Australian Government

BUILDING OUR FUTURE

M12 Motorway Environmental Impact Statement

Appendix P Air quality impact assessment

Roads and Maritime Services | October 2019

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Glossary of terms and abbreviations

Term	Meaning
AAQ NEPM	National Environment Protection Measure for Ambient Air Quality
AAQMFQTP	Ambient Air Quality Monitoring and Fuel Quality Testing Project
Air Toxics NEPM	National Environment Protection Measure for Air Toxics
Approved Methods	Approved Methods for the Modelling and Assessment of Air Pollutants in NSW
AQI	Air quality index
AQIA	Air quality impact assessment
ATMP	Air Toxics Monitoring Program
AWS	Automatic weather station
BoM	Bureau of Meteorology
CAQMP	Construction Air quality Management Plan
CO	Carbon monoxide
EIS	Environmental Impact Statement
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPA	Environment Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EESG	Environment, Energy and Science Group of the Department of Planning, Industry and Environment (former NSW Office of Environment and Heritage)
$g/m^2/month$	Grams per square meter per month
GMR	Greater Metropolitan Region
km	Kilometres
$\mu g/m^3$	Micrograms per cubic metre
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
O_3	Ozone
OU	Odour units
Pb	Lead
$PM_{2.5}$	Particulate matter with equivalent aerodynamic diameter less than 2.5 microns
PM_{10}	Particulate matter with equivalent aerodynamic diameter less than 10 microns
POEO Act	*Protection of the Environment Operations Act 1997*
POEO Clean Air Regulation	Protection of the Environment Operations (Clean Air) Regulation 2010

Term	Meaning
SEARs	Secretary's Environmental Assessment Requirements
SO_2	Sulfur dioxide
TfNSW	Transport for NSW
TRAQ	Tool for Roadside Air Quality
TSP	Total suspended particulates
UK IAQM	United Kingdom Institute of Air Quality Management
VOC	Volatile organic compounds

Executive summary

Background

Roads and Maritime Services (Roads and Maritime) is seeking approval under Part 5, Division 5.2 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) to construct and operate the M12 Motorway project to provide direct access between the Western Sydney Airport at Badgerys Creek and Sydney's motorway network. The project has been determined to be a controlled action under Section 75 of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) (EPBC Act) (EPBC 2018/8286) for significant impact to threatened species and communities (Section 18 and Section 18A of the EPBC Act). As such, the project requires assessment and approval from the Commonwealth Government.

The M12 Motorway would run between the M7 Motorway at Cecil Hills and The Northern Road at Luddenham for a distance of about 16 kilometres and would be opened to traffic prior to opening of the Western Sydney Airport.

Purpose of this report

This report has been prepared to support the environmental impact statement (EIS) for the M12 Motorway project. The EIS has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) for the project (SSI 9364), as well as the Australian Government assessment requirements under the EPBC Act. The EIS for the project provides sufficient information to enable the NSW Minister for Planning and Public Spaces and the Commonwealth Minister for the Environment to make a determination on whether the project can proceed. This report presents an assessment of the construction and operational activities for the project that have the potential to impact air quality.

Overview of potential impacts

Construction

Dust was determined to be the primary air quality and amenity issue during construction. Dust emissions would result from clearing and demolition, excavation, materials handling, stockpiling and compaction activities. A semi-quantitative risk-based approach was therefore undertaken to determine the potential for dust impacts during construction of the project using the method developed by the UK Institute of Air Quality Management (UK IAQM) presented in 'Guidance on the assessment of dust from demolition and construction Version 1.1' (2014). This approach was selected as it provided mitigation and management measures that were commensurate to the assessed levels of potential risk. The Institute of Air Quality Management approach was also determined to be a more appropriate assessment approach than modelling. In practice, it is not possible to realistically quantify impacts using dispersion modelling. To do so would require knowledge of the weather conditions for the period in which work would be taking place in each construction location.

The potential for dust impacts was determined, using the UK IAQM method, by assessing four primary dust generating activities associated with construction activities. These activities included demolition, earthworks, construction and trackout (ie dust emissions associated with the loading and movement of materials). This assessment methodology considered three different types of dust impacts, being the annoyance of dust soiling, the risk of human health, and impacts to nearby ecological receivers.

It was concluded that construction of the project has the potential to present a 'high' risk of dust impacts, as defined by the UK IAQM methodology. Measures to mitigate or otherwise effectively manage the potential for dust impacts during construction of the project have been developed with reference to the guidance presented in the UK IAQM guideline.

A qualitative assessment was also undertaken to assess the potential for other air quality impacts due to exhaust emissions from the combustion of fossil fuels, odours arising from uncovered contaminated and/or hazardous materials, and airborne hazardous materials (eg asbestos and fungal spores). Specific measures were developed to manage these issues during construction. Provided these measures are adequately implemented, significant impacts are not anticipated.

Operation

Air quality during operation of the project was modelled using the Roads and Maritime Tool for Roadside Air Quality (TRAQ) screening-level dispersion model. Changes in traffic conditions along the adjoining road network, including The Northern Road, the M7 Motorway and Elizabeth Drive; were used to inform the assessment. Potential local changes in air quality at surrounding receivers as a result of the project were quantified.

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

For the project, the following key results were predicted:

- **M12 Motorway (the project):**
  - 24-hour averaged PM_{10} and $PM_{2.5}$ concentrations were predicted to increase by up to around 10 per cent and 25 per cent respectively compared with existing contributions experienced. Total (ie background plus roadway contributions) concentrations were predicted to remain below the respective NSW EPA impact assessment criteria.
  - Annually averaged PM_{10} concentration were predicted to increase by up to seven per cent compared with existing, with total concentrations also predicted to remain below the criteria from the Approved Methods.
  - Background annually averaged $PM_{2.5}$ was already measured at the EPA's impact assessment criteria. Additional contributions from the roadway were predicted to be 1.5 µg/m^3 or less at the surrounding receivers within the study area.
- **The Northern Road:**
  - 24-hour averaged PM_{10} and $PM_{2.5}$ concentrations were predicted to change by two µg/m^3 or less compared with the equivalent no project timescales. Total (ie background plus roadway contributions) concentrations were predicted to remain below the respective NSW EPA impact assessment criteria.
  - Annually averaged PM_{10} concentration were predicted to increase by up 0.9 µg/m^3 compared with the equivalent no project timescales, with total concentrations also predicted to remain below the criteria from the Approved Methods.
  - Background annually averaged $PM_{2.5}$ was already measured at the EPA's impact assessment criteria. One further receiver was predicted to experience roadway contributions of more than two µg/m^3 compared with the equivalent no project timescales.
- **M7 Motorway:**
  - 24-hour averaged PM_{10} and $PM_{2.5}$ concentrations were predicted to decrease by up to 1.3 µg/m^3 compared with the equivalent no project timescales. Total (ie background plus roadway contributions) concentrations were predicted to remain below the respective NSW EPA impact assessment criteria.
  - Annually averaged PM_{10} concentration were predicted to decrease by up 0.5 µg/m^3 compared with the equivalent no project timescales, with total concentrations also predicted to remain below the criteria from the Approved Methods.

  - Background annually averaged $PM_{2.5}$ was already measured at the EPA's impact assessment criteria. One less receiver was predicted to experience roadway contributions of more than two µg/m^3 compared with the equivalent no project timescales.
- **Elizabeth Drive:**
  - 24-hour averaged PM_{10} and $PM_{2.5}$ concentrations were predicted to decrease by up to 1.2 µg/m^3 compared with the equivalent no project timescales. Total (ie background plus roadway contributions) concentrations were predicted to remain below the respective NSW EPA impact assessment criteria.
  - Annually averaged PM_{10} concentration were predicted to decrease by up 0.5 µg/m^3 compared with the equivalent no project timescales, with total concentrations also predicted to remain below the criteria from the Approved Methods.
  - Background annually averaged $PM_{2.5}$ was already measured at the EPA's impact assessment criteria. Roadway contributions were predicted to decrease by up to 0.5 µg/m^3 compared with the equivalent no project timescales.

Concentrations of carbon monoxide (CO), nitrogen dioxide (NO_2) and volatile organic compounds (VOCs) as benzene in the vicinity of the new M12 Motorway were predicted to increase by up to about 17 per cent relative to existing conditions, at the nearest sensitive receivers. However, the predicted concentrations were well below EPA impact assessment criteria. A similar outcome was determined for receivers around The Northern Road, the M7 Motorway and Elizabeth Drive.

Any changes in air quality due to the project need to be considered in context, with the forecast changes in surface traffic on existing major roads in the area due to Airport, and other projects and developments; as well as expected changes in background concentrations over time from those applied in the assessment. Still, it was concluded that 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 OEH air quality monitoring stations. Therefore, it was considered unlikely that the project would have a measurable effect on regional background conditions.

Cumulative impacts

The potential for local and regional cumulative impacts during the construction and operation of the project with other ongoing and planned developments in the area was assessed. It was determined that there is potential for local cumulative construction-related and operational air quality impacts at receivers from the project and the other nearby projects reviewed. Noting the level of controls committed for the project, as well as committed or expected from the other projects, it was concluded that this would present a limited level of risk. Wider regional cumulative impacts during construction would not be expected from the project and these other projects. Regarding operations, cumulative impacts from several of these other projects was also considered within the traffic inputs applied in the assessment. It was determined that there was the potential for local cumulative operational air quality impacts from several of these projects with the most notable being the Western Sydney Airport. It was not concluded that the project would materially contribute to any regional cumulative air quality impacts.

Summary of environmental management measures

A number of management measures will be implemented to mitigate or otherwise effectively manage the risk of dust impacts during construction. These include actions to improve communications, on-site dust management, inspections and monitoring, site and plant/equipment preparation and maintenance, and the on-site practices of personnel and contractors. Measures will also be implemented to address the other potential air quality issues (ie exhaust emissions, odours arising from uncovered contaminated and/or hazardous materials, and airborne hazardous materials) that were identified during construction.

No operational air quality environmental measures were deemed necessary as the assessment found that the project would not result in unacceptable changes in air quality for receivers near the project. In addition, the project would result in traffic-related air quality contributions that are comparable to, or less than, those in the vicinity of The Northern Road, the M7 Motorway and Elizabeth Drive.

Recommendations to co-ordinate with the other identified projects to limit the potential for cumulative air quality impacts were also included.

Conclusion

It has been 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 to 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 would be effectively managed.

1. Introduction

1.1 Background

Roads and Maritime Services (Roads and Maritime) is seeking approval under Part 5, Division 5.2 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) to construct and operate the M12 Motorway project to provide direct access between the Western Sydney Airport at Badgerys Creek and Sydney's motorway network (the project). In addition, the project has been determined to be a controlled action under Section 75 of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) (EPBC Act) (EPBC 2018/8286) for significant impact to threatened species and communities (Section 18 and Section 18A of the EPBC Act). As such, the project requires assessment and approval from the Commonwealth Government.

The M12 Motorway would run between the M7 Motorway at Cecil Hills and The Northern Road at Luddenham for a distance of about 16 kilometres and would be opened to traffic prior to opening of the Western Sydney Airport. The project would commence about 30 kilometres west of the Sydney central business district, at its connection with the M7 Motorway. The project traverses the local government areas of Fairfield, Liverpool and Penrith. The suburbs of Cecil Park and Cecil Hills are found to the east of the M12 Motorway, with Luddenham to the west.

The project is predominately located in greenfield areas. The topography in and around the project comprises rolling hills and small valleys between generally north–south ridge lines. The existing land uses are semi-rural residential, recreational, agricultural, commercial and industrial. The main residential areas are Kemps Creek, Mount Vernon and Cecil Hills.

The project is required to support the opening of the Western Sydney Airport by connecting Sydney's motorway network to the airport. The project would also serve and facilitate the growth and development of the Western Sydney which is expected to undergo significant development and land use change over the coming decades. The motorway 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.

The project location is shown in **Figure 1-1** in relation to its regional context.

1.2 Project overview

The project would include the following key features:

- A new dual-carriageway motorway between the M7 Motorway and The Northern Road with two lanes in each direction with a central median allowing future expansion to six lanes
- Motorway access via three interchanges/intersections:
  - A motorway-to-motorway interchange at the M7 Motorway and associated works (extending about four kilometres within the existing M7 Motorway corridor)
  - A grade separated interchange referred to as the Western Sydney Airport interchange, including a dual-carriageway four lane airport access road (two lanes in each direction for about 1.5 kilometres) connecting with the Western Sydney Airport Main Access Road
  - A signalised intersection at The Northern Road with provision for grade separation in the future
- Bridge structures across Ropes Creek, Kemps Creek, South Creek, Badgerys Creek and Cosgroves Creek
- A bridge structure across the M12 Motorway into Western Sydney Parklands to maintain access to the existing water tower and mobile telephone/other service towers on the ridgeline in the vicinity of Cecil Hills, to the west of the M7 Motorway

- Bridge structures at interchanges and at Clifton Avenue, Elizabeth Drive, Luddenham Road and other local roads to maintain local access and connectivity
- Inclusion of active transport (pedestrian and cyclist) facilities through provision of pedestrian bridges and an off-road shared user path including connections to existing and future shared user path networks
- Modifications to the local road network, as required, to facilitate connections across and around the M12 Motorway including:
  - Realignment of Elizabeth Drive at the Western Sydney Airport, with Elizabeth Drive bridging over the airport access road and future passenger rail line to the airport
  - Realignment of Clifton Avenue over the M12 Motorway, with associated adjustments to nearby property access
  - Relocation of Salisbury Avenue cul-de-sac, on the southern side of the M12 Motorway
  - Realignment of Wallgrove Road north of its intersection with Elizabeth Drive to accommodate the M7 Motorway northbound entry ramp
- Adjustment, protection or relocation of existing utilities
- Ancillary facilities to support motorway operations, smart motorways operation in the future and the existing M7 Motorway operation, including gantries, electronic signage and ramp metering
- Other roadside furniture including safety barriers, signage and street lighting
- Adjustments of waterways, where required, including Kemps Creek, South Creek and Badgerys Creek
- Permanent water quality management measures including swales and basins
- Establishment and use of temporary ancillary facilities, temporary construction sedimentation basins, access tracks and haul roads during construction
- Permanent and temporary property adjustments and property access refinements as required.

The project overview presented in this document represents the proposed design as described in the EIS. If the project is approved, a further detailed design process would follow, which may include variations to the design as described in the EIS. Flexibility has been provided in the design described in the EIS to allow for refinement of the project during detailed design, in response to any submissions received following the exhibition of the environmental impact statement (EIS), or if opportunities arise to further minimise potential environmental impacts.

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

1.3 Purpose and scope of this report

This report has been prepared to support the environmental impact statement (EIS) for the M12 Motorway project. The EIS has been prepared to address the Secretary’s Environmental Assessment Requirements (SEARs) for the project (SSI 9364) and to enable the Minister for Planning and Public Spaces to make a determination on whether the project can proceed. The report presents an assessment of the construction and operational activities for the project that have the potential to impact air quality.

