Systems and procedures.

The following waste management related impacts have the potential to occur during operation of the project:

- Excessive waste being directed to landfill due to inadequate collection, classification and disposal of waste
- Operation of the project may result in the diversion of excessive waste to landfill due to inadequate collection, classification and disposal of waste.

8.5.5 Cumulative impacts

Infrastructure and urban development projects that are planned or under construction in the vicinity of the project are presented in **Table 7-3**.

Specifically, a range of other transport infrastructure and urban development projects have started or are planned in or near the primary study area. These include major road infrastructure upgrades associated with the WSIP, the Western Sydney Airport, upgrade of The Northern Road, transport projects such as the Sydney Metro Greater West, and the planned future development of the Western Sydney Aerotropolis. Interaction with these projects may change the waste impacts of the project.

Construction impacts

The M12 Motorway is anticipated to produce manageable quantities of construction waste, which would be processed at facilities that were identified to have annual throughput limits far in excess of the quantities likely to be generated by construction activities where practicable (**Table 8-54**). The addition of expected construction waste from the assessed project would also be able to be handled by the existing and proposed waste facilities in the area where practicable.

As the M12 Motorway is expected to have a fill deficit, disposal of excavated material is not relevant to cumulative impacts with the exception of contaminated material. If the construction of any of the road or rail projects assessed is anticipated to have a surplus of excavated material, it may be possible to use that fill material for the construction of the M12 Motorway, reducing the total quantity of reusable material generated by projects across Sydney that is sent to landfill. The western Sydney area has sufficient capacity for waste management facilities to accept waste from the concurrent or overlapping construction of the projects.

Material that is identified as contaminated is to be segregated from uncontaminated material onsite to prevent cross-contamination and removed offsite to a licensed disposal facility.

As a result, and considering the management measures for each project are implemented, the cumulative impacts resulting from the construction of the M12 Motorway and the other projects assessed are anticipated to be minor.

Operational impacts

The M12 Motorway is expected to generate minimal operational waste (see **Section 8.5.4**). The other road and rail projects being assessed for cumulative impacts would similarly generate minimal operational waste. The Airport is estimated to generate about 5251 tonnes of waste per year (DIRD, 2016).

The waste management market in western Sydney would be able to handle the volume of cumulative waste generated. As such, the cumulative impacts resulting from the operation of the M12 Motorway and the projects assessed, waste impacts are anticipated to be minor.

8.5.6 Environmental management measures

Waste will be managed and mitigated through the development of construction management plans and implementation of standard approaches to operational waste management.

As a general rule, all waste will be managed in accordance with the waste hierarchy. Measures to avoid, minimise or manage waste streams generated by the project would ensure that all waste generated during the construction and operation of the project are effectively stored, handled, treated, reused, recycled and/or disposed of in accordance with applicable legislation and guidelines, and in a manner that protects human health and environmental values.

Contingency measures will be implemented to manage unexpected waste volumes and types of waste materials generated from the construction and operation of the project. Suitable areas within ancillary facilities will be identified to allow for the management of unexpected waste materials, including contaminated materials. These areas will be hardstand or lined areas that are appropriately stabilised and bunded, with sufficient area for stockpile storage and segregation.

In the event of discovery of previously unidentified contaminated material, all relevant work would cease near the discovery and the unidentified contaminated material would be managed in accordance with an unexpected contaminated lands discovery procedure. Further discussion of measures to manage potential impacts from contaminated material, spills and reduced air quality are outlined in **Section 7.9, Section 7.10, Section 8.1** and **Section 8.2**.

The environmental management measures that would be implemented to minimise the waste impacts of the project, along with the responsibility and timing for those measures, are presented in **Table 8-56**.

Table 8-56 Environmental management measures (waste)

Impact	Reference	Environmental management measure	Responsibility	Timing
Inappropriate handling and/or disposal of waste	W01	A construction waste and resource management plan (CWRMP) will be prepared for the project and outline appropriate management procedures. It will include, but not be limited to: • Identification of the waste types and volumes that are likely to be generated by the project • Adherence to the waste minimisation hierarchy principles of avoid/reduce/ reuse/recycle/dispose • Waste management procedures to manage the handling and disposal of waste, including unsuitable material or unexpected waste volumes • Identification of reporting requirements and procedures for tracking of waste types and quantities • A resource management strategy detailing the process to identify reuse options for surplus materials • A procurement strategy to minimise unnecessary consumption of materials and waste generation in accordance with relevant legislation and guidelines.	Roads and Maritime / Contractor	Prior to construction

Impact	Reference	Environmental management measure	Responsibility	Timing
	W02	A spoil management plan will be prepared for the project as part of the CWRMP and in line with the CSWMP. The spoil management plan will outline appropriate management procedures for the generation and importation of spoil. It will include, but not be limited to: • Procedures for classification of spoil • Identification of spoil reuse measures • Spoil stockpile management procedures • Spoil haulage routes • Spoil disposal and reuse locations • Imported spoil sources and volumes.	Contractor	During construction
	W03	Wherever feasible and reasonable, construction material will be sourced from within the Sydney region.	Roads and Maritime / Contractor	During construction
Unexpected waste volumes and types during construction	W04	Suitable areas will be identified to allow for contingency management of unexpected waste materials, including contaminated materials. Suitable areas will be required to be hardstand or lined areas that are appropriately stabilised and bunded, with sufficient area for stockpile storage.	Roads and Maritime / Contractor	During construction

8.6 Climate change risk and greenhouse gas

This section presents an overview of the climate change risk assessment and greenhouse gas (GHG) assessment carried out for the project, and approach to the management of identified climate change risks, including a number of climate adaption actions to be implemented in detailed design, and measures to minimise GHG emissions. **Table 8-57**presents the SEARs that relate to climate change and identifies where they were addressed in this EIS.

Table 8-57 SEARs (climate change risk)

Secretary's requirement	Where addressed in this EIS
22. Climate change risk	
a. The proponent must assess the risk and vulnerability of the project to climate change in accordance with the current guidelines.	The policy and planning setting and relevant guidelines are presented in **Section 8.6.1** and **Section 8.6.2** The risk and vulnerability of the project to climate change is presented in **Section 8.6.4**
b. The proponent must quantify specific climate change risks with reference to the NSW Government's climate projections at 10 kilometre resolution (or lesser resolution if 10km projections are not available) and incorporate specific adaptation actions in the design.	Assessment of climate change risks with reference to climate change projections to 2030, and adaptation actions, are presented in **Section 8.6.1** and **Section 8.6.2**

The project SEARs also outline the requirement to consider sea level rise and storm intensity due to climate change in assessing impacts on flooding. **Section 7.8** includes discussions of how climate change was considered within the assessment of potential flooding impacts from the project.

8.6.1 Policy and planning setting

National policy

In 2015 the Australian Government announced a commitment to target a reduction in GHG emissions by 26 to 28 per cent below 2005 levels by 2030. This target was submitted to the United Nations Framework Convention on Climate Change (UNFCCC) at the 21st Conference of the Parties (COP21) that was held in Paris in December 2015. The Australian Government ratified the Paris Agreement on the 9th of November 2016.

The Australian Government's Direct Action Plan (DoEE, 2015a) outlines policies that provide positive incentives for businesses and communities to reduce emissions, including the Emissions Reduction Fund and the Safeguard Mechanism to ensure that the 2030 emissions reduction target will be achieved.

In addition to reducing GHG emissions, there is a need to adapt and build resilience of Australia's communities, economy and environment to climate change, In 2015 the Australian Government released the National Climate Resilience and Adaptation Strategy (DoEE, 2015b) which sets out how Australia is managing the risks associated with a changing climate. The Strategy outlines a set of guiding principles to enable effective adaptation practice and resilience building, as well as outlining the Government's vision for a climate-resilient future. The guiding principles include:

- Shared responsibility and collaboration between all levels of government, businesses, communities and individuals
- Factoring climate risk into all decision-making processes
- Supporting those who are most vulnerable to natural disasters and climate change
- Managing risks based on the best available scientific evidence
- Regularly revisiting decisions and outcomes over time to identify opportunities to implement flexible choices.

The Strategy identifies the need to consider extreme weather events and future climatic conditions in the design and construction of infrastructure, and notes that State, territory and local governments share a greater responsibility for responding to climate change and natural disasters that affect both public and privately-owned built assets.

National Policy

In 2016 the NSW Government released the *NSW Climate Change Policy Framework* (OEH, 2016d, which commits NSW to achieving net-zero emissions by 2050. The Framework aims to maximise the economic, social and environmental wellbeing of NSW in the context of a changing climate and current and emerging international and national policy settings and actions to address climate change. In particular, it highlights the policy direction for the NSW Government including to:

- Reduce risks and damage to public and private assets in NSW arising from climate change
- Reduce climate change impacts on health and wellbeing
- Manage impacts on natural resources, ecosystems and communities.

The policy refers to the Climate Change Fund Strategic Plan 2017-2022 (OEH, 2016e) which sets out priority investment areas for funding over a five year period from 2017, including supporting programs to help households and businesses reduce their exposure to natural hazards and to be more resilient to climate change.

Refer to **Chapter 2** and **Section 8.4.1** for further discussion on the policy and planning setting for the project.

8.6.2 Assessment methodology

Climate change risk assessment

The methodology applied for the climate change risk assessment follows the approach presented in the Technical Guide for Climate Change Adaptation for the State Road Network (Road and Maritime, in draft) (the 'Technical Guide'). Use of the Technical Guide ensures a consistent approach to climate risk assessment and adaption across the wider road network. This approach is also closely aligned with AS/NZS 31000:2018 Risk Management and the Department of the Environment and Heritage (2006) document Climate Change Impacts and Risk Management – A Guide for Business and Government.

In addition to the Technical Guide, the climate change risk assessment was carried out in accordance with the following relevant guidance and standards:

- National Climate Resilience and Adaptation Strategy (DoEE, 2015b)
- NSW Climate Change Policy Framework (OEH, 2016d)
- Environmental Sustainability Strategy 2015-19 (Roads and Maritime, 2016g)
- Australian Standard AS 5334-2013 Climate change adaptation for settlements and infrastructure – A risk-based approach
- Australian and New Zealand Standard AS/NZ ISO 31000:2018 Risk Management – Guidelines
- Roads and Maritime Risk Analyser Project v2.0 (an internal risk analyser to assess risk across Roads and Maritime infrastructure projects) (Roads and Maritime, 2018e).

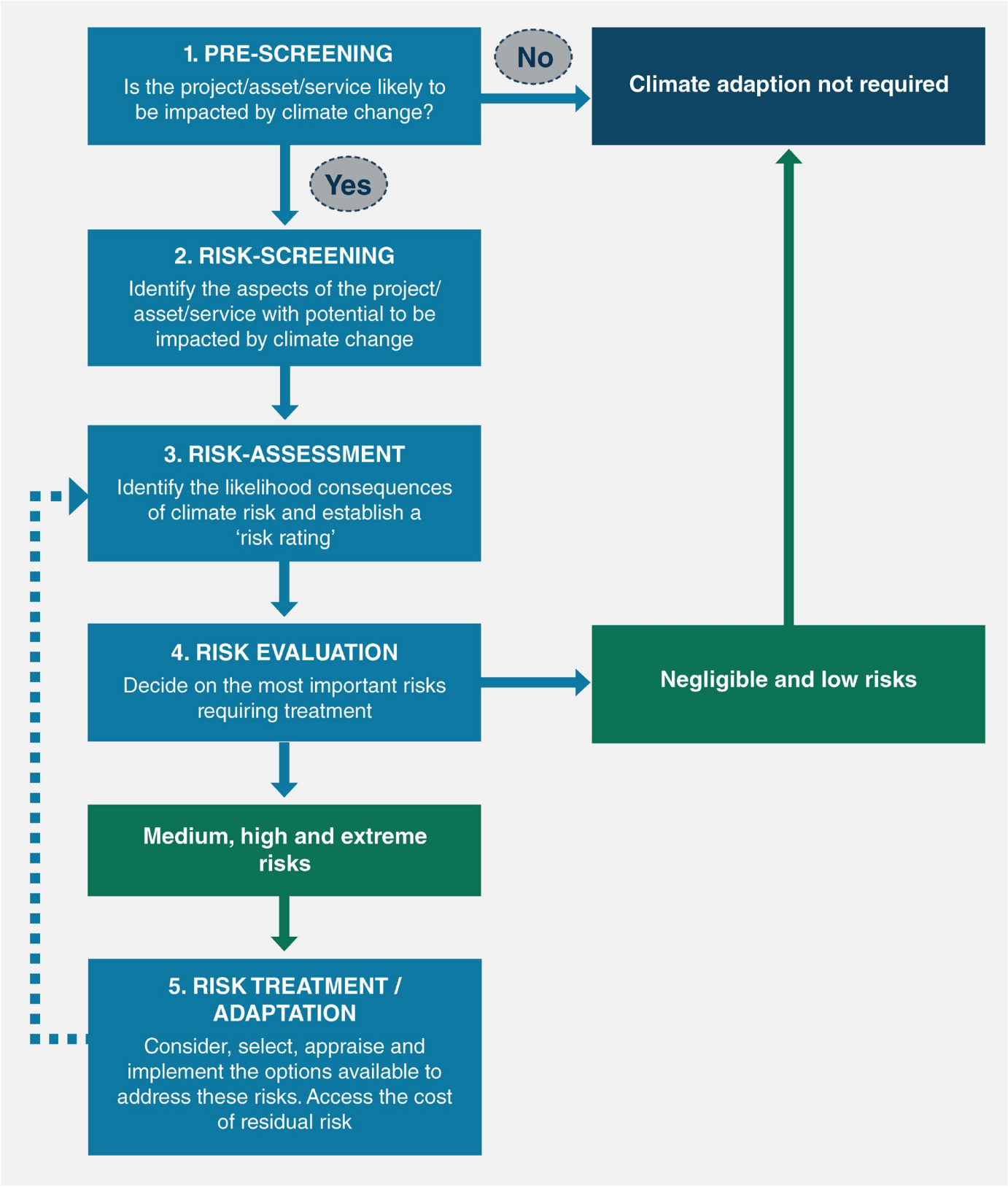
The approach adopted for the climate change risk assessments comprises five steps as shown in **Figure 8-34**. Each of these steps is described below.

Climate change step 1: Pre-screening

A pre-screening exercise was carried out to determine whether the project would likely be impacted by climate change and would therefore require a climate change risk assessment to be carried out. As part of the exercise the following issues were considered:

- Site location (eg proximity to bushland, the ocean, floodplains and general weather characteristics) and project objectives
- Climate variables of relevance to the project (eg temperature, precipitation, etc)
- Natural weather and climate related hazard patterns (eg flooding) in the local surroundings
- Likely capacity of project components to withstand changes in climate (eg suitability of bridge span widths and flood management measures incorporated into design)
- Significance of the project infrastructure and willingness to accept risk (eg significant climate risks may not be able to be absorbed by larger infrastructure projects such as motorways that are likely to have high volumes of road users).
- Desired level of service (eg the project would be designed to be above the one in 100 flood event)
- Design life of the project components (eg bridges would be designed with a 100 year design life).

Based on consideration of the project against each of the above items it was determined that a climate change risk assessment was required. The project's site location, significant investment required, long design life, and its exposure to potential climate hazards mean that it may be susceptible to impacts from climate change.



Adapted from Draft Technical Guide Climate Change Adaptation for the Road Network (Roads and Maritime, no date)

Figure 8-34 Climate change risk assessment approach

Climate change step 2: Risk screening

Screening aims to identify the projects potential exposure to relevant climate change impacts. The following steps were carried out to identify potential climate change risks for the project:

- Identification of relevant climate variables – climate variables were identified based on those with the potential to impact the project as outlined in the Technical Guide and presented in **Table 8-58**
- Selection of climate projections to determine the likely changes to relevant climate variables. Climate change projections were selected using data published by the Commonwealth Scientific and Industrial Research Organisation (CISRO) and accessed through the Climate Change in Australia portal (the Climate Futures Tool). Projections were identified based on the geographic longitudinal and latitudinal data closest to the project available within the Climate Futures Tool (see **Table 8-58**).
- Adoption of a climate change projection scenario – A conservative high-emission scenario referred to as the 'representative concentration pathway (RCP) 8.5' scenario was selected for the project. This scenario is defined by the Intergovernmental Panel on Climate Change (IPCC) as the scenario where carbon dioxide concentration reaches about 940 parts per million by the end of the 21st century. It represents a worst-case scenario, however, is the currently accepted conservative scenario to assess climate risk.
- Selection of relevant time periods to consider for the assessment of the likely climate change risks at relevant future time periods within the design life of the project – Climate change risks were developed for three periods, broadly reflecting the design life and key phases of different elements of the project:
  - 2030: construction of the project is anticipated to begin in the first quarter of 2022 and therefore the 2030 time period is likely to best reflect near-term climate risks for the project
  - 2070: the project includes assets and systems with short to mid-term operating timeframes, such as communications and other electronic systems and landscaping, as well as road surfaces
  - 2090: the project includes assets and systems with long operating timeframes with a design life of 100 years, such as drainage structures and barriers/rails as well as "permanent" assets, which would become fixed and on-going features of the project, such as: bridges and embankment culverts (and other inaccessible drainage).

When assessing each risk the timeframe relevant to that risk was considered and the 'worst case' scenario was selected where multiple time periods apply. For risks associated with construction the 2030 timescale was selected. For operational elements of the project the relevant design life of the element considered within the risk statement was identified and the corresponding appropriate, worst case, timescale was applied.

Using the above information, initial direct and indirect climate change risks were identified using a screening matrix presented in **Table 8-58**. This table identifies which project components may be at risk from future changes to each of the relevant climate variables for the project that should be investigated further as part of the risk assessment process outlined in Step 3 below.

As part of the screening process, a multi-disciplinary risk workshop was held on 4 April 2018 to determine potential risks to the project from climate change. The workshop was attended by a multi-disciplinary team including the asset owners and operators, project engineers, climate change specialists, maintenance specialists, environmental specialists and project managers. The workshop attendees used the screening matrix presented in **Table 8-58** as a starting point to then identify a comprehensive list of potential climate change risks for the project.

Table 8-58 Climate change risk screening matrix

Climate variable	Project component									
	All bridges	Bridges over watercourses (only)	Surface and sub-surface drainage	Cuttings, embankment and remaining walls	Pavement and base layers	Ancillary infrastructure (signs, traffic signals etc)	Cyclist/ Pedestrian facilities	Power supply	Water treatment facilities	Landscaping
Extreme rainfall		✓	✓	✓		✓	✓	✓	✓	✓
Extreme temperature	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mean surface temperature									✓	✓
Wind speed	✓	✓				✓	✓	✓		✓
Mean rainfall		✓	✓	✓		✓	✓	✓	✓	✓
Atmospheric carbon dioxide	✓	✓	✓	✓		✓	✓			✓
Bushfire weather						✓	✓	✓		✓

Climate change step 3: Risk assessment

The overall risk rating for each of the identified climate risks in Step 2 were determined by assessing the likelihood of the impact occurring using the likelihood scale presented in **Table 8-59**, and the likely consequence of the impact (if it occurred) using the consequence scale presented in **Table 8-60**. These likelihood and consequence scales were adapted from Roads and Maritime's Risk Analyser Project v2.0 (Roads and Maritime, 2018e).

By combining the likelihood and consequence levels, an overall risk rating was determined for each risk using the combined risk likelihood and consequence matrix presented in **Table 8-61**. These overall risk ratings present what the risks to the project are before the implementation of any mitigation or adaptation treatments.

Table 8-59 Climate change risk likelihood scale

Likelihood level	Description	Likelihood
Almost certain	Likely to occur frequently in most circumstances within the project lifecycle.	> 81 %
Likely	Likely to occur often in most circumstances within the project lifecycle.	51-80 %
Possible	Likely to occur on occasions within the project lifecycle.	21-50 %
Unlikely	Could occur at some time but not often within the project lifecycle.	11-20 %
Rare	May occur at some time but unusual within the project lifecycle.	1-10 %
Improbable	Could occur but very improbable within the project lifecycle.	< 1 %

Table 8-60 Climate change risk consequence scale

Consequence level	Definition
Catastrophic	• Irreversible large-scale impact • Permanent damage • Regulatory intervention maximum fines and penalties and/or
Severe	• >5 years and <10 years impact. • Irreparable damage of cultural significance and/or • Tier 1 prosecution (up to $5 million)
Major	• Long-term (>24 months but < five years) • Tier 2 prosecution (up to $1M corporate) and/or • Partial impairment of the ecosystem
Serious	• Short to mid-term (<24 months) impact Notification to regulator
Moderate	• Short term repairable damage or social impact on local population <12 months)
Minor	• Localised impacts rectified by on site resources and/or • Isolated, easily contained, no lasting effects

Table 8-61 Climate change risk likelihood and consequence combination matrix

	Consequence					
Likelihood	Minor	Moderate	Serious	Major	Severe	Catastrophic
Frequent	Moderate	High	High	Extreme	Extreme	Extreme
Likely	Moderate	Moderate	High	High	Extreme	Extreme
Possible	Low	Moderate	Moderate	High	High	Extreme
Unlikely	Low	Low	Moderate	Moderate	High	High
Rare	Low	Low	Low	Moderate	Moderate	High
Improbable	Low	Low	Low	Low	Moderate	Moderate

Source: Roads and Maritime's Risk Analyser Project v2.0 (Roads and Maritime, 2018e)

Climate change step 4: Risk evaluation

The aim of the risk evaluation process was to determine those risks that require mitigation or adaptation treatment to be implemented. All risks identified as having moderate, high or extreme risk were identified as requiring treatment.

Risks evaluated as low were determined not to require further consideration.

Climate change step 5: Risk treatment/adaptation

Mitigation or adaptation treatment was identified for all moderate, high and extreme risks in order to reduce the original unmitigated risk ratings. These treatments comprise:

- Design features to prevent or minimise risk. In many cases these design features have already been incorporated into the project design
- Identification of management procedures for the construction and operation of the project, including incident response measures
- Choice of engineering materials
- Identification of management of revegetation and fauna impacts.

Greenhouse gas assessment

Roads and Maritime in collaboration with other state (and New Zealand) transport authorities, released the Greenhouse Gas Assessment Workbook for Road Projects (the Workbook) (Transport Authorities Greenhouse Group, 2013) to help standardise greenhouse gas assessments of road construction projects. The workbook was prepared to estimate the GHG emissions associated with construction, operation and maintenance stages of road projects, but does not estimate the GHG emissions associated with traffic using a project. The methodology outlined in the Workbook formed the basis for the greenhouse gas assessment. For emissions generated by road users the Tools for Roadside Air Quality (TRAQ) tool was used, described in more detail below (under 'Step 2: Determine the quantity of GHG emissions generated by each emissions source').

The GHG assessment has also considered other relevant GHG reporting legislation and guidelines including:

- Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard (World Business Council for Sustainable Development and World Resources Institute, 2004)
- *National Greenhouse and Energy Reporting Act 2007* (Commonwealth)
- National Greenhouse and Energy Reporting (Measurement) Determination (Commonwealth)
- National Greenhouse and Energy Reporting System Measurement: Technical Guidelines for the Estimation of Greenhouse Gas Emissions by Facilities in Australia (DoEE, 2017)
- AS/ISO 14064.1:2006 Greenhouse Gas Part 1: Specification with guidance at the organisational level for quantification and reporting of greenhouse gas emissions and removals
- The current Australian National Greenhouse Accounts: National Greenhouse Accounts Factors (NGA Factors) (DoEE, 2018b).

To calculate the potential GHG emissions generated by the project a two-step process was followed, as described below.

Greenhouse gas step 1: Define the assessment boundary

Under 'the Greenhouse Gas Protocol' (World Resource Institute/World Business council for Sustainable Development, 2004), a project's direct and indirect emissions sources can be delineated into three 'scopes' (Scope 1, Scope 2 and Scope 3) for GHG accounting and reporting purposes.