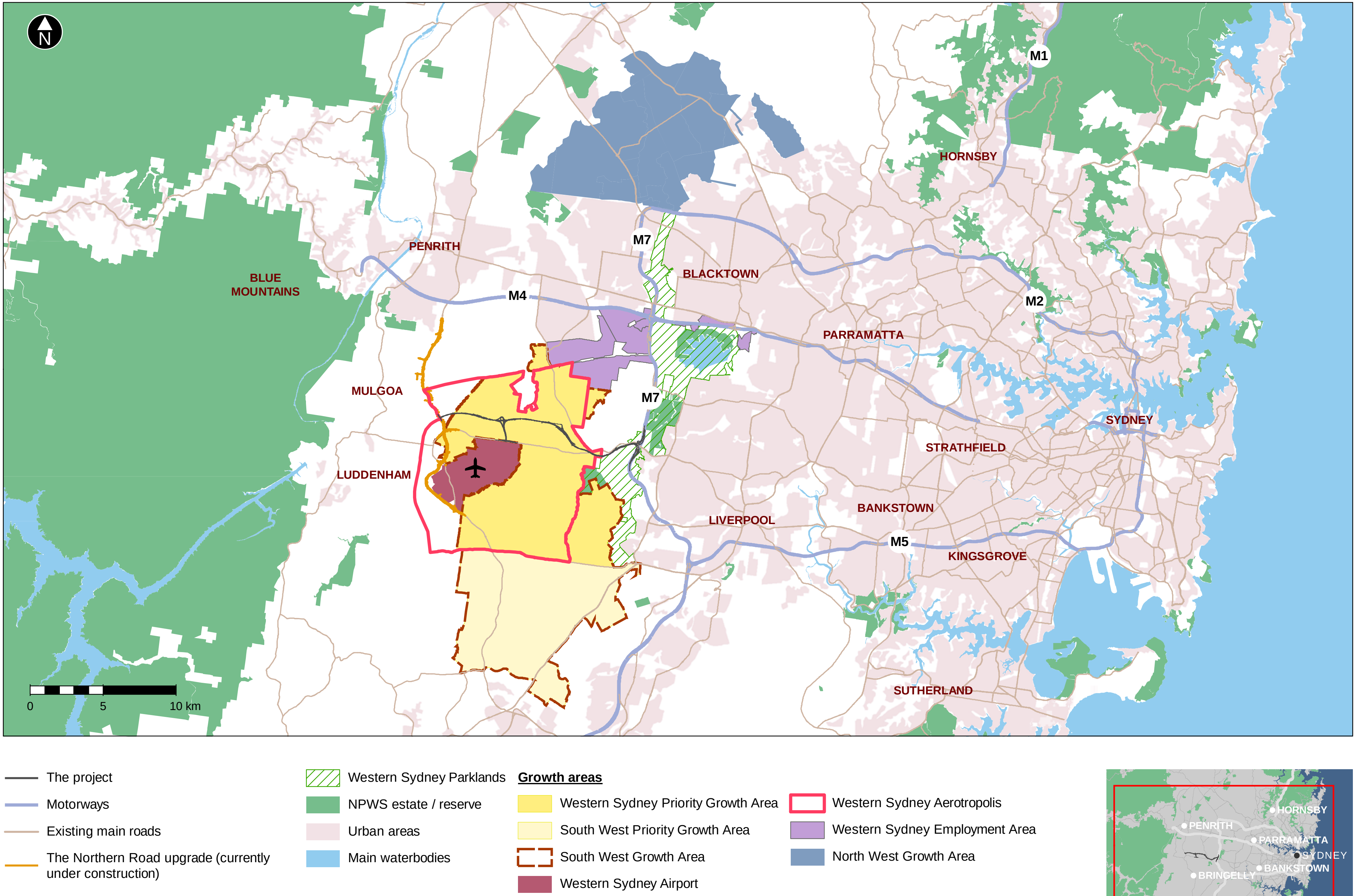

Figure 1-1 Project location (regional context)

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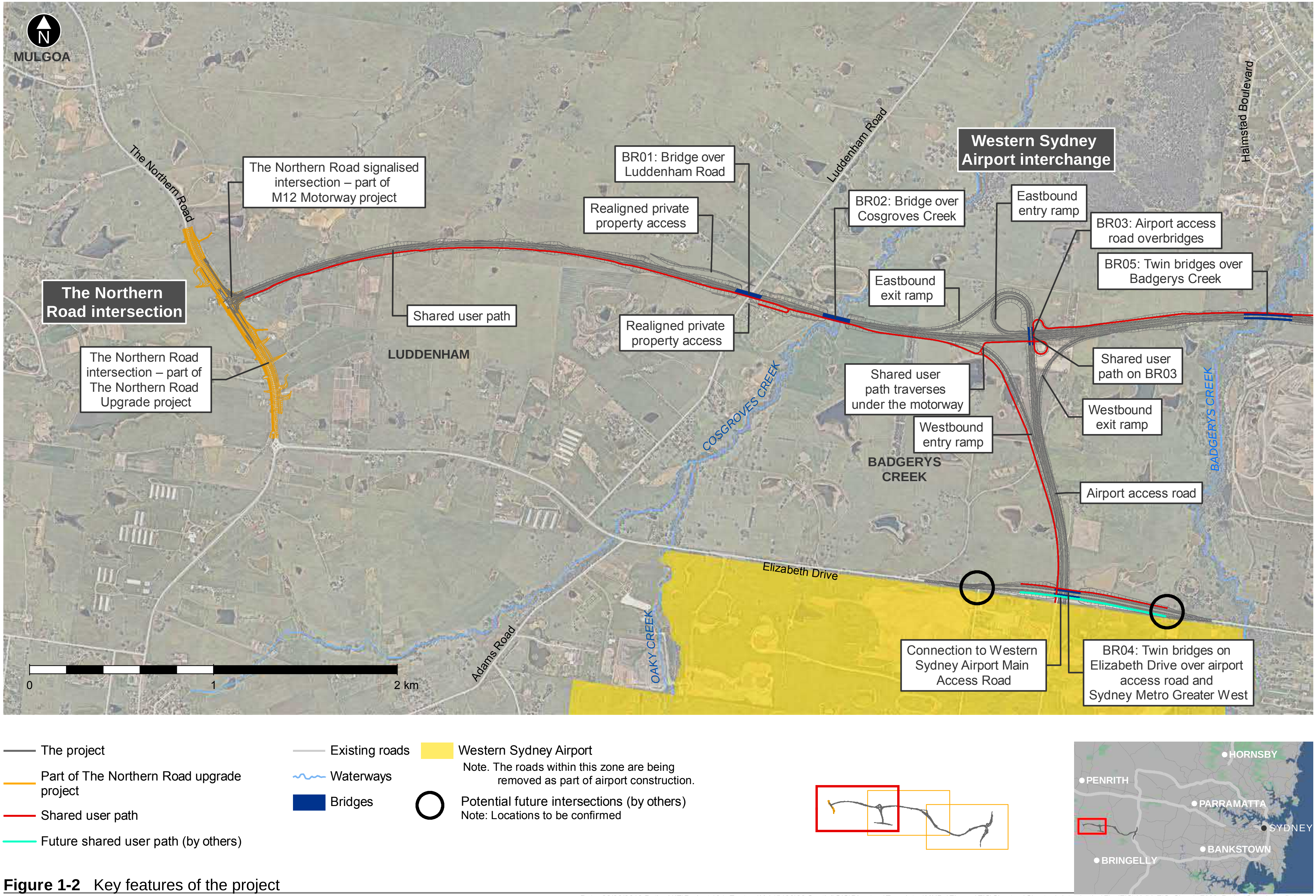

Figure 1-2 Key features of the project

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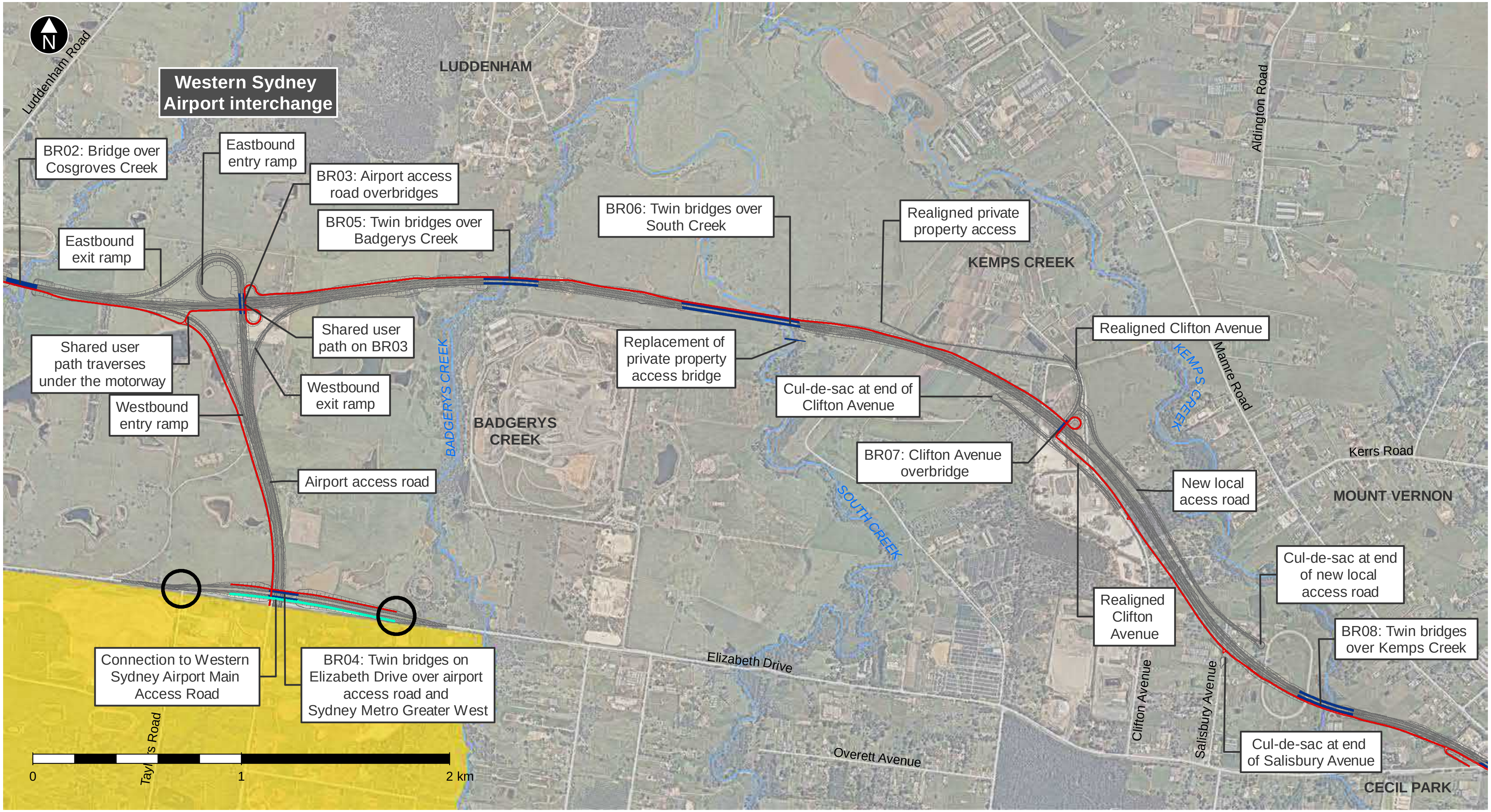

The project

Part of The Northern Road upgrade project

Shared user path

Future shared user path (by others)

Existing roads

Waterways

Bridges

Western Sydney Airport

Note. The roads within this zone are being removed as part of airport construction.

Potential future intersections (by others)

Note: Locations to be confirmed

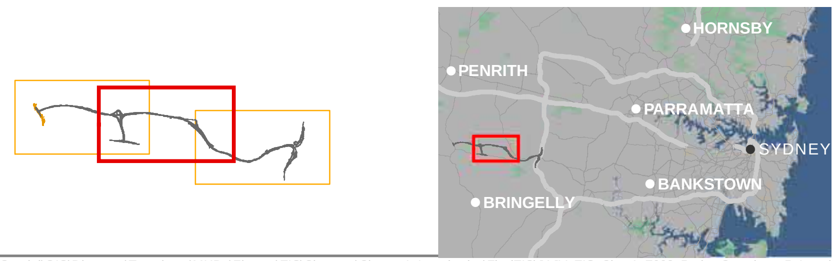

Figure 1-2 Key features of the project

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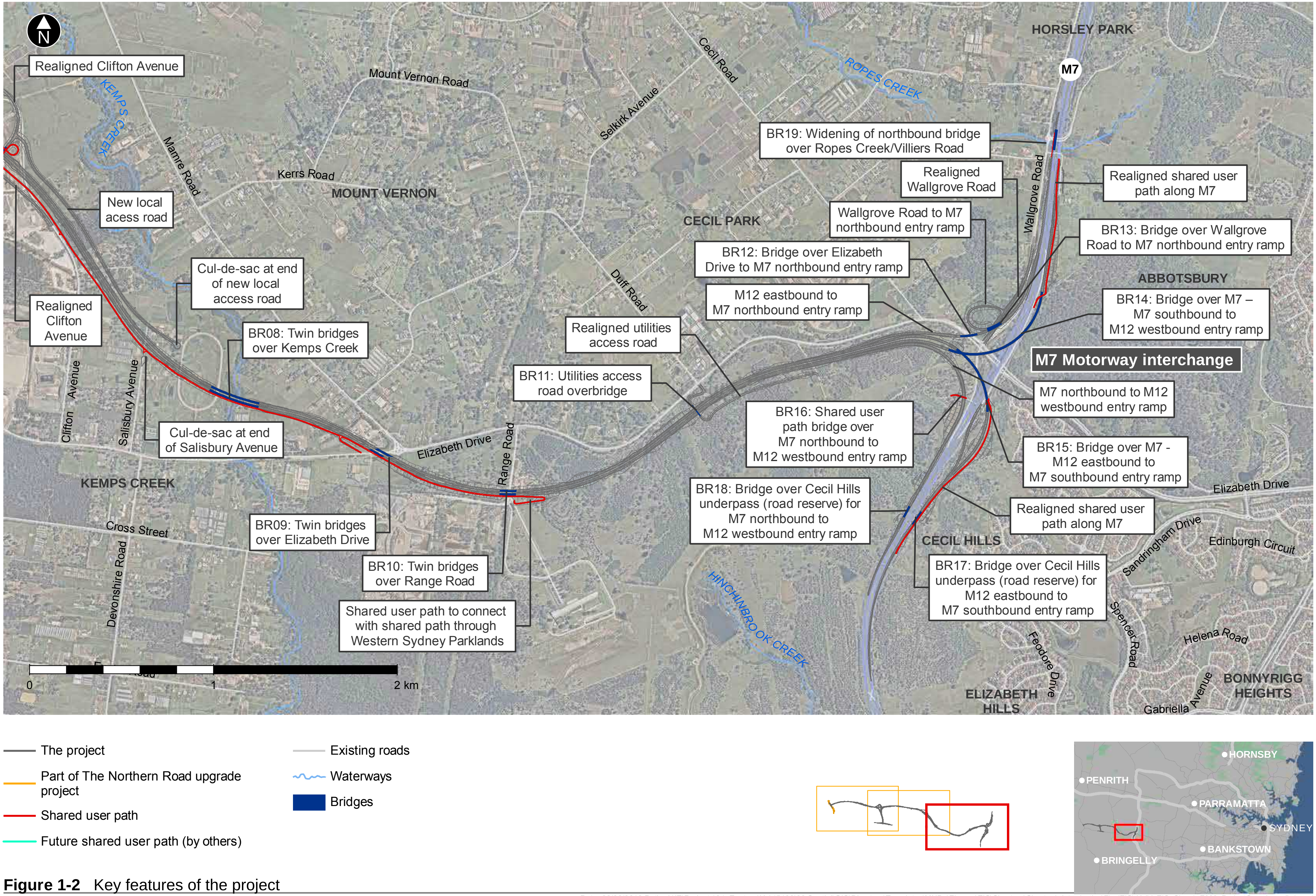

Figure 1-2 Key features of the project

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1.4 SEARs

Table 1-1 lists the Secretary's environmental assessment requirements (SEARs) requirements relating specifically to the assessment of the project's potential impacts on air quality, with a reference to the chapter or section of this report where each requirement is addressed.

Table 1-1 SEARs (air quality)

Secretary's requirement	Where addressed in this report
13. 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	**Chapter 6** and **Chapter 8**
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	**Chapter 3**, **Chapter 6** to **Chapter 8**
b. a cumulative local and regional air quality impact assessment.	**Chapter 7**

2. Air quality considerations

2.1 Overview of Chapter

This chapter identifies and describes the main air quality risks during the construction and operational phases of the project, including the key air pollutants; the processes or pathways of how they can affect air quality; and the types of impacts that can occur if they are not properly controlled and managed.

2.2 Construction

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. Dust is a general term used to describe airborne particulate matter in the form of total suspended solids (TSP) or particulate matter with a smaller aerodynamic diameter (PM_{10} and $PM_{2.5}$), or dust that is deposited on surfaces. When not properly managed, elevated airborne or deposited dust levels have the potential to cause adverse health or nuisance impacts. These types of impacts can include:

- Respiratory-related health issues
- Nuisance impacts including dust soiling (ie the unwanted settling of dust on surfaces)
- Reduced visibility and irritation of the eyes.

High dust levels can also cause physical and chemical impacts to vegetation (Farmer, 1993). Impacts on vegetation can include physically smothering the leaves, physically blocking the stomata (Farmer, 1993; Doley, 2006) and an increase in leaf temperature (Doley, 2006). Critical loads vary with plant function and it is not possible to predict the precise nature of one plant response from the known response of another (Doley, 2006). A recent study (Doley, 2006) examined the physical effects of dust on vegetation and suggested that the most sensitive plant functions may be altered with dust loads of about eight grams per square metre (g/m^2) for dusts with medium diameters of 50 micrometres (µm).

Exhaust emission 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 and/or hazardous materials, and airborne hazardous materials (eg asbestos and fungal spores). However, as dust represent the primary air quality-related risk during construction, it is the focus of the construction air quality assessment. Measures to address exhaust emissions from construction plant and equipment, odour and airborne hazardous materials are provided in **Chapter 8**.

2.3 Operations

2.3.1 Significance of emissions from road traffic

Emissions from traffic along roads is a key source of air pollution in Australian cities. 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 have been linked to a variety of impacts at a local scale, including impacts to human health and amenity, heritage, as well as ecological environmental values; along with impacts at wider regional scales.

2.3.2 Key pollutants associated with road traffic

The 'Australia: State of the Environment 2016 – Atmosphere' (SoE 2016) report (Keywood, Hibberd and Emmerson, 2017) lists carbon monoxide (CO), oxides of nitrogen (NO_x) including nitrogen dioxide (NO_2) and particulate matter (PM_{10} and $PM_{2.5}$) as the primary pollutants associated with motor vehicle emissions. Volatile organic compounds (VOCs) are also noted to be a key pollutant associated with motor vehicle exhaust emissions.

In other locations sulfur dioxide (SO_2) is another key pollutant associated with road vehicles, although this isn't generally the case in Australia owing to the relatively low sulfur content in Australian fuels (DEC, 2005). Ozone (O_3) is another notable pollutant connected to emissions from traffic, although it is secondary pollutant, formed through chemical reactions of NO_2 in the atmosphere.

2.3.3 Exposure pathways

The M12 Motorway would be a new surface road. There are various sources of emissions to air associated with surface roads including:

- Exhaust emissions from the combustion of, predominantly, fossil fuels associated with vehicle movements during operation; these include CO, NO_x, PM_{10}, $PM_{2.5}$ and VOCs
- Fugitive emissions of PM_{10} and $PM_{2.5}$ from the wearing of tyres, vehicle brakes and the road surface; as well as from the entrainment of particulate matter
- Re-entrainment of PM_{10} and $PM_{2.5}$ as a result of air flows associated with traffic movements along the new road
- VOCs from the evaporation of oils, lubricants and fuel used in vehicles.

The mass of pollutants emitted from roadways is based on several factors including:

- Aspects related to the road, including:
  - Gradient
  - Number of lanes
  - Nature (eg dual-carriageway, dual-direction)
- Aspects related to the road associated traffic, including:
  - Volume
  - Relative proportion of light and heavy vehicles
  - Speed
  - Distribution throughout the day.

The potential for impacts from these emissions is a function of the total mass of pollutants emitted from the roadway and the characteristics of the receiving environment. These include:

- Physical and atmospheric conditions:
  - Local meteorology
  - Terrain features
  - Ambient air quality conditions
- Environmental values of the receiving environment:
  - Density and proximity of human and environmental receiver locations.

The key air quality consideration associated with the project during operation (see **Section 6.2**) is the changes in local air quality associated with traffic changes as a result of:

- Any new traffic that would be introduced via a new surface road (ie as a direct result of the project)
- Direct traffic changes along adjoining roads (ie The Northern Road, M7 Motorway) as a result of the project
- Indirect traffic changes along Elizabeth Drive.

3. Policy and planning setting

3.1 Overview

There are several statutes and guidelines that apply to the regulation of emissions to air from road transport operations. This section identifies and summarises the relevant requirements from these regulations, policies and guidelines which include:

- NSW *Protection of the Environment Operations Act 1997* (POEO Act NSW)
- NSW Protection of the Environment Operations (Clean Air) Regulation 2010 (POEO Clean Air Regulation)
- 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 (NSW EPA, 2016)
- Approved Methods for Sampling and Analysis of Air Pollutants in NSW (NSW Department of Environment and Conservation [DEC], 2005)
- Air Emissions Inventory for the Greater Metropolitan Region in New South Wales, (EPA, 2012)
- 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, 2006).

Requirements relevant to the project from each of these documents are outlined below. It is noted that there are other standards which regulate emissions from new and in-service vehicles and fuel quality, although these are not relevant to how air quality impacts have been assessed from the project.

3.2 NSW Protection of the Environment Operations Act 1997

The NSW *Protection of the Environment Operations Act 1997* (POEO Act NSW) is the primary piece of legislation for the regulation of potential pollution impacts associated with Scheduled operations or activities in NSW. Scheduled activities are those defined in Schedule 1 of the POEO Act. These include road construction where the activity results in the existence of four or more traffic lanes (other than bicycle lanes or lanes used for entry or exit) for at least:

- Roads classified under the *NSW Roads Act 1993* as a ‘freeway’ or’ tollway’:
  - One kilometre of their length in the metropolitan area, or five kilometres of their length in any other area
- Roads classified as a main road:
  - Three kilometres of their length in the metropolitan area, or five kilometres of their length in any other area.

The project comprises about 16 kilometres of new roadway and its construction would constitute as a Scheduled activity under the POEO Act. As such, project construction activities would need to comply with the requirements of Chapter 5, Part 5.4 – Air Pollution of the Act. In general, these requirements seek to ensure that emissions from a project do not result in unacceptable air quality beyond the project, including at surrounding sensitive receivers.

3.3 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.

3.4 National Environment Protection (Ambient Air Quality) Measure

In 1998 the National Environment Protection (Ambient Air Quality) Measure (NEPM) was entered into force. The statute established national ambient air standards for six key pollutants:

- Carbon monoxide (CO)
- Nitrogen dioxide (NO_2)
- Sulfur dioxide (SO_2)
- Lead (Pb)
- Photochemical oxidants as ozone (O_3)
- Particulate matter with an aerodynamic diameter less than 10 microns (PM_{10}).

The intent of these standards is to preserve air quality conditions to allow for adequate protection of human health and well-being.

In 2003, the NEPM was expanded to include advisory reporting standards for particulate matter with an equivalent aerodynamic diameter less than 2.5 microns ($PM_{2.5}$). On 25 February 2016, NEPM entered into force and introduced the following changes:

- $PM_{2.5}$ advisory reporting standards were changed to formal standards like the other six key pollutants
- The annually averaged PM_{10} standard was updated from 30 μg/m^3 to 25 μg/m^3
- An aim to reduce the 24-hour and annually averaged $PM_{2.5}$ standards from eight μg/m^3 and 25 μg/m^3 to seven μg/m^3 and 20 μg/m^3 by 2025 was introduced
- Initiating a nationally consistent approach to reporting population exposure to $PM_{2.5}$
- Replacing the five-day exceedance form of the 24-hour $PM_{2.5}$ and PM_{10} standards with an exceptional event rule.

Further, on 7 December 2018, the National Government notified of their intent to vary the NEPM again to strengthen standards applicable to O_3, SO_2 and NO_2. This update would reflect current scientific understanding to provide a higher level of health protection from air pollution impacts associated with these pollutants for the Australian population.

The ambient air standards presented in the NEPM apply to urban ambient air quality monitoring stations, which broadly represent levels of exposure to urban populations. The standards are not intended to be used as criteria for assessing air quality impacts associated with projects and developments. These criteria are set by the States and Territories. In NSW, the 'Approved Methods for the Modelling and Assessment of Air Pollutants in NSW' (Approved Methods), (EPA, 2016) provides criteria for assessing air quality impacts from projects and developments.

The impact assessment criteria from the Approved Methods (presented and discussed in **Section 3.6**) for CO, NO_2, SO_2, Pb, O_3, PM_{10} and $PM_{2.5}$ are presently the same as the ambient air standards contained in the NEPM. As discussed below, the impact assessment criteria from the Approved Methods are designed for the assessment of emissions to air from industrial point sources rather than diffuse emissions from roadways. Nevertheless, assessment of air quality impacts from a project requires some basis for review, and so the impact assessment criteria from the Approved Methods were considered for the project.

3.5 National Environment Protection Measure for Air Toxics (Air Toxics NEPM)

Recognising the health effects associated with exposure to air toxics, the Air Toxics NEPM was developed to improve the information base regarding ambient air toxics within the Australian environment to facilitate the development of ambient air quality standards for these substances. Five priority pollutants are covered; benzene, formaldehyde, toluene, xylenes and benzo(a)pyrene. The Air Toxics NEPM includes monitoring investigation levels for these pollutants, which are for use in assessing the significance of monitored concentrations with respect to provisions for the protection of human health. These monitoring investigation levels are not intended for assessing compliance from projects and developments.

The Approved Methods contains impact assessment criteria for these air toxic pollutants which are discussed in **Section 3.6**. As for CO, NO_2, SO_2, Pb, O_3, PM_{10} and $PM_{2.5}$, the impact assessment criteria for air toxics in the Approved Methods are designed for the assessment of emissions to air from industry and not roadways but provide a basis for reviewing the levels predicted from the project.

3.6 Approved Methods for the Modelling and Assessment of Air Pollutants in NSW

The Approved Methods (EPA, 2016) outlines the approach to be applied for the modelling and assessment of air pollutants from stationary sources in NSW. Although the procedure does not relate specifically to road projects, the impact assessment criteria have been considered to provide an indication of the significance of a project's effect on air quality. Criteria relevant to the key pollutants related to the project are listed in **Table 3-1**. Column four lists where these criteria were adopted from.

Table 3-1 EPA air quality impact assessment criteria

Pollutant	Averaging time	Concentration	Source
Particulate matter (as PM_{10})	24-hour	50 µg/m^3	EPA 2016, DoE, 2016
	Annual	25 µg/m^3	EPA 2016, DoE, 2016
Particulate matter (as $PM_{2.5}$)	24-hour	25 µg/m^3	EPA 2016, DoE, 2016
	Annual	8 µg/m^3	EPA 2016, DoE, 2016
Nitrogen dioxide (NO_2)	one-hour	246 µg/m^3	EPA 2016, NEPC, 1998
	Annual	62 µg/m^3	EPA 2016, NEPC, 1998
Carbon monoxide (CO)	15 minutes	100 mg/m^3	EPA 2016, WHO, 2000
	1 hour	30 mg/m^3	EPA 2016, WHO, 2000
	8 hours	10 mg/m^3	EPA 2016, NEPC, 1998
Benzene	1 hour	29 µg/m^3	EPA 2016, GoV, 2001

The intent of each of these criteria have been summarised below:

- Particulate matter (PM_{10} and $PM_{2.5}$) – Part 2, Clause 5 of the NEPM states that the desired outcome of the measure is 'ambient air quality that allows for the adequate protection of human health and well-being'.
- Total suspended solids (TSP) – The now rescinded Ambient Air Quality Goals Recommended by the National Health and Medical Research Council, (National Health and Medical Research Council, 1996) states that 'at these levels [the criterion in **Table 3-1,** above] there still may be some people who will experience respiratory symptoms' but that the intent of this criteria is the protection of human health for the broader majority of the population.
- Carbon monoxide (CO) – The criteria for CO adopted from the WHO Air Quality Guidelines for Europe, 2nd Edition, (World Health Organisation, 2000) are intended to preserve a COHb (Carbon monoxide haemoglobin oxygen carrying capacity of the blood) safe level of 2.5 per cent for a 'normal subject' engaging in light or moderate exercise. Exposures to concentrations above these levels for the periods specified were stated to result in adverse health effects.
- Nitrogen dioxide (NO_2) – The same objective is stated for NO_2 in the Ambient Air – National Environment Protection Measure for Ambient Air Quality, (National Environment Protection Council, 1998); namely to provide 'adequate protection of human health and well-being'. Guidance regarding NO_2 exposure is detailed in the World Health Organisation (2000) guideline which indicates that a one-hour averaged criteria of 200 µg/m^3 includes a 50 per cent 'safety margin' and that it was only when short-term exposure was greater than 400 µg/m^3 that there was 'evidence to suggest possible small effects in function of asthmatics'.
- Volatile organic compounds (VOCs) – This criterion is adopted from guidance presented in State Environment Protection Policy (Air Quality Management) No. S 240, (Government of Victoria, 2001). Part II Schedule A of the guideline describes how this criterion includes a factor of safety of 40, given the high toxicity and potential health effects arising from exposure to such substances.

The criteria for PM_{10}, $PM_{2.5}$, NO_2 and CO relate to the total maximum predicted concentration. This comprises of the maximum predicted incremental concentration from the activity (ie the predicted impacts due to the project alone) and background levels (ie ambient pollutant concentrations from all surrounding natural and anthropogenic sources without the project). Further details of the background levels applied in the assessment are discussed below in **Section 5.2.4**. These criteria apply to the nearest existing or likely future sensitive receiver areas in relation to the project. Benzene is classified in NEPM as an air toxic and, as such, its assessment criteria applies at a site boundary. It is important to note that these criteria are not limits. Although these criteria do not specifically apply to road projects, they have been considered to provide an indication of the significance of the project's effect on air quality during operations.

3.7 Approved Methods for Sampling and Analysis of Air Pollutants in NSW

The 'Approved Methods for Sampling and Analysis of Air Pollutants in NSW' (DEC, 2005) provides guidance for the monitoring and analysis of air pollutants in NSW. Ambient air quality data collected from stations being operated by the Environment, Energy and Science Group (EESG) of the Department of Planning, Industry and Environment (former NSW Office of Environment and Heritage) in accordance with this guideline were adopted for this assessment.

3.8 Air Emissions Inventory for the Greater Metropolitan Region in New South Wales

The Air Emissions Inventory for the Greater Metropolitan Region in New South Wales, (EPA, 2012) provides the outcomes of a study into the anthropogenic (ie human-made), and natural sources of emissions to air in the Greater Metropolitan Region comprising of Sydney, Newcastle and Wollongong. The investigation quantifies emissions from all sources of air pollution, including on-road transportation. The study and subsequent updates established vehicle emission databases for the base year of assessment (2008), and projections for 2011, 2016, 2021, 2026, 2031 and 2036. These emission factors are incorporated into the Roads and Maritime Tool for Roadside Air Quality (TRAQ) which was used to perform the assessment of potential operational air quality impacts associated with the project (see **Section 4.4**).

3.9 Guidance on the assessment of dust from demolition and construction Version 1.1

The UK Institute of Air Quality Management (UK IAQM) developed the guideline, 'Guidance on the assessment of dust from demolition and construction Version 1.1', (UK IAQM, 2014). The document provides an approach for assessing the potential for dust-related impacts during construction, taking into consideration the sensitivity of the local environment and the expected magnitude of different construction activities. Further details of the UK IAQM assessment methodology is provided in **Section 4.3**, and it is applied to the project in **Section 6.1**.

3.10 Assessment and Management of Odour from Stationary Sources in NSW (DEC, 2006)

The document, 'Assessment and Management of Odour from Stationary Sources in NSW', (DEC, 2006) provides guidance for the assessment and management of odours arising from stationary sources in NSW. Given the nature of the project involving a new roadway, this guideline is not strictly applicable. Still, recommendations for the management of odours should they arise during construction were considered with reference to the guidance presented.

4. Assessment methodology

4.1 Overview

The methods applied to assess the potential for impacts during the project's construction and operation are designed to address the primary risks to air quality during the project's construction and operation in accordance with the SEARs and the statutes, policies and guidelines listed in **Chapter 3**. These risks are identified above in **Chapter 2**. In general, the assessment involved:

- 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 respectively; as well as local terrain characteristics which also have the potential to influence how pollutants are dispersed
- Using the UK IAQM's semi-quantitative risk-based approach to assess potential air quality impacts during construction
- Applying the Roads and Maritime TRAQ tool to predict changes in emissions to air during operations
- Reviewing potential cumulative air quality impacts from nearby projects
- Developing measures to mitigation or otherwise effectively manage any potential impacts predicted.

The following sections provide details of how each of these assessment steps were completed with steps one and two already addressed in **Chapter 2** and **Chapter 3** respectively.

4.2 Existing environment

4.2.1 Climate and meteorology

Climate and meteorological conditions are important for determining the direction and rate at which emissions from a source would be released to the air. The key factors affecting dispersion are wind speed and direction. Air temperature and precipitation are also important meteorological aspects which influence rates of emission and dispersion.

Climate and meteorological conditions around the project were established by considering long-term data from the nearby automatic weather station operated by the BoM at Bringelly (see **Figure 6-1**). These data were used to determine times of the year that are most conducive to dust generation. In addition, the data were also used to identify if the prevailing local wind conditions would transport emissions from the project towards sensitive receivers. Existing prevailing climate and meteorological conditions around the project are discussed in **Section 5.1**.

4.2.2 Terrain

Terrain features can influence how pollutants are dispersed from a source to surrounding receivers. Terrain is not specifically considered in the construction or operational impact assessment methodologies (that is, UK IAQM and TRAQ respectively). However, there are no significant terrain features in the vicinity of the project that would affect the outcomes of this assessment.

4.2.3 Local and regional ambient air quality

To identify 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. Previous studies (EPA, 2012; NSW Government, 2017) were reviewed to identify key characteristics and factors contributing to air quality around the Greater Sydney Region. Local air quality conditions around the project were determined by reviewing monitoring data gathered from nearby monitoring stations managed by EESG.

This review of regional and local air quality conditions for the project is presented in **Section 5.2**.