The greenhouse gas scopes are presented in **Figure 8-35** and are described as follows:

- Scope 1 – Direct GHG Emissions - Scope 1 GHG emissions are direct GHG emissions from sources that are owned or controlled by the project. Scope 1 can include direct emissions sources such as fuel consumption within machinery used during construction and operation by vehicles and equipment which the proponent owns and has operational control over
- Scope 2 – Electricity Indirect GHG Emissions – These account for GHG emissions arising from purchased electricity consumed onsite. Scope 2 emissions are considered indirect as they occur at an offsite facility where electricity is generated. Scope 2 emissions associated with the project include the electricity that would be consumed by street lighting during operation and electricity sourced from the electricity network used during construction
- Scope 3 – Other Indirect GHG Emissions – Scope 3 emissions are those that are a consequence of the project but occur outside the site operational boundary and are not under the proponent's direct control, such as delivery of materials to site. Scope 3 emissions also include the upstream and downstream emissions associated with the production of fuel, electricity and materials for the project. Scope 3 emissions are an optional reporting category that allows for the treatment of all other indirect emissions associated with a project.

The following six GHGs were considered in this assessment:

- Carbon dioxide
- Methane
- Nitrous oxide
- Sulphur hexafluoride
- Hydro fluorocarbons
- Perfluorocarbons.

Each GHG behaves differently in the atmosphere with respect to its ability to trap outgoing radiation and in respect to their lifespan in the atmosphere. Each GHG was compared to the global warming potential of carbon dioxide over a 100-year period in order to achieve a single unit of measurement. The global warming potential of each GHG was determined based on the latest NGA Factors. The resulting aggregated emissions are referred to in terms of tonnes of carbon dioxide equivalent emissions (tCO_2-e).

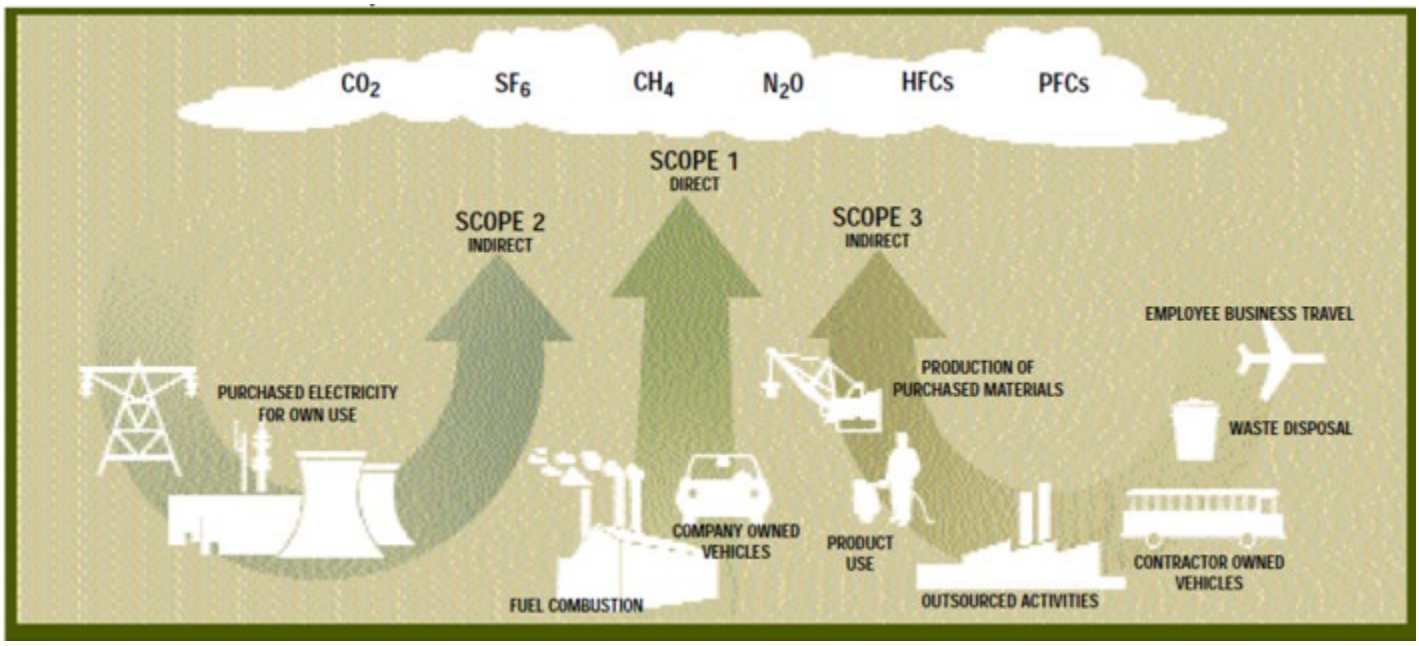


Figure 8-35 Overview of scope and greenhouse gas emissions sources (World Resource Institute/World Business Council for Sustainable Development)

GHG from the project would be material, in that they would account for more than five per cent of the overall GHG emitted as a result of the project. The following emissions sources were determined to be relevant to the project:

- Fuel consumed during construction
- Vegetation removed during construction
- Production of construction materials
- Energy and fuel consumption during operations
- Production of materials used for ongoing maintenance
- Fuel consumed by road users.

Any emissions sources not listed above were considered to be immaterial, as per the Workbook, and have not been included within this assessment.

Greenhouse gas step 2: Determine the quantity of GHG emissions generated by each emissions source

The GHG emissions from project construction were estimated using *Carbon Gauge GHG Calculator for Roads Project Version 01.130612* (Carbon Gauge), including emissions associated with fuel consumed during construction by machinery and the removal of vegetation. The quantification of GHG emissions from vegetation assumes that all carbon in vegetation is converted to carbon dioxide and released to the atmosphere.

The emissions associated with the extraction of raw materials, processing, manufacturing and transportation of materials for construction are referred to as embodied emissions. Embodied emissions are a scope 3 emissions source and have also been determined during the Carbon Gauge assessment method.

Operational electricity use and emissions associated with the ongoing maintenance of the project were also estimated using the Carbon Gauge assessment method. For emissions generated by road users the Tools for Roadside Air Quality (TRAQ) tool was used. TRAQ is a tool for modelling emissions from vehicles using roads, using input data on traffic numbers and type, average traffic speeds, numbers of lanes and standard emissions factors for road going vehicles. TRAQ was used to determine emissions associated with current and future operational road use, both with and without the project. GHG emissions, modelled using TRAQ, took account of (both with and without the project):

- The expected mix of road users (vehicle types)
- Average number of vehicles
- Length of road
- Average and peak traffic speeds
- Surface roughness
- Road gradient.

The assessment for operational road use has not factored in likely improvements in vehicle fuel efficiency or a growing proportion of the vehicle fleet comprising electric vehicles. The assessment is therefore considered a conservative estimate of future GHG emissions.

The GHG assessment carried out for the construction and operation of the project was based on the design as set out in this document and construction activities outlined in **Chapter 5**.

8.6.3 Existing environment

GHGs are gases that when released into the atmosphere effectively trap heat influencing global temperatures. The release of GHGs into the atmosphere is caused by both natural processes (such as bushfires) and human activities (eg burning fossil fuels and land clearing).

Since the industrial revolution the concentration of GHGs, in parts per million, was rapidly increasing which has led to an increase in the earth's average surface temperature and has contributed to the phenomenon of 'climate change'.

The term 'climate' refers to the typical weather conditions for a specific geographical area, usually averaged over at least 30 years. Climate variability represents the 'normal' day to day seasonal and year to year variability in the components of climate (eg temperature, rainfall). However, climate variability may also generate extreme conditions such as flooding, heatwaves and hail which require management.

Climate change is likely to bring about changes in both average climate conditions and the frequency and severity of extreme events. This progressive change has implications for sea levels, ocean temperatures and the functionality of natural ecosystems. Climate change also means that asset owners and managers can no longer rely on prevailing assumptions that climate will be more or less the same as it was over the past 50 or 100 years.

The Intergovernmental Panel on Climate Change (IPCC) is a scientific intergovernmental body set up by the World Meteorological Organisation and the United Nations Environment Program to provide decision-makers and others interested in climate change with an objective source of information about climate change. It is made up of over 1000 scientists worldwide.

The world's leading climate scientists presented the following key findings in the Intergovernmental Panel on Climate Change Fifth Assessment Report (AR5) (IPCC, 2014):

- Warming of the climate system is unequivocal and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and oceans have warmed, the amounts of snow and ice have diminished, and sea level has risen
- In recent decades, changes in climate have caused impacts on natural and human systems on all continents and across the oceans. Impacts are due to observed climate change, irrespective of its cause, indicating the sensitivity of natural and human systems to changing climate
- Surface temperature is projected to rise over the 21st century under all assessed emission scenarios. It is very likely that heat waves will occur more often and last longer, and that extreme precipitation events will become more intense and frequent in many regions. The ocean will continue to warm and acidify, and global mean sea level will rise
- Many aspects of climate change and associated impacts will continue for centuries, even if anthropogenic emissions of greenhouse gases are stopped. The risks of abrupt or irreversible changes increase as the magnitude of the warming increases
- In urban areas, climate change is projected to increase risks for people, economies and ecosystems, including risks from heat stress, storms and extreme precipitation, inland and coastal flooding, water scarcity, sea-level rise, and storm surges
- Building adaptive capacity is crucial for effective selection and implementation of adaptation options.

The report also found (with high confidence) that Australia is currently experiencing the effects of climate change, including changes to extreme temperatures, mean and extreme rainfall, frequency and intensity of storm evens, increases in bushfire weather, ocean warming and acidification, and sea level rise (IPCC, 2014).

Climate change considerations for road projects

Roads can be exposed and vulnerable to climate change owing to their long design life during which many impacts of climate change are likely to become more significant (Roads and Maritime, draft). The main impacts that have potential to impact on a road project are typically associated with an increase in extreme rainfall intensity and frequency which can exacerbate flooding or landslides risks, increase scour around bridge infrastructure or result in direct damage to the road infrastructure. Surface roads, such as the project, are also susceptible to increases in extreme heat which may increase the rate of deterioration of road pavements or result in additional loads on steel or concrete joints on bridges through thermal expansion.

Climate change projections

The Technical Guide identifies a number of climate variables that may be altered by climate change and impact on the State road network. However, in order to project changes in climate and identify associated risks to the project, there is a need to understand current climatic conditions using historical data of observed climate in the local area. This historical data is then compared to future climate scenarios to identify the projected changes from existing conditions to future conditions.

The existing climatic conditions for the project were identified using data published by the CSIRO (2015) and the Bureau of Meteorology (BoM) (2018b) collected from the Badgerys Creek Automatic Weather Station (station identification 067108) which is about 3.2 kilometres south of the project and was collecting climate data since 1995. Data from this weather station was used as it is the nearest weather station to the construction footprint and is considered to be representative of the current conditions applicable to the project.

Climate model projections were identified using data published by CSIRO in 2016 and accessed through the Climate Futures Tool (https://www.climatechangeinaustralia.gov.au/en/). Projection data available from the 'NSW Climate Data Portal' was also reviewed, however the Climate Futures Tool was found to present a more complete set of projections and included more climate variables than the NSW Climate Data Portal data, including those that required consideration for this assessment. The Climate Futures Tool also provided projections for a longer time scale (up to the 2090 timescale) which was required to consider the design life of various project components. The Climate Futures Tool was therefore considered to be a more complete and appropriate data source and was adopted for all climate variables in this assessment to ensure consistency.

As discussed in **Table 8-62**, changes in each climate variable were projected for 2030, 2070 and 2090, with the adoption of a conservative high-emission RCP 8.5 scenario. A summary of available projections are presented in.

The projections indicate that there is likely to be an increase in the frequency of extreme heat events with an additional 28 days above 35 degrees Celsius, and an additional five days above 40 degrees Celsius by the year 2090. An increase in annual average temperature (both minimum and maximum) is also projected for all timescales modelled. A decrease in annual average rainfall is expected, with a reduction of about 3.5 per cent by 2090. Due to the decrease in annual average rainfall and increase in average temperature, the number of severe fire danger days in NSW is projected to increase from an average of 0.9 days per year to 2.1 days per year in 2090. Only minor variations in wind speed are projected, with a reduction of 0.3 per cent of the baseline average by 2090.

Average annual rainfall is expected to decrease by around 3.5 per cent by 2090. Despite projected lower average annual rainfall, there is a high confidence (CSIRO, 2015) that the intensity of heavy rainfall extremes will increase, however the magnitude of change cannot be reliably projected and is therefore not presented below. Similarly, projections of extreme wind speed are unreliable and generally unavailable, as the intensity of extreme wind speeds across the land surface is highly dependent on the surrounding terrain, including vegetation and buildings that are not included in global climate models.

Projections of drought have also not been included in this summary, as there is a low confidence in predicting how the frequency and duration of drought will change into the future, though there is medium confidence that the time spent in drought will increase over the course of the 21st century under an RCP8.5 emissions scenario.

Table 8-62 Climate change projections (RCP 8.5 scenario)

Climate variable	Baseline and year	2030	2070	2090
Average annual temperature (˚C change)	Mean Minimum: 10.9 ˚C (1995 - 2018)[1]	+1.0	+3.2	+4.5
	Mean maximum: 24.0 ˚C (1995 - 2018)[1]	+1.4	+3.5	+5.0
Average annual rainfall (% change)	832.7 mm (1995 - 2018)[1]	-6.4	-0.7	-3.5
Extreme temperature (change in number of days)	Nine days per year with a daily temperature above 35 ˚C (1981 - 2010)[2]	Additional four days above 35 ˚C	Additional 18 days above 35 ˚C	Additional 28 days above 35 ˚C
	One day per year with a daily temperature above 40 ˚C (1981 - 2010)[2]	Zero additional days above 40 ˚C	Additional three days above 40 ˚C	Additional five days above 40 ˚C
Bushfire weather (number of days)	0.9 severe fire danger days (1995)[3]	1.3 severe fire danger days	Data not available[3]	2.1 severe fire danger days
Average daily wind speed (% change)	13.35 km/h (1995 - 2018)[3]	+0.2	-0.0	-0.3

[1]1995 – 2018 are the years of operation of the Badgerys Creek Automatic Weather Station

[2]1981 – 2010 are the baseline years provided by the CSIRO Climate Futures Tool

[3]1995 is the baseline year provided by the CSIRO in the East Coast Cluster Report. Projections of the number of severe fire danger days were only made for 2030 and 2090 (CSIRO, 2015).

Greenhouse gas inventory

The Australian NGA Accounts estimate Australian GHGs for 2016, the most recent year with complete data available, to be 532.9 megatonnes of CO_2-e (DoEE, 2018b). NSW total emissions for 2016 were reported to be 130.3 megatonnes of CO_2-e (DoEE, 2018). The transport sector accounted for around 18.3 per cent of Australia's GHG emissions in 2016 (ie 97.5 million tonnes of CO_2-e) and 18 per cent of total GHG emissions in NSW (DoEE, 2018). About 85 per cent of the GHG emissions from the Australian transport sector and 84 per cent of the NSW transport sector was attributable to road transportation in 2016.

GHG emissions for the existing road network in the vicinity of the project, including The Northern Road, Elizabeth Drive and the M7 Motorway, were modelled using TRAQ to identify the emissions currently produced within the context if the project. The TRAQ modelling indicated that annual GHG emissions from vehicle use for 2020 on the existing road network around the project would be 37,483 tCO_2-e.

8.6.4 Assessment of potential impacts

Climate change risk assessment

Construction

Table 8-63 presents the potential climate change risks that were identified for the project during construction, with a moderate or high rating. The ratings assume the incorporation of standard construction controls but otherwise were identified for the project before the identification and inclusion of mitigation measures into the design as set out in this document.

Climate change risks relevant to the construction phase of the project were determined using climate change projections to 2030 to align with the projects proposed construction timeframe. Three risks to construction were identified as having a rating of moderate or higher. all of which were found to be moderate.

Table 8-63 Climate change risks to project construction (2030) before mitigation

Risk scenario	Likelihood	Consequence	Risk rating
Extreme heat			
Increased frequency, severity and duration of extreme temperatures (days exceeding 35˚C) leading to adverse health impacts for construction workers and potential health and safety incidents.	Unlikely	Major	Moderate
Extreme precipitation			
Increased frequency, severity and duration of extreme precipitation events leading to unsuitable and unsafe conditions for construction to proceed, resulting in an increase in ‘stop work’ days and subsequent delays to the construction program.	Possible	Serious	Moderate
Bushfires			
Increased frequency and severity of bushfires leading to smoke generation, resulting in potential health effects for construction workers and health and safety incidents, potential increase in ‘stop work’ days, and subsequent delays to construction program.	Unlikely	Major	Moderate

A residual risk assessment was carried out in accordance with the methods outlined in **Section 8.6.2** to consider the climate change risks following the implementation of adaptation measures. The adaptation measures and residual likelihood, consequence and risk are presented in **Table 8-64** for construction. Where possible, adaptation measures were directly incorporated into the design of the project. Additional opportunities to incorporate adaptation measures into the design will be considered in the detailed design stage of the project.

For construction, the residual risk assessment identified one low risk and two moderate risks.

Table 8-64 Residual risk to project after mitigation (construction)

Risk scenario	Original risk rating	Adaptation/mitigation options	Likelihood	Consequence	Residual risk rating
Extreme heat					
Increased frequency, severity and duration of extreme temperatures (days exceeding 35˚C) leading to adverse health impacts for construction workers and potential health and safety incidents.	Moderate	Adaptive management approach to be applied to workplace health and safety planning. This includes use of Roads and Maritime Work Health and Safety Procedures. Examples of potential work health safety practices may include stop work protocols for extreme heat days, or increased training and education for personnel regarding health and safety procedures during periods of extreme heat.	Rare	Serious	Low
Extreme precipitation					
Increased frequency, severity and duration of extreme precipitation events leading to unsuitable and unsafe conditions for construction to proceed, resulting in an increase in ‘stop work’ days and subsequent delays to the construction program.	Moderate	The location of temporary construction ancillary facilities has considered the risk of flood and strong winds associated with severe storm events, with site uses more vulnerable to the impacts of severe storms located away from the areas of highest risk to minimise impact.	Unlikely	Serious	Moderate
Bushfires					
Increased frequency and severity of bushfires leading to smoke generation, resulting in potential health effects for construction workers and health and safety incidents, potential increase in ‘stop work’ days, and subsequent delays to construction program.	Moderate	Adaptive management approach to be applied to workplace health and safety planning. This includes use of Roads and Maritime Work Health and Safety Procedures. Examples of potential work health safety practices may include stop work protocols for extreme heat days, or increased training and education for personnel regarding health and safety procedures during periods of extreme heat. Variable messaging signs to be used to display messages warning drivers of changes in conditions. Variable messaging signs are proposed as part of the project.	Rare	Major	Low

Operation

Climate change risks relevant to project operation were determined using climate change projections for 2030, 2070 and 2090, aligning with the design life of the project components. Where a risk may be relevant to all three timeframes a worst case scenario (typically the 2090 climate change scenario) was assessed. A total of 32 direct and indirect risks were identified for the project. The assessment identified:

- No extreme risks
- Three high risks
- 11 moderate risks
- 18 low risks.

Table 8-65 presents the risk assessment carried out for risks with a moderate or higher rating. As discussed in **Section 8.6.2**, risks that were identified as having a low rating have not been presented within this EIS as they were not considered to require any additional risk treatment, as these risks are considered tolerable. Low risks that were identified for project operation include power outages as a result of extreme hot days that may result in failure of variable message signs and lighting, extreme heat that may cause minor damage to the road surface and require additional maintenance and increases in the severity of storm events leading to an increased incidence of minor flooding resulting in damage to road furniture, variable message signs or power supply.

Table 8-65 Climate change risks to project operation (2030, 2070, 2090) before adaptation/mitigation

Risk scenario	Likelihood	Consequence	Risk rating
Extreme heat			
Increased frequency, severity and duration of extreme temperatures (days exceeding 35 ˚C) leading to increased stress of carriageway to bridge connections resulting in structural failure of carriageway.	Rare	Catastrophic	High
Increased frequency, severity and duration of extreme temperatures (days exceeding 35 ˚C) leading to adverse health impacts for maintenance workers and potential health and safety incidents for road users.	Unlikely	Serious	Moderate
Extreme rainfall			
Increased rainfall from severe storm events resulting in increased scour of embankments and cuttings, leading to increased likelihood of landslips causing damage to infrastructure.	Unlikely	Major	Moderate
Increased rainfall from severe storm events leading to a higher frequency of floods resulting in overtopping of the road and complete loss of infrastructure service.	Unlikely	Major	Moderate
Increased rainfall from severe storm events leading to higher velocity runoff flows through creeks, resulting in increased scour and damage to the asset.	Possible	Serious	Moderate
Health and safety risks to road users and users of cycle and pedestrian facilities due to flooding or an increased number of accidents as a result of an increase extreme rainfall.	Possible	Severe	High
Bushfires			
Increased frequency and severity of bushfires leading to reduced visibility due to smoke, resulting in road users being unable to view signs, signals and other vehicles, and potential health and safety incidents.	Unlikely	Major	Moderate

Risk scenario	Likelihood	Consequence	Risk rating
Increased frequency and severity of bushfires leading to smoke generation, resulting in health effects for maintenance workers and road users, and potential health and safety incidents.	Unlikely	Major	Moderate
Increased frequency and severity of bushfires resulting in increased maintenance and damage to landscaping	Possible	Serious	Moderate
Increased frequency and severity of bushfires resulting in impact on trucks carrying dangerous goods, leading to explosions and associated risk to life.	Rare	Catastrophic	High
Increased frequency and severity of bushfires leading to increased fauna movement onto the motorway, resulting in increased accidents.	Unlikely	Major	Moderate
Increased frequency and severity of bushfires leading to road closures, resulting in restricted access and increased congestion for road users and emergency vehicles	Unlikely	Serious	Moderate
Droughts			
Long periods of dry weather leading to a build-up of fuel, rubber and brake dust on road surfaces, resulting in a decrease in skid resistance and increase in accidents in wet weather events.	Unlikely	Major	Moderate
Long periods of dry weather leading to a build-up of rubber and brake dust on road surfaces, resulting in increased runoff of pollutants from the carriageway.	Possible	Moderate	Moderate

A residual risk assessment for operational risks was carried out in accordance with the methods outlined in **Section 8.6.2** to consider the climate change risks following the implementation of adaptation measures. The adaptation measures and residual likelihood, consequence and risk are presented in **Table 8-66** for operation. Where possible, adaptation measures were directly incorporated into the design as set out in this document. Additional opportunities to incorporate adaptation measures into the design will be considered in the detailed design stage of the project. Following the implementation of adaption and mitigation opportunities the assessment identified:

- No extreme risks
- One high risk
- Nine moderate risks
- 22 low risks.

In some cases, while adaptation opportunities have reduced the likelihood and/or consequence associated with a risk, the overall risk rating has not reduced in accordance with the risk rating matrix presented in **Table 8-61**.

Greenhouse gas assessment

Construction

Construction emissions associated with the project would result from the following:

- Vegetation clearing
- Consumption of fuel through use of equipment and vehicles
- Production of construction materials.