4.3 Impacts during construction

As identified in **Section 2.2**, potential impacts to human health, annoyance and ecology from dust generation represents the primary air quality-related risk during construction. The assessment has followed guidance presented in 'Guidance on the assessment of dust from demolition and construction Version 1.1' (UK IAQM, 2014) to identify the potential for dust impacts during the project. The IAQM aims to identify risks and recommend appropriate management measures. It considers potential dust impacts arising from four primary activities during construction and demolition activities:

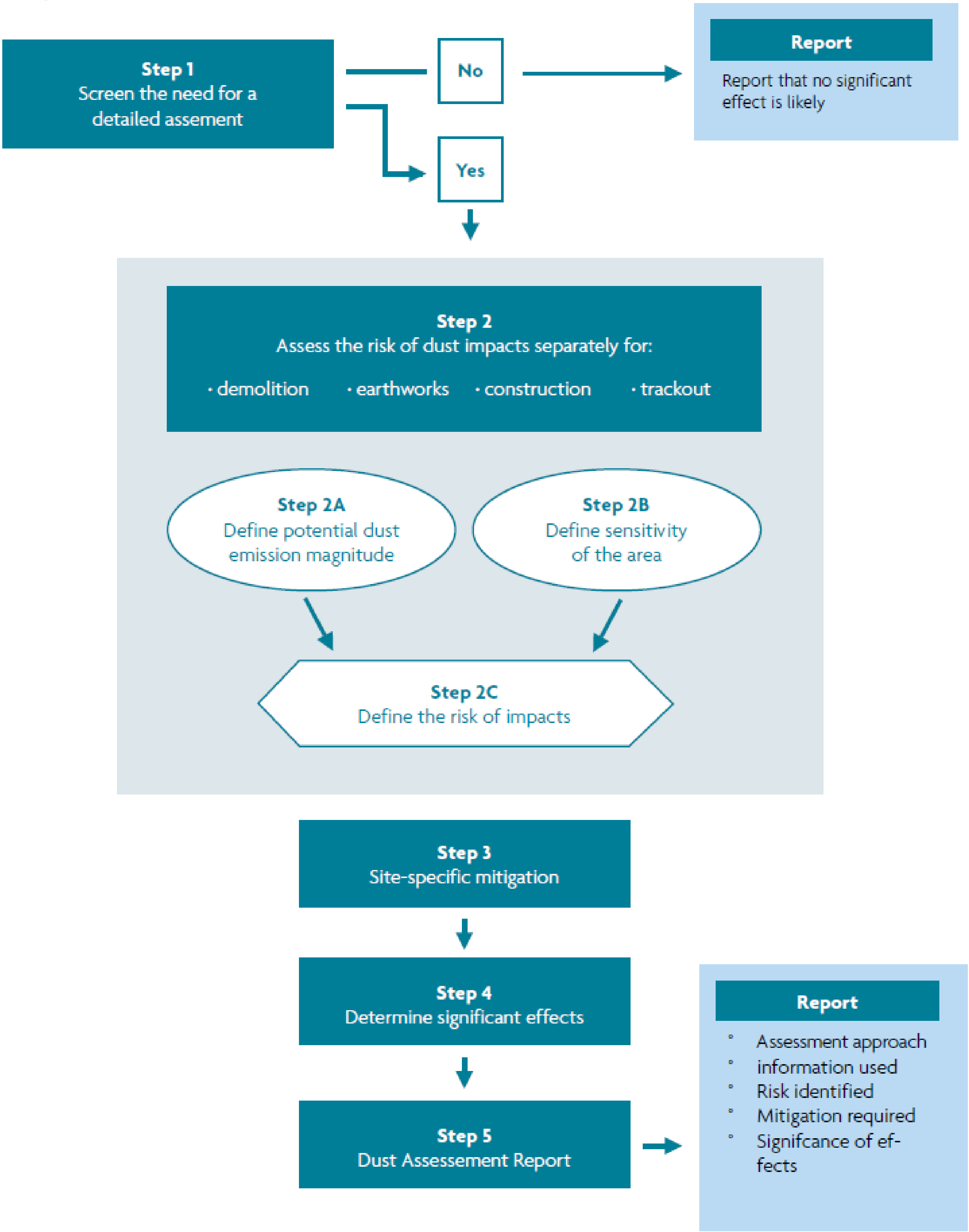
- Demolition
- Earthworks
- Construction
- 'Trackout' or the transport-related handling of construction materials.

Application of this semi-quantitative, risk-based assessment approach is consistent with the approach used to assess construction related impacts on other recent large-scale Australian road transport projects including the new M5 Motorway and M4 Motorway East projects, and F6 Motorway. The approach is preferred as it can be difficult to reliably predict potential impacts using modelling approaches which have high levels of uncertainty about when, where and how intensively specific activities would be completed, and the corresponding weather conditions. The IAQM provides robust mitigation and management measures which are aligned to the assessed levels of unmitigated risk.

The assessment procedure involves four steps of assessment, with the intended outcome of developing suitable mitigation measures to avoid any potential nuisance, human health and ecological impacts from dust generated during the four primary activities. These steps are presented in **Figure 4-1** and involve:

- Step 1 involved a screening review to establish a study area for construction (see **Figure 6-1** and **Figure 6-2**) and identify nearby human and ecological receivers which have the potential to be impacted by the intended works.
- Following this identification, the next step involved evaluating of the potential magnitude (Step 2A) and sensitivity of the surrounding receiving environment to dust impacts (Step 2B). Step 2A and 2B were combined in Step 2C to estimate the risk of dust impacts if no mitigation measures were applied. Step 2 was completed for different work areas across the project so that changes in risk profiles could be identified and assessed across the entire project.
- Step 3 subsequently involved the development of mitigation for each work location, commensurate to the level of risk determined in Step 2.
- Finally, Step 4 involved evaluating any residual dust-related risks following the application of the control measures developed during Step 3 to verify that a suitable level of mitigation has been developed to reduce the impacts to the extent practicable.
- The assessment methodology is intrinsically linked to the process, and so full details of how the assessment was completed and its outcomes are presented in **Section 6.1**.

- As noted in **Section 2.2**, there are other air quality risks that have the potential to result in impacts to sensitive receivers during construction. These included exhaust emissions from construction plant and equipment, odour and airborne hazardous materials. These matters have been assessed qualitatively and are discussed in **Section 6.1.5**, with mitigation and management measures provided in **Section 8.1**.



Source: UK IAQM, 2014

Figure 4-1 UK IAQM Construction air quality assessment procedure

4.4 Impacts during operations

4.4.1 Overview

Changes to local air quality as a result of the project were quantitatively assessed using the Roads and Maritime TRAQ tool; a system which uses the CALINE dispersion model to predict air pollutant concentrations near roadways. TRAQ considers both combustion exhaust emissions as well as emissions from brake and tyre wear. The tool is intended to provide 'first-pass screening' of air quality impacts in connection with road-related projects when preparing environmental impact assessments. The model applies conservative, worst-case scenarios 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 EPA's Approved Methods
- Establishing ambient air quality conditions in the local area surrounding the project using publicly available data from the EESG
- Determining assessment scenarios and quantitatively predicting emissions to air during operation of the project using TRAQ
- Developing measures to mitigate or otherwise effectively manage any potential impacts.

The following sections provide further detail of how each of these steps were carried out.

4.4.2 Study area and sensitive receivers

The study area for the operational assessment comprises a 200-metre buffer from the edge of the construction footprint. This area (see **Figure 6-3** and **Figure 6-4**) is based on the TRAQ operational air quality prediction model (discussed below in **Section 4.4.6**) that evaluates impacts to 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.

Section 5.2 of the Approved Methods considers sensitive receivers as 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 area as presented in State Environmental Planning Policy (Sydney Region Growth Centres) 2006 (Growth Centres SEPP), *State Environmental Planning Policy (Sydney Region Growth Centres) Amendment (Miscellaneous) 2010*, and The Western Sydney Aerotropolis Land Use and Infrastructure Implementation Plan, Stage 1: Initial Precincts (LUIIP) (NSW Department of Planning and Environment, 2018). These are identified below in **Section 6.2.2**.

4.4.3Assessment guidance

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 do not specifically 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 listed above in **Chapter 3**, and have also be reproduced below in **Table 4-1**.

Table 4-1 Impact assessment criteria

Pollutant	Averaging time	Concentration	Source
Solid particles (as PM_{10})	24-hour	50 µg/m^3	EPA 2016, DoE, 2016
	Annual	25 µg/m^3	EPA 2016, DoE, 2016
Solid particles (as $PM_{2.5}$)	24-hour	25 µg/m^3	EPA 2016, DoE, 2016
	Annual	8 µg/m^3	EPA 2016, DoE, 2016
Nitrogen dioxide (NO_2)	one-hour	246 µg/m^3	EPA 2016, NEPC, 1998
	Annual	62 µg/m^3	EPA 2016, NEPC, 1998
Carbon monoxide (CO)	15 minutes	100 mg/m^3	EPA 2016, WHO, 2000
	1 hour	30 mg/m^3	EPA 2016, WHO, 2000
	8 hours	10 mg/m^3	EPA 2016, NEPC, 1998
Benzene	one-hour	29 µg/m^3	EPA 2016, GoV, 2001

Source: EPA, 2016

As discussed in **Section 3.7**, these criteria apply to the total concentration at nearby sensitive receivers, or in other words, the contribution from the source being assessed, as well as ambient background concentrations. They are intended for stationary industrial sources, not projects such as roadways, but have still been considered to evaluate the significance of any changes in concentrations as a result of the project.

4.4.4 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 and processed into the relevant metrics relevant to the respective criteria. These data, as well as other common metrics used to explain background air quality conditions, are presented and explained in **Section 5.2.4.**

4.4.5 Assessment scenarios

As outlined above, one of the objectives of the operational air quality assessment was to determine the potential changes in air quality associated with the traffic introduced via the new M12 Motorway, as well as from directly related traffic changes along adjoining roads (ie The Northern Road, M7 Motorway) and indirect but related traffic changes along Elizabeth Drive (a nearby alternative east-west road traffic route.

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: Concentrations from existing traffic flows along The Northern Road, the M7 Motorway and Elizabeth Drive were predicted. The existing traffic numbers considered in the assessment is detailed in **Annexure B**. 2017 traffic was applied in the existing scenario. This is because the majority of traffic counts were undertaken at this time, with other data adjusted to account for any time difference.
- Scenario 2 - With 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. The traffic information applied in this assessment scenario is listed in **Annexure B**.
- Scenario 3 - Without the project (ie do nothing), 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 information for these roads for 2026 traffic forecast without the addition of the project. These traffic data are summarised in **Annexure B**.
- Scenario 4 - With the 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 (see **Annexure B**).
- Scenario 5 - Without the project (ie do nothing), 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 information for these roads for 2036 traffic forecast without the new M12 Motorway. These data are listed in **Annexure B**.

The assumptions in the traffic modelling within the forecasts completed in Traffic Assessment and adopted for this assessment are summarised below:

- Scenario 1 – Reflects the transport network as it was in 2017 with no new projects or upgrades. 2017 was adopted as the existing year as the majority of traffic counts were undertaken at this time, with other data adjusted to account for any time difference.
- Scenario 2 – Traffic forecasts include the Northern Road upgrade, Bringelly Road upgrade, Elizabeth Drive upgrade between M7 Motorway and Mamre Road, along with the opening and operation of the Western Sydney Airport and two access intersections along Elizabeth Drive between Adams Road and Taylors Road. Includes forecast traffic growth to 2026 based on the LU14 population and employment forecast standard land use scenario developed by Roads and Maritime as well as the operation of business parks adjacent to the Western Sydney Airport.
- Scenario 3 – As for Scenario 2, without the new M12 Motorway.
- Scenario 4 – Forecasts include all upgrades assumed in 2026 do minimum, as well as upgrade of M7 Motorway to 3 lanes in each direction, upgrade of Cowpasture Road between M7 Motorway and Camden Valley Way, realignment and upgrade of Luddenham Road and Dams Road intersection, realignment of Mamre Road and Devonshire Road intersection, upgrade of Elizabeth Drive between The Northern Road and Mamre Road and upgrade of Fifteenth Avenue between Cowpasture Road and Fourth Avenue. Includes forecast traffic growth to 2036 based on the LU14 standard land use scenario as well as the operation of business parks adjacent to the Western Sydney Airport.
- Scenario 5 – As for Scenario 4, without the new M12 Motorway.

In evaluating potential air quality emissions from the scenarios above, for modelling and assessment purposes, the new M12 Motorway, was divided into several 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. Details of these segments are listed below and displayed in **Figure 6-4.** Impacts resulting from traffic changes along The Northern Road, the M7 Motorway and Elizabeth Drive as a result of the new M12 Motorway were also evaluated.

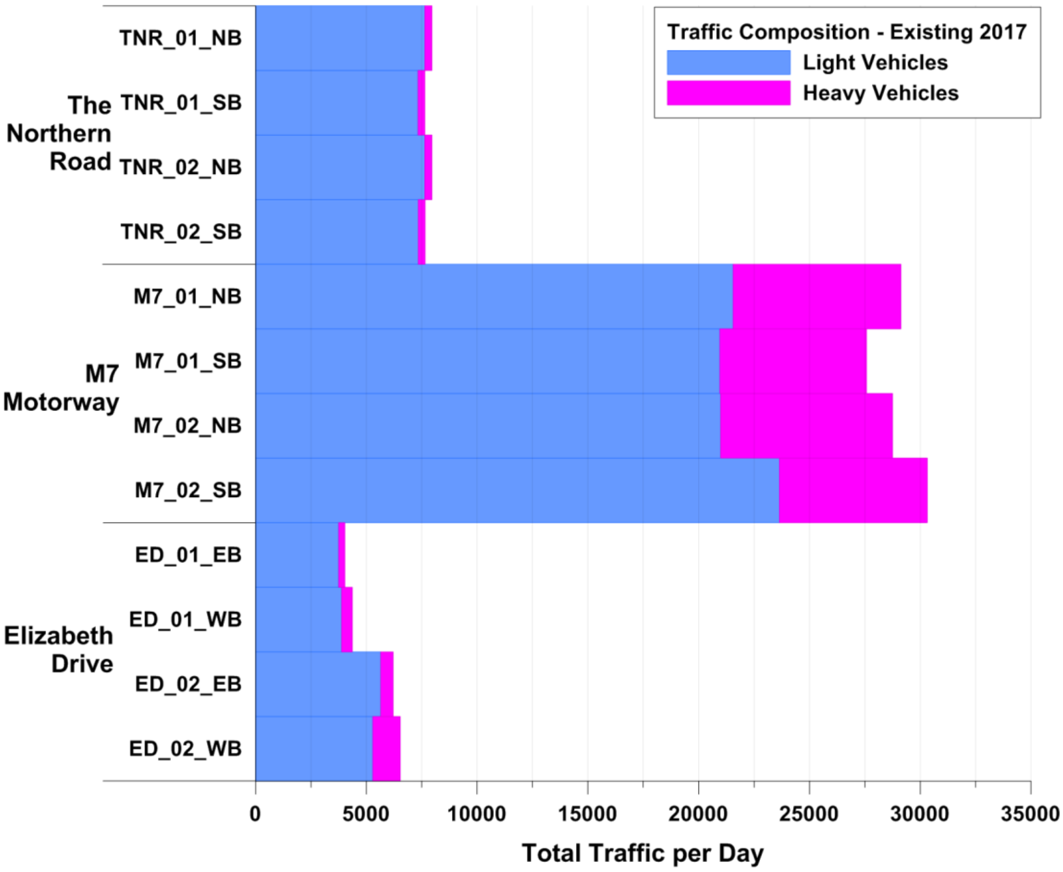
Segments of these roads around which impacts were evaluated are listed below and shown in **Figure 6-4**:

- New M12 Motorway:
  - Segment 1: M12_01 – M12 Motorway between The Northern Road and Western Sydney Airport entrance/exit
  - Segment 2: M12_02 – M12 Motorway between Western Sydney Airport entrance/exit road and Clifton Avenue
  - Segment 3: M12_03 – M12 Motorway between Clifton Avenue and Elizabeth Drive near Mamre Road
  - Segment 4: M12_04 – M12 Motorway between Elizabeth Drive near Mamre Road and the M7 Motorway
- The Northern Road (at the M12 Motorway):
  - Segment 5: TNR_01 – The Northern Road between Elizabeth Drive and the M12 Motorway
  - Segment 6: TNR_02 – The Northern Road between the M12 Motorway and Littlefields Road
- M7 Motorway (at the M12 Motorway):
  - Segment 7: M7_01 – M7 Motorway south of the M12 Motorway intersection within the study area
  - Segment 8: M7_02 – M7 Motorway north of the M12 Motorway intersection within the study area
- Elizabeth Drive (Connecting to Western Sydney Airport Access Road):
  - Segment 9: ED_01 – Elizabeth Drive between Adams Road and Western Sydney Airport entrance/exit
  - Segment 10: ED_02 – Elizabeth Drive between Western Sydney Airport entrance/exit and the M12 Motorway ramp near Mamre Road.

A detailed account of the traffic inputs for all assessment scenarios are listed in **Annexure B**. Summarises of volume and light vehicle and heavy vehicle compositions are presented in **Figure 4-2** to **Figure 4-6** below. Appendix F of the EIS provides further details about each scenario and reasoning behind projected changes in traffic along key roads in the study area.