Table 8-66 Residual risk to project after mitigation (operation)

Risk scenario	Original risk rating	Adaptation/mitigation options	Residual likelihood rating	Residual consequence rating	Residual risk rating
Extreme heat					
Increased frequency, severity and duration of extreme temperatures (days exceeding 35 ˚C) leading to increased stress of carriageway to bridge connections resulting in structural failure of carriageway.	High	Detailed design to consider the full range of potential temperature extremes on the project (particularly bridge structures) which may occur as a result of climate change and choose materials able to withstand heat where feasible, to minimise the likelihood of infrastructure failures.	Unlikely	Catastrophic	Moderate
Increased frequency, severity and duration of extreme temperatures (days exceeding 35 ˚C) leading to adverse health impacts for maintenance workers and potential health and safety incidents for road users.	Moderate	Adaptive management approach to be applied to workplace health and safety planning. This includes use of Roads and Maritime Work Health and Safety Procedures. Examples of potential work health safety practices may include stop work protocols for extreme heat days, or increased training and education for personnel regarding health and safety procedures during periods of extreme heat.	Rare	Serious	Low
Extreme rainfall					
Increased rainfall from severe storm events resulting in increased scour of embankments and cuttings, leading to increased likelihood of landslips causing damage to infrastructure.	Moderate	Detailed design to consider inclusion of measures to reduce velocity and volume of stormwater flows to reduce potential impact of scour. All roads and bridges to be sealed, cleared areas to be landscaped and scour protection to be installed.	Rare	Major	Low
Increased rainfall from severe storm events leading to a higher frequency of floods resulting in overtopping of the road and complete loss of infrastructure service.	Moderate	Stormwater infrastructure was designed to ensure flood immunity for the motorway up to and including the one in 100-year storm event.	Rare	Major	Moderate
Increased rainfall from severe storm events leading to higher velocity runoff flows through creeks, resulting in increased scour and damage to the asset.	Moderate	Detailed design to consider energy dissipation at culvert outlets when velocities exceed existing magnitudes. Stormwater infrastructure was designed to ensure suitable conveyance to minimise change in flow velocities and has considered future conditions under climate change. No significant change in velocity is anticipated.	Unlikely	Serious	Moderate

Risk scenario	Original risk rating	Adaptation/mitigation options	Residual likelihood rating	Residual consequence rating	Residual risk rating
Extreme rainfall event leading to accident/s resulting in potential health and safety incidents for road user or active transport users.	High	Variable messaging signs to be used to display messages warning drivers of changes in weather and traffic conditions. Variable messaging signs are proposed as part of the project	Unlikely	Severe	High
Bushfires					
Increased frequency and severity of bushfires leading to reduced visibility due to smoke, resulting in road users being unable to view signs, signals and other vehicles, and potential health and safety incidents.	Moderate	Variable messaging signs to be used to display messages warning drivers of changes in weather and traffic conditions. Variable messaging signs are proposed as part of the project.	Rare	Major	Moderate
Increased frequency and severity of bushfires leading to smoke generation, resulting in health effects for maintenance workers and road users, and potential health and safety incidents.	Moderate	Adaptive management approach to be applied to workplace health and safety planning. This includes use of Roads and Maritime Work Health and Safety Procedures. Variable messaging signs can display messages warning drivers of changes in conditions. Variable messaging signs are proposed as part of the project.	Rare	Major	Moderate
Increased frequency and severity of bushfires resulting in increased maintenance and damage to landscaping	Moderate	Detailed design to consider the use of native species which are typically more fire tolerant and can more rapidly regenerate after fire events.	Unlikely	Serious	Moderate
Increased frequency and severity of bushfires resulting in impact on trucks carrying dangerous goods, leading to explosions and associated risk to life.	High	Median crossovers and heavy vehicle emergency stopping bays proposed as part of the project. Variable messaging signs can display messages notifying trucks carrying dangerous goods to cease travel in that direction and direct them to the nearest stopping bay or median crossover. Variable messaging signs are proposed as part of the project.	Improbable	Catastrophic	Moderate
Increased frequency and severity of bushfires leading to increased fauna movement onto the motorway, resulting in increased accidents.	Moderate	Detailed design to maintain fauna passage along main creek lines under bridge structures (see **Section 7.1**)	Unlikely	Serious	Moderate

Risk scenario	Original risk rating	Adaptation/mitigation options	Residual likelihood rating	Residual consequence rating	Residual risk rating
Increased frequency and severity of bushfires leading to road closures, resulting in restricted access and increased congestion for road users and emergency vehicles	Moderate	Median crossovers and heavy vehicle emergency stopping bays proposed as part of the project. Variable messaging signs can display messages notifying trucks carrying dangerous goods to cease travel in that direction and direct them to the nearest stopping bay or median crossover. Variable messaging signs are proposed as part of the project.	Rare	Serious	Low
Droughts					
Long periods of dry weather leading to a build-up of fuel, rubber and brake dust on road surfaces, resulting in a decrease in skid resistance and increase in accidents in wet weather events.	Moderate	Variable messaging signs can post changes to speed limits and alert drivers to changes in conditions. Variable messaging signs are proposed as part of the project.	Rare	Major	Moderate
Long periods of dry weather leading to a build-up of rubber and brake dust on road surfaces, resulting in increased runoff of pollutants from the carriageway.	Moderate	Water quality treatment features are proposed as part of the project, consisting of grassed swales and water quality basins. Water quality treatment features will be further considered within detailed design.	Unlikely	Moderate	Low

Construction emissions were calculated using the methodology outlined in the Workbook (described in **Section 8.6.2**).

The scope 1, scope 2 and scope 3 emissions that would be generated by the project based on the emissions source are presented in **Table 8-67**. It is estimated that the project would generate about 271,597 tCO_2-e of total construction GHG emissions over the entire duration of construction, comprising 117,809 tCO_2-e of scope 1 emissions and 153,788 tCO_2-e of scope 3 emissions. No material scope 2 emissions sources were identified for the construction of the project and consequently no scope 2 GHG emissions were quantified.

Construction materials would contribute the greatest proportion of construction emissions, generating 150,488 tCO_2-e and comprising 55 per cent of total construction emissions. Steel would represent the highest contributing individual construction material generating 52,452 tCO_2-e (19.7 per cent of total construction emissions). Fuel combustion and vegetation removal would generate 46,718 tCO_2-e and 74,402 tCO_2-e respectively.

Table 8-67 Construction GHG emissions (tCO_2-e)

Emission source	Scope 1 emissions (tCO_2-e)	Scope 2 emissions (tCO_2-e)	Scope 3 emissions (tCO_2-e)	Total emissions (tCO_2-e)	% of total emissions
Fuel combustion					
Electricity generation	399	-	30	430	0.16
Site vehicles	438	-	33	471	0.17
Plant and equipment used in demolition and earthworks	24,979	-	1905	26,883	9.90
Other plant and equipment	15,408	-	1175	16,583	6.11
Plant and equipment used in vegetation removal	2184	-	167	2350	0.87
Total fuel use	43,408	-	3310	46,718	17.20
Vegetation removal					
Loss of carbon sink	74,402	-	-	74,402	27.39
Total vegetation removal	74,402	-	-	74,402	27.39
Construction materials					
Aggregate	-	-	7998	7998	2.94
Concrete	-	-	42,626	42,626	15.69
Cement (binder)	-	-	44,976	44,976	15.56
Steel	-	-	53,452	53,452	19.68
Bitumen	-	-	1436	1436	0.53

Emission source	Scope 1 emissions (tCO_2-e)	Scope 2 emissions (tCO_2-e)	Scope 3 emissions (tCO_2-e)	Total emissions (tCO_2-e)	% of total emissions
Total construction materials	-	-	150,488	150,488	55.41
Total construction emissions	117,810	-	153,789	271,607	100
Per cent of total	43		57	100	-

Operation

Activities that would generate GHG emission during operation include:

- Electricity (eg for powering street lighting, variable message signs and traffic signals)
- Use of diesel fuel for the operation of maintenance vehicles and machinery and embodied energy within materials for maintaining the road
- Use of the road by vehicles.

Annual use of electricity would result in scope 2 and scope 3 GHG emissions. The predicted total GHG emissions associated with the use of electricity during operations of the project were estimated to be 20,399 tCO_2-e per annum.

Ongoing maintenance of the project would result in the use of materials and the combustion of fuel (eg associated with the use of maintenance vehicles and machinery and equipment). Emission estimates for the use of fuel and materials are based on the replacement of five per cent of the asphalt road surface every 50 years, in accordance with the Carbon Gauge assessment method, with only the top layer requiring replacement. The use of fuel and materials to carry out maintenance activities were estimated to generate about 12,243 tCO_2-e of scope 1 emissions and 13,753 tCO_2-e of scope 3 emissions over a 50 year maintenance assessment period. The total GHG emissions associated with road maintenance over a design life of 50 years would be 25,996 tCO_2-e.

Fuel combustion by future road users would likely generate the greatest amount of GHGs during its operation. The project would allow greater number of vehicles to travel through the area with greater efficiency and would attract road users seeking to access the Badgerys Creek Airport. The local network that would be influenced by the project would include The Northern Road, Elizabeth Drive and the M7 Motorway. GHG emissions from fuel consumption were modelled for the time periods 2026 (year of opening) and 2036 (future year). A comparison was made of GHG emissions that would be produced by the project against a ‘no build’ scenario where vehicles use the existing road network (the ‘without project’ scenario). The GHG analysis was based on the traffic forecast data presented in **Section 7.2.6**.

Table 8-68 shows that an increase in GHG emissions from fuel consumption is expected from the year of opening, and a further increase in GHG emissions is expected from the future year scenario. This is directly associated with the significant increase in traffic using the road network and the M12 Motorway. Traffic demand is forecast to increase within the surrounding network which is the key contributing factor to the increase GHG emissions generated under the ‘with project’ scenario compared to the ‘without project’ scenario. This is reflective of the large increase in residential land that is planned for release as part of the Western Sydney Aerotropolis and the South West Growth Area, as well as employment land associated with Western Sydney Airport.

Table 8-68 GHG emissions from fuel consumption for the 'with project' and 'without project' scenarios within the surrounding road network

Year	With project (tCO2-e)	Without project (tCO2-e)	Difference (tCO2-e)
2026	93,194	51,948	41,246
2036	144,006	83,449	60,557

The combined estimated scope 1, scope 2 and scope 3 GHG emissions for the operation, including use of the project by road users, and maintenance of the project were estimated to be about 114,113 tCO_2-e for the year of opening, and 134,925 tCO_2-e in 2036.

8.6.5 Cumulative impacts

Climate change risks

Construction

The climate change risk assessment only identified three potential risks with a risk rating or moderate or greater associated with project construction, relating to increase in extreme heat, extreme precipitation and bushfire (see **Table 8-63**). The risks identified for the project during construction would not be altered by the presence of multiple projects being constructed near one another. For example, the potential for a bushfire to generate smoke causing health impacts of construction delays would not be altered by concurrent construction projects occurring within the western Sydney area.

Additional risks not identified as moderate or above for the project, such as extreme rainfall resulting in changes in surface water runoff causing impacts on receiving sensitive environments, may be altered by multiple projects being constructed near one another. Generally, these risks would only increase where project boundaries are adjacent and construction timing overlaps. The construction of the project, as well as other nearby projects such as the Western Sydney Airport, the Sydney Metro Greater West and The Northern Road upgrade (Stage 5 and Stage 6), would occur within the near term where the effects of climate change would be less pronounced than in later time periods (see **Table 8-62**). These projects have the potential to overlap with the project temporally or spatially and may alter the effects of climate change risks on the projects. However, the likelihood, and therefore overall risk of cumulative climate change risks resulting in serious consequences is generally considered low.

Operation

Potential risks that may result from the operation of the project with consideration of other projects being carried out in the area include:

- Increased frequency, severity and duration of rainfall events resulting in floods greater than the designed capacity, changes in overland floods and change in flooding regimes. These changes may be exacerbated by regimes being altered by multiple projects within close proximity to one another, in particular the Western Sydney Airport and Sydney Metro Greater West. Changes may lead to increased afflux upstream resulting in damage to surrounding properties. Flooding infrastructure for the project was designed to consider climate change by taking into consideration a (theoretical) one in 2000 year storm event. Impacts of flooding, including impacts from nearby projects and changes in rainfall patterns associated with climate change, are described in **Section 7.8.4** concluding that overall, the project would have minor cumulative flooding impacts associated with operation of the project and the other ongoing and planned developments in the area.

- Increased frequency and severity of bushfires leading to a breakdown of the surrounding road network and/or the motorway, resulting in motorists becoming trapped on the motorway and restricting the movement of traffic and emergency vehicles. Cumulative changes to the road network may impact the ability of road users to evacuate in the event of a bushfire. The operation of other road projects within the vicinity of the project, including The Northern Road upgrade, Elizabeth drive Upgrade, Mamre Road upgrade and Outer Sydney Orbital may provide greater network capacity reducing impacts from bushfires on the road network.
- Increased demand on the road network associated with high flood or bushfire risks, with implications for emergency management during extreme events. As above improved network capacity as a result of nearby road upgrade projects may have a positive cumulative impact by reducing likelihood of network congestion in responses to climatic events.
- Increased demand on the surrounding power network on extreme hot days resulting in power outages to lighting and variable messages signs resulting in potential for accidents to occur. The Western Sydney Airport, for example, may be a substantial consumer of power resulting in increased pressure on the power network.
- Introduction of additional infrastructure as part of the project and other nearby projects may increase the effects of urban heat island effect, resulting in an increase in local average temperatures and exacerbate extreme heat events. The Western Sydney Airport is immediately adjacent to the project and is likely to have large areas of impervious hard surface that may influence urban heat island effect.

The adaptation measures identified in **Table 8-64** would increase the projects resilience to climate change and reduce the cumulative impact of any climate change risks on the project or surrounding environment.

Greenhouse gases

GHGs are atmospherically mobile and therefore an increase in the concentration of GHGs as a result of the project would not increase in a single area or at a local scale (eg in Western Sydney) as a result of multiple projects being developed concurrently. Rather, the cumulative impacts of GHG emissions relate to each project's contribution to the overall increase in GHGs in the atmosphere which contribute to global climate change. Cumulative GHG emissions for construction and operation have therefore been considered in the context of the NSW and Australian GHG inventories (described in **Section 8.6.3**).

Construction

The combined estimated scope 1, scope 2 and scope 3 GHG emissions for the construction of the project are about 271,597 tCO_2-e per annum (see **Section 8.6.4**). When compared to the most recent Australia inventory (532.9 megatonnes of CO_2-e) and NSW inventory (130.3 megatonnes of CO_2-e) of GHG emissions the construction of the project would contribute about 0.05 per cent of Australia's total annual GHG emissions and 0.21 per cent of NSW's total annual GHG emissions. The total contribution of the construction of the project to the effects of climate change is therefore considered to be minor.

Operation

The combined estimated scope 1, scope 2 and scope 3 GHG emissions for the operation and maintenance of the project are about 114,006 tCO_2-e per annum for the year of opening (2026) (see **Section 8.6.4**). When compared to the most recent Australian (532.9 megatonnes of CO_2-e) and NSW (130.3 megatonnes of CO_2-e) inventories of GHG emissions the project would contribute about 0.02 and 0.09 per cent of total GHG emissions in its year of opening respectively. In its year of opening the project would contribute about 0.5 per cent of a total of 23.1 megatonnes of CO_2-e GHG emissions generated by the road transportation in NSW.

8.6.6 Environmental management measures

Adaptation and mitigation measures for all moderate and high risks were identified to reduce the likelihood of each risk and increase the project's resilience to climate change Where possible, adaptation measures were directly incorporated into the design of the project. Adaptation measures that have already been incorporated into the project design include:

- The location of temporary construction ancillary facilities has considered the risk of flood and strong winds associated with severe storm events, with site uses more vulnerable to the impacts of severe storms located away from the areas of highest risk to minimise impact
- Variable messaging signs are proposed as part of the project
- Cleared areas would be landscaped and scour protection would be installed
- Stormwater infrastructure was designed to ensure flood immunity for the motorway up to and including the one in 100-year storm event
- Median crossovers and heavy vehicle emergency stopping bays were included as part of the project
- Water quality treatment features are proposed as part of the project, consisting of grassed swales and water quality basins.

The environmental management measures that would be implemented to minimise the climate change and greenhouse gas impacts of the project, along with the responsibility and timing for those measures, are presented in **Table 8-69**.

Table 8-69 Environmental management measures (Climate change and greenhouse gas)

Impact	Reference	Environmental management measure	Responsibility	Timing
Climate change risks	CC01	Detailed design will incorporate appropriate adaptation measures for all climate change risks with an original risk rating of moderate or above. These will include but not be limited to: • Consideration of the full range of potential temperature extremes on the project (particularly bridge structures) which may occur as a result of climate change and consider material capacity to withstand heat during material type selection to minimise the likelihood of infrastructure failures • Consideration of energy dissipation at culvert outlets when velocities exceed existing magnitudes • Consideration of the use of native species which are typically more fire tolerant and can more rapidly regenerate after fire events • Maintenance of fauna passage along main creek lines under bridges.	Contractor	Detailed design
	CC02	A climate change monitoring and adaptive management framework will be prepared and implemented for the project. The framework will incorporate performance monitoring criteria and measures, and the requirement for periodic review of the climate change risk assessment and framework against updated climate data to ensure currency.	Roads and Maritime /Contractor	Detailed design and construction

Impact	Reference	Environmental management measure	Responsibility	Timing
	CC03	An adaptive management approach will be applied to workplace health and safety planning during construction and operation in line with the WHSMP. This will include use of Roads and Maritime Work Health and Safety Procedures.	Roads and Maritime /Contractor	Prior to construction, during construction and during operation
GHG emissions	GG01	Targets to reduce GHG emissions during construction and operation will be included in the project's sustainability management plan.	Roads and Maritime /Contractor	Detailed design and construction
	GG02	Updated GHG assessment based on the detailed design for the project and the final project when built will be carried out.	Contractor	Detailed design and construction
	GG03	Vegetation removal will be minimised where practicable.	Contractor	Detailed design and construction
	GG04	The procurement of goods and services will consider goods and services that: • Are from local suppliers • Make use of recycled materials or materials with a low embodied energy content. • Are energy efficient or have low embodied energy • Minimise the generation of waste	Contractor	Detailed design and construction
	GG05	Construction plant and equipment will be well maintained to maximise fuel efficiency.	Contractor	Construction

9. Summary of environmental management measures

This chapter collates the environmental management measures for the project that are identified through the impact assessment process. This chapter also describes the proposed framework for managing the potential impact of this project through the creation of CEMPs and sub-plans which set out specific impact mitigation and management measures.

9.1 Environmental management framework

Roads and Maritime manages its environmental responsibilities and environmental performance through the implementation of an environmental management framework that is broadly consistent with the principles contained within the ISO 14000 series and standards. This includes establishing a corporate environmental policy, setting environmental direction through objectives and targets, integrating these into work systems, and providing measures for continuous improvement. Roads and Maritime's Environment Policy Statement (Roads and Maritime, 2016i) outlines the agency's commitment to effectively manage any impact that lead to an adverse impact on the environment. The impacts associated with the project were assessed in accordance with the SEARs.

Roads and Maritime would ensure the commitments made in this EIS as well as any conditions of approval or legal requirements are fulfilled. The environmental management measures set out in **Table 9-1** would be monitored during construction and operation of the project to confirm their effectiveness, and whether any additional measures are required.

The management of environmental impact during construction is documented in the CEMP. The CEMP provides the system to manage and control the environmental aspects of the project during pre-construction and construction. It also provides the overall framework for the system and procedures to ensure environmental impact is minimised and legislative requirements are fulfilled. This includes the preparation of environmental sub-plans, which detail how environmental issues are managed through construction.

The management of environmental impact during the project's operation is best achieved through its design. The iterative design and environmental assessment process allows impact on be avoided or minimised where possible. Roads and Maritime has an ongoing obligation to minimise the environmental impact during all phases of the project including during detailed design when the design is being optimised. Where environmental controls were incorporated into the design there is a program of monitoring and review including independent auditing, to ensure the controls comply with stated objectives.

9.2 Construction Environmental Management Plan

Roads and Maritime has developed, through its contract specifications, a model specification that requires construction contractors to implement an environmental management system in the form of a CEMP. CEMP's are prepared in accordance with:

- Roads and Maritime's QA Specification G10 – Traffic Management
- Roads and Maritime's QA Specification G36 – Environmental Protection (Management System)
- Roads and Maritime's QA Specification G38 – Soil and Water Management (Soil and Water Management Plan)
- Roads and Maritime's QA Specification G40 – Clearing and Grubbing
- Roads and Maritime's Division 5.2 CEMP Template
- Guideline for the preparation of Environmental Management Plans (DIPNR, 2004)
- AS/NZS ISO 14001:2016, 'Environmental Management Systems - requirements with guidance for use' (AS/NZS, 2016).

The CEMP provides a structured approach to the management of environmental issues identified in this EIS during construction of the project. Implementing the CEMP would effectively ensure that the project meets regulatory and policy requirements in a systematic manner and continually improves its performance. The strategies defined in the CEMP would be developed with consideration of the project approval requirements, and mitigation measures presented in the EIS. The CEMP establishes the system for implementation, monitoring and continuous improvement to minimise impact from the project on the environment.

In particular, the CEMP:

- Assigns responsibilities for planning, implementing, maintaining and monitoring environmental controls including the responsibilities of sub-contractors
- Provides specific mitigation measures and controls that can be applied to avoid or minimise negative environmental impact
- Provides specific mechanisms for compliance with applicable policies, approvals, licences, permits, consultation agreements and legislation
- States objectives and targets for issues that are important to the environmental performance of the project
- Outlines a monitoring regime to check the adequacy of controls as they are implemented during construction. This includes monitoring to validate the impact predicted for the project, to measure the effectiveness of environmental controls and implementation of the CEMP, and to address approval requirements. Where non-conformance is detected further analysis would be carried out, identifying and implementing corrective actions to rectify the non-conformance
- Includes the requirements of regular inspections to evaluate the effectiveness of controls and compliance with CEMP and sub-plans. This includes daily and post rainfall inspections by the contractor and weekly or fortnightly inspections by Roads and Maritime and regulatory agencies. Any maintenance or deficiencies in controls would be recorded and provided to the contractor for corrective action
- Provides details of communications within the project team and with government authorities and the community. This includes the requirement to prepare and implement a community communications strategy and a complaints and enquiries procedure in accordance with AS 4269-1995: Complaints Handling (Australian Standard, 1995)
- Includes copies of approvals, licenses and permits
- Includes the provision of environmental sub-plans which detail how construction activities would be managed to avoid or minimise impact including the type, location and timing of environmental controls. Refer to **Section 9.2.2** for more detail on CEMP sub plans
- Provides an emergency response procedure for mitigating environmental damage and procedures for planning restoration activities consistent with Roads and Maritime's Environmental Incident Classification and Reporting Procedure. The procedure provides a process of systematically responding to and managing emergency situations, it also outlines the process of, and legal requirements for, reporting and notification of incidents
- Provides details of training and awareness programs for personnel working on the project. This includes a compulsory site induction that outlines the requirements of the CEMP and legislative requirements, regular tool box talks on specific environmental issues, and daily pre-start meetings
- Provides for an environmental auditing program including six monthly audits carried out by the contractor to verify compliance with the CEMP and sub-plans, conditions of approval, relevant legislation. External audits would also be carried out every six months in accordance with ISO 19011:2014 - Guidelines for auditing management systems (AS/NZS, 2014)
- Provides a mechanism for regular evaluation of environmental performance. This includes regular management reviews by the contractor, and an annual review conducted by the contractor and stakeholders as part of the continual improvement process.

9.2.1 CEMP Sub-plans

A number of environmental management sub-plans support the CEMP. These documents would be prepared to identify requirements and processes applicable to specific impacts described in the EIS. They would address requirements of conditions of approval and other measures identified in the EIS. The construction sub-plans that would be prepared for the project include:

- Construction flora and fauna management plan
- Construction transport and traffic management plan
- Construction cultural heritage management plan (including Aboriginal and non-Aboriginal heritage)
- Construction noise and vibration management plan
- Construction flood management plan
- Construction soil and water management plan
- Construction contaminated land management plan
- Construction air quality management plan
- Construction waste and resource management plan.

9.2.2 Non-conformance and corrective action

In the event that a non-conformance is identified, a corrective/preventative action (or actions) must be implemented. In addition, environmental management improvement opportunities can be initiated as a result of incidents or emergencies, monitoring and measurement, audit findings or other reviews. Improvement opportunities may also result in the implementation of corrective/preventative actions.

Corrective/preventative actions and improvement opportunities would be entered into the contractor's quality system database and include detail of the issue, action required and timing and responsibilities. The record would be updated with date of close out and any necessary notes. The database would be reviewed regularly to ensure actions are closed out as required.

Non-conforming activities may be stopped, if necessary, by personnel outlined in the CEMP. The work would not start until a corrective/preventative action was closed out.

Procedures for rectifying any non-compliance identified during environmental auditing, review of compliance or incident management are also documented in a compliance tracking program. A compliance tracking program would be established to track compliance against the following for pre-construction and construction phases of the project:

- Conditions of approval
- Management measures identified in the EIS and submissions report
- Legislative requirements
- Licensing conditions
- Contract specifications relating to environmental matters.

9.3 Summary of management measures

A summary of the environmental management measures that would be implemented during the construction and operation of the project is presented in **Table 9-1**. The estimated costs of environmental mitigation measures were captured in project capital costs and, whilst difficult to quantify specifically, would represent less than 10 per cent of project costs.

Table 9-1 Summary of environmental management measures

Impact	Reference	Environmental management measure	Responsibility	Timing
General				
Community consultation	G01	A Community Communication Strategy will be prepared for the project to facilitate communication with the local community including relevant Government agencies, Councils, adjoining affected landowners and businesses, and other relevant stakeholders that may be affected by the project. The strategy will: • Identify people or organisations to be consulted during the delivery of the project • Set out procedures and mechanisms for the regular distribution of information about the project • Outline mechanisms to keep relevant stakeholders updated on site construction activities, schedules and milestones • Outline avenues for the community to provide feedback (including a 24 hour, toll free project information and complaints line) or to register complaints and through which Roads and Maritime will respond to community feedback • Outline a process to resolve complaints and issues raised The Community Communication Strategy will include a Construction Fatigue Protocol to minimise impacts associated with construction fatigue. The Protocol will include consideration of noise attenuation and restriction of out-of-hours work or use of noise intensive equipment where reasonable and feasible.	Roads and Maritime / Contractor	Prior to construction
General construction management	G02	A CEMP will be prepared and implemented for the project in accordance with the Department of Infrastructure, Planning and Natural Resources Guideline for the Preparation of Environmental Management Plans (DIPNR 2004), for the ongoing management of environmental issues during construction of the project.	Contractor	Prior to construction and during construction

Impact	Reference	Environmental management measure	Responsibility	Timing
Biodiversity				
All biodiversity impacts	B01	A CFFMP will be prepared. The measures in the CFFMP will include: • A site specific induction • Identification of clearing limits and exclusion fencing • Pre-clearance surveys • Vegetation clearing procedures • An unexpected finds procedure • Procedures for weed management and monitoring • A process for de-watering farm dams and the relocation of aquatic fauna • Provision of supplementary fauna habitat (eg nest boxes).	Contractor	Prior to construction
	B02	A Habitat Compensation Plan (HCP) will be prepared and implemented as part of the CFFMP for the project. The HCP will targeted those species that will be impacted by the loss of hollows. Measures will include: nest boxes, reuse of salvaged hollows and/or new technologies eg chainsaw hollows), as well as replacement of woody debris and bushrock with consideration to Guide 5 and Guide 8 of Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011).	Contractor	Prior to construction
Removal of native vegetation, threatened species, and threatened species habitat	B03	Native vegetation, threatened species and threatened species habitat removal will be minimised where practicable through detailed design. This will include avoiding the nest and surrounds of the White-bellied Sea-Eagle, where practicable.	Contractor	Detailed design
	B04	Biodiversity offsets for the project will be purchased and managed in accordance with the Biodiversity Offset Strategy prepared for the project.	Roads and Maritime	Prior to operation

Impact	Reference	Environmental management measure	Responsibility	Timing
	B05	Pre-clearing surveys will be carried out in accordance with Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011) (Guide 1: Pre-clearing process). The following species identified on or near the study area will require particular attention: • White-bellied Sea-Eagle If design cannot avoid the White-bellied Sea-Eagle nest, then pre-clearing measures to avoid impact on the nest will be implemented. This will include pre-clearing survey to establish if it is currently being used and removal of the next by an ecologist experienced in similar procedures. The potential impacts of habitat removal will be minimised by removing the nest outside of the nesting period (typically lays between June and September, with young remaining in the nest for 70 days). Time will be allowed on either side of the nesting period to allow individuals to select and construct a new nest site before clearing. • Cumberland Plain Land Snail Pre-clearance surveys carried out immediately before clearing works by a qualified ecologist in all vegetated areas to be disturbed that were identified as known or potential habitat for Cumberland Plain Land Snail (see **Figure 7-9**). As identified in the CFFMP, all individual Cumberland Plain Land Snails found during pre-clearance surveys will be translocated to adjacent areas of suitable habitat.	Contractor	Prior to construction
	B06	An unexpected threatened species finds procedure will be developed as part of the CFFMP and based on Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011) (Guide 1: Pre-clearing process). The procedure will include requirements for workers to be made aware of the potential flora and fauna species that may be encountered during construction (including training staff on species identification) and outline the process for the identification and management of unexpected flora and fauna. In the event that any threatened species are identified during construction, the following steps would be carried out: 1. Stop work immediately in the location of the unexpected find to avoid any potential impacts. 2. Notify the environmental manager. 3. Environmental manger will arrange for an ecologist to conduct an assessment of significance of the likely impact, develop management options, and notify DPIE, EESG and DoEE as appropriate. 4. If a significant impact is unlikely to occur, rebegin work and maintain regular site inspections. 5. If a significant impact is likely to occur: a. Consult with DPIE, EESG and DoEE as appropriate. b. Obtain approvals, licenses or permits as required. c. Rebegin work once advice is sought and necessary approvals, licenses and permits are obtained. 6. Include species in subsequent inductions, toolbox talks and update the CEMP.	Contractor	During construction

Impact	Reference	Environmental management measure	Responsibility	Timing
Removal of native vegetation and threatened species habitat	B07	Vegetation and habitat removal will be carried out in accordance with Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011) (Guide 4: Clearing of vegetation and removal of bushrock).	Contractor	During construction
	B08	Revegetation will be carried out in accordance with Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011) (Guide 3: Re-establishment of native vegetation) and the Landscape Plan prepared for the project.	Roads and Maritime / Contractor	During construction
	B09	Habitat will be replaced or re-instated in accordance with Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011) (Guide 5: Re-use of woody debris and bushrock and Guide 8: Nest boxes). A Habitat Compensation Plan, as described in B02 will include this measure.	Contractor	During construction
Riparian vegetation	B10	Removal of riparian vegetation at creek crossings will be minimised and vegetation connectivity across the riparian zone will be maintained where possible.	Contractor	During construction
Riparian vegetation and aquatic impacts	B11	Measures to protect aquatic and riparian habitat will be outlined in the CFFMP and protected in accordance with *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA, 2011) (*Guide 10: Aquatic habitats and riparian zones*) and Section 3.3.2 *Standard precautions and mitigation measures* of the Policy and guidelines for fish habitat conservation and management Update 2013 (DPI, 2013).	Contractor	Prior to construction
Aquatic impacts	B12	Creek adjustments will be investigated and removed or minimised during detailed design where feasible. Proposed creek adjustments will be designed such that they result in minimal changes to flow velocities.	Contractor	Detailed design
	B13	Creek corridors will be revegetated with locally native riparian vegetation, in accordance with the requirements of the Policy and guidelines for fish habitat conservation and management (DPI, 2013) and in consideration of the Guidelines for instream works on waterfront land (DPI, 2012b). The creek channels will be rehabilitated to preconstruction conditions or better.	Roads and Maritime / Contractor	During construction
	B14	Bridge pier locations within instream (main waterway channel) or on creek banks will be avoided during detailed design at the South Creek, Cosgroves Creek, Badgerys Creek and Kemps Creek crossings. Where avoidance is not possible, further biodiversity assessment will be required.	Contractor	Detailed design
	B15	Large woody debris will be retained for creek crossing works where practicable. Any large woody debris placed in the realigned waterways will be relocated in consultation with an ecologist.	Contractor	During construction

Impact	Reference	Environmental management measure	Responsibility	Timing
	B16	Permanent and temporary waterway crossings will be designed and constructed to maintain fish passage in accordance with Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (Fairfull and Witheridge, 2003). Crossing types should be matched to waterway type as per Table 1 in Fairfull and Witheridge (2003)	Contractor	During construction
	B17	The temporary application of mulch during construction will be managed to avoid the potential for material and tannin run-off into waterways. This will include limiting the application of mulch near waterways where practicable. The application of mulch for permanent landscaping must be designed and planned to avoid material and tannin runoff.	Roads and Maritime / Contractor	During construction
	B18	Emergency response protocols and procedures will be included in the Project CEMP and implemented in the event of a contaminant spill or leak.	Contractor	During construction
	B19	Spill kits will be located to allow for timely response to uncontained spills. Site inductions will include a briefing on the use of spill kits.	Contractor	During construction
Groundwater Dependent Ecosystems	B20	Interruptions to water flows associated with groundwater dependent ecosystems will be minimised through detailed design.	Contractor	Detailed design
Changes to hydrology	B21	Changes to existing surface water flows will be minimised through detailed design.	Contractor	Detailed design
Fragmentation of identified biodiversity links and habitat corridors	B22	Connectivity measures will be implemented in accordance with Wildlife Connectivity Guidelines for Road Projects (Roads and Maritime, under preparation). Fencing will be located to reduce roadkill of fauna species and funnel animals to creek crossings where safe passage will be available. Detailed design is to retain fauna passage at all four main creek lines (Cosgroves, South, Kemps and Badgerys Creeks).	Contractor	Detailed design and during construction
Edge effects on adjacent native vegetation and habitat	B23	Exclusion zones will be set up at the limit of clearing in accordance with Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011) (Guide 2: Exclusion zones).	Contractor	During construction
Injury and mortality of fauna	B24	Fauna will be managed in accordance with Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011) (Guide 9: Fauna handling).	Contractor	During construction

Impact	Reference	Environmental management measure	Responsibility	Timing
Invasion and spread of pest species	B25	Weed species will be managed in accordance with Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011) (Guide 6: Weed management).	Contractor	During construction
Invasion and spread of pathogens and disease	B26	Pathogens will be managed in accordance with Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011) (Guide 2: Exclusion zones).	Contractor	During construction
Noise, light and vibration	B27	Shading impacts will be minimised through detailed design of bridge and culvert structures. The need for artificial lighting during construction and operation will be minimised through detailed design where feasible, including directing lighting away from vegetated areas where practicable.	Contractor	Detailed design, during construction
Transport and traffic				
Construction transport and traffic	TT01	A construction transport and traffic management plan (CTTMP) will be prepared as part of the CEMP in consultation with relevant local Councils, and in accordance with relevant guidelines. The CTTMP will outline: • Staging and planning of works to minimise the need to occupy roads where practicable, including identification of haulage routes • Safe alternative routes for pedestrians and cyclists in accordance with relevant safety and accessibility standards. • The requirements for traffic control plans to be prepared for each work area which will include details of site access and specific traffic control measures (including signage) to manage traffic movements • Road safety audit requirements • Parking arrangements for construction staff • Identification of access arrangements at construction sites detailing vehicle access movements • Measures to minimise changes to the existing road network, property access, bus stops and pedestrian/cyclist facilities where feasible • Measures to communicate and notify of any changes in traffic conditions on roads or paths to road users, emergency services, public transport operators, and other relevant stakeholders • Measures to manage construction traffic interfaces and access arrangements with Western Sydney Airport and Sydney Metro Greater West • Requirements for appropriate warning and signage for traffic and other road users such as cyclists and pedestrians in the vicinity of work areas and work site access, and road diversions.	Contractor	Prior to construction and during construction

Impact	Reference	Environmental management measure	Responsibility	Timing
	TT02	Changes to bus stops will be implemented in consultation with TfNSW, relevant councils, and relevant bus operators. Alternate temporary bus stops will be provided with appropriate signage to direct commuters. Safe access will be provided in accordance with relevant safety and accessibility standards.	Contractor	Prior to construction, during construction and after construction
	TT03	Movements of haulage vehicles will be planned to minimise movements on the road network during the AM and PM peak periods where practicable.	Contractor	Prior to construction and during Construction
Impacts on M7 Motorway traffic and shared user path users	TT04	Consultation will be carried out with the operators of the M7 Motorway to develop measures to manage the potential impacts of construction within the operating M7 Motorway corridor.	Roads and Maritime / Contractor	Detailed design, prior to construction, and during construction
	TT05	Roads and Maritime will continue to work with Western Sydney Parklands Trust to support the delivery of a shared user path within Western Sydney Parklands to connect from Range Road to the existing M7 Motorway shared user path. If it is determined during consultation that the shared user path connection through the Western Sydney Parklands will not be delivered, Roads and Maritime will provide an alternative alignment for the shared user path in this section via either Elizabeth Drive, or alongside the M12 Motorway from Range Road to the M7 shared user path network.	Roads and Maritime	Detailed design, during construction
Damage or impacts on local road infrastructure	TT06	A road dilapidation report will be prepared before impacts on local roads in consultation with relevant councils and other relevant stakeholders. The report will document the existing conditions of local roads and outline measures to repair damage to roads from heavy vehicle movements associated with the project.	Contractor	Prior to construction

Impact	Reference	Environmental management measure	Responsibility	Timing
Impacts on property access	TT07	Existing property access would be maintained at all times. Any changes to access arrangements or alternative access that are necessary during construction will be done with consultation with the landowner. Any changes to access will provide the same equivalent pre-existing level of access unless agreed to by the land owner Property access that is physically affected by the project will be reinstated to at least an equivalent standard, in consultation with the landowner.	Roads and Maritime / Contractor	Detailed design, prior to construction, and during construction
Impacts on businesses	TT08	A signage strategy will be prepared as part of the CTTMP to provide for appropriate signage for businesses where existing signage is obscured/no longer visible or where customers are required to use alternative access to reach the businesses during construction.	Contractor	Prior to construction
Urban design, landscape character and visual amenity				
Impacts on views and landscape character from construction and operation of the project	LVIA01	An Urban Design and Landscape Plan (UDLP) will be prepared to minimise landscape character and visual impacts, and detail and guide the implementation of landscape features to be installed as part of the project, including re-vegetation requirements. This will include requirements for the provision of vegetative screening to soften the appearance of structural elements of the project such as noise walls and provide screening of sensitive views. The UDLP will also consider the requirements of the heritage interpretation framework that will be prepared for the project (NAH02). The UDLP will be prepared in accordance with applicable guidelines, be consistent with the concept project identity in the EIS and relevant urban design objectives and principles for the project including consideration of implementation of Crime Prevention Through Environmental Design (CPTED) principles, and in consultation with relevant councils.	Contractor / Roads and Maritime	Detailed design
	LVIA02	A detailed Landscape Plan will be prepared for the project and implemented throughout construction. The plan will guide the implementation of measures to minimise landscape character and visual impacts, including revegetation requirements.	Contractor	Detailed design, prior to construction and during construction
	LVIA03	Existing vegetation within the construction footprint will be retained and protected where possible. This includes densely vegetated areas such as remnant riparian forests and Cumberland Woodlands in Western Sydney Parkland.	Contractor	Detailed design and

Impact	Reference	Environmental management measure	Responsibility	Timing
				during construction
	LVIA04	Site levels and grades for the project will integrate with the surrounding terrain to help the visual assimilation of the project into the surrounding landscape where practicable. Engineer slopes with gradients no steeper than 3H:1V where possible to maximise the establishment of vegetation on these batters and allow for appropriate maintenance.	Contractor	Detailed design
	LVIA05	Project elements such as ancillary facility hoardings will be designed and maintained to minimise impacts on landscape character and visual amenity. This will include selecting colours and materials that are visually recessive and blend into the surrounding landscape where practicable, and the prompt removal of graffiti.	Contractor	Detailed design, prior to construction and during construction
	LVIA06	Where noise mitigation such as noise barriers are required, they will be designed with the aim of minimising visual impacts.	Contractor	Detailed design
	LVIA07	Temporary and permanent lighting will be designed and implemented with consideration of: • The need to orientate lighting to minimise light spill and glare impacts on nearby receivers • The need to minimise vandalism and maintenance requirements • Requirements of the National Airports Safeguarding Framework (NASF) (National Airports Safeguarding Advisory Group, n.d.) for operational lighting • Opportunities to implement sustainability initiatives in design such as energy efficient or solar lighting.	Contractor	Detailed design, prior to construction and during construction
Urban design elements	LVIA08	The findings and recommendation of the Aboriginal cultural heritage design process managed by Balarinji will be incorporated into the urban design and implemented as part of the project, including interpretive initiatives.	Roads and Maritime / Contractor	Detailed design, prior to construction and during construction

Impact	Reference	Environmental management measure	Responsibility	Timing
	LVIA09	Shared user paths to be delivered as part of the project will not preclude connections to future open space corridors and land use as identified in the Western Sydney Land Use and Infrastructure Implementation Plan (LUIIP) (DPE 2018). Where further design of adjacent open space corridors is undertaken, shared user paths will be provided to connect at an appropriate location. Shared user paths will be designed to be located away from road-side edges to provide an immersive landscape experience for pedestrians and cyclists, where possible.	Roads and Maritime / Contractor	Detailed design
	LVIA10	Establish an Urban Design Review Panel to provide advice and input into the development of the UDLP.	Roads and Maritime	Detailed design
	LVIA11	Highly visible elements of the project including potential noise barriers, retaining walls, bridge structures and urban design material selection will be designed to satisfy functional requirements and adopt the design principles detailed in the M12 EIS Landscape Character, Visual Impact Assessment and Urban Design Report. The proposed designs will be documented in the relevant UDLP for the project.	Contractor	Detailed design
	LVIA12	Consider a standard design for retaining walls and major structures across the project, to present a coordinated ‘suite of elements’.	Contractor	Detailed design
Safety in design	LVIA13	The project must consider CPTED principles during detailed design to minimise safety risks to all users. The project must carry out periodic CPTED reviews by a qualified professional and implement any additional recommendations where reasonable and feasible.	Contractor	Detailed design

Impact	Reference	Environmental management measure	Responsibility	Timing
Revegetation and landscaping	LVIA14	A tree management strategy will be prepared for the project, outlining: • Measures to minimise tree removal to retain and protect as many trees within the construction footprint as reasonable and feasible • Measures to avoid damage to trees that are to be retained within the construction footprint to ensure the maintenance of health and stability of the trees in accordance with AS4970-2009 Protection of trees on development sites • Requirements for the pruning of trees to be carried out by a suitably qualified person in accordance with AS 4373-2007 Pruning of amenity trees • Consideration of maintenance requirements and safety standards • Requirements for the replacement trees where removal cannot be avoided including: – Net increase in the number of trees (not identified as within an EEC) – Where it is not practicable to plant trees in the operational footprint an alternative location will be identified in consultation with relevant councils and in consideration of future development in the local area – Minimum pot size in accordance with part 3.2.1 (Rural road reserves) in the Roads and Maritime Landscape Guideline (2018b) subject to long-term viability of the plant.	Contractor	Detailed design and prior to construction
	LVIA15	Revegetation for the project will consider the land use requirements of the National Airports Safeguarding Framework (NASF) (National Airports Safeguarding Advisory Group, n.d.) to minimise the risk of wildlife strikes at the Western Sydney Airport.	Contractor	Detailed design
	LVIA16	Carry out appropriate soil analysis and identify soil preparation requirements for landscaping treatments to inform the Urban Design and Landscaping Plan and vegetation management in accordance with Roads and Maritime's Batter Surface Stabilisation Guideline (2015b).	Contractor	Detailed design and during construction
Socio-economic, land use and property				
Property acquisition and lease	SLP01	Areas of land leased for the purposes of construction will be reinstated at the end of the lease to at least equivalent standard in consultation with the landowner.	Contactor	During construction
	SLP02	All partial and full acquisitions and associated property adjustments will be carried out in accordance with the requirements of the *Land Acquisition (Just Terms Compensation) Act 1991* and the Land acquisition reform 2016 in consultation with landowners.	Roads and Maritime	Prior to construction

Impact	Reference	Environmental management measure	Responsibility	Timing
	SLP03	A Personal Manager - Acquisition (PMA) will be appointed to assist landowners and residents who may be affected by acquisition requirements for the project. The PMA will provide ongoing support for relocated persons, including dispute resolution and counselling, and provision of contact information for relevant services.	Roads and Maritime	Detailed design
	SLP04	Property adjustments, including replacement of farm infrastructure (such as fencing) and relocation of property access, prior to work that impact the property will be carried out in consultation with property owners/ business managers.	Contractor / Roads and Maritime	Prior to construction, during construction
Utility impacts	SLP05	The project will be designed with the aim of minimising impacts on existing utilities and services, in consultation with utility owners and/or providers of services where feasible and reasonable.	Contractor / Roads and Maritime	Detailed design
	SLP06	Utility owners and/or providers of services will be identified and consulted with before works start, to determine the requirements for access to, protection of, or relocation of services. Disruption to existing services will be minimised where feasible and local residents and businesses will be notified before any planned disruption.	Contractor	Prior to construction
Agricultural land use	SLP07	Construction activities will be planned to minimise disruption to existing agricultural operations/activities in surrounding properties where feasible and reasonable (eg stock access, access to farm dams, etc) unless otherwise agreed by the landowner.	Contractor	Prior to construction
Social infrastructure	SLP08	Adjustments to facilities in Western Sydney Parklands (eg walking and cycling trails and Sydney International Shooting Centre access) will be carried out in consultation with the Western Sydney Parklands Trust.	Roads and Maritime / Contractor	Prior to construction and during construction
	SLP09	Roads and Maritime will continue to work with Western Sydney Parklands Trust to support their delivery of a replacement for the Wylde Mountain Bike Trail by Western Sydney Parklands Trust.	Roads and Maritime	Prior to construction

Impact	Reference	Environmental management measure	Responsibility	Timing
Impacts on community facilities	SLP10	Ongoing consultation regarding management of potential impacts will be carried out in accordance with the Community Communication Strategy with the following community facilities: • Kemps Creek Sporting and Bowling Club • Kemps Creek Cougars Baseball Club • Science of the Soul Study Centre • Muhammadi Welfare Association of Australia • Schools such as Kemps Creek Public School and Christadelphian Heritage College, and Irfran College • Western Sydney Parklands • Sydney International Shooting Centre.	Roads and Maritime / Contractor	Prior to construction and during construction
Construction fatigue	SLP11	Construction fatigue will be managed in accordance with the Community Communication Strategy.	Roads and Maritime / Contractor	Prior to construction and during construction
Impacts on businesses	SLP12	On-going consultation will be carried out with local business owners that may be impacted during construction (including owners of agricultural businesses) in accordance with the Community Communication Strategy for the project.	Contractor / Roads and Maritime	Prior to construction and during Construction
	SLP13	A business impact risk register will be established and maintained for the duration of construction to identify and manage specific impacts on individual businesses.	Contractor	Prior to construction and during construction

Impact	Reference	Environmental management measure	Responsibility	Timing
Aboriginal heritage				
General	AH01	A construction cultural heritage management plan (CCHMP) will be developed for the project in consultation with the project RAPs and EESG. The CCHMP will include: • An unexpected finds procedure for the discovery of Aboriginal ancestral remains, Aboriginal objects or new Aboriginal sites consistent with Roads and Maritime Standard Management Procedure Unexpected Heritage Items (Roads and Maritime, 2015c). This procedure will also outline requirements to manage unexpected human remains finds in accordance with NSW statutory requirements, and relevant guidelines and standards prepared by EESG. The Procedure will outline the process for consulting with the RAPs in the event that previously unidentified Aboriginal heritage is discovered. • Procedures for the management and curation of salvaged Aboriginal objects • Detailed locations and installation procedures for fencing and protective coverings • Details of permissible activities inside protected Aboriginal areas • Procedures for consideration of heritage aspects within site inductions and toolbox talks for construction workers and supervisors.	Contractor	Prior to construction
	AH02	A detailed Aboriginal Cultural Salvage Strategy will be prepared for the project in consultation with project RAPs and EESG to guide the salvage excavation process for Aboriginal sites that will be salvaged. The strategy will address specific questions about each site and will be based on the salvage excavation methodology outlined in the ACHAR and prepared in consultation with EESG and project RAPs. All salvage collections and excavations will be carried out by a suitably qualified and experienced archaeologist. The method and extent of excavation required, and management of artefacts finds will be determined in consultation with project RAPs and EESG. Following completion of all salvage works associated with Aboriginal heritage sites, an Aboriginal Cultural Heritage Report will be prepared in accordance with relevant guidelines and in consultation with project RAPs and EESG. The Aboriginal Cultural Heritage Report will document all results of the salvage activities including analysis of artefacts from collections and excavations and management of all artefact finds.	Roads and Maritime /Contractor	Detailed design