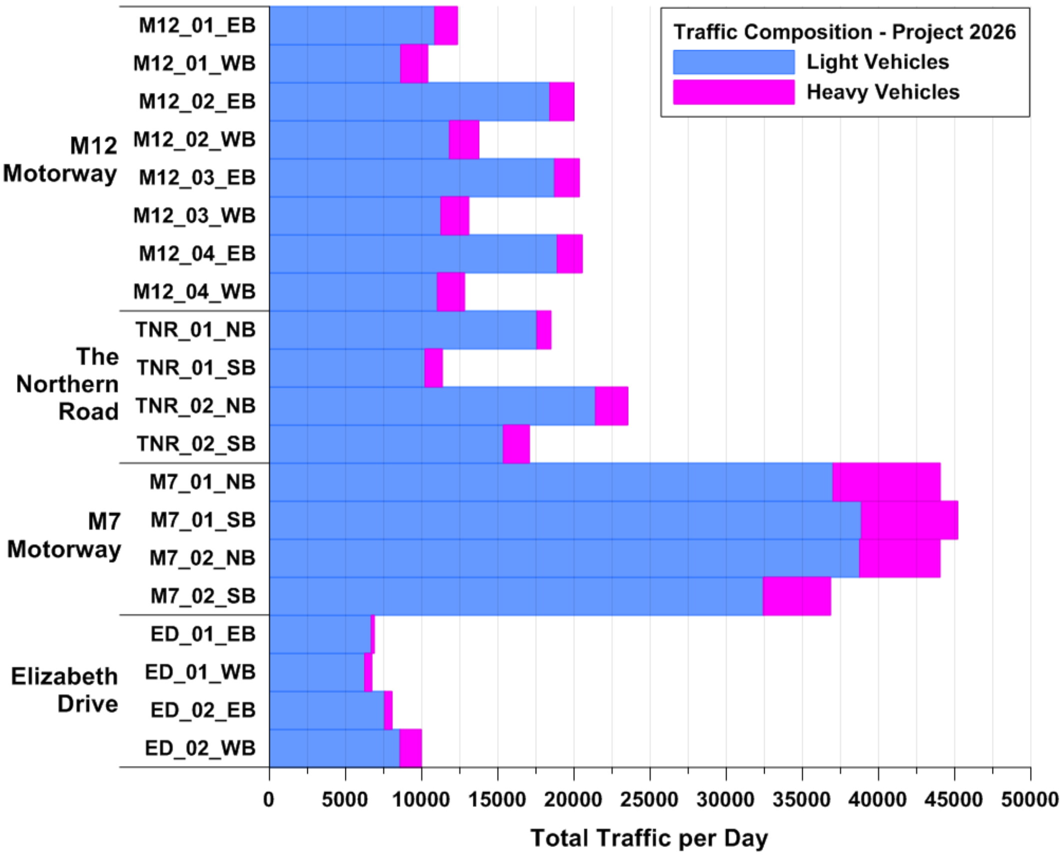
Figure 4-2 presents a summary of the volumes of light and heavy vehicles applied for the Existing Scenario (Scenario 1). As displayed, the greatest traffic flows for existing operations (ie Scenario 1) is along the M7 Motorway, which also has the highest proportion of heavy vehicles. There is some variation in traffic volumes along different segments of the same roadways and for the different directions, with the greatest difference being between segments ED_01 (Elizabeth Drive between Adams Road and Western Sydney Airport entrance/exit) and ED_02 (Elizabeth Drive between Western Sydney Airport entrance/exit and the M12 Motorway ramp near Mamre Road).

Traffic applied in the model for Scenario 2 (with the project at year of opening, 2026) is summarised in **Figure 4-3**. As displayed, total daily volumes are predicted to be the greatest along segments of the M7 Motorway. Eastbound volumes along the new M12 Motorway are predicted to be considerably higher than westbound volumes, reflecting the high number of vehicles travelling from Sydney’s west to the Western Sydney Airport and further east.



Note: NB – Northbound, SB – Southbound, EB – Eastbound, and WB - Westbound

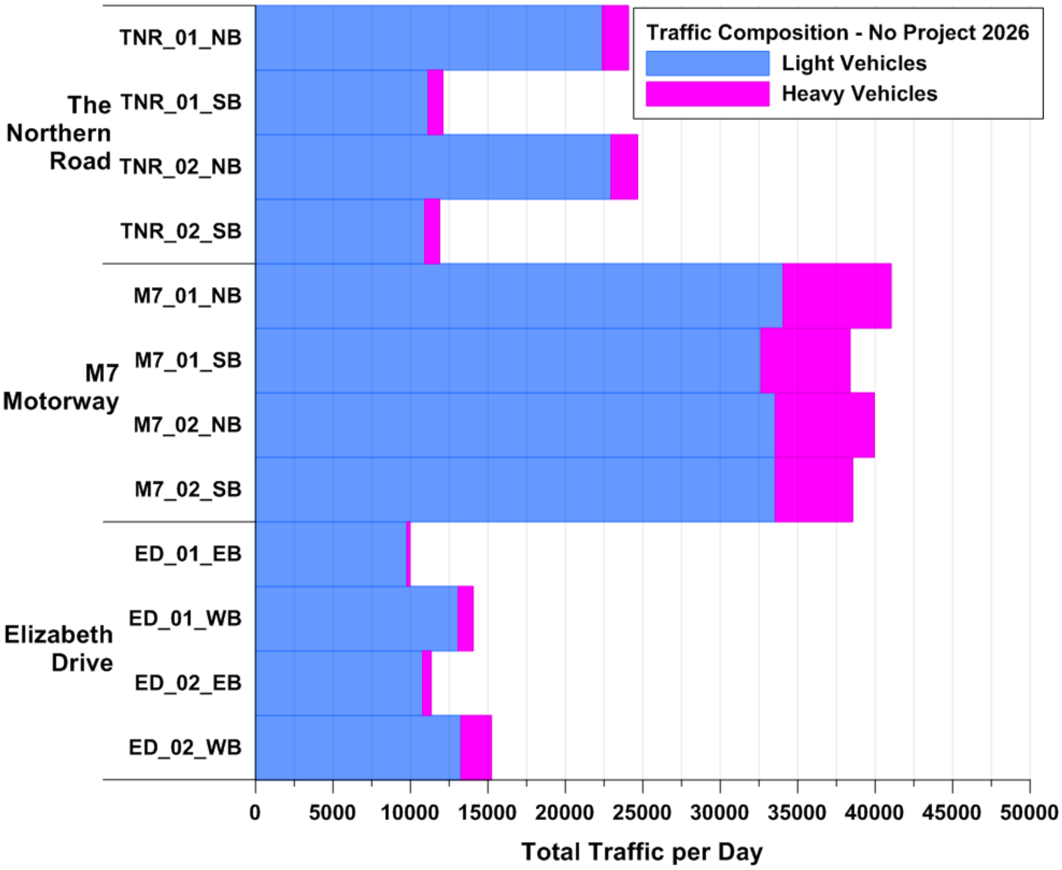
Figure 4-2 Summary of traffic inputs - Existing operations (Scenario 1)



Note: NB – Northbound, SB – Southbound, EB – Eastbound, and WB - Westbound

Figure 4-3 Summary of traffic inputs – With project, at year of opening (2026) (Scenario 2)

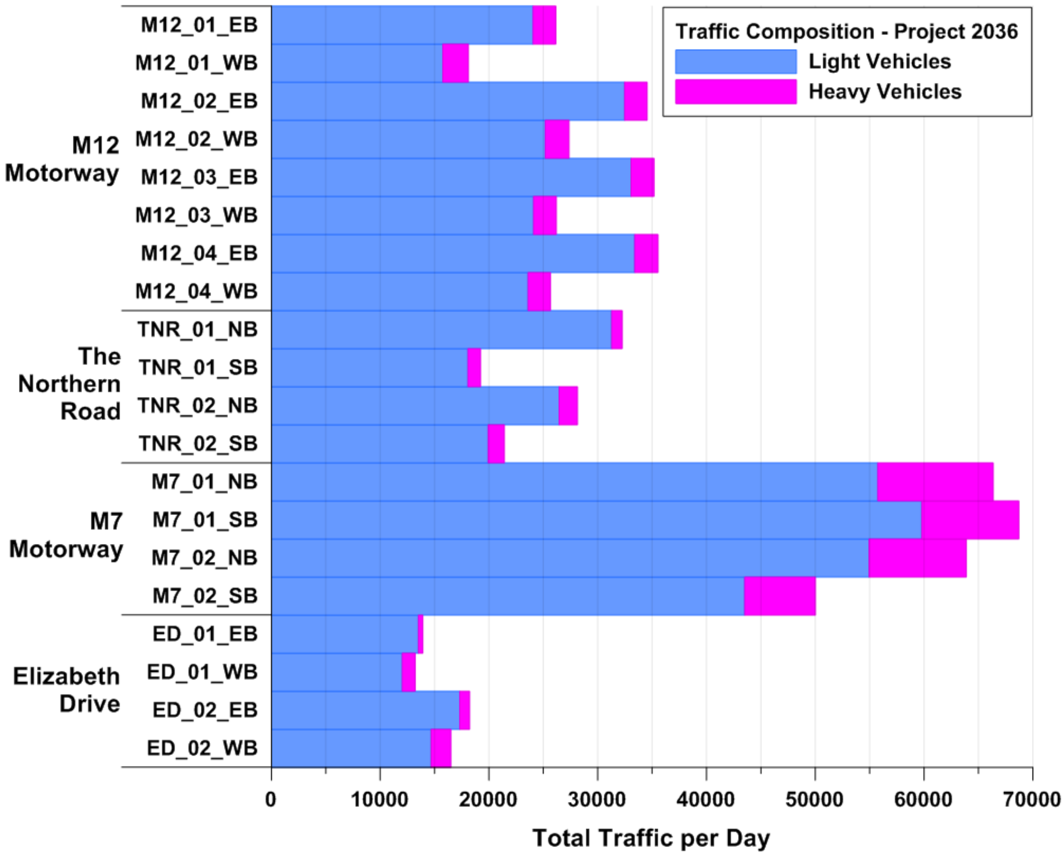
Forecasts applied in Scenario 3 (ie without project at 2026) are summarised below in **Figure 4-4**. As displayed, volumes along the northbound segments of The Northern Road (TNR_01 and TNR_02) are predicted to be higher without the project than with the project (shown in Scenario 2). This is also the case in both directions along Elizabeth Drive. Volumes along the M7 Motorway however are predicted to be lower for Scenario 3 (without the project) compared with Scenario 2 (with the project).



Note: NB – Northbound, SB – Southbound, EB – Eastbound, and WB - Westbound

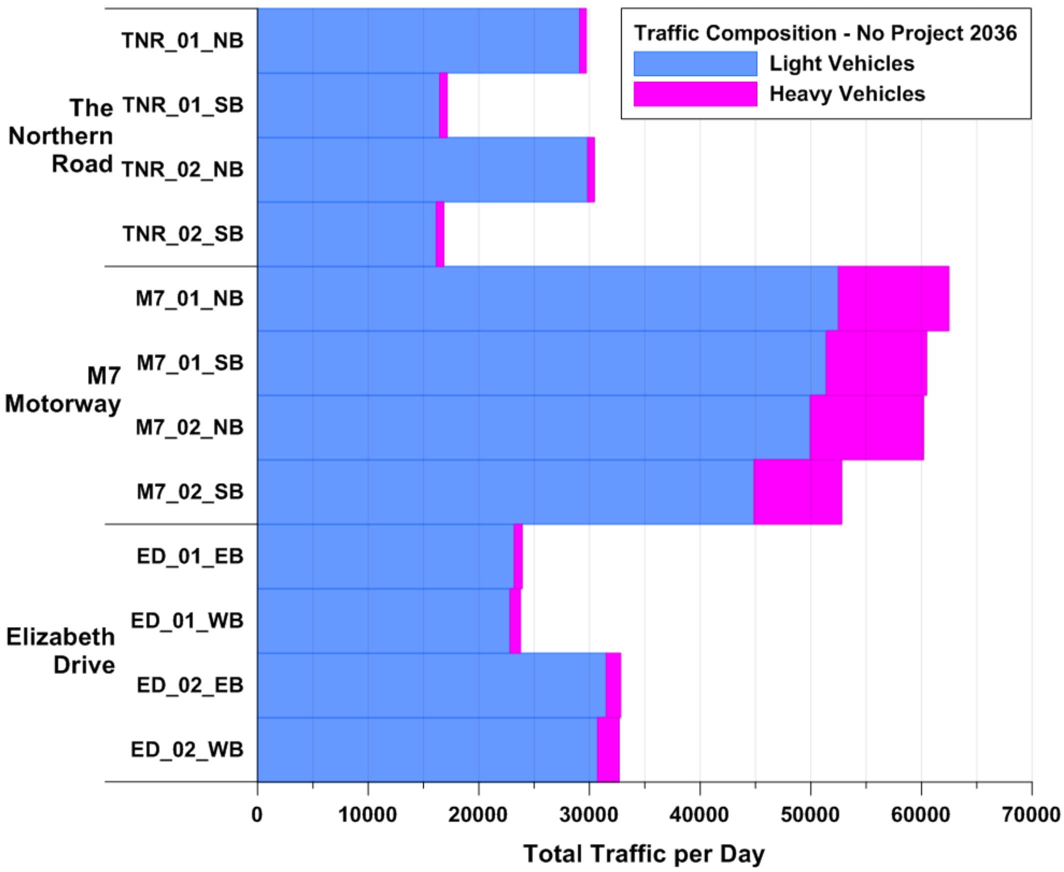
Figure 4-4 Summary of traffic inputs – Without project (ie do nothing), Year of opening (2026), (Scenario 3)

Summaries of the forecast traffic applied in the assessment for Scenario 4 and Scenario 5 are displayed below in **Figure 4-5** and **Figure 4-6** respectively. For these 2036 scenarios, the same relative trends were observed between project and no project as for 2026. That is to say that Scenario 4 (project, 2036) flows along The Northern Road assessment segments increase compared with Scenario 5 (no project, 2036). This is also the case along the M7 Motorway, with the exception of southbound traffic flows along segment M7_02, which decrease with the project. Volumes along the Elizabeth Drive segments increase considerably for Scenario 5 (no project, 2036), compared with Scenario 4 (project, 2036), as drivers are forecast to use this east-west pathway in the absence of the M12 Motorway alternative.



Note: NB – Northbound, SB – Southbound, EB – Eastbound, and WB - Westbound

Figure 4-5 Summary of traffic inputs – With project, 10 years' after opening (2036) scenario, (Scenario 4)



Note: NB – Northbound, SB – Southbound, EB – Eastbound, and WB - Westbound

Figure 4-6 Summary of traffic inputs – Without project (ie do nothing), 10 years' after opening (2036) (Scenario 5)

4.4.6 Model conservatism, set-up and evaluation of results

Overview

As noted above in **Section 4.4.1**, the method for determining the potential for changes in local air quality as a result of the project is conservative. 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. The key conservative assumptions include worst-case wind angles, stable atmospheric conditions, and low winds that allow for high air pollutant concentrations to occur. A high-level summary of the assessment process is shown in **Figure 4-7**, with further details provided below.

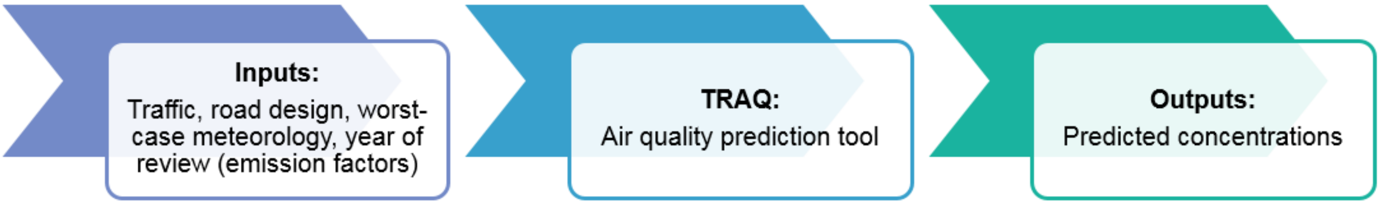


Figure 4-7 Overview of operational air quality assessment process

Key inputs, TRAQ set-up

Key input settings that were applied in the model are listed in **Annexure A**. In general, worst-case meteorological conditions were considered (ie those that would result in the highest concentration of pollutants from traffic at surrounding sensitive receivers). These conditions include low wind speeds (ie which result in the least dispersion of pollutants) during highly stable conditions (ie where vertical atmospheric movement is inhibited).

Traffic volumes and characteristics (ie composition of light and heavy vehicle types, speed and distribution) were applied along each segment for each assessment scenario listed above in **Section 4.4.5** based on forecasts prepared as part of the Transport and traffic assessment completed for the EIS (Appendix F). Full details of the data applied in the operational air quality assessment are listed in **Annexure B**.

Emissions of PM_{10}, $PM_{2.5}$, CO, NO_2 and VOCs as benzene from vehicles were determined using emission factors developed by the EPA from the Greater Metropolitan Motor Vehicle Emissions Inventory (MVEI). Emission factors for 2016 (the nearest conservative year available) were applied in Scenario 1 2026 factors were applied in Scenarios 2 and 3. Finally, 2036 vehicle emission factors used in Scenarios 4 and 5. The 2026 and 2036 future emission factors 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.