Impact	Reference	Environmental management measure	Responsibility	Timing
Impacts on Aboriginal heritage during construction	AH03	A work method statement will be prepared for the works within identified Aboriginal sites in consultation with a suitably qualified and experienced archaeologist. The method statement will be prepared to minimise impacts on Aboriginal sites where feasible, including input into detailed design. Measures will include (but not be limited to): • Designing and locating bridges (including bridge pylons), haulage routes and other access roads to minimise potential disturbance of soils where feasible • Focusing protection measures on the zone within 100 metres of creeks including consideration of opportunities to cover the original cultural deposits in temporary protective barriers such as geotextile fabric and a layer of clean fill.	Contractor	Detailed design, prior to construction and during construction
Impacts on identified cultural deposits	AH04	An investigation will be carried out during detailed design to minimise impacts on the CHRP site where feasible.	Contractor	Detailed design
	AH05	Investigations will be carried out during detailed design to determine the feasibility of retaining cultural deposits between the pylons of bridges or elevated structures at the following sites: • BCW • BCE • SCW T1 • SCW T2 • SCE This will include covering the original cultural deposits beneath temporary protective barriers such as geotextile fabric and a layer of clean fill material.	Contractor	Detailed design
	AH06	Salvage collection of surface artefacts will be carried out at the following sites: • BCE • SCW T2 • KCW • PCP8 • CHRP • RR • M12A1 • Isolated artefact 4 • TNR-AFT-14.	Contractor / Roads and Maritime	Prior to construction

Impact	Reference	Environmental management measure	Responsibility	Timing
	AH07	Salvage excavation will be carried out at the following sites: • CCW • BWB • BCW • SCW T1 • SCW T2 • SCE • KCW • CHRP. The methodology and extent of excavations required for the above sites will be in accordance with site specific requirements outlined in the ACHAR prepared for the project.	Contractor / Roads and Maritime	Prior to construction
Non-Aboriginal heritage				
General	NAH01	A construction cultural heritage management plan (CCHMP) will be prepared for the project as part of the CEMP in consultation with DPC (Heritage). The CCHMP will include as a minimum: • A list, plan and maps with GIS layers showing the location of identified heritage items both within, and near, the construction footprint • A significance assessment and statement of significance for each item • Protocols and procedures including inductions and toolbox talks for all contractors and subcontractors working in the area to be informed of all exclusion zones, the elements and their significance, to prevent accidental damage or encroachment • Protocols and procedures to be implemented during construction to avoid or minimise impacts on items of heritage significance including protective fencing • The Roads and Maritime Unexpected Heritage Items Procedure (Roads and Maritime, 2015c) which would be followed in the event that unexpected heritage finds are uncovered during construction.	Contractor	Prior to construction

Impact	Reference	Environmental management measure	Responsibility	Timing
	NAH02	A suitably qualified heritage specialist will be engaged to prepare a heritage interpretation framework to guide development of the detailed urban design for the project. This framework will be prepared in accordance with the Interpreting Heritage Places and Items Guidelines (NSW Heritage Office, 2005) and will include: • Integration of heritage themes and values to be incorporated • Collaboration with other design elements and themes for the project, including those associated with Western Sydney Airport and Sydney Metro Greater West, to develop an integrative design approach with surrounding development • Opportunities for design responses for Aboriginal and non-Aboriginal heritage	Contractor / Roads and Maritime	Detailed design
	NAH03	Impacts on Non-Aboriginal heritage items will be avoided or minimised where reasonable and feasible. Where impacts are unavoidable, works will be carried out in accordance with the measures for individual Non-Aboriginal heritage items outlined in measures NAH04 to NAH12.	Roads and Maritime / Contractor	Detailed design, prior to construction and during construction
McGarvie Smith Farm (Item 1, Penrith LEP 857)	NAH04	A suitably qualified heritage consultant will be engaged to prepare an archival photographic recording of the site in accordance with the Heritage Information Series How to prepare archival records of heritage items (NSW Heritage Office, 1998). This will include both buildings and landscape features such as dams, and earthworks. The recording will include a detailed map showing the location of the features. Options will be investigated to provide funding support to the property's current owner to prepare a thematic heritage study of CSIRO and other agricultural research stations, including both McGarvie Smith Farm and McMaster Field Station, and other relevant agricultural research stations and similar facilities located in NSW. The thematic study will include a review of the role of such properties in veterinary research, association with agricultural, pastoral and animal husbandry groups, use of pioneering methods and practices and contribution to the development of farming in Australia. In the event that landowners do not prepare this study, Roads and Maritime will engage a heritage specialist to do so.	Roads and Maritime / Contractor	Detailed design and prior to construction

Impact	Reference	Environmental management measure	Responsibility	Timing
The Fleurs Radio Telescope Site (Item 2, Penrith LEP 832)	NAH05	• All extant elements of the radio telescopes and associated infrastructure, including rubbish mounds situated outside the construction footprint will be left intact • Ground penetrating radar, or other remote sensing survey techniques, will be carried out under the supervision of a suitably qualified and experienced archaeologist before any ground disturbance within the heritage curtilage of the Fleurs Radio Telescope Site contained within the construction footprint to identify any sub-surface cables • Measures will be included in the CHMP to describe how the heritage values of the site will be conserved and managed during construction • Roads and Maritime will engage a suitably qualified heritage consultant to prepare an archival photographic recording of the impacted areas of the property, in accordance with DPC (Heritage) guidelines (Heritage Council of NSW 2006) • The heritage interpretation framework for the project (NAH02) will include interpretation measures that will improve community awareness of the history of the Fleurs Radio Telescope as well as determine suitable locations for the presentation of information that are publicly accessible.	Roads and Maritime / Contractor	Detailed design and prior to construction
Upper Canal System (Pheasants Nest Weir to Prospect Reservoir (Item 4, SHR 01373)	NAH06	• Relevant conservation policies outlined in the Upper Canal CMP (NSW Public Works Government Architect's Office, 2016) will be incorporated into the construction cultural heritage management plan (CCHMP) to ensure heritage fabric is not impacted by the project. • The CCHMP will be consistent with and require implementation of relevant measures outlined in The Guidelines for development adjacent to the Upper Canal and Warragamba Pipelines (Sydney Catchment Authority 2012) which sets out guidelines for designing, planning or assessing development on land adjacent to this pipeline • Guidelines and associated safe working distances to be adhered to for heritage structures as outlined in **Appendix K** • A safe working distance exclusion zone will be established around the exposed tunnel air shaft in the M7 Motorway median in accordance with the process outlined in noise and vibration management measures NV09 - NV10.	Roads and Maritime / Contractor	Prior to construction and during construction

Impact	Reference	Environmental management measure	Responsibility	Timing
McMaster Field Station (Item 6)	NAH07	• A suitably qualified heritage consultant will be engaged to prepare an archival photographic recording of the impacted area, in accordance with DPC (Heritage) guidelines (Heritage Council of NSW 2006) (Heritage Council of NSW 2006). This will include both buildings and landscape features such as dams, and earthworks. The recording will include a detailed map showing the location of the features. • Options will be investigated to provide funding support to property's current owner to prepare a thematic heritage study of CSIRO and other agricultural research stations, including both McMaster Field Station and McGarvie Smith Farm, and other relevant agricultural research stations and similar facilities located in NSW. The thematic study will include a review of the role of such properties in veterinary research, association with agricultural, pastoral and animal husbandry groups, use of pioneering methods and practices and contribution to development of farming in NSW and Australia. In the event that landowners do not prepare this study, Roads and Maritime will engage a heritage specialist to do so. • A potential use zone will be established around the McMaster Farm group of buildings, including a suitable buffer zone, and no construction activities will take place within this zone. This zone will be incorporated into the construction heritage management plan (CHMP). The potential use zone will include safe working distances to be adhered to for heritage structures as outlined in **Appendix K** . Before occupying or utilising the buildings, a dilapidation survey will be carried out and a heritage architect will be engaged to advise on proposed modifications and management measures to avoid and minimise impact on the buildings.	Roads and Maritime / Contractor	Detailed design, prior to construction and during construction
Fleurs Aerodrome (Item 7)	NAH08	• A suitably qualified heritage consultant will be engaged to prepare an archival photographic recording of the impacted area before its disturbance and/or removal, in accordance with DPC (Heritage) guidelines (Heritage Council of NSW 2006). The recording will include a detailed map showing the location of the features. • An interpretive framework developed for the project will include consideration of elements to enable the continued interpretation and understanding of the airstrip at Fleurs Aerodrome as a linear and continuous element. This will be carried out in consultation with Department of Defence and consider opportunities for involvement of veterans groups. • Relevant guidelines and associated safe working distances will be adhered to for remaining heritage structures as outlined in the **Appendix K**	Contractor / Roads and Maritime	Detailed design, prior to construction and during construction

Impact	Reference	Environmental management measure	Responsibility	Timing
Cecil Park School, Post Office and Church Site (Item 8)	NAH09	• Roads and Maritime will liaise with local museums and/or historical societies to arrange a long-term secure artefact repository for the artefact assemblage. Once that arrangement has been made, DPC (Heritage) will be notified for their records. In the short term, Roads and Maritime will provide secure short-term secure storage for the assemblage. • An Archaeological Research Design (ARD) for archaeological salvage of the former historical complex will be prepared and implemented prior to construction commencing by a suitably qualified historical archaeologist who fulfils the Heritage Council's *Excavation Director Criteria* to conduct open area excavation of a locally significant archaeological site. The ARD will include a revised impact assessment, revised research questions and a methodology to ensure archaeological relics within the project construction footprint are adequately investigated in accordance with standard NSW archaeological practice.	Contractor / Roads and Maritime	Detailed design
South, Kemps and Badgerys Creek Confluence Weirs Scenic Landscape (Item 12)	NAH10	• Management measures identified in the project UDLP (LVIA01) will be implemented during detailed design to minimise impacts on landscape and vistas • Flooding management measures (F01 to F08) and surface water quality and hydrology management measures (SWH01 to SWH13) will be implemented to reduce broader impacts on the surrounding scenic landscape.	Contractor / Roads and Maritime	Detailed design, prior to construction and during construction

Impact	Reference	Environmental management measure	Responsibility	Timing
Noise and vibration				
General construction noise and vibration	NV01	A construction noise and vibration management plan (CNVMP) will be prepared for the project to mitigate and manage noise and vibration impacts during construction. The CNVMP will be implemented for the duration of construction of the project and will: • Identify nearby sensitive receivers • Include a description of the construction activities equipment and working hours • Identify relevant noise and vibration performance criteria for the project and license and approval conditions. • Include modelling results showing construction noise impacts based on detailed design information • Outline standard and additional mitigation measures from the Construction Noise and Vibration Guideline (CNVG) (Roads and Maritime 2016e) and information about when each will be applied • Outline requirements for the development and implementation of an Out-of-hours Work Protocol • Outline requirements for noise and vibration monitoring that will be carried out to monitor project performance associated with the noise and vibration criteria • Describe community consultation and complaints handling procedures in accordance with the Community Communication Strategy to be developed for the project • Outline measures to manage noise impacts associated with heavy vehicle movements both on and offsite • Outline measures to minimise cumulative construction impacts and the likelihood for 'construction fatigue' from concurrent and consecutive projects in the area • Outline requirements to minimise and manage construction fatigue, in consultation with the community.	Contractor	Prior to construction and during construction
	NV02	Measures to minimise and manage construction fatigue are to be investigated through the planning of construction staging	Contractor	Detailed design, prior to construction and during construction

Impact	Reference	Environmental management measure	Responsibility	Timing
	NV03	Detailed noise assessments will be carried out for ancillary facilities with the potential to involve high noise generating activities (including batching plant operations). The assessments will consider the proposed site layouts and noise generating activities that will occur at the facilities and assess predicted noise levels against the relevant noise management criteria. The assessments will also consider the requirement for appropriate noise mitigation within ancillary facilities and adjacent to construction works, depending on the predicted noise levels. Any mitigation measures required will be implemented before the start of activities that generate noise and vibration impacts.	Contractor	Prior to construction
	NV04	Monitoring will be carried out at the start of high noise and vibration activities to confirm that actual noise and vibration levels are consistent with the noise and vibration impact predictions. Where mitigation measures were included, measurements will be carried out to confirm the effectiveness. Where the monitoring identifies higher levels of noise and vibration compared to predicted levels, or where mitigation is shown to be ineffective against measured noise and vibration levels, additional mitigation measures will be identified and implemented to appropriately manage impacts where feasible and reasonable.	Contractor	Construction
	NV05	Where reasonable and feasible, receivers identified as requiring at-property treatment for operational noise mitigation will be identified and offered treatment before construction activities begin that are likely to impact them.	Roads and Maritime / Contractor	Prior to construction
Vibration impacts	NV06	Activities that generate vibration will be managed to avoid impacts on structures and sensitive receivers. This includes implementing appropriate safe working distances where practicable.	Contractor	Prior to construction and during construction
	NV07	The use of alternatives to vibration generating equipment will be considered where vibration impacts are predicted.	Contractor	During construction
	NV08	Where works are within the minimum working distances and considered likely to exceed the cosmetic damage objectives (as shown in Figure 7-3 of **Appendix K**) , construction works will not proceed unless: • A different construction method with lower source vibration levels is used, where feasible • Attended vibration measurements are carried out at the start of the works to determine the risk of exceeding the vibration objectives.	Contractor	During construction

Impact	Reference	Environmental management measure	Responsibility	Timing
	NV09	Building Condition Surveys will be offered in writing to property owners before construction where there is a potential for construction activities to cause structural or cosmetic damage. A comprehensive report will be prepared by a suitably qualified professional before the relevant works begin and will comprise a written and photographic condition.	Contractor	Prior to construction
Vibrations impacts on the Upper Canal System and Gas Pipelines	NV10	Surveys will be carried out to confirm the existing condition of the WaterNSW Upper Canal System and Jemena high pressure gas pipelines to determine appropriate vibration criteria. This will also include consideration of distances from the vibration intensive activity (piling, rock-breaking and vibratory rolling), as well as ground conditions. A vibration criterion of a peak particle velocity (PPV) will be determined in consultation with the relevant utility/service providers. In-situ monitoring will be carried out to confirm the vibration levels and assess the impact of vibration. Where the monitoring identifies exceedances in the relevant criteria, or where impacts are identified, additional mitigation measures will be identified and implemented to appropriately manage impacts.	Roads and Maritime / Contractor	Detailed design and during construction
Vibration impacts on heritage structures	NV11	The following structures have the potential to be within the safe working distances for sensitive structures (Group 3 from DIN 4150): • Item 1: McGarvie Smith Farm • Item 2: Fleurs Radio Telescope Site • Item 4: Upper Canal System • Item 6: McMaster Field Station • Item 7: Fleurs Aerodrome A detailed survey will be completed to determine the potential for vibration impacts and to define appropriate criteria for each heritage item. Vibration monitoring will be carried out when vibration intensive tasks are occurring within the minimum working distances to heritage structures. Where the monitoring identifies exceedances in the relevant criteria, or where impacts are identified, additional mitigation measures will be identified and implemented to appropriately manage impacts.	Contractor	Prior to construction and during construction

Impact	Reference	Environmental management measure	Responsibility	Timing
Construction traffic noise	NV12	Construction vehicle movements (both on and offsite) will be managed to minimise noise impacts. Where feasible, this will include (but not be limited to): • Establishment and use of internal haul routes, or existing major roads where this is not feasible • Restriction of heavy vehicle movements to standard construction hours • Locating traffic marshalling areas away from residences to minimise noise impacts from idling vehicles • Instructing workers on the operation of heavy vehicles entering and exiting the site to minimise noise	Contractor	During construction
Cumulative construction impacts	NV13	The likelihood of cumulative construction noise impacts will be considered during detailed design when detailed construction schedules of other projects are available. Construction works will be scheduled with the aim of minimising concurrent works near sensitive receivers where possible in consultation with managers of other nearby projects that are likely to result in a cumulative impact. This will include the coordination of respite between the various construction projects where receivers are likely to experience concurrent construction impacts where feasible. Coordination between project teams would be carried out throughout construction.	Contractor	Prior to construction and during construction
Operational noise and vibration	NV14	Operational noise and vibration mitigation measures will be identified in an Operational Noise and Vibration Review (ONVR). Requirements for mitigation measures, including quieter noise pavements, noise barriers, and at-property treatments, will be reviewed as part of the ONVR and as the detailed design progresses. The implementation of treatments will be carried out in accordance with Roads and Maritime Noise Mitigation guidelines (2015d).	Contractor / Roads and Maritime	Detailed design, during construction and prior to operation
	NV15	Within 12 months of start of operation of the project, actual operational noise performance will be compared to predicted operational noise performance. The need for additional mitigation or management measures to address identified operational performance issues and meet relevant operational noise criteria will be assessed and implemented where feasible and reasonable.	Roads and Maritime	During operation
Flooding				
Potential changes to flood impacts resulting from detailed design	F01	Further flood investigations and hydrological and hydraulic modelling will be carried out during detailed design to ensure the flood immunity objectives and design criteria for the project are met. The modelling will be used to define the nature of both main stream flooding and major overland flow along the full length of the project corridor under pre- and post- project conditions and to define the full extent of any impact that the project will have on patterns of both main stream flooding and major overland flow. The hydraulic model(s) will be based on two-dimensional hydraulic modelling software. The modelling will take into account any updated regional flood modelling and information available at the time.	Contractor	Detailed design

Impact	Reference	Environmental management measure	Responsibility	Timing
Flooding impacts on property	F02	Should the updated flood modelling show the project will result in an adverse flooding impact, Road and Maritime will consult with landowners regarding appropriate mitigation measures to be implemented by the contractor in relation to each individual property.	Roads and Maritime / Contractor	Detailed design
Flooding impacts during construction	F03	A flood management plan will be prepared as part of the CEMP for the project and will detail the processes for flood preparedness, materials management, weather monitoring, site management and flood incident management. The flood management plan will be developed in accordance with: • Managing Urban Stormwater, Soils and Construction, Volume 1 4th Edition, March 2004 (Landcom 2004) and Managing Urban Stormwater, Volume 2D – Main Road Construction (DECC 2008b) • Roads and Maritime Erosion and Sedimentation Management Procedure (Roads and Traffic Authority 2009) • Roads and Maritime Technical Guideline: Temporary Stormwater Drainage for Road Construction (Roads and Maritime 2011c) • Roads and Maritime Stockpile Management Guideline (Roads and Maritime 2011d).	Contractor	Prior to construction
Flooding and creek adjustment impacts	F04	Creek adjustments would be re-considered and/or further refined to minimise the impact on the creeks during detailed design.	Roads and Maritime / Contractor	Detailed design
Flooding impacts of bridges and culverts	F05	Detailed construction staging plans will be developed during detailed design so that bridges and culverts are constructed in a way that minimises flood risk.	Contractor	Detailed design
	F06	Measures to address potential impacts of culvert blockage on afflux will be further investigated during detailed design and may include the installation of debris deflectors, trash racks or similar on drainage inlets where reasonable and feasible.	Contractor	Detailed design
Impacts on existing drainage systems	F07	Activities that may affect existing drainage systems during construction will be carried out so that existing hydraulic capacity of these systems is maintained where practicable.	Contractor	During construction
Flooding impacts during operation	F08	The proposed bridges, culverts and changes to watercourses will be further refined during the detailed design to minimise potential flooding impacts.	Roads and Maritime /Contractor	Detailed design

Impact	Reference	Environmental management measure	Responsibility	Timing
Surface water and hydrology				
General	SWH01	A construction soil and water management plan (CSWMP) will be prepared for the project. The plan will outline measures to manage soil and water impacts associated with the construction works, including contaminated land. The CSWMP will provide: • Measures to minimise/manage erosion and sediment transport both within the construction footprint and offsite including requirements for the preparation of erosion and sediment control plans (ESCP) for all progressive stages of construction • Measures to manage waste including the classification and handling of spoil • Procedures to manage unexpected contaminated finds including asbestos which would be outlined in the contaminated land management plan and asbestos management plan to be prepared for the project • Measures to manage stockpiles including locations, separation of waste types, sediment controls and stabilisation • Measures to manage groundwater de-watering and impacts including mitigation required • Processes for de-watering of water that has accumulated on site and from sediment basins, including relevant discharge criteria • Measures to manage potential tannin leachate • Measures to manage accidental spills including the requirement to maintain materials such as spill kits • Measures to manage potential saline soils • Details of surface water and groundwater quality monitoring to be carried out before, throughout, and following construction • Controls for sensitive receiving environments including SEPP Coastal Wetlands which may include but not be limited to: – Designation of ‘no go’ zones for construction plant and equipment – Creation of catch/diversion drains and sediment fences at the downstream boundary of construction activities where practicable to ensure containment of sediment-laden runoff and diversion toward sediment sump treatment areas (not sediment basins) to prevent flow of runoff to the SEPP Coastal Wetland. • Erosion and sediment control measures will be implemented and maintained at all work sites in accordance with the principles and requirements in Managing Urban Stormwater – Soils and Construction, Volume 1 (Landcom 2004) and Volume 2D (NSW Department of Environment, Climate Change and Water 2008b), commonly referred to as the “Blue Book”, as well as relevant Roads and Maritime Guidelines.	Contractor	Prior to construction

Impact	Reference	Environmental management measure	Responsibility	Timing
	SWH02	A soil conservation specialist will be engaged by both Roads and Maritime and the Contractor for the duration of construction of the project to provide advice on the planning and implementation of erosion and sediment control including review of ESCPs.	Roads and Maritime / Contractor	Prior to construction and during construction
	SWH03	A water reuse strategy will be developed for both construction and operational phases of the project to reduce reliance on potable water. This strategy will be prepared during the detailed design stage and implemented throughout the project and will outline the construction and operational water requirements and potential water sources to supply the water demand in consultation with Sydney Water. Alternative water supply options to potable water will be investigated, with the aim of reusing water using recycled water where feasible.	Contractor	Detailed design, prior to construction, and throughout construction and operation
Impacts of stockpiles	SWH04	Stockpiles will be managed to minimise the potential for mobilisation and transport of dust and sediment in runoff in accordance with Roads and Maritime Stockpile Sites Management Guideline (Roads and Maritime, 2015e). This will include: • Minimising the number of stockpiles, area used for stockpiles, and time that they are left exposed • Locating stockpiles away from drainage lines, waterways and areas where they may be susceptible to wind erosion • Stabilising stockpiles, establishing appropriate sediment controls and suppressing dust as required.	Contractor	Construction
Surface water quality impacts	SWH05	A construction water quality monitoring program will be developed and included in the CSWMP for the project to establish baseline conditions, observe any changes in surface water and groundwater during construction, and inform appropriate management responses. The program will be based on the water quality monitoring methodology water quality indicators and the monitoring locations identified in the Surface water and hydrology assessment report (**Appendix M**), and Groundwater quality and hydrology assessment report (**Appendix N**). Baseline monitoring will be carried out monthly for a minimum of 12 months before the start of construction. As a minimum this will include three wet weather sampling events over six months where feasible. Sampling locations and monitoring methodology to be carried out during construction will be further developed in detailed design in accordance with the Guideline for Construction Water Quality Monitoring (RTA 2003b) and the 'ANZECC water quality guidelines' (ANZECC/ARMCANZ (2000). It will include collection of samples for analysis from sedimentation basin discharge points, visual monitoring of other points of release of construction waters and monitoring of downstream waterways.	Roads and Maritime / Contractor	Prior to construction, and during construction and operation

Impact	Reference	Environmental management measure	Responsibility	Timing
		The monitoring frequency during construction will be confirmed during detailed design however will include at least monthly construction monitoring at all monitoring sites which will preferentially monitor following wet weather events. Should the results of monitoring identify that the water quality management measures are not effective in adequately mitigating water quality impacts, additional mitigation measures will be identified and implemented as required.		
	SWH06	An operational water quality monitoring program will be developed and implemented following the completion of construction to observe any changes in surface water and groundwater following construction, and inform appropriate management responses. The program will be based on the water quality monitoring methodology, water quality indicators, and the monitoring locations presented in the Surface water and hydrology assessment report (**Appendix M**), and Groundwater quality and hydrology assessment report (**Appendix N**). The monitoring program will be carried out monthly and will preferentially monitor following wet weather events when rainfall results in discharge from control sites or is greater than a nominated rainfall threshold which will be identified in detailed design. Monitoring will be carried out for a minimum of 12 months following the completion of construction, or until the affected waterways are certified by a suitably qualified and experienced independent expert as being rehabilitated to an acceptable condition and/or the permanent water quality structures are deemed to be operating satisfactorily. Should the results of monitoring identify that the water quality management measures are not effective in adequately mitigating water quality impacts, additional mitigation measures will be identified and implemented as required.	Roads and Maritime / Contractor	Prior to operation and during operation
	SWH07	The performance water quality controls developed for the design as set out in this document (including but not limited to temporary and permanent sediment basins) will be verified as the detailed design develops for the project to ensure the objectives of the project are achieved. In the instance that during detailed design it cannot be demonstrated that the water quality controls would be effective in mitigation potential impacts, additional mitigation measures would be identified and implemented.	Contractor	Detailed design
	SWH08	Further water quality assessment will be undertaken during detailed design to establish site specific discharge criteria for construction sediment basins. Based on this, the number, location and size of the basins will be further refined during the detailed design with consideration to the relevant NSW EPA Environment Protection Licence application requirements and the environmental values of the downstream receiving waterway.	Roads and Maritime/ Contractor	Detailed design

Impact	Reference	Environmental management measure	Responsibility	Timing
	SWH09	Practical measures to prevent water pollution and control, abate or mitigate impacts to the environment will be investigated at the detailed design stages of the project with the aim to make improvements to the currently proposed water quality controls. Such measures may include: • Larger or high efficiency temporary basins • Alternative dry bioretention operational basins.	Roads and Maritime/ Contractor	Detailed design
Impacts of de-watering	SWH10	A de-watering management plan will be prepared as part of the CSWMP which will outline the de-watering methodology, supervision requirements, staff responsibilities and training, and approvals required before any de-watering activity begins.	Contractor	During construction
Impacts on water bodies	SWH11	The following measures will be carried out to manage activities within watercourses or on waterfront land: • Implementing practices to minimise disturbance of banks • Undertaking bank stabilisation and installing instream structures • Maintaining minimum flows to assist in maintaining the viability of aquatic communities and preventing barriers to fish passage • Constructing instream crossings during low flows and design so that drainage off crossing doesn't contribute sediment load to the stream • All drainage feature crossings (permanent and temporary watercourse crossings and stream diversions), drainage swales and depressions will be designed by a suitably qualified and experienced professional and will be designed and constructed in accordance with relevant guidelines.	Contractor	Prior to construction and during construction
	SWH12	A set of hydrologic and hydraulic models will be developed, which are to be used to define the nature of both main stream flooding and major overland flow along the full length of the project operational footprint under pre- and post-project conditions. The hydraulic model is to extend a sufficient distance upstream and downstream of the project operational footprint, to negate any boundary effects and to define the full extent of any impact that the project will have on patterns of both main stream flooding and major overland flow. The hydraulic model(s) is to be based on the TUFLOW (or equivalent) two-dimensional (in plan) hydraulic modelling software. The models will be used to verify the nature and extent of impacts and to confirm the type of mitigation measures required. The models will also be used during detailed design to describe the interaction between the project and flows particularly with respect to culverts and to assist in refining the design for flows arriving at and travelling through culverts.	Contractor	Detailed design

Impact	Reference	Environmental management measure	Responsibility	Timing
Impacts on SEPP Coastal Wetlands	SWH13	Consideration will be given to the design of operational water quality, erosion and sediment controls incorporated into the design of the construction access track being left in place upstream from the SEPP wetland, and within the proximity area of the SEPP Coastal Wetland ID117.	Contractor	Detailed design
Groundwater quality and hydrology				
Impacts on Groundwater quality and flows	GW01	Groundwater monitoring will be carried out as part of the construction water quality monitoring program for the project. The groundwater monitoring will be based on the water quality monitoring methodology, water quality indicators and the monitoring locations presented in the Groundwater quality and hydrology assessment report (**Appendix N**). Baseline groundwater monitoring will be carried out at least monthly for at least six months before construction. Monitoring will also be carried out at least monthly during construction and will continue for at least six months of operation to verify that there are no groundwater impacts, and that management measures are adequate.	Roads and Maritime / Contractor	Prior to construction, and during construction
Alteration of groundwater flows and levels	GW02	Potential impacts on groundwater flows will be reconsidered as the detailed design for the project progresses, particularly in relation to the projects vertical alignment and extent of road cuttings. The aim of this will be to ensure that the groundwater controls proposed for the design as set out in this document would remain effective in mitigating groundwater impacts. In the instance that, during detailed design it cannot be demonstrated that the groundwater controls would be effective in mitigating potential impacts, or if observed groundwater inflow rates into the western cut are higher than estimated, additional measures will be implemented to minimise potential impacts on groundwater flows due to road cuttings or other sub-surface components of the project.	Contractor	Detailed design

Impact	Reference	Environmental management measure	Responsibility	Timing
Soils and contamination				
Salinity	SC01	Construction within areas of moderate to high risk saline soils will be managed in accordance with the CSWMP. Specific measures will also include (but not be limited to): • Ongoing groundwater monitoring of salinity as part of the water quality monitoring program • Identification and management of saline discharge sites • Progressive stabilisation and revegetation of exposed areas following disturbance as soon as is practicable • Testing to confirm the presence of saline soils in areas of high salinity potential prior to disturbance. • Soil salinity management will also be carried out in accordance with the NSW Department of Primary Industries (2014) Salinity Training Handbook.	Contractor	Prior to construction and during construction
	SC02	Testing will be carried out to confirm the presence of saline soils in areas of high salinity potential and to confirm the presence of ASS around creeks prior to disturbance.	Contractor	Prior to construction and during construction
Impacts of soil and groundwater contamination	SC03	A contaminated land management plan (CLMP) will be prepared for the project. The CLMP will include: • Control measures to manage identified areas of contamination, including surface soils in the vicinity of TP303, TP304, TP310 and TP311 containing heavy metal and PAH concentrations • Procedures for unexpected contamination • Measures to manage potential ASS (as required based on testing results) within sediments of the creeks in the construction footprint to minimise impacts to the environment • Requirements for excavation of unexpected contaminants to be carried out in consultation with project Remedial Actions Plans. • Requirements for the disposal of contaminated waste in accordance with the POEO Act and the Protection of the Environment Operations (Waste) Regulation 2014.	Contractor	Prior to construction
	SC04	An asbestos management plan (AMP) will be prepared as part of the CLMP for the project. The AMP will guide the excavation, handling, storage and disposal of management of asbestos discovered during construction, including procedures for any unexpected asbestos. The AMP will also outline requirements for the encapsulation of asbestos to be carried out in accordance with project Remedial Action Plans.	Contractor	Prior to construction

Impact	Reference	Environmental management measure	Responsibility	Timing
	SC05	Detailed site (contamination) investigations will be carried out in accordance with the NSW EPA (1995) Sampling Design Guidelines and other NSW EPA endorsed guidance including the NEPM (2013) guidelines within the following AEI locations to confirm the presence of contamination before the start of construction at these locations: • Within AEI 19: the area of miscellaneous construction activities and stockpiles of building materials along Luddenham Road (Lot 1, DP228498). • Within AEI 7: Former Kari and Ghossayn solid waste landfill (Lot 17, Clifton Avenue). • Within AEI21: Substantial volume of illegally dumped material along Range Road, Cecil Park • Within the 'potential areas of existing fill' identified in the Soils and contamination assessment report (**Appendix O**) for the project. Depending on results of the investigations, or if remediation is deemed required at any site within the construction footprint, a Remedial Action Plan will be prepared before construction.	Contractor	Prior to construction
	SC06	Further intrusive asbestos investigations throughout the construction footprint will be carried out to assess asbestos risks before the start of construction. The investigations are to include visual assessments and ground truthing along the length of the project.	Contractor	Prior to construction
	SC07	A hazardous building materials management plan will be prepared in accordance with relevant guidelines to manage the removal of known and unexpected hazardous building during demolition activities. Before demolishing structures and/or buildings, a hazardous building materials audit will also be carried out in accordance with Australian Standard (AS 2601-2001) The demolition of structures. Where hazardous building materials are present, they will be managed to reduce the potential for contamination in accordance with the POEO Act and the Protection of the Environment Operations (Waste) Regulation (2014).	Contractor	Prior to construction and during construction
	SC08	All waste will be classified in accordance with the NSW EPA's Waste Classification Guidelines, with appropriate records and disposal dockets retained for audit purposes.	Contractor	Before and during construction

Impact	Reference	Environmental management measure	Responsibility	Timing
Soil gas contamination	SC09	A detailed investigation will be carried out within the area next to the SUEZ Kemps Creek Resource Recovery Park to assess the extent of high-risk soil gas. A report will be prepared to document the outcomes of the investigation and outline measures to manage risks including nuisance odours to the surrounding area during excavation, and prevent the build-up of gases in buildings, basins, and sub-surface trenches and pits, and other enclosed spaces/depressions associated with the project during construction. These investigations will be carried out in accordance (where applicable) with the Guideline for the Assessment and Management of Sites Impacted by Hazardous Ground Gases (NSW EPA 2012a) and Assessing Risks Posed by Hazardous Ground Gases to Buildings Report (C665) (Wilson et al. 2007). This will include undertaking gas monitoring.	Contractor	Prior to construction and during construction
	SC10	Should the further investigations determine that gas concentrations remain elevated near the project footprint, gas monitoring will be carried out during construction within the construction footprint next to the SUEZ Kemps Creek Resource Recovery Park. If excavations are to be carried out within enclosed structures, gas accumulation monitoring will be carried out before and during construction. On site gas monitoring will be carried out in accordance with the NSW EPA (2016a) Environmental Guidelines: Solid Waste Landfills.	Contractor	During construction
	SC11	Should a gas hazard be present (either explosive or asphyxiation hazard), an appropriate gas management plan will be developed and implemented to manage spark generation, explosive environments and confined spaces. This plan will be implemented during construction within gas hazard areas and to manage works within below ground structures such as service trenches during operation. If temporary site sheds and storages are proposed within gas hazard area, appropriate measures will be implemented (eg breezeways) to avoid gas ingress and accumulation into these structures.	Contractor	Prior to construction and during construction
Air quality				
General air quality impacts during construction	AQ01	A construction air quality management plan (CAQMP) will be developed and implemented for the project to manage potential air quality impacts associated with construction. The CAQMP will identify activities that may results in air quality impacts and associated mitigation measures to avoid or minimise these impacts. The CAQMP will provide: • Measures to minimise dust generation associated with earthworks and other activities that disturb the ground surface, stockpiles, and haulage routes • Measures to minimise emissions from machinery and vehicles associated with the project • Procedures for inspection, monitoring and addressing any impacts where required. The CAQMP will be implemented for the duration of construction.	Contractor	Prior to construction and during construction

Impact	Reference	Environmental management measure	Responsibility	Timing
Dust impacts during construction	AQ02	Dust generation will be minimised during construction where possible. Where practicable, specific measures will include (but not be limited to): • Regularly watering exposed and disturbed areas including stockpiles, especially during inclement weather conditions • Adjusting the intensity of activities based on measured and observed dust levels, weather forecasts and the proximity of and direction of the works in relation to the nearest surrounding receivers • Ensuring loads are covered, and any loose materials/debris are removed before vehicles exit the site • Minimising the number of stockpiles and amount of material stockpiled where practicable • Positioning stockpiling areas as far as possible from surrounding receivers, including potentially ecologically sensitive receivers • Limiting stockpiling activities during conditions where winds are blowing strongly in the direction(s) from the stockpiling location to nearby receivers • Consultation with nearby developers to co-ordinate and plan activities where practicable to minimise the potential for cumulative dust-related impacts • The planning and undertaking of demolition activities, including the removal of hazardous building materials in a manner that minimises dust generation. This will also include the removal of hazardous building materials before the start of general demolition works.	Contractor	During construction
Odours during construction	AQ03	Odorous materials identified on site will be excavated in a staged process and exposed areas of odorous material will be kept to a minimum to reduce the total emissions from the site where feasible.	Contractor	During construction
Health and safety				
General	HS01	A work health safety management plan (WHSMP) will be prepared for the project. The WHSMP will include: • Details of the hazards and risks associated with construction activities • Risk management measures • Procedures to comply with all legislative and industry standard requirements • Use of appropriate personal protective equipment • Contingency plans, as required • An incident response management plan • Training for all personnel (including subcontractors) including site inductions, the recognition and awareness of site hazards and the locations of relevant equipment to protect themselves and manage any spills. All staff would have the relevant training and certificates.	Contractor	Prior to construction

Impact	Reference	Environmental management measure	Responsibility	Timing
Bushfire	HS02	Measures to mitigate and manage bushfire risk will be developed and included as part of site-specific hazard and risk management measures within the WHSMP. Measures will include the maintenance of ancillary facilities in a tidy and orderly manner and the storage and management of dangerous goods and hazardous materials in a safe location.	Contractor	Prior to construction
Incident response	HS03	An incident response management plan will be developed and implemented. The response to incidents within the road will be managed in accordance with the memorandum of understanding between Roads and Maritime and the NSW Police Service, NSW Rural Fire Service, NSW Fire Brigade and other emergency services.	Contractor	Prior to construction
Storage of dangerous goods and hazardous substances	HS04	Storage, handling and use of dangerous goods and hazardous substances would be in accordance with the *Work Health and Safety Act 2011* and the *Storage and Handling of Dangerous Goods Code of Practice* (WorkCover NSW, 2005).	Contractor	During construction and operation
	HS05	Secure, bunded areas will be provided around storage areas for oils, fuels and other hazardous liquids.	Contractor	During construction
	HS06	Safety Data Sheets will be obtained for dangerous goods and hazardous substances stored onsite before their arrival.	Contractor	During construction
Contamination from transportation of hazardous good	HS07	All hazardous substances will be transported in accordance with relevant legislation and codes, including the Road and Rail Transport (Dangerous Goods) (Road) Regulation 1998 and the 'Australian Code for the Transport of Dangerous Goods by Road and Rail' (National Transport Commission, 2008).	Contractor	During construction
Sustainability				
Project sustainability outcomes	SU1	A sustainability management plan for the project will be developed and implemented during detailed design, to give effect to the sustainability strategy for the project. The management plan will detail measures to meet the sustainability objectives and targets and IS rating tool credit requirements.	Contractor	Throughout detailed design, construction, and operation

Impact	Reference	Environmental management measure	Responsibility	Timing
Waste				
Inappropriate handling and/or disposal of waste	W01	A construction waste and resource management plan (CWRMP) will be prepared for the project and outline appropriate management procedures. It will include, but not be limited to: • Identification of the waste types and volumes that are likely to be generated by the project • Adherence to the waste minimisation hierarchy principles of avoid/reduce/ reuse/recycle/dispose • Waste management procedures to manage the handling and disposal of waste, including unsuitable material or unexpected waste volumes • Identification of reporting requirements and procedures for tracking of waste types and quantities • A resource management strategy detailing the process to identify reuse options for surplus materials • A procurement strategy to minimise unnecessary consumption of materials and waste generation in accordance with relevant legislation and guidelines.	Roads and Maritime /Contractor	Prior to construction
	W02	A spoil management plan will be prepared for the project as part of the CWRMP and in line with the CSWMP. The spoil management plan will outline appropriate management procedures for the generation and importation of spoil. It will include, but not be limited to: • Procedures for classification of spoil • Identification of spoil reuse measures • Spoil stockpile management procedures • Spoil haulage routes • Spoil disposal and reuse locations • Imported spoil sources and volumes.	Contractor	During construction
	W03	Wherever feasible and reasonable, construction material will be sourced from within the Sydney region.	Roads and Maritime /Contractor	During construction
Unexpected waste volumes and types during construction	W04	Suitable areas will be identified to allow for contingency management of unexpected waste materials, including contaminated materials. Suitable areas will be required to be hardstand or lined areas that are appropriately stabilised and bunded, with sufficient area for stockpile storage.	Roads and Maritime /Contractor	During construction

Impact	Reference	Environmental management measure	Responsibility	Timing
Climate change and greenhouse gas				
Climate change risks	CC01	Detailed design will incorporate appropriate adaptation measures for all climate change risks with an original risk rating of moderate or above. These will include but not be limited to: • Consideration of the full range of potential temperature extremes on the project (particularly bridge structures) which may occur as a result of climate change and consider material capacity to withstand heat during material type selection to minimise the likelihood of infrastructure failures • Consideration of energy dissipation at culvert outlets when velocities exceed existing magnitudes • Consideration of the use of native species which are typically more fire tolerant and can more rapidly regenerate after fire events • Maintenance of fauna passage along main creek lines under bridges.	Contractor	Detailed design
	CC02	A climate change monitoring and adaptive management framework will be prepared and implemented for the project. The framework will incorporate performance monitoring criteria and measures, and the requirement for periodic review of the climate change risk assessment and framework against updated climate data to ensure currency.	Roads and Maritime /Contractor	Detailed design and construction
	CC03	An adaptive management approach will be applied to workplace health and safety planning during construction and operation in line with the WHSMP. This will include use of Roads and Maritime Work Health and Safety Procedures.	Roads and Maritime /Contractor	Prior to construction, during construction and during operation
GHG emissions	GG01	Targets to reduce GHG emissions during construction and operation will be included in the project's sustainability management plan.	Roads and Maritime /Contractor	Detailed design and construction
	GG02	Updated GHG assessment based on the detailed design for the project and the final project when built will be carried out.	Contractor	Detailed design and construction
	GG03	Vegetation removal will be minimised where practicable.	Contractor	Detailed design and construction

Impact	Reference	Environmental management measure	Responsibility	Timing
	GG04	The procurement of goods and services will consider goods and services that: • Are from local suppliers • Make use of recycled materials or materials with a low embodied energy content. • Are energy efficient or have low embodied energy • Minimise the generation of waste	Contractor	Detailed design and construction
	GG05	Construction plant and equipment will be well maintained to maximise fuel efficiency.	Contractor	Construction
Cumulative impacts				
	CU01	Regular consultation will be carried out with nearby/adjoining projects and key stakeholders during the detailed design and construction phase to review potential cumulative impacts and integrate designs and construction methodologies (including traffic impacts and noise management), as far as practicable to minimise cumulative impacts.	Roads and Maritime /Contractor	Detailed design and construction
	CU02	Communication strategies across relevant Roads and Maritime projects will be managed to be consistent in their messaging to the community to avoid confusion.	Roads and Maritime	Detailed design and construction

10. Environmental risk analysis

An environmental risk analysis was carried out for the project as part of the EIS. This chapter outlines the environmental risk analysis process and identifies key environmental risks associated with the project that were identified through this process. This chapter also outlines management measures to address associated risks and assesses the potential for residual risk once measures were implemented.

Table 10-1 presents the SEARs that relate to environmental risk analysis and identifies where they were addressed in this EIS.

Table 10-1 SEARs (environmental risk)

Secretary's requirement	Where addressed in this EIS
2. Environmental Impact Statement	
1. The EIS must include, but not necessarily be limited to, the following: j. The identification and assessment of key issues as provided in the 'Assessment of Key Issues' performance outcome;	Identification and assessment of key issues is provided in **Chapter 7** and **Chapter 8** A summary of the assessment of key issues is provided in **Appendix A**
l. measures to avoid, minimise or offset impacts must be linked to the impact(s) they treat, so it is clear which measures will be applied to each impact;	Management measures to avoid, minimise or offset key issue impacts are described in **Chapter 7** and **Chapter 8** A summary of management measures is provided in **Chapter 9**
3. Assessment of key issues	
2. For each key issue the Proponent must: c. identify, describe and quantify (if possible) the impacts associated with the issue, including the likelihood and consequence (including worst case scenario) of the impact (comprehensive risk assessment), and the cumulative impacts	Identification and where possible, quantification of potential impacts, including cumulative impacts and worst case assessment of key issues is provided in **Chapter 7** and **Chapter 8** A comprehensive risk assessment is provided in **Table 10.5**
g. detail how any residual impacts will be managed or offset, and the approach and effectiveness of these measures.	A summary of residual impact risk is provided in **Section 10.2** Measures to manage or offset residual impacts and their effectiveness are discussed in **Section 10.3** and **Appendix A**

10.1 Overview

The process to assess environmental risk associated with the project has involved:

- Undertaking a preliminary environmental investigation as part of the State significant infrastructure scoping report (Roads and Maritime, 2018g) to identify key environmental issues, support the SSI application for the project, and help to inform the project SEARs
- Assessing the key issues and other issues presented in the SEARs that were issued for the project (see **Appendix B** for a complete list of the SEARs)
- Undertaking an environmental risk analysis to confirm the potential environmental issues associated with the project following the outcomes of the detailed assessments presented in **Chapter 7** and **Chapter 8**, as presented in this chapter.

Through the process, environmental issues associated with the project were categorised as either 'key issues' or 'other issues' (see **Table 10-2**). This was carried out to identify those issues that will require a more detailed assessment in this EIS to ensure potential impacts are properly identified and project specific management measures are developed.

Table 10-2 Environmental risk categories

Risk category	Description
Key issue	Potential for moderate to high impacts (including perceived impacts) requiring a more detailed assessment and associated project specific management measures to mitigate identified impacts
Other issue	Potential for low impacts that can be adequately managed through the implementation of standard and best practice management measures

As required by the SEARs, the identification and assessment of key issues has continued during the course of preparation of the environmental assessment. The emphasis was on using the detailed information gathered during the assessment process to review the environmental aspects of the project. More specifically, the analysis:

- Identified potential impacts, including issues identified in the SEARs and other issues identified during the undertaking of detailed environmental assessments
- Identified environmental management measures in relation to each identified impact
- Identified environmental risk associated with each environmental impact identified in the EIS, before the implementation of environmental management measures
- Identified residual environmental impacts that may remain following the implementation of identified environmental management measures for each impact.

The environmental issues identified for the project are assessed in **Chapter 7** and **Chapter 8**, where management measures have also been identified to mitigate each identified impact. Cumulative impacts that may be associated with the project are assessed in **Chapter 8**.

An environmental risks analysis, including a likelihood and consequence analysis, was carried out for each environmental issue identified for the project. As required by the SEARs, residual environmental impacts have also been assessed through the risk analysis process, where residual risks were identified following the implementation of management measures for each environmental impact (see **Table 10-5**).

The management approaches for residual impacts are discussed in **Section 10.3.**

10.1.1 Likelihood and consequence ratings

Environmental impacts were assessed for their potential risk, both before, and following the implementation of environmental management measures. This was carried out by assessing the likelihood of an impact occurring and the consequence of the impact occurring, using the categories presented in **Table 10-3** and **Table 10-4**. These categories were adopted from the Roads and Maritime risk framework (Roads and Maritime, 2018e) and the Roads and Maritime risk Analyser Project v2.0 (Roads and Maritime, 2018e).