Evaluation of results

Impacts from traffic changes as a result of the project for nearby receivers along The Northern Road, the M7 Motorway and Elizabeth Drive were determined by comparing predictions from Scenarios 2 and 3, and 4 and 5 respectively. Changes at receivers along these roads relative to existing conditions were determined by comparing Scenario 1 predictions with the other assessment scenarios. Changes in air quality conditions at receivers along the new M12 Motorway were evaluated by comparing predictions with existing background concentrations which are established in **Section 5.2**. As outlined in **Section 3.6**, guidance values from the NSW EPA's Approved Methods were considered to review the significance of any changes in concentrations as a result of the project.

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.

4.5 Cumulative impacts

Where activities that would be associated with the project take place at the same time as other nearby projects which also have the potential to affect air quality conditions at the same surrounding receivers, there is the potential for cumulative impacts to occur. Cumulative impacts were reviewed by considering the impacts predicted in publicly available environmental impact assessments for nearby approved projects.

Identification of projects for consideration was based on the following criteria:

- Project size – major projects or known development planned in the study area were considered
- Project location – includes projects or developments planned near the project, including link and feeder roads within about 10 kilometres of the project
- Project timeframe – relevant projects likely to be carried out at some point during the construction period of, and would interact with, the project.

Projects that may contribute to cumulative impacts along with the project using these criteria are listed in **Table 7-1**. The table identifies the relevance of each project to the project in terms of spatial and temporal considerations.

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 Western Sydney Airport having already been included in the traffic forecasts applied in the assessment (see further detail above in **Section 4.4.5**).

The operational impacts associated with aircraft operations at Western Sydney Airport have been quantitatively assessed by considering the predicted concentration from these activities presented in 'Western Sydney Airport EIS – Local Air Quality and Greenhouse Gas Assessment' (Pacific Environment Limited, 2016), in conjunction with those predicted from the project. Remaining cumulative impacts associated with other projects where data was not available, were qualitatively assessed. **Chapter 7** provides details of this aspect of the assessment.

5. Existing environment

5.1 Climate and meteorology

5.1.1 Climate

The nearest weather station with long-term historical climate records is the Badgerys Creek automatic weather station (site 067108) operated by the BoM. This station is located about 4.5 kilometres south of the project (see **Figure 6-1**) and, given the low terrain relief, data collected from this station is broadly representative of conditions within the construction study area. The long-term temperature and rainfall averages recorded at this station from 1995 (date of commencement of measurement at the weather station) to May 2018 are presented in **Table 5-1**.

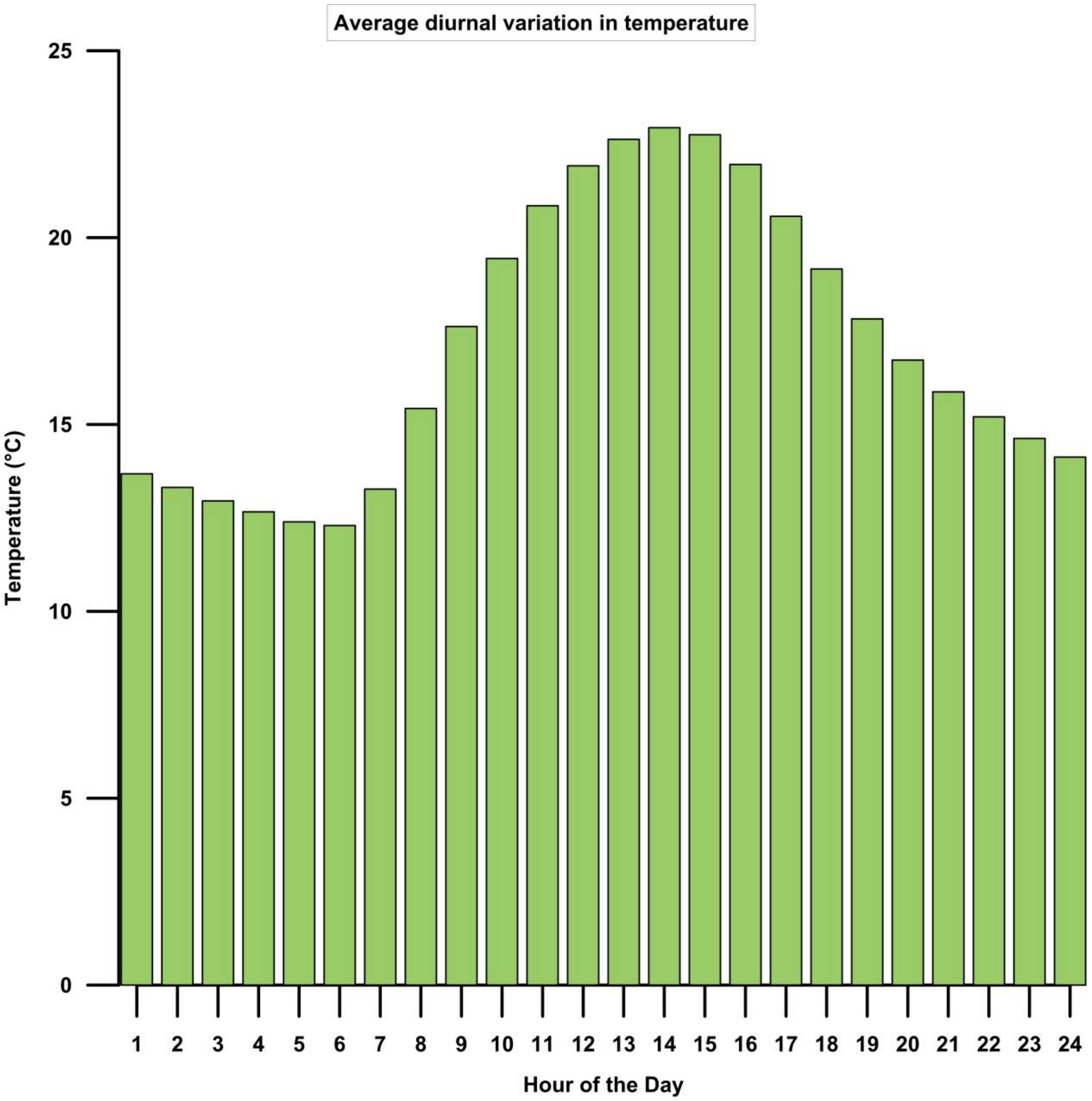
This data indicates that the construction and operation study areas experience warm and wet summers (December to February) with mean daily maximum temperatures between 28 and 30 degrees Celsius. Early spring is the driest season, with average monthly rainfall from July to September around 31 millimetres per month. The average annual rainfall is 680.9 millimetres over an average of 67.8 rain days per year. Dust generation is the primary air quality risk during construction, and these long-term climate data are useful for identifying periods throughout the year when dusty conditions (ie warm and dry periods) are most likely.

Table 5-1 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, 2018

Data collected at Badgerys Creek over the last five calendar years (2018 to 2014) was further reviewed to identify changes in average temperature by hour of the day. The trends observed are displayed in **Figure 5-1**.



Source: BoM, 2018

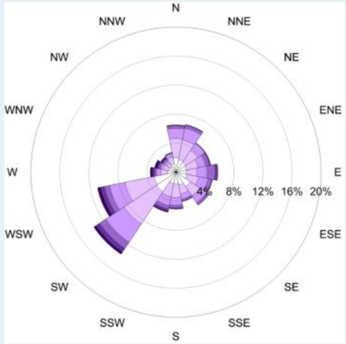
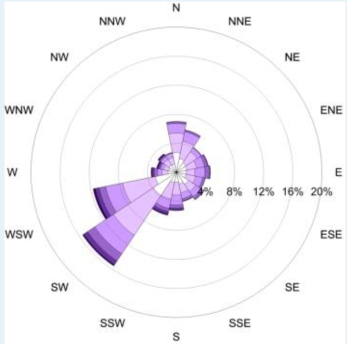
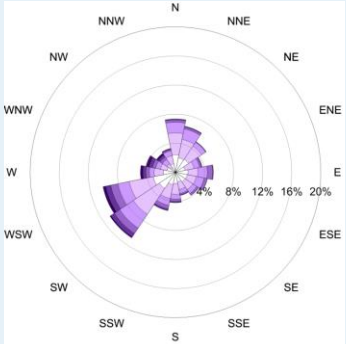
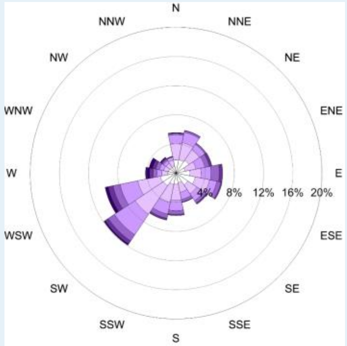
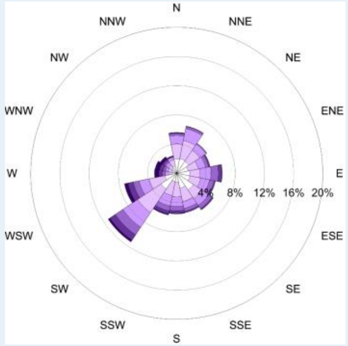
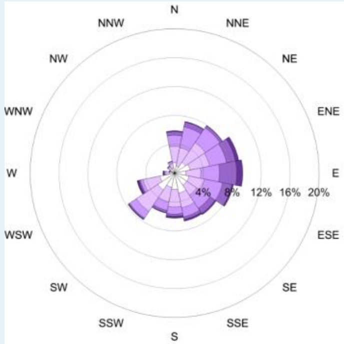
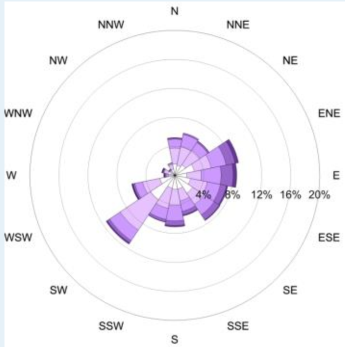
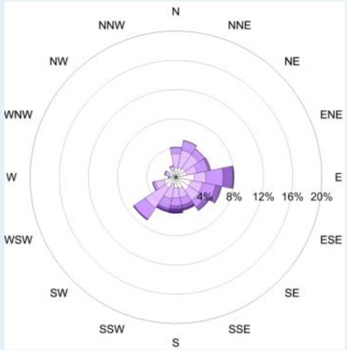
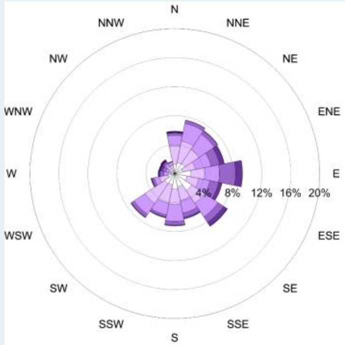
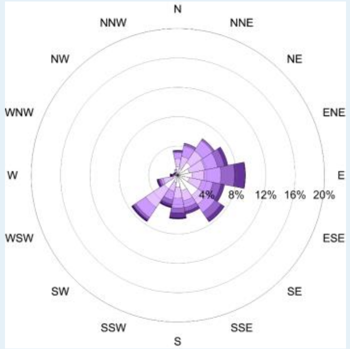
Figure 5-1 Badgerys Creek Diurnal temperatures (2014 to 2018)

Temperatures were highest for hours in the early afternoon (midday to 3pm), with average temperatures lowest in early mornings (3am to 6am).

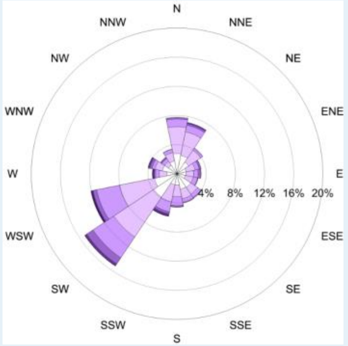
5.1.2 Meteorology

Annual and seasonal trends

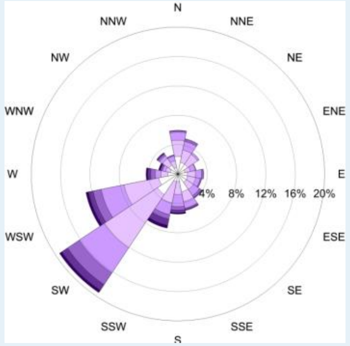
Meteorological conditions are important for determining the direction and rate at which air pollution would disperse. Meteorological data collected at Badgerys Creek AWS from 2014 to 2018 were reviewed to identify recent annual and seasonal local trends. Annual and seasonal wind roses for these years are displayed below in **Figure 5-2**.

2014	2015	2016	2017	2018
Annual				
 Calm = 9.2%	 Calm = 10.4%	 Calm = 14.6%	 Calm = 9.2%	 Calm = 13.8%
Summer				
 Calm = 8.1%	 Calm = 7.6%	 Calm = 31.7%	 Calm = 8.5%	 Calm = 26.3%
Autumn				

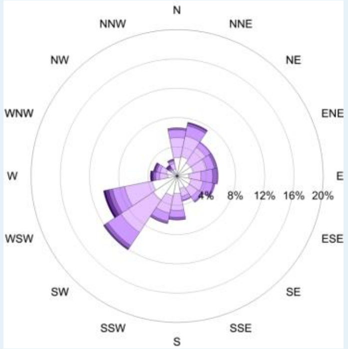
2014	2015	2016	2017	2018



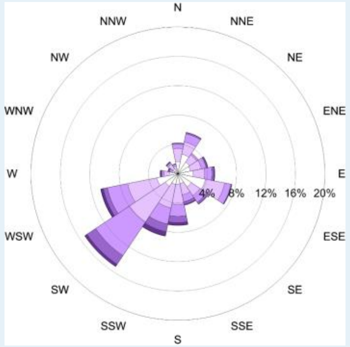
Calm = 11.5%



Calm = 8.9%



Calm = 9.8%



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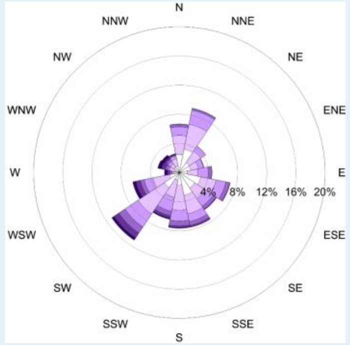
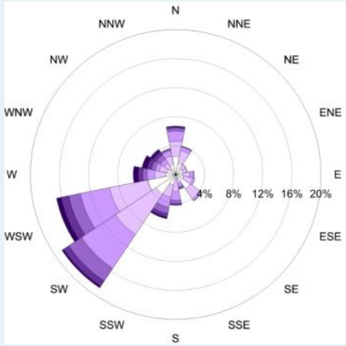
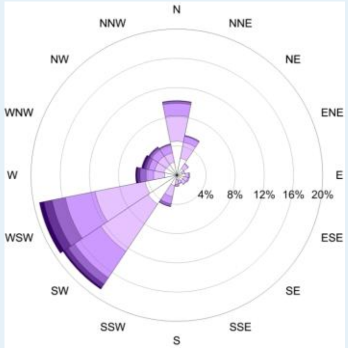


Calm = 8.7%

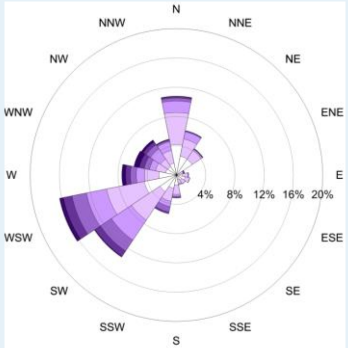
Winter



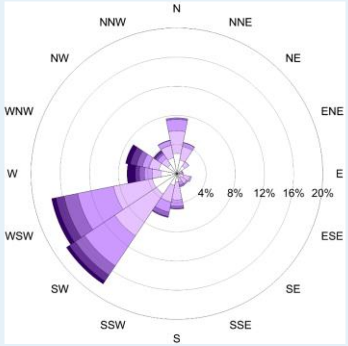
Calm = 9.7%



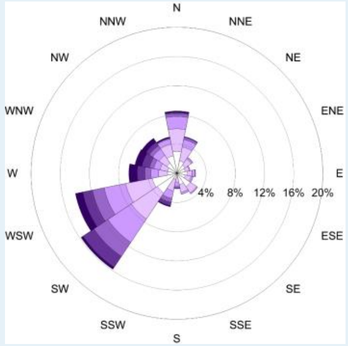
Calm = 11.3%



Calm = 8.6%



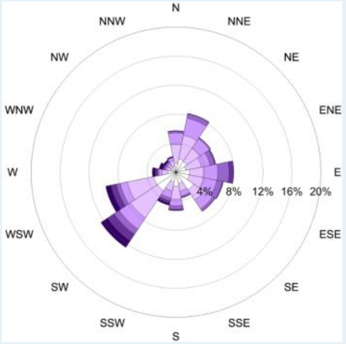
Calm = 9.2%



Calm = 10.6%

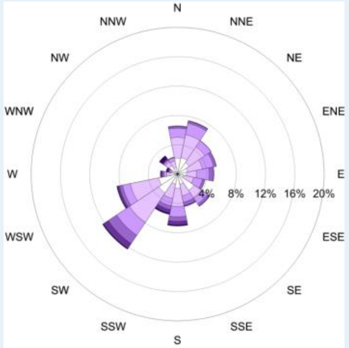
Spring

2014



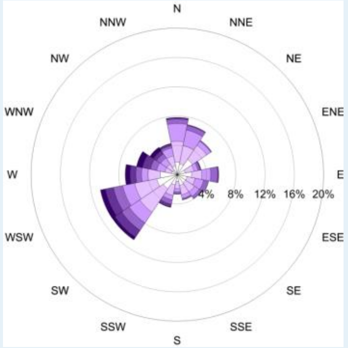
Calm = 7.7%

2015



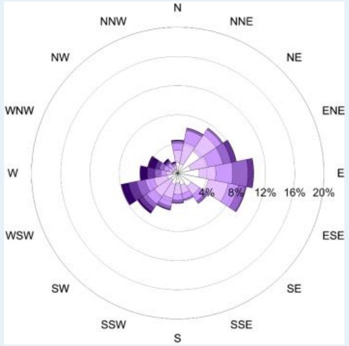
Calm = 13.6%

2016



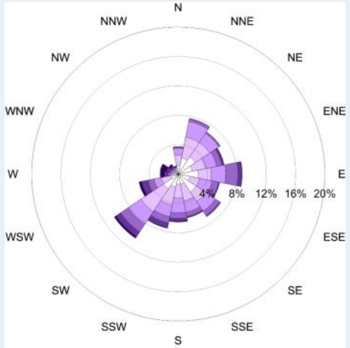
Calm = 8.4%

2017



Calm = 7.4%

2018



Calm = 10.0%

Legend

Wind speed (m/s)

- >0.5 - 1.5
- >1.5 - 3
- >3 - 4.5
- >4.5 - 6
- >6 - 7.5
- >7.5

Source: BoM, 2018

Figure 5-2 Annual and seasonal wind roses, Badgerys Creek AWS (2014 to 2018)

Long-term data from Badgerys Creek AWS were also reviewed to identify prevailing seasonal trends. These are described below:

- 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.