Table 10-3 Likelihood of environmental risks

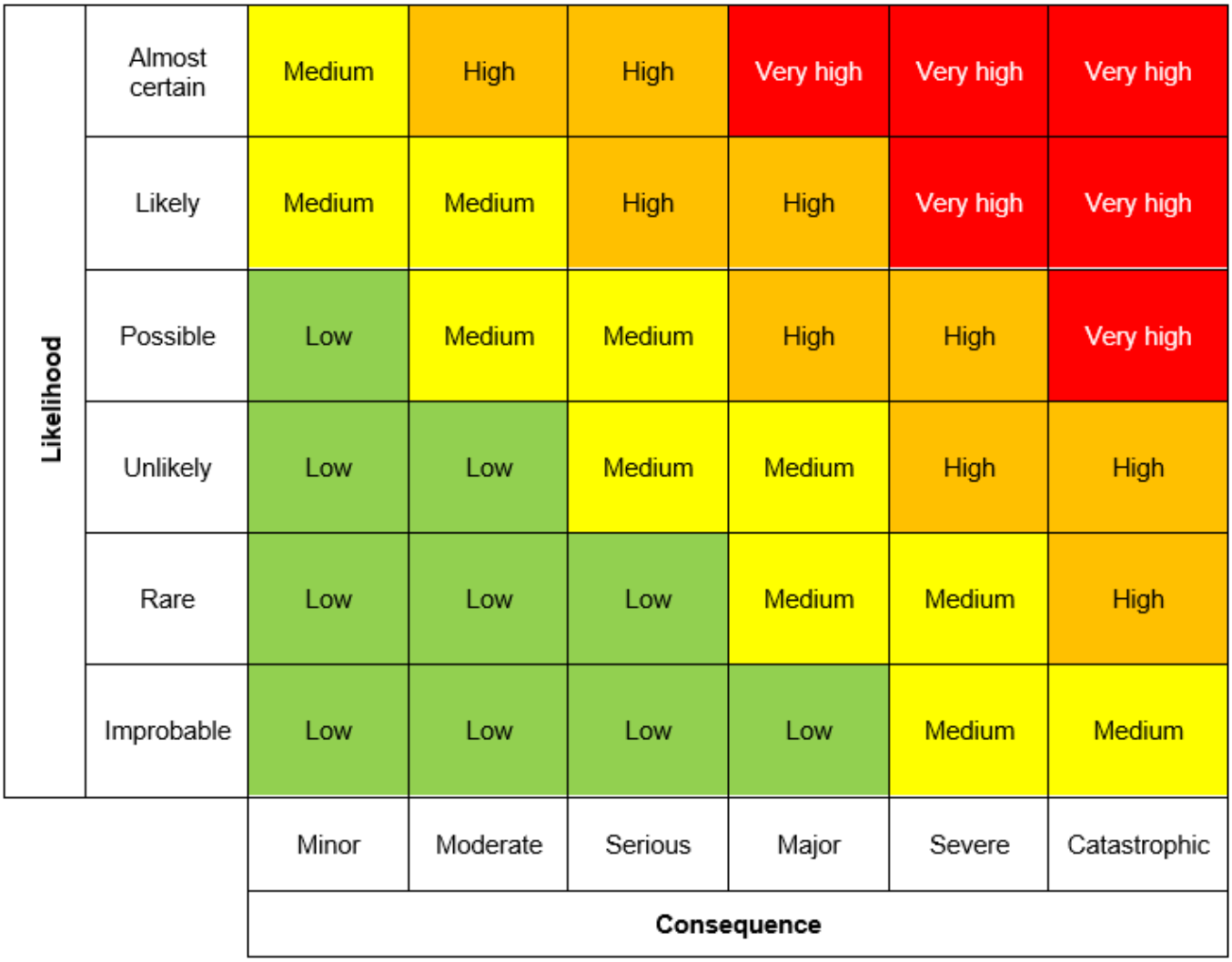
Likelihood Level	Description	Likelihood
Almost certain	Almost certain to occur frequently in most circumstances within the project lifecycle.	> 81%
Likely	Likely to occur often in most circumstances within the project lifecycle.	51% - 80%
Possible	Likely to occur on occasions within the project lifecycle.	21% - 50%
Unlikely	Could occur at some time but not often within the project lifecycle.	11% - 20%
Rare	May occur at some time but unusual within the project lifecycle.	1% - 10%
Improbable	Could occur but very improbable within the project lifecycle.	< 1%

Table 10-4 Consequence of environmental risks

Consequence	Definition
Catastrophic	• Irreversible large-scale impact • Permanent damage • Regulatory intervention maximum fines and penalties and/or
Severe	• >5 years and <10 years impact • Irreparable damage of cultural significance
Major	• Long-term (>24 months but <5 years) • Partial impairment of the ecosystem
Serious	• Short to mid-term (<24 months) impact • Notification to regulator
Moderate	• Short term repairable damage or social impact on local population <12 months
Minor	• Localised impacts rectified by on site resources • Isolated, easily contained, no lasting effects

Following the application of a likelihood and consequence rating, an overarching risk rating was assigned for each identified environmental impact using the risk matrix presented as **Figure 10-1**, which was adapted from the Roads and Maritime risk framework (Roads and Maritime, 2018e) and the Roads and Maritime Risk Analyser v2.0 (Roads and Maritime, 2018e).

If a residual risk rating has not been lowered or remains at a ‘high’ rating or above following the implementation of management measures, additional management measures were identified, or justification was provided for the risk where additional mitigation cannot be implemented and the risk is unavoidable.



Source: Adapted from the RMS risk framework 2018 and the RMS Risk Analyser Projects v2.0 (Roads and Maritime, 2018e)

Figure 10-1 Risk matrix

10.2 Risk analysis approach

The assessment of identified environmental impacts was based on the design for the project as presented in **Chapter 5**. Impacts for each identified environmental issue were assessed at a level commensurate to the degree and significance of the likely impact, with a focus on avoiding or minimising impacts, for example through altering the design or construction method.

To minimise potential impacts on an acceptable level, management measures were developed for those identified impacts that could not be avoided and these are presented in **Chapter 9**.

Environmental management measures will be implemented during construction under a CEMP, while measures to be implemented during operation will carried out as part of Roads and Maritime standard management practices as described in **Chapter 9**.

Detailed design will further seek to avoid and minimise identified environmental impacts where practicable. The identified management measures will also be reassessed during detailed design for their effectiveness and appropriateness.

The environmental risk analysis is presented in **Table 10-5**. The analysis has considered all key issues identified by the SEARs, as well as other environmental issues identified through the preparation of the EIS that have the potential to be impacted by the project. Refer to **Chapter 7** and **Chapter 8** for detailed assessments of each issue. It is noted that positive impacts, while discussed throughout **Chapter 7** and **Chapter 8**, have not been considered in the environmental risk analysis, as they would not introduce an environmental risk.

The numerical codes provided in the management measures column refers to the unique identification numbers of the relevant environmental management measures as summarised in **Chapter 9**.

Table 10-5 Environmental risk analysis summary

Summary of key impacts	Construction/ operation	Likelihood	Consequence	Risk	Environmental management measures	Residual likelihood	Residual consequence	Residual risk
Biodiversity								
Vegetation clearing including threatened flora (*Pultenaea parviflora* and *Dillwynia tenuifolia*) and endangered ecological communities listed under both the TSC Act and the EPBC Act, including the critically endangered Cumberland Plain Woodland	Construction	Almost certain	Catastrophic	Very High	• B01 • B02 • B03 • B04 • B05 • B06 • B07 • B08 • B09	Likely	Major	High
Fragmentation of native vegetation and habitat corridors from vegetation removal and fencing, including in Western Sydney Parklands and impacts on riparian corridors of Cosgroves Creek, Badgerys Creek, South Creek and Kemps Creek	Construction and operation	Almost certain	Severe	Very high	• B01 • B02 • B03 • B04 • B05 • B07 • B08 • B09 • B10 • B11 • B12 • B13 • B15 • B16 • B22	Likely	Moderate	Medium

Summary of key impacts	Construction/ operation	Likelihood	Consequence	Risk	Environmental management measures	Residual likelihood	Residual consequence	Residual risk
Removal of threatened fauna habitat, including hollow-bearing trees and habitat of the Cumberland Plain Land Snail and Southern Myotis	Construction	Almost certain	Severe	Very high	• B01 • B02 • B03 • B04 • B05 • B06 • B07 • B08 • B09 • B11	Likely	Moderate	Medium
Impacts on aquatic habitat and hydrology from creek adjustments, direct removal of vegetation and snags, instream works, and indirect impacts such as shading and sedimentation	Construction and operation	Almost certain	Major	Very high	• B01 • B10 • B11 • B12 • B13 • B14 • B15 • B16 • B27	Likely	Moderate	Medium
Fauna injury and mortality during vegetation clearing and vehicle collision, particularly less mobile species	Construction and operation	Possible	Major	High	• B01 • B22 • B23	Unlikely	Serious	Medium
Indirect impacts on fauna from increased light and vibration during construction and operation	Construction and operation	Unlikely	Minor	Low	• B27	Unlikely	Minor	Low

Summary of key impacts	Construction/ operation	Likelihood	Consequence	Risk	Environmental management measures	Residual likelihood	Residual consequence	Residual risk
Invasion and spread of pests and weeds	Construction	Possible	Serious	Medium	• B01 • B25 • B26	Unlikely	Moderate	Low
Transport and traffic								
Construction impacts on road network performance including delays and increased travel times, due to reduced speed limits, increased movements of construction vehicles on the surrounding road network and road closures and detours, including impacts on public transport	Construction	Almost certain	Major	Very high	• TT01 • TT02 • TT03 • TT04	Almost certain	Moderate	High
Other impacts on public transport including the relocation of bus stops	Construction	Possible	Serious	Medium	• TT01 • TT02	Unlikely	Minor	Low
Temporary and permanent impacts on property access including closures of local roads	Construction and operation	Almost certain	Catastrophic	Very high	• TT01 • TT07	Likely	Moderate	Medium
Operational intersection performance impacts and increased travel times including potential increased traffic in some parts of the network as a result of the project	Operation	Likely	Minor	Medium	• TT01 • TT03 • TT04	Likely	Minor	Medium
Urban design, landscape character and visual amenity								
Moderate to high impacts on landscape character zones due to the scale of the project particularly at LCZ3and LCZ6	Operation	Almost certain	Catastrophic	Very high	• LVIA01 • LVIA02 • LVIA03 • LVIA05	Almost certain	Moderate	High

Summary of key impacts	Construction/ operation	Likelihood	Consequence	Risk	Environmental management measures	Residual likelihood	Residual consequence	Residual risk
Impacts on visual amenity associated with construction activities and ancillary facilities and hoardings, including artificial lighting during night-time works	Construction	Almost certain	Moderate	High	• LVIA01 • LVIA02 • LVIA05 • LVIA06 • LVIA07	Almost certain	Minor	Medium
Visual amenity impacts during operation due to the scale of the project, particularly high impacts on viewpoints that have existing high quality rural views, including permanent lighting	Operation	Almost certain	Catastrophic	Very high	• LVIA01 • LVIA03 • LVIA04 • LVIA07 • LVIA10	Almost Certain	Moderate	High
Socio-economic, land use and property								
Impacts on residents and businesses as a result of total or partial acquisition	Pre-construction	Likely	Severe	Very high	• SLP02 • SLP03 • SLP04	Likely	Major	High
Alterations to property access for some properties due to the construction and operation of the project	Construction	Almost certain	Major	Very high	• SLP04 • SLP06 • SLP07 • SLP10 • SLP12	Almost certain	Moderate	High

Summary of key impacts	Construction/ operation	Likelihood	Consequence	Risk	Environmental management measures	Residual likelihood	Residual consequence	Residual risk
Reduced local amenity (dust, noise and visual impact) from construction activities	Construction	Likely	Major	High	• LVIA01 • LVIA03 • LVIA05 • LVIA06 • NV01 • NV11 • AQ01 • AQ02	Likely	Moderate	Medium
Changes to some land use	Construction and operation	Almost certain	Major	Very high	• SLP05 • SLP07 • SLP08 • SLP09	Almost certain	Moderate	High
Adverse impacts on business and economic activity within western Sydney as a result of construction	Construction	Likely	Major	High	• SLP12 • SLP13	Possible	Moderate	Medium
Adverse impacts on recreational users as a result of the motorway, particularly users of the Western Sydney Parklands and the Wylde Mountain Bike Trail	Construction	Likely	Major	High	• SLP09 • SLP10	Unlikely	Moderate	Low
Construction fatigue experienced by surrounding community caused by cumulative impacts of the project and other surrounding construction	Construction	Likely	Severe	Very high	• SLP11	Possible	Moderate	Medium

Summary of key impacts	Construction/ operation	Likelihood	Consequence	Risk	Environmental management measures	Residual likelihood	Residual consequence	Residual risk
Aboriginal heritage								
Total or partial harm to 19 Aboriginal archaeological heritage sites, including 6 sites assessed as being of high significance and eight registered AHIMs sites	Construction	Almost certain	Catastrophic	Very high	• AH01 • AH02 • AH03 • AH04 • AH05 • AH06 • AH07	Almost certain	Moderate	High
Potential impact on previously unidentified Aboriginal heritage items (unexpected finds)	Construction	Likely	Severe	Very high	• AH01	Possible	Moderate	Medium
Non-Aboriginal heritage								
Direct impacts on five non-Aboriginal heritage sites, including major impacts on four of the items, all of which are classified as being of local significance	Construction	Almost certain	Severe	Very high	• NAH01 • NAH02 • NAH03 • NAH04 • NAH05 • NAH06 • NAH07 • NAH08 • NAH09 • NAH10	Almost certain	Moderate	High
Potential impacts on previously unidentified heritage items (unexpected finds)	Construction	Possible	Severe	High	• NAH01	Possible	Moderate	Medium

Summary of key impacts	Construction/ operation	Likelihood	Consequence	Risk	Environmental management measures	Residual likelihood	Residual consequence	Residual risk
Potential for indirect impacts on heritage items such as vibration and visual impacts, including impacts on the State significant Upper Canal System	Construction and operation	Possible	Major	High	• NAH01 • NAH03 • NAH06 • NV03 • NV05 • NV06 • NV07 • NV09 • NV10	Unlikely	Moderate	Low
Noise and vibration								
Construction noise and vibration impacts associated with construction activities and ancillary facilities including the use of noise intensive equipment, particularly in NCA01, NCA06, and NCA07 where residential receivers are located close to the construction footprint	Construction	Almost certain	Major	Very high	• NV01 • NV02 • NV03 • NV04 • NV05 • NV06 • NV11 • NV12	Almost certain	Moderate	High
Construction vibration resulting in damage to 19 structures within the recommended minimum working distances, including five heritage items	Construction	Possible	Severe	High	• NV01 • NV05 • NV06 • NV10	Unlikely	Moderate	Low
Construction traffic noise impacts on receivers near the construction routes, particularly on local roads including Wallgrove Road	Construction	Almost certain	Major	Very high	• NV01 • NV02 • NV11	Likely	Moderate	Medium

Summary of key impacts	Construction/ operation	Likelihood	Consequence	Risk	Environmental management measures	Residual likelihood	Residual consequence	Residual risk
Increases in road traffic noise at most NCAs, particularly those that have low existing road traffic noise levels and those with receivers located close to the project	Operation	Likely	Catastrophic	Very high	• NV01 • NV13 • NV14	Likely	Minor	Medium
Flooding								
Adverse impacts on surrounding properties and infrastructure due to increases in flood levels (for events up to 100 year ARI) and changes to flood behaviour associated with earthworks, stockpiling, and temporary and permanent structures including creek crossings and creek adjustments	Construction and operation	Unlikely	Major	Medium	• F01 • F02 • F04 • F05 • F06 • F07 • F08	Unlikely	Moderate	Low
Scour impacts on creeks and minor drainage lines from stormwater runoff during construction and operation	Construction and operation	Possible	Major	High	• F03 • F04 • SWH01 • SWH10	Unlikely	Moderate	Low
Increases in flood hazards for road users, particularly at Luddenham Road, and users of the proposed shared user path	Operation	Rare	Minor	Low	• F01 • F06 • F08	Rare	Minor	Low
Impacts on flood levels and behaviour due to potential increases in flow rates and associated flood levels under future climate change	Operation	Unlikely	Major	Medium	• F01 • F08	Rare	Minor	Low
Surface water and hydrology								
Construction sites could increase potential runoff and scour to during heavy rainfall	Construction	Likely	Major	High	• SWH01 • SWH02	Unlikely	Moderate	Low

Summary of key impacts	Construction/ operation	Likelihood	Consequence	Risk	Environmental management measures	Residual likelihood	Residual consequence	Residual risk
Increase the scour potential in drainage lines due to increased volume and velocity of water from new hardstand area	Operation	Likely	Serious	High	• SWH01 • SWH12	Unlikely	Moderate	Low
Impacts on surface water quality from erosion	Construction	Likely	Major	High	• SWH01 • SWH05 • SWH06 • SWH07	Unlikely	Moderate	Low
Impacts on surface water quality from accidental spills	Construction	Possible	Serious	Medium	• SWH01	Unlikely	Moderate	Low
Increase volume of stormwater from the project	Operation	Almost certain	Moderate	High	• SWH01 • SWH12 • SWH08	Likely	Minor	Low
Increase in the transport of road surface pollutants (brake dust, rubber, oils, fuels) to local waterways via the pavement drainage system. Risk of spills	Operation	Likely	Moderate	Medium	• SWH01 • SWH04 • SWH08 • SWH09	Possible	Minor	Low
Groundwater quality and hydrology								
Impacts on groundwater quality due to accidental spills or leaks, mobilisation of contaminants, and groundwater inflows	Construction	Rare	Major	Medium	• GW01 • GW04	Improbable	Major	Low
Impacts on groundwater quality due to seepage of water from water quality basins	Operation	Unlikely	Serious	Medium	• GW01	Rare	Serious	Low
Soils and contamination								
Impacts on local soil and water quality due to the disturbance of saline soils or acid sulfate soils	Construction	Likely	Moderate	Medium	• SC01 • SC02	Unlikely	Minor	Low

Summary of key impacts	Construction/ operation	Likelihood	Consequence	Risk	Environmental management measures	Residual likelihood	Residual consequence	Residual risk
Impacts on human health, soils and waterways from the disturbance of contaminants during construction including asbestos, particularly within the seven moderate to high risk AEIs, and during the removal or disturbance of potentially hazardous building materials	Construction	Likely	Major	High	• SC01 • SC02 • SC03 • SC04 • SC05 • SC08 • SC09 • SC10	Unlikely	Major	Medium
Health impacts of soil gas that may be present beneath areas next to the SUEZ Kemps Creek Resource Recovery Park, including explosion and asphyxiation when working within confined spaces and service trenches	Construction	Unlikely	Catastrophic	High	• SC08 • SC09 • SC10	Unlikely	Serious	Medium
Potential water quality impacts due to soil erosion during construction, particularly Picton soils within the eastern portion of the construction footprint which have the potential for mass movement and slope instability	Construction	Likely	Major	High	• SC01 • SC02 •	Unlikely	Moderate	Low
Air quality								
Mobilisation of dust and odour during construction activities resulting in dust soiling, nuisance odour, human health and ecological impacts	Construction	Almost certain	Major	Very high	• AQ01 • AQ02 • AQ03	Likely	Moderate	Medium
Health and safety								
Impacts on sensitive receivers from air quality, water quality and noise impacts	Construction	Unlikely	Serious	Medium	• HS01	Unlikely	Moderate	Low

Summary of key impacts	Construction/ operation	Likelihood	Consequence	Risk	Environmental management measures	Residual likelihood	Residual consequence	Residual risk
Impacts on public safety, including pedestrian safety, subsidence risks, bushfire risks and the handling and use of dangerous goods	Construction	Rare	Serious	Low	• HS01 • HS02 • HS03 • HS04 • HS05 • HS06 • HS07	Improbable	Moderate	Low
Impacts on public safety, including pedestrian and road safety	Operation	Rare	Catastrophic	High	• HS01 • HS03	Improbable	Catastrophic	Medium
Waste								
Inappropriate handling or disposal of waste	Construction	Possible	Severe	High	• W01 • W02 • W04	Unlikely	Serious	Medium
Climate change								
Increase in greenhouse gas emissions from construction	Construction	Almost certain	Moderate	High	• GG01 • GG02 • GG05	Almost certain	Minor	Medium
Increased energy use (and greenhouse gas emissions) due to the operation of the road (lighting, signals, and maintenance)	Operation	Almost certain	Moderate	High	• GG01 • GG02 • GG04	Almost certain	Minor	Medium
Cumulative impacts								
Additional impacts arising from interaction with adjacent upgrade projects and other surrounding developments during the construction period.	Construction	Almost certain	Serious	High	• NV12 • CU01 • CU02	Likely	Moderate	Medium

10.3 Residual impacts

10.3.1 High and medium residual risk

The risk analysis outlined in **Table 10-5** has identified several high and medium level residual risks. Opportunities will be identified during detailed design to:

- Resolve residual impacts and risks through design refinement
- Develop effective construction methodologies and planning to ensure that management measures can be effectively implemented
- Implement a process of review, correction and audit for the management measures that were identified in **Chapter 9**. A process of continuous improvement will allow for management measures to be updated and improved during construction and operation where feasible and reasonable.

Where high and medium level residual risks are still likely, additional and where appropriate refined management measures will be developed to ensure those risks are suitably mitigated.

10.3.2 Low residual risk

Regardless of the low risk rating for some residual risks identified in **Table 10-5**, an appropriate process of review and continual improvement will be applied to address these potential impacts during construction and operation as far as is reasonable and feasible.

11. Project justification and conclusion

This chapter presents a justification of the project and a conclusion to the environmental impact statement. The justification considers how the project balances strategic and project needs against the protection of the environment and planning outcomes outlined in the objects of the EP&A Act, including ecologically sustainable development and community consultation.

Table 11-1 outlines the SEARs that relate to the project justification and conclusion and identifies where they are addressed in this EIS.

Table 11-1 SEARs (project justification and conclusion)

Secretary's requirement	Where addressed in EIS
2. Environmental impact statement	
1. The EIS must include, but not necessarily be limited to, the following: d. a summary of the strategic need for the project with regard to its critical State significance and relevant State Government policy;	Strategic justification and project need are the subject of **Chapter 3** of this EIS **Section 3.1** specifically addresses the State and Federal government legislation and policy framework under which the project was developed **Section 2.1** sets out the statutory basis on which the project was determined to be of critical State significance
p. a chapter that synthesises the environmental impact assessment and provides: – the reasons justifying carrying out the project as proposed, having regard to the biophysical, economic and social considerations, including ecologically sustainable development and cumulative impacts.	The reasons justifying carrying out the project are set out in **Section 11.1** The project synthesis is attached to this EIS in **Appendix A**

11.1 Justification

11.1.1 Project justification

The project is considered to be essential for the State for economic reasons; principally due to the role that the project would have in facilitating the development of and access to the proposed Western Sydney Airport, employment lands and South West Growth Area. To support the airport and realise economic growth objectives for western Sydney, a dedicated mixed-use business development zone, the Western Sydney Aerotropolis, is planned in land surrounding the airport.

The combined effect of the Western Sydney Airport and the Aerotropolis is expected to significantly increase traffic demand, placing pressure on the existing local road network. Network performance modelling indicates that the existing road network would have insufficient capacity to carry the traffic that would be generated by the land use surrounding and within the wider study area and that many roads surrounding the study area would be at or near capacity in the future.

Western Sydney is expected to experience record population growth, with around one million additional people living in the region by 2031. The project would allow for an increasing number of residents in western Sydney to access nearby jobs, housing and transport, health facilities, schools and social infrastructure through the provision of transport links. The project would provide essential road capacity to cater for major planned development and reduce projected future demand on the local road network.

The project would help address western Sydney's future transport challenges as follows:

- The project would address major capacity constraints on the arterial road network arising from the development and operation of the Western Sydney Airport. Without the project, ageing, narrow or lower-order roads would have to perform a traffic function that is better suited to motorway infrastructure. Relying on lower-order roads reduces amenity and results in congestion, increased travel times, decreased travel time reliability and more traffic incidents.
- The project would facilitate the Greater Sydney Region Plan's goal of delivering a 30-minute city by facilitating greater access to jobs within 30 minutes of people's homes in western Sydney.
- The project would provide critical land transport network capacity to and from the Western Sydney Airport and the Aerotropolis. When operational and fully developed, these will be major trip generators and will be economically critical to Greater Sydney and the NSW economy. Even with major public transport and freight initiatives currently under investigation in western Sydney (for example Sydney Metro Greater West and the Western Sydney Freight Line), major new road capacity is needed to connect Western Sydney Aerotropolis to markets and customers across Greater Sydney.
- The project would serve Greater Sydney's wider, highly diverse freight and business travel task. The freight, commercial and service travel tasks require the distribution of goods and services across Greater Sydney, which relies on more diverse and dispersed point-to-point transport connections. The project supports this task by providing connections between Western Sydney Aerotropolis to other employment areas and population centres and the broader Sydney motorway network.
- The project would serve natural growth in demand from Greater Sydney's growing population and economy. Over the next 20 years, the number of average weekday trips across Greater Sydney is forecast to increase by 40 per cent, while freight volumes are forecast to double. Much of this growth in freight volumes would occur on the motorway network.

There is a need to ensure that connections to the rest of Greater Sydney's transport network are provided to support and maintain Western Sydney Aerotropolis as the catalyst for economic growth in Western Sydney. Current infrastructure priorities in the Western City are focussed on supporting the Western Sydney Airport as well as associated employment and population growth.

The objectives of the WSIP were developed broadly to facilitate these infrastructure priorities and support the projected land use change and residential growth in the region, providing resilient connections for freight and passengers to and from the Western Sydney Airport. The project meets the objectives of the WSIP and the specific project objectives as outlined in **Section 3.3** by:

- Providing sufficient road capacity to meet traffic demand generated by the planned Western Sydney urban development
- Providing a high standard connection to the airport with capacity to meet future freight and passenger needs
- Providing a road which supports and integrates with the broader transport network
- Supporting the provision of an integrated regional and local public transport system
- Preserving the access function of Elizabeth Drive
- Providing active local transport within the east–west corridor
- Making provision for connection to the future Outer Sydney Orbital.