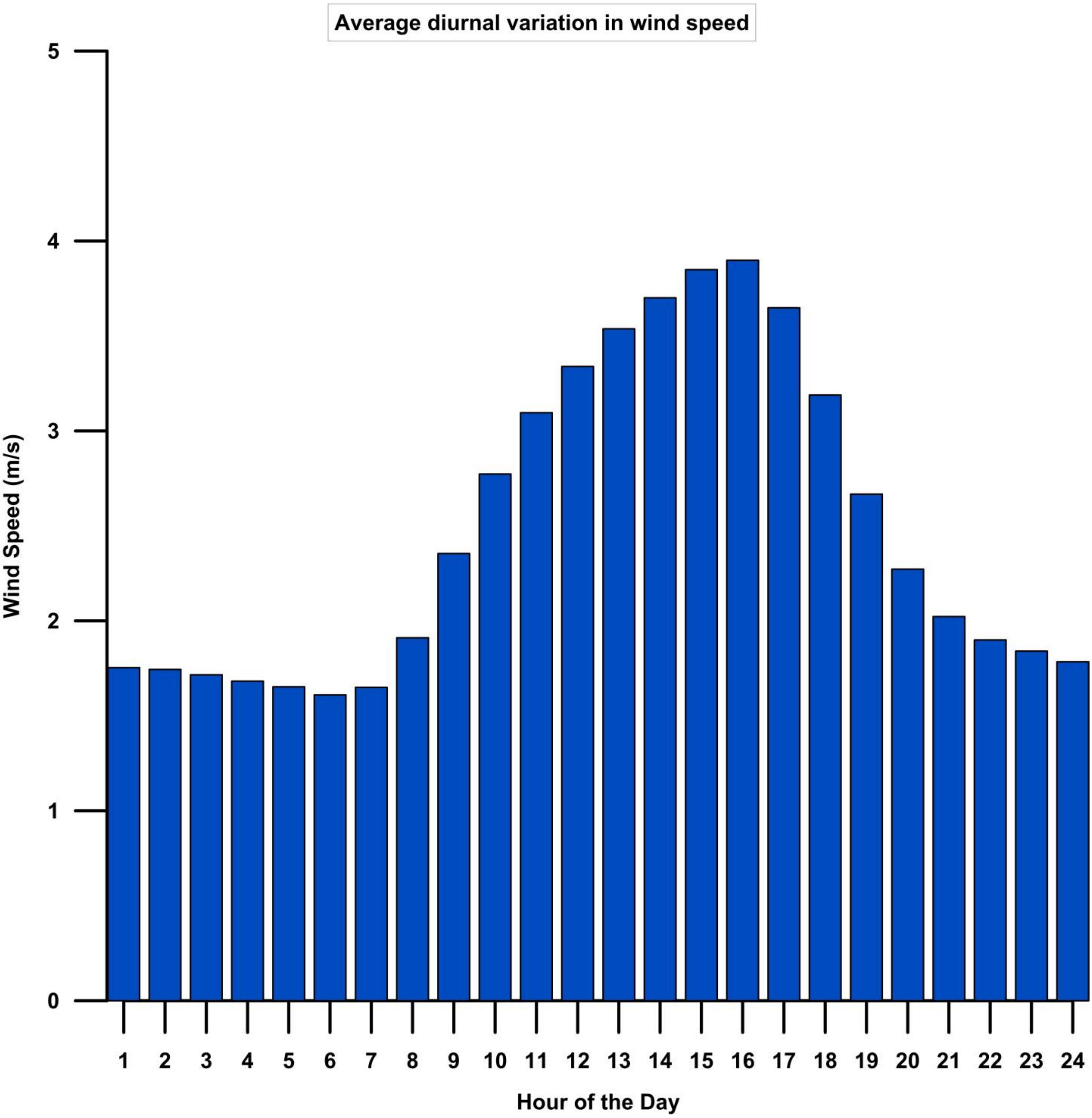
These data indicate that receivers located to the northeast of the project within the construction and operational study areas would most frequently experience winds blowing from the project. These receivers would consequentially be most at risk from emissions to air generated during the project construction and operation.

Daily

Records from Badgerys Creek AWS were further reviewed to understand typical meteorological conditions and how they change throughout the day. **Figure 5-3** shows average annual wind speeds for each hour of the day from data measured from 2014 to 2018.

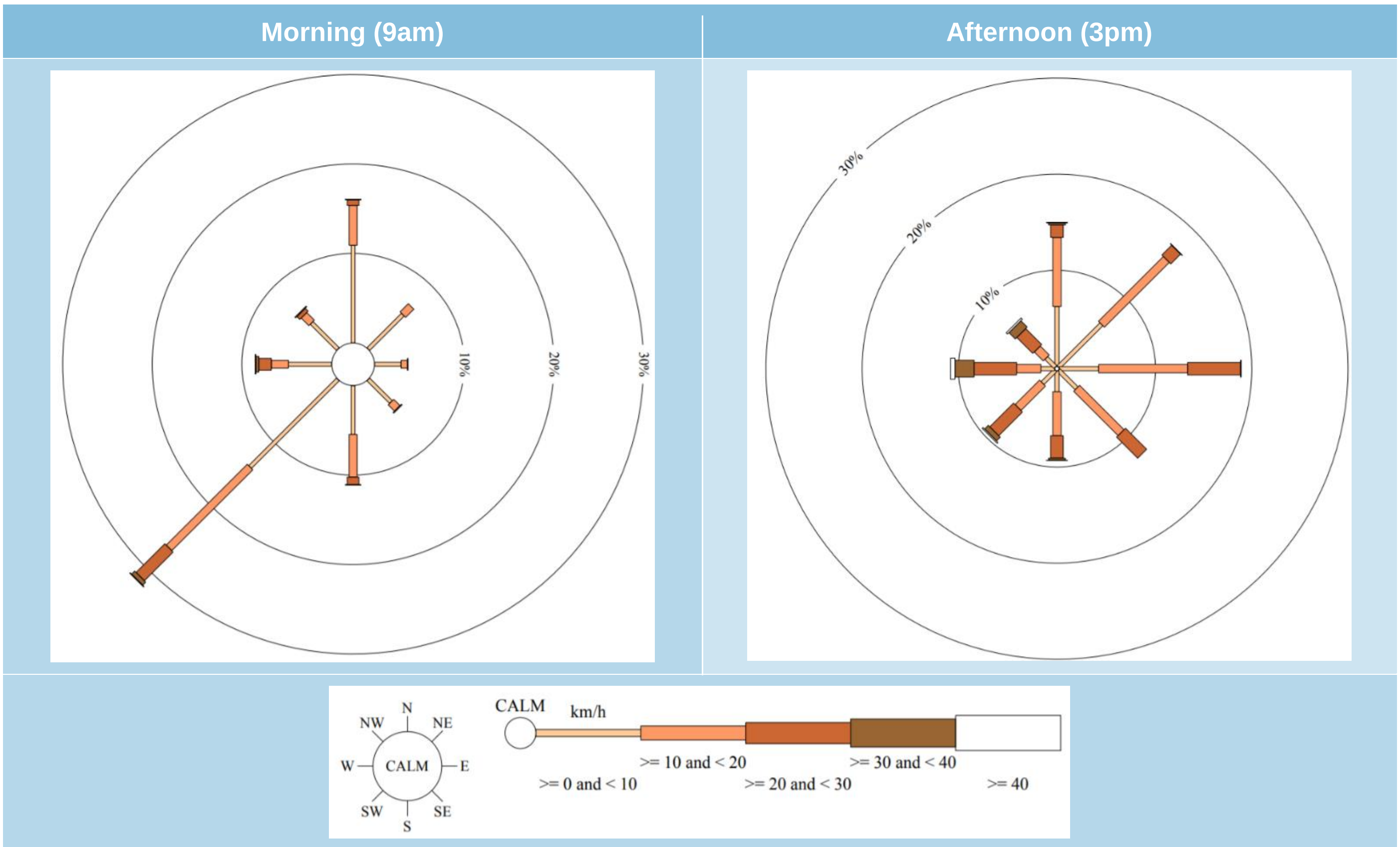
As displayed, local average wind speeds are lowest during night time and early morning periods, pick up to abound two metres per second at around 9am and increasing to nearly four metres per second at 4pm, before decreasing back below two metres per second at 9pm. Higher wind speeds can lead to a higher generation of dust emissions. Times when higher wind speeds occur around the project are during standard construction hours. The BoM produces long-term morning (9am) and afternoon (3pm) wind roses for Badgerys Creek AWS; times consistent with standard construction hours. These have been reproduced in **Figure 5-4**.

As shown in **Figure 5-4**, 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 construction activities would be most likely to experience winds blowing from the direction of the site during mornings; and receivers orientated to the south through to the north-west in the afternoons.



Source: BoM, 2018

Figure 5-3 Badgerys Creek Diurnal wind speeds (2014 to 2018)



Source: BoM, 2018

Figure 5-4 Long-term morning and afternoon wind conditions (Badgerys Creek AWS)

5.2 Background air quality

5.2.1 Overview

The following sections describe:

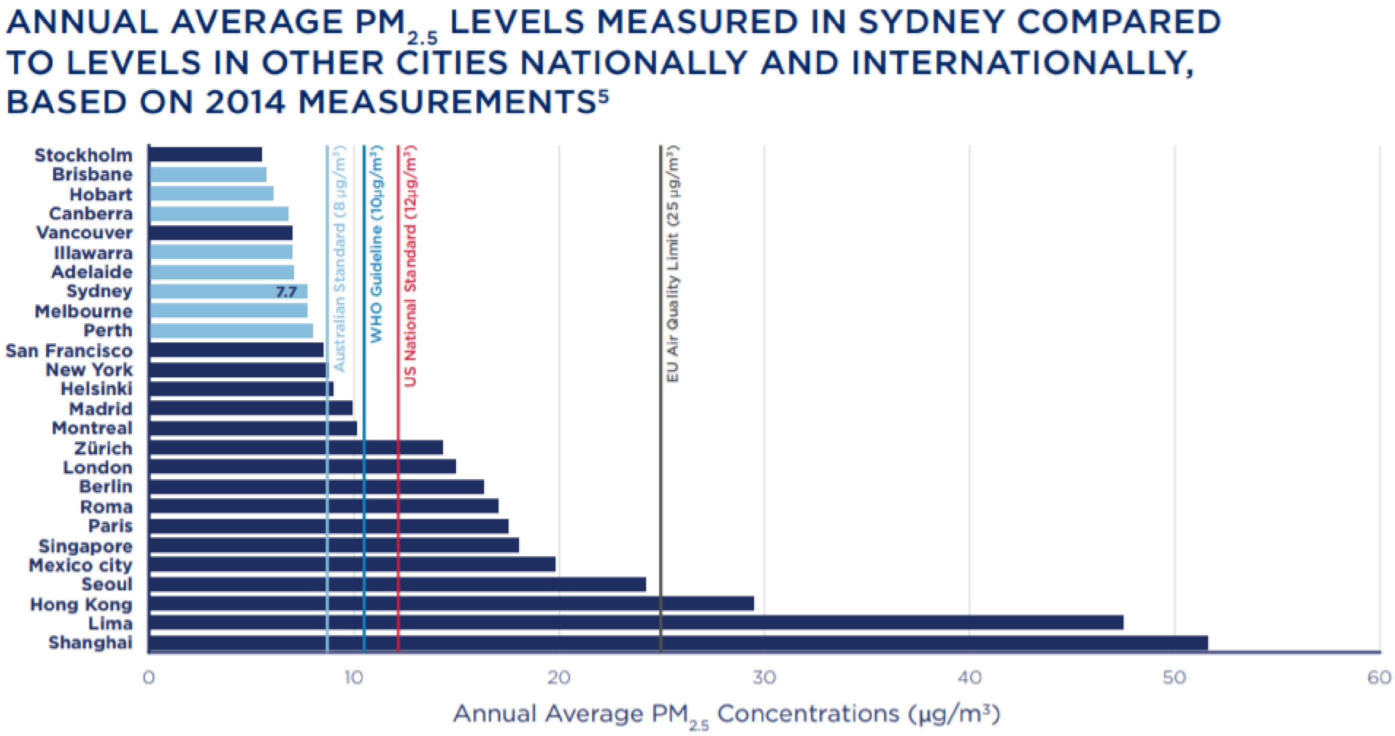
- General characteristics of air quality in and around the greater Sydney region
- Key sources of emissions to air in and around the greater Sydney region
- Local air quality conditions as measured at background air quality monitoring stations at sensitive receivers around the project
- How regional and locally measured air quality conditions around the project were considered in the assessment.

5.2.2 General air quality characteristics in greater Sydney region

Nationally and Internationally

Sydney's air quality is comparable with other major cities around Australia and is 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.

As displayed below in **Figure 5-5**, compared with other major cities around the world, Sydney's annually averaged $PM_{2.5}$ concentration; a key pollutant related to adverse health effects; is comparable or better than other cities in Europe and North America (eg Vancouver, New York, Helsinki) and less than half of the annual averages experienced at other major centres around the world including London, Paris, Singapore, Mexico City, Seoul, Hong Kong, Lima and Shanghai (NSW Government, 2017).