In addition, the project would help to fulfil the goals and objectives of numerous strategic planning instruments, including:

- The NSW State Priorities (NSW Government, 2015a)
- The NSW State Infrastructure Strategy (Infrastructure NSW, 2018)
- The Greater Sydney Commission's Greater Sydney Region Plan (GSC, 2018a)
- The Western Sydney Aerotropolis Land Use and Infrastructure Implementation Plan (DPE, 2018a)
- Future Transport Strategy 2056 (NSW Government, 2018a)
- The Western Sydney Infrastructure Plan (Roads and Maritime, 2016a)
- NSW Key Freight Routes Road expenditure and Investment Plan (Transport and Infrastructure Council, 2016)
- NSW Bike Plan (Bicycle NSW, 2010).

Table 11-2 describes the project objectives and the manner in which the project meets those objectives.

Table 11-2 Meeting the project objectives

Project objective	Current transport issues	Way project addresses current issues	Expected benefits from project	Benefiting stakeholders
Provide sufficient road capacity to meet traffic demand generated by the planned Western Sydney urban development	• There is insufficient road capacity to support forecast traffic growth within the area by 2026. Strategic modelling indicates sections of Elizabeth Drive will operate at LoS E by 2026 • The Western Sydney Aerotropolis and South West Growth Area will require good accessibility to the Western Sydney Airport, The Northern Road, and M7 Motorway as development occurs in the region	• Supports and enables development within the Western Sydney Aerotropolis and South West Growth Area	• Current and future residents of Western Sydney to have dual carriageway access to the Western Sydney Airport, M7 Motorway, The Northern Road and the Western Sydney Aerotropolis. • Maintain a LOS of D or better	• Community • Local businesses • Road users • Airport users
Provide a high standard connection to the airport with capacity to meet future freight and passenger needs	• Without the M12 Motorway, there is no high standard connection to the airport to meet future freight and passenger needs	• Freight and Western Sydney Airport passenger road users to have dual carriageway access to the Western Sydney Airport, M7 Motorway, The Northern Road and Western Sydney Aerotropolis	• Provides higher standard road link that facilitates more efficient journeys to the Western Sydney Airport and Western Sydney Aerotropolis.	• Airport users • Freight industry
Provide a road which supports and integrates with the broader transport network	• Existing infrastructure provides insufficient capacity to support employment growth in the Western Sydney Aerotropolis • Accessibility to The Northern Road and M7 Motorway will be required along this corridor	• Supports employment zones identified in the Metropolitan or Regional Land Use Strategies • Improves access (faster and more efficient) to Penrith, Parramatta and Liverpool • Supports access to a precinct of employment growth • Does not preclude construction of public transport infrastructure, ie Sydney Metro Greater West	• Workers in the Western Sydney Airport and Aerotropolis to have dual carriageway access to The Northern Road, M7 Motorway, Western Sydney Airport and surrounding developments including the South West Growth Area • Volatile organic compounds (VOCs) are reduced	• Community • Freight industry • Businesses and Aerotropolis workers • Passengers and freight to the airport

Project objective	Current transport issues	Way project addresses current issues	Expected benefits from project	Benefiting stakeholders
Support the provision of an integrated local public transport system	• Infrastructure required, due to the current lack of public transport facilities, to support operation of the Western Sydney Airport, Western Sydney Aerotropolis and South West Growth Area. • The demand for public transport is likely to significantly increase with the development of the proposed Western Sydney Airport.	• Provides key road link that supports public transport use to the South West Growth Area and for people accessing the Western Sydney Aerotropolis and Western Sydney Airport • Does not preclude construction of public transport infrastructure ie Sydney Metro Greater West	• Anticipated minor shift in mode share to bus use • Improved access to major transport hubs and stations (including the Western Sydney Airport) • Improved reliability of travel times and timetabling for bus operators	• Bus operators • Community • Public transport users
Preserve the access function of Elizabeth Drive	• Infrastructure required to separate local and through or airport traffic to reduce conflicts leading to delays • There is insufficient capacity to support forecast residential and economic growth within the area by 2030 • Strategic traffic modelling indicates sections of Elizabeth Drive will operate at LOS E by 2026	• Provides strategic connection between the motorway network and Western Sydney Airport and Aerotropolis • Helps prevent reduction in access (including for emergency vehicles) • Preserves future strategic transport connections	• Reduction in travel times along the Elizabeth Drive corridor • Maintain a LOS of D or better • Average travel speed is improved	• Freight industry • Community
Provide active local transport within the east–west corridor	• There are no existing dedicated active transport facilities along Elizabeth Drive between the M7 Motorway and The Northern Road • With the magnitude of upcoming commercial, residential and industrial development, there will significant demand for high-quality bicycle paths and footpaths for both recreation and commuting purposes	• The project includes construction of a dedicated, off-road shared user path connecting to the M7 Motorway and The Northern Road shared user paths • The shared user path will also provide direct access to the Western Sydney Airport, connecting to similar infrastructure within the airport precinct	• Active transport (bicycle and pedestrian) connectivity between the M7 Motorway, Elizabeth Drive, Western Sydney Parklands, Western Sydney Airport and Aerotropolis, The Northern Road • Opportunity for community to improve health through use of the shared user path	• Community • Cycling groups

Project objective	Current transport issues	Way project addresses current issues	Expected benefits from project	Benefiting stakeholders
Make provision for connection to the future Outer Sydney Orbital	• Future Transport 2056 lists Outer Sydney Orbital from Great Western Highway to the Western Sydney Airport as 'Greater Sydney Initiative for Investigation (10-20 years)'. If the Outer Sydney Orbital is built in the future, the western portion of the project would form part of the Outer Sydney Orbital alignment. This necessitates the project's Western Sydney Airport interchange would need to be integrated with the Outer Sydney Orbital.	• Delivery of project within cost and timeframe constraints whilst providing for future connection to Outer Sydney Orbital • Preservation of corridor for future Outer Sydney Orbital and M12 Motorway connection • Design of the Western Sydney Airport interchange in order for Outer Sydney Orbital to connect and prioritise dominant traffic movements • Design of the M12 Motorway between The Northern Road and the Western Sydney Airport interchange to integrate a future parallel carriageway for the Outer Sydney Orbital	• Provides for connection and integration of the future Outer Sydney Orbital and the M12 Motorway with reduced cost, complexity and impact on community and road users	• Community • Road users • Freight industry

11.1.2 Objects of the EP&A Act

The objects of the EP&A Act provide a framework within which the justification of the project can be considered. A summary of this assessment is provided in **Table 11-3**.

Table 11-3 Summary assessment of how the project meets the objects of the EP&A Act

EP&A Act objective	Commentary
(a) to promote the social and economic welfare of the community and a better environment by the proper management, development and conservation of the State's natural and other resources,	The project would adopt resource efficiency measures throughout construction and operation where practical, including: • Recycled products used in construction • Energy efficiency measures, including recovery of virgin excavated natural material and a range of other materials, reuse of topsoil, diversion of office waste from landfill minimising the volume of fill required, minimising transport emissions associated with haulage of imported fill • Water efficiency measures would be implemented during construction and operation, including use of recycled water during where practical • The project would seek to reuse or recycle uncontaminated spoil generated where possible. Construction and demolition waste would be reused and/or recycled as part of the project where possible. Sustainability measures are described in **Section 8.4** (Sustainability). The outcomes from this EIS, including any relevant conditions that may be applied to the project by the Minister for Planning, would be used to finalise the sustainability objectives and targets for the project. The project integrates a shared user path utilising the corridor to connect with existing pathways and facilitate future connections to new urban development, providing an important community benefit. Where reasonable and feasible, the project was designed to avoid impacts on the natural and built environment and to minimise the need for land acquisition. The project would provide improved traffic conditions, safety and efficiency on parts of the surface road network, and would result in improvements to local amenity.
(b) to facilitate ecologically sustainable development by integrating relevant economic, environmental and social considerations in decision-making about environmental planning and assessment,	As described in **Section 11.1.3**, the project is consistent with the four principles of ecologically sustainable development, which are: • Precautionary principle • Inter-generational equity • Conservation of biological diversity and ecological integrity • Improved valuation and pricing and incentive mechanisms. Detailed assessment of the project against the principles of ecologically sustainable development is provided in **Section 8.4**.

EP&A Act objective	Commentary
(c) to promote the orderly and economic use and development of land,	The primary function of the project is to provide essential road access for the Western Sydney Airport upon its opening. This provides economic benefits for NSW by supporting a major economic catalyst for growth and enabling connectivity to the motorway network for supporting activities (eg freight transport). Establishing the M12 Motorway early in the urban development process for surrounding areas (eg Western Sydney Aerotropolis and planned precincts) supports orderly and economic development of surrounding areas. With a focus on connectivity, the project enables flexibility for the surrounding land uses, as described in the strategic planning policies. Socio-economic, land use and property impacts are assessed in **Section 7.4**.
(d) to promote the delivery and maintenance of affordable housing,	Not relevant to this project.
(e) to protect the environment, including the conservation of threatened and other species of native animals and plants, ecological communities and their habitats,	Biodiversity values were considered in the development and selection of the strategic route options and the design as set out in this document. Environmental management measures were identified to further reduce the severity of direct and indirect impacts of the project on biodiversity. Once all practicable steps to avoid or minimise impacts were implemented at the design phase, mitigation measures will be implemented to further lessen the potential ecological impacts of the project. A number of mitigation measures to minimise direct and indirect ecological impacts would be implemented as part of the project in line with Roads and Maritime Biodiversity Guidelines – Protecting and managing biodiversity on RTA projects. Any residual impacts that cannot be avoided, minimised or mitigated, would be offset in accordance with the Framework for Biodiversity Assessment (OEH, 2014a), the NSW Biodiversity Offsets Policy for Major Projects (OEH, 2014b) and the Policy and Guidelines for Fish Habitat Conservation and Management (Update 2013). Biodiversity impacts are assessed in **Section 7.1.**
(f) to promote the sustainable management of built and cultural heritage (including Aboriginal cultural heritage),	Route selection, design changes and alignment refinements were made, as well as locations selected for ancillary facilities, in order to avoid and minimise impacts on Aboriginal heritage sites where possible, while considering engineering, environmental, social and economic requirements. A strategic objective for the project is to create a unique and distinct identity interpreting the rich sense of place, Aboriginal and cultural heritage. Further, the project vision and the urban design and landscape concept interprets the key themes associated with non-Aboriginal settlement in the local area. The project contributes to broader understanding of the heritage values of the locality through the vision for the project (‘connection to Country’) described above. Environmental management strategies were adopted to minimise the impacts on Aboriginal and non-Aboriginal heritage sites. The measures for managing the impacts of the project on heritage values are described in **Section 7.5** and **Section 7.6.**

EP&A Act objective	Commentary
(g) to promote good design and amenity of the built environment,	A collaborative design process has identified several design objectives and features that were incorporated into the design as set out in this document to promote good design and amenity of the project elements and its place in the surrounding landscape. The design of the project was guided by a set of principles and objectives that have provided a platform for engaging with stakeholders and informing the physical designs proposed. These include: • Providing a 'connection to Country' • Positively influencing the structure of the Western Parkland City • Creating a project identity • Creating an active study area and enhance user experience • Re-establishing natural systems. The philosophy behind the urban design and landscaping measures for managing the impacts of the project are described in **Section 7.3.**
(h) to promote the proper construction and maintenance of buildings, including the protection of the health and safety of their occupants,	Not relevant to the project.
(i) to promote the sharing of the responsibility for environmental planning and assessment between the different levels of government in the State,	Consultation was carried out with the relevant local councils and government agencies throughout the development of the project and the preparation of this environmental impact statement. All levels of government were encouraged to be actively involved in and to contribute to the evolution of the project and this environmental impact statement through historical and continuing consultation activities. Consultation carried out to date is described in **Chapter 6**.
(j) to provide increased opportunity for community participation in environmental planning and assessment.	Community consultation was carried out through all stages of the project's development. Activities carried out from the early planning phase in mid-2015 include the NSW Government's announcement of the start of the M12 Motorway investigations in August 2015, shortlisting of the route options in early 2016, announcement of the preferred route November 2016, to the announcement of the preliminary design and access strategy in early 2018. Consultation has continued during preparation of this EIS, including public information sessions and community updates. Community feedback was considered at each stage of the project development to inform the selection of the preferred corridor alignment and subsequent design development and refinements. Community consultation would continue through the detailed design, construction and operational stages, should the project be approved. Details of community involvement are provided in **Chapter 6.**

11.1.3 Ecologically sustainable development

Ecologically sustainable development (ESD) is development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends. The principles of ESD were an integral consideration throughout the development of the project. The EP&A Regulation lists the requirements of an environmental impact statement in Part 3 section 7.

This includes:

> *(f) the reasons justifying the carrying out of the development, activity or infrastructure in the manner proposed, having regard to biophysical, economic and social considerations, including the principles of ecologically sustainable development…*

ESD requires the effective integration of economic and environmental considerations in decision-making processes. The four main principles supporting the achievement of ESD are discussed below.

Precautionary principle

The precautionary principle deals with reconciling scientific uncertainty about environmental impacts with certainty in decision-making. It provides that where there is a threat of serious or irreversible environmental damage, the absence of full scientific certainty should not be used as a reason to postpone measures to prevent environmental degradation.

This principle was considered during route options development (see **Chapter 4**). The precautionary principle has guided the assessment of environmental impacts for this EIS and the development of mitigation measures.

This EIS communicates the assessment of environmental impacts associated with the project. The EIS was prepared adopting a conservative approach, which included assessing the worst case impacts and scenarios. It was carried out using the best available technical information and has adopted best practice environmental standards, goals and measures to minimise environmental risks. The environmental assessment was carried out in collaboration with key stakeholders and relevant statutory and agency requirements.

Route selection, safeguards and management measures were comprehensively assessed and measures implemented to avoid or minimise potential impacts. The project, along with the identified safeguards and management measures does not result in an unacceptable residual risk and does not generate significant, serious or irreversible environmental harm.

As discussed in **Chapter 8.4**, sustainability workshops and meetings were held during EIS development with planning and design teams, which sought to preserve opportunities for the implementation of sustainability initiatives in future detailed design development.

The project's design and assessment of impacts takes into consideration the significant change expected in the surrounding area, an endorsed policy of the NSW Government, supported by local councils and infrastructure providers. In this context of significant change, the project seeks to limit the potential impacts on the construction footprint through appropriate design and mitigation measures. Design of the bridges, cuttings, embankments would not generate off site impacts that would unreasonably limit the development of surrounding land for the purposes outlined in strategic documents.

Further, the project supports the development of surrounding land, particularly the Western Sydney Airport, through early establishment of the primary airport road access in the development process. This allows surrounding development to have good access for construction and ability to plan around a known landscape element. Design features are included to facilitate access across the project's alignment between properties and for pedestrians/cyclists.

Inter-generational equity

Social equity is concerned with the distribution of economic, social and environmental costs and benefits. Inter-generational equity introduces a temporal element with a focus on minimising the distribution of costs to future generations.

The project may impact on inter-generational equity through the consumption of resources during construction and operation, including fuel and raw materials. The project would result in the consumption of fuels, such as diesel, during construction and operation. Diesel is derived from oil which is a non-renewable resource and its use has the potential to negatively impact future generations.

The project would connect the Western Sydney Airport and the associated Western Sydney Aerotropolis, providing for anticipated future transport needs and creating linkages to service the future population of western Sydney and the Western Sydney Employment Area. This would allow future generations of residents in western Sydney to access nearby jobs, housing and transport, health facilities, schools and social infrastructure through the provision of transport links.

The M12 Motorway fits both in the current landscape, through landscape treatment, and with future urbanisation of the surrounding landscape. Measures including bridges, overpasses and underpasses provide the opportunity for continuation of current uses, as well as supporting future development. Current plans are early concept master plans, but the design of the road builds upon fundamental road design requirements with landscape and architectural treatments that provide flexibility for future development responses.

Elements of the project, such as bridges, have a design life of about 100 years and would therefore support the needs of both current and future generations. Environmental impacts were assessed throughout this EIS and environmental management measures were identified with the intention of maximising intergenerational equity.

The project's resilience to future climate change is considered in **Section 8.6**, which identifies potential climate risks to the project, adaptation incorporated in the project's design development, and recommended next steps for the development of adaptation options during detailed design. The project would contribute to building the resilience of metropolitan Sydney by providing an evacuation route in the instance of flooding. The introduction of a major transport route that would be above the 100 year ARI flood levels, into the wider transport network would have a beneficial influence on flood evacuation in a broader context. Improvements to the traffic network can reduce the likelihood of delays for users reliant on the network for flood evacuation from other areas in the wider network. Having this flood-free link would improve emergency management options, both for flooding near the project and for surrounding areas where the traffic improvements would help dissipate evacuating vehicles. Similarly, improvements to the traffic network can reduce the likelihood of delays for users reliant on the network for evacuation as a result of other emergencies such as bushfire, where the additional traffic capacity provided by the project would reduce the potential for congestion.

Management measures were identified for potential environmental impacts on protect future health, diversity and productivity of the environment. During construction and operation of the project, opportunities would be taken to reduce material use, reuse waste materials and maximise the use of materials with low embodied environmental impact, where feasible.

Conservation of biological diversity and ecological integrity

Biodiversity values were considered in the development and selection of the strategic route options and the design as set out in this document. Conservation of biological diversity and ecological integrity is a fundamental consideration of the project. The design and assessment of the project was carried out with the aim of identifying, avoiding, minimising and mitigating impacts. In particular, the route through Western Sydney Parklands was chosen to minimise the need for vegetation clearance as well as maintaining the integrity of the Parklands for future generations and protecting scenic and cultural landscapes by locating new infrastructure closer to disturbed areas.

Measures adopted to minimise or avoid impacts on biological diversity and ecological integrity include bridge structures over key watercourses and riparian zones, which also enable movement of wildlife and water across the corridor. Environmental management measures were identified to further reduce the severity of direct and indirect impacts of the project on biodiversity. Where it is not possible to avoid impacts, ecological input during the remainder of the design process would focus on minimising impacts on

biodiversity as far as possible. Where there are likely to be residual impacts associated with vegetation clearance, such impacts would be offset in accordance with the Framework for Biodiversity Assessment (OEH, 2014a), the NSW Biodiversity Offsets Policy for Major Projects (OEH, 2014b) and the Policy and Guidelines for Fish Habitat Conservation and Management (Update 2013).

Fauna injury or mortality could occur during construction of the project, as a result of direct collision with vehicles and equipment within the project footprint. Mobile species (such as birds) may be able to move away quickly and easily, but other less mobile species, or those with high fidelity with their home range, may be slower to move away or may not relocate at all, potentially resulting in injury or mortality of the individual.

Although there is potential for some injury or mortality of fauna species, the project is unlikely to result in a large number of fauna injury or mortality incidents, as key wildlife corridors are provided along riparian zones under proposed bridges. Over time, as the surrounding area becomes more urbanised, the risk of injury or mortality incidents would diminish due to improved corridor definition and treatments of parklands.

A key element of the project's landscape concept is consistency with strategic plans for the Western Parkland City and preservation of corridors that align with watercourses. Along with protecting riparian zones, the project would plant a net increase of 960 landscape trees, which contributes to the NSW Government's commitment to plant five million trees in Greater Sydney by 2030. The landscape concept is to be delivered with consideration of safety requirements for vegetation near major airports (eg minimise foraging habitat to discourage birds in flight paths).

A number of management measures to minimise direct and indirect ecological impacts would be implemented as part of the project in line with Roads and Maritime Biodiversity Guidelines – Protecting and managing biodiversity on RTA projects. These measures would be detailed in the flora and fauna management plan for the project which includes: site-specific environmental induction; identification of clearing limits and protective fencing; vegetation clearance procedures; pre-clearance surveys; erosion and sediment controls; weed management and monitoring.

About 73.65 hectares of native vegetation would be cleared for the project, of which about 73.27 hectares meets the criteria for TECs listed under the TSC Act. About 38.93 hectares of native vegetation to be cleared meets the criteria for TECs listed under the EPBC Act. This vegetation clearing would be offset as discussed in **Section 7.1.7**. The project would result in impacts on the following listed under the TSC Act:

- About 90 individuals of the Endangered species *Pultenaea parviflora*, which is also listed as Vulnerable under the EPBC Act
- About 244 individuals of the Vulnerable species *Dillwynia tenuifolia*
- About 55.58 hectares of potential foraging habitat for five Vulnerable microbat species
- About 55.20 hectares of potential foraging habitat for the Vulnerable species Grey-headed Flying-fox (*Pteropus poliocephalus*), which is also listed as Vulnerable under the EPBC Act
- About 3.69 hectares of potential foraging habitat and anticipated removal of one active nest for the Vulnerable species White-bellied Sea-Eagle (*Haliaeetus leucogaster*)
- Seven ecosystem credit species listed under the TSC Act
- About 1.86 hectares of potential habitat for the Endangered species Cumberland Plain Land Snail (*Meridolum corneovirens*)
- About 0.92 hectares of potential breeding habitat and about 3.69 hectares of potential foraging habitat for the Vulnerable species Southern Myotis (*Myotis macropus*).

This EIS provides a detailed assessment of potential impacts on biodiversity and identifies a range of management measures to further avoid and minimise potential impacts. Refer to **Section 7.1** and **Appendix E** for additional detail.

Improved valuation and pricing of environmental resources

The principle of internalising environmental costs into decision making requires consideration of all environmental resources which may be affected by the carrying out of a project, including air, water, land and living things. Environmental factors include:

- Polluter pays (ie those who generate pollution and waste should bear the cost of containment, avoidance or abatement)
- The users of goods and services should pay prices based on the full life cycle of costs of providing the goods
- Environmental goals, having been established, should be pursued in the most cost-effective ways.

The value placed on avoiding and minimising environmental impacts is demonstrated in the design features incorporated into the project description, including opportunities for:

- Reducing emissions through efficient road design
- Protecting riparian areas and wildlife corridors through elevating road surface on bridges over major creeks
- Reducing overall waste by reusing excavated material for fill purposes
- Managing waste on site as far as practical
- Maximising use of recycled water sourced on site during construction
- Minimising noise through adoption of integrated noise mitigation measures
- Protecting biodiversity by assessing and managing impacts on habitat and connectivity of vegetation
- Ensuring sustainability in procurement through procurement of appropriate skills and maximising enforceability of sustainability contract requirements
- Design elements to improve local amenity, such as providing the shared user path
- Integrating urban and landscape design features that reflect the local Aboriginal and non-Aboriginal cultural and historical values.

Land use impacts are detailed in **Chapter 7.4** and **Appendix H**. **Appendix G** contains specific guidance on design of a cohesive project identity and high quality user experience for the project.

Environmental factors were considered throughout the development of the design and in planning for construction and operation of the project. As a consequence, environmental impacts were avoided or minimised where practical during the concept design development for the project.

Management measures outlined in this EIS will be implemented during construction and operation of the project. These management measures would be revised and updated as required during the detailed design stage of the project and as the project passes through the assessment process.

The cost of these management measures is incorporated into the project cost, as well as the extent of environmental investigations carried out to inform this EIS.

11.2 Conclusion

This environmental assessment has addressed the key issues identified in the Secretary's environmental assessment requirements (SEARs) issued under Division 5.2 of the EP&A Act and the relevant provisions of Schedule 2 of the EP&A Regulation. A checklist showing where the SEARs are addressed in this environmental assessment is provided in **Appendix A**. The assessment has also addressed the additional key issues identified in the environmental risk analysis in **Chapter 10**.

The project was justified in relation to its strategic transport need and its anticipated benefits, taking into account biophysical, economic and social considerations, including ecologically sustainable development and cumulative impacts. The project is considered to best meet the project objectives when compared to all other alternatives and options.

Key environmental issues were examined throughout the design development process. Consultation was carried out with affected community and stakeholders to identify key potential impacts at an early stage and where possible, impacts were avoided or appropriate management measures developed. This has resulted in a number of design changes that have mitigated many of the potential impacts. Provided the measures and commitments specified in the EIS are applied and effectively implemented during the detailed design, construction and operational phases, the identified environmental impacts are considered to be acceptable and manageable.

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