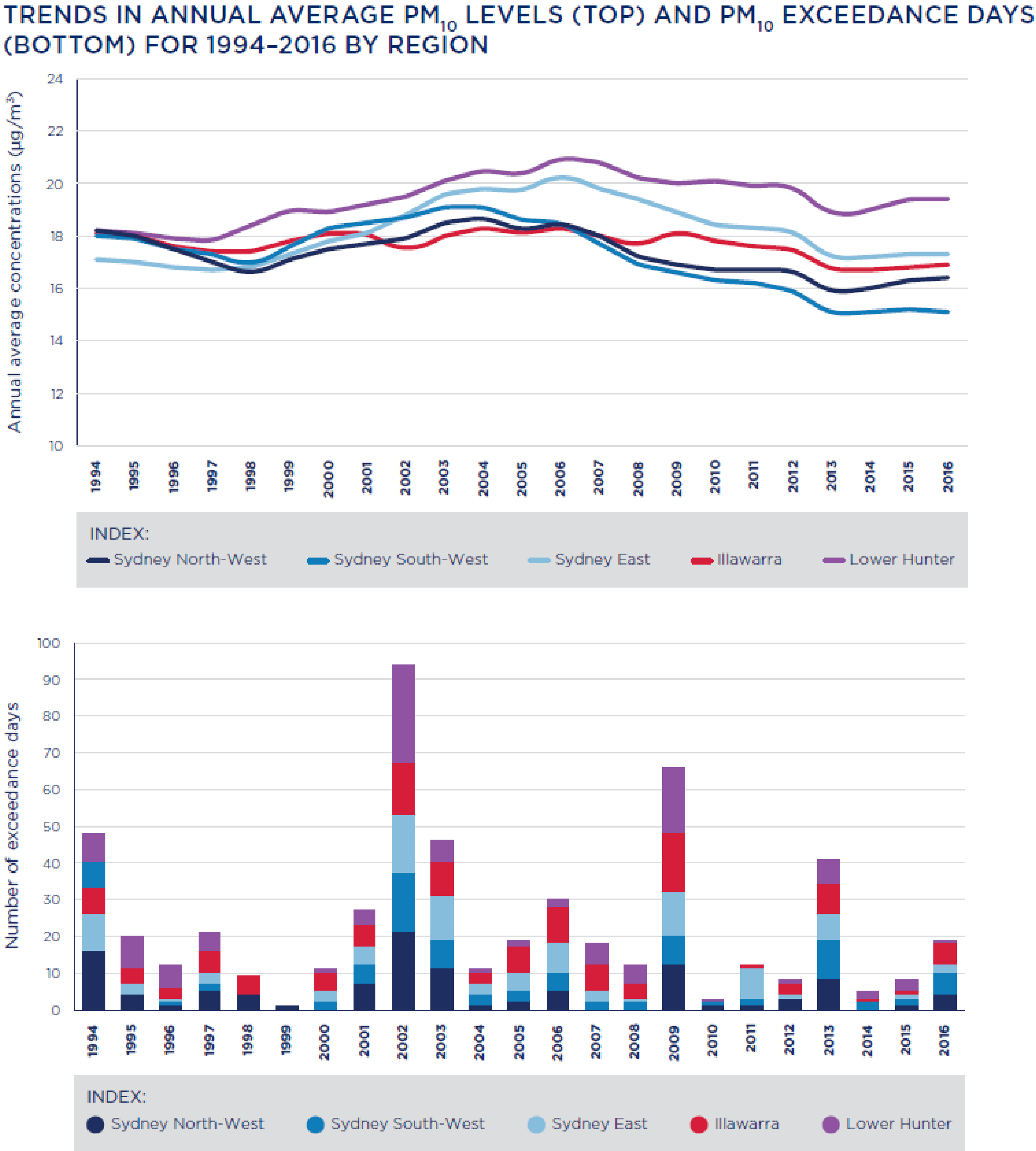
Source: NSW Government, 2017

Figure 5-5 Comparison of annually averaged $PM_{2.5}$ concentrations in Sydney with other national and international cities

Temporal trends

Although the number of cars on Sydney's roads having increased over time, government initiatives and technological advancements have resulted in substantial reductions in vehicle-related emissions in Sydney over the past two decades (Roads and Maritime, 2018). With continued population growth, the number of vehicles on Sydney's roads is expected to continue increasing into the future, however it is expected that total emissions from motor vehicles will fall over the next decade as newer, cleaner vehicles replace older, less efficient vehicles (Roads and Maritime, 2018).

Figure 5-6 displays annually averaged PM_{10} concentrations and number of exceedances of the 50 µg/m^3 recorded across different regions of Sydney and the Sydney Greater Metropolitan Region (GMR) from 1994 to 2016. As shown, annual PM_{10} concentrations across the Sydney South-West Region has improved steadily from around 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. These observations are consistent with the information presented above, and it could be inferred that government initiatives and technological advancements are contributing to improvements in air quality across the region.

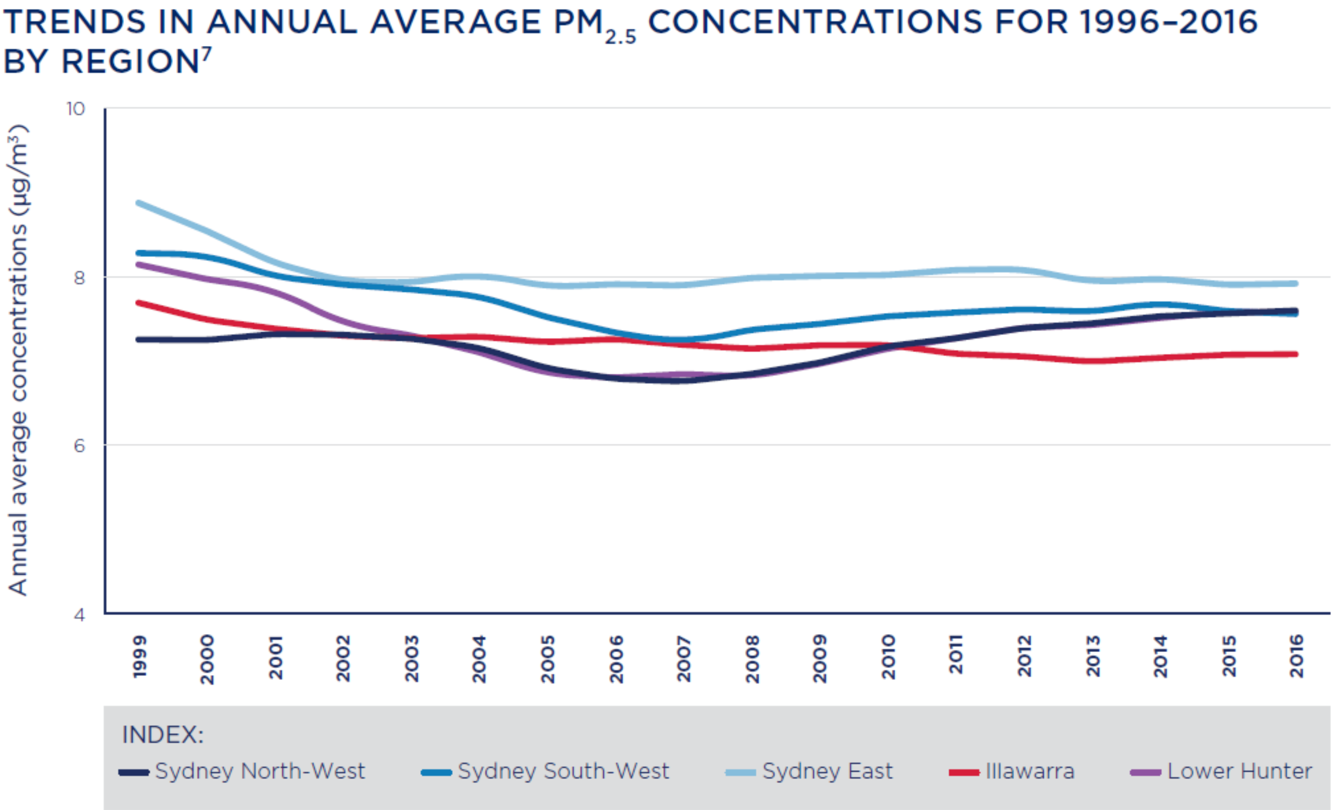


Source: NSW Government, 2017

Figure 5-6 PM_{10} trends 1994 to 2016 for different regions of Sydney GMR

As shown in **Figure 5-7**, 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.

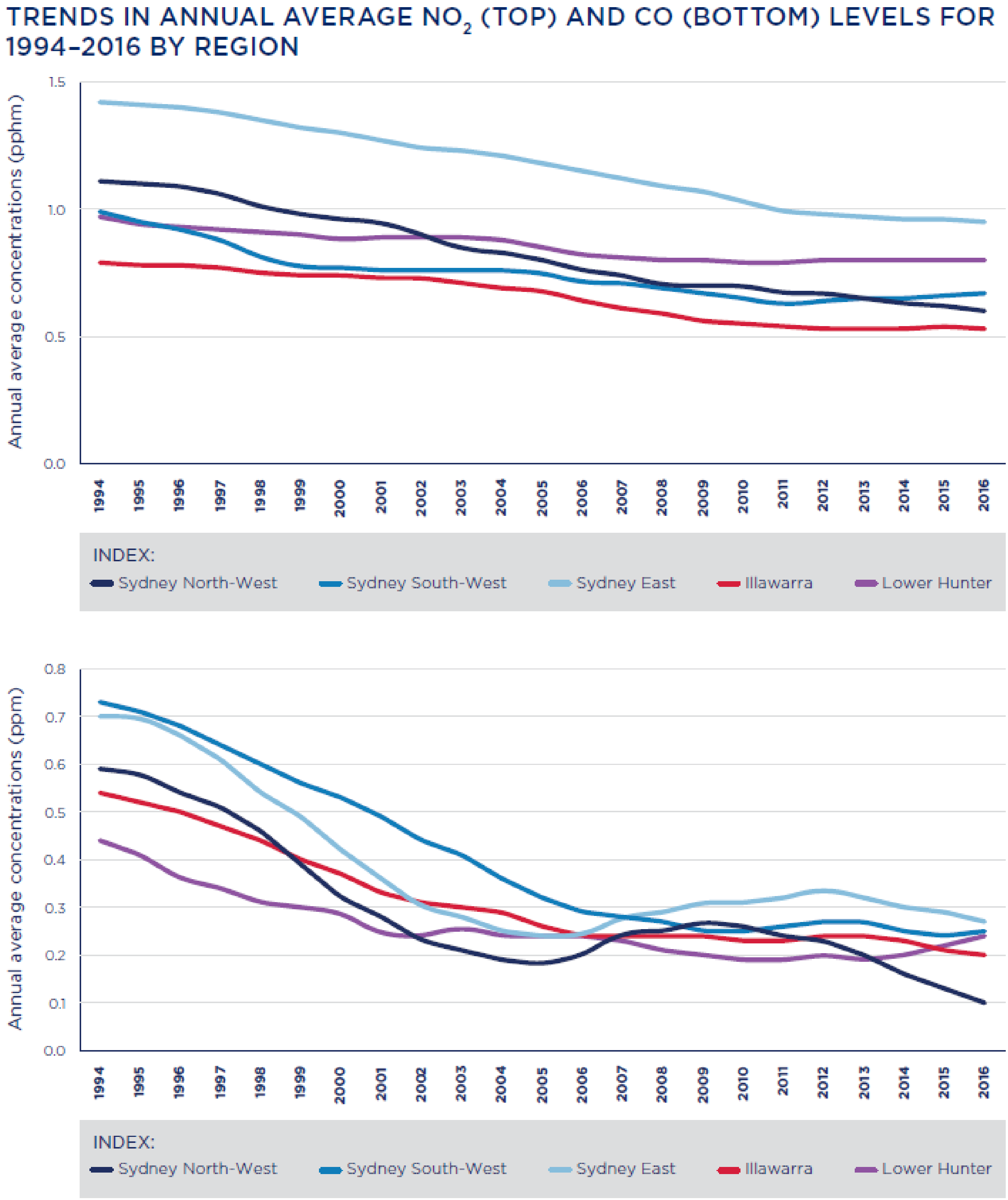
As displayed **Figure 5-8**, annual concentration trends for NO_2 and CO in the Sydney South-West Region were also found to have decreased over the period from 1994 to 2016. These increases are noted to have tapered off in recent years, as the balance between efficiencies and population growth has been reached.



Source: NSW Government, 2017

Figure 5-7 $PM_{2.5}$ trends 1999 to 2016 for different regions of Sydney GMR

Population growth, urbanisation, increases in energy and transport demand coupled against technological improvements and higher regulation of emission sources are expected to influence how regional air quality conditions will change in the future. Further, changes in climate are expected to affect natural contributions to future air quality conditions, affecting rainfall, temperature, and weather patterns, and the frequency of more extreme events (eg prolonged drought, dust storms, high temperatures leading to bush fires).



Source: NSW Government, 2017

Figure 5-8 NO_2 and CO trends 1999 to 2016 for different regions of Sydney GMR

5.2.3 Key sources of emissions to air in the greater Sydney region

The air quality in the greater Sydney region is influenced by a variety of different anthropogenic and natural sources (Roads and Maritime, 2018). The EPA (2012a) has estimated the contributions of anthropogenic and natural sources of PM_{10}, $PM_{2.5}$, CO, NO_x and Total VOCs to air quality in the Sydney Region from the 2008 dataset. These contributions are displayed below in **Figure 5-9**.

As displayed in **Figure 5-9**, about 81 and 92 per cent of PM_{10} and $PM_{2.5}$ contributions were found to be human-made. Anthropogenic contributions were higher for CO (98 per cent) and NO_x (98 per cent), with human-made total VOC contributions totalling 75 per cent.

The EPA (2012a) also investigated the relative contribution of PM_{10}, $PM_{2.5}$, CO, NO_x and Total VOCs in the Sydney region from on-road mobile (ie road traffic), off-road mobile, domestic-commercial, commercial and industrial sources. These are summarised below in **Figure 5-10**.

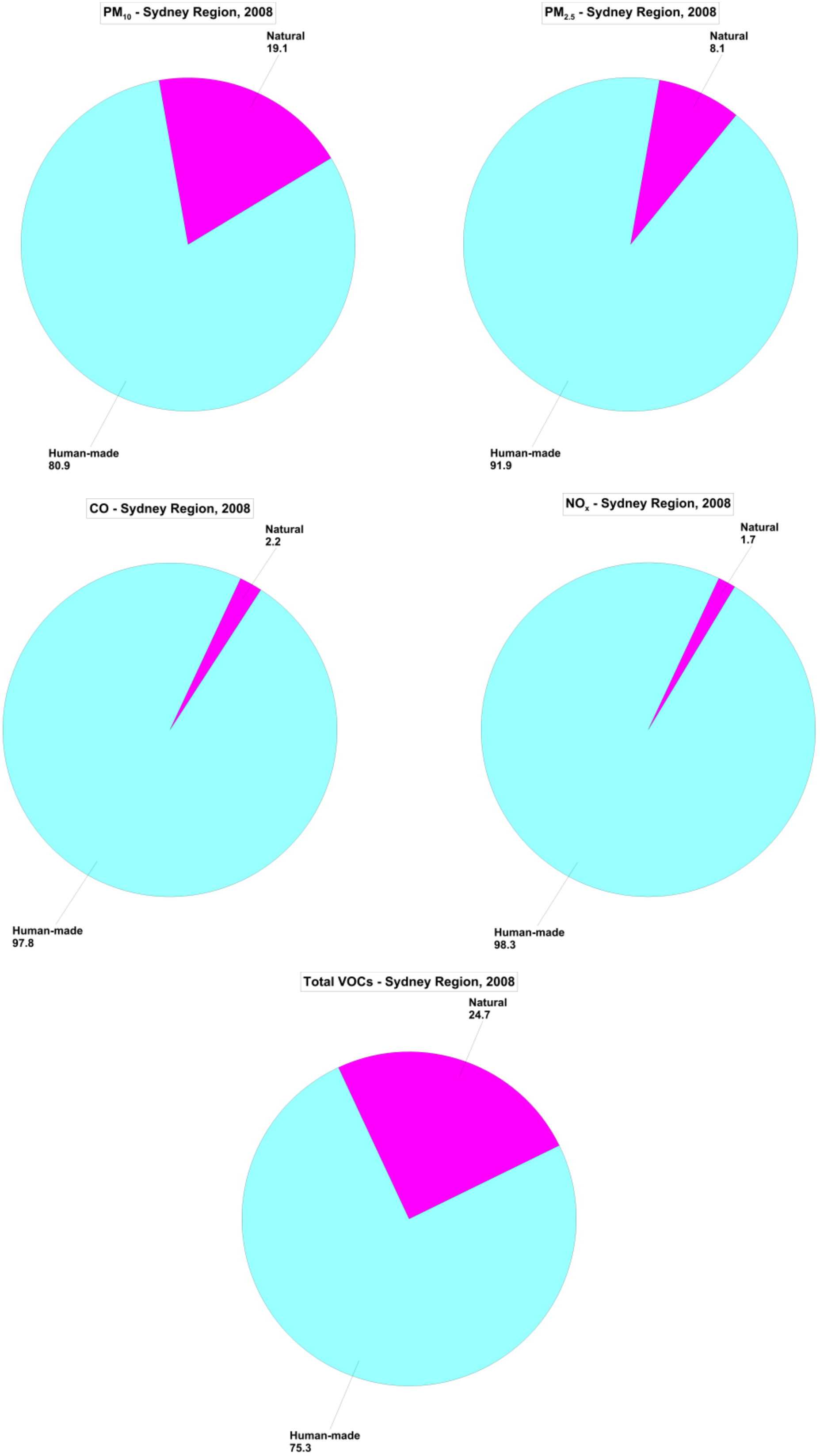
As shown, road traffic is the major source of CO (51 per cent) and NO_x (62 per cent) in the greater Sydney region. The EPA found that emissions from industrial and domestic-commercial were the dominant sources of particulate matter (PM_{10} and $PM_{2.5}$), with emissions from road traffic contributing about 13 and 14 per cent of anthropogenic PM_{10} and $PM_{2.5}$ in the region respectively. On-road mobile sources were also found to contribute about 24 per cent of total VOCs emitted.

The EPA's 2012 study also investigated the contribution of different types of on-road mobile vehicle source emissions to the totals expressed above in **Figure 5-10**. Emissions from the following sources were considered:

- Exhaust emissions from petrol passenger vehicles
- Exhaust emissions from light duty diesel vehicles
- Exhaust emissions from petrol light commercial vehicles
- Exhaust emissions from heavy duty diesel vehicles
- Exhaust emissions from other vehicles
- Evaporative losses from all vehicles
- Non-exhaust particulate matter from all vehicles.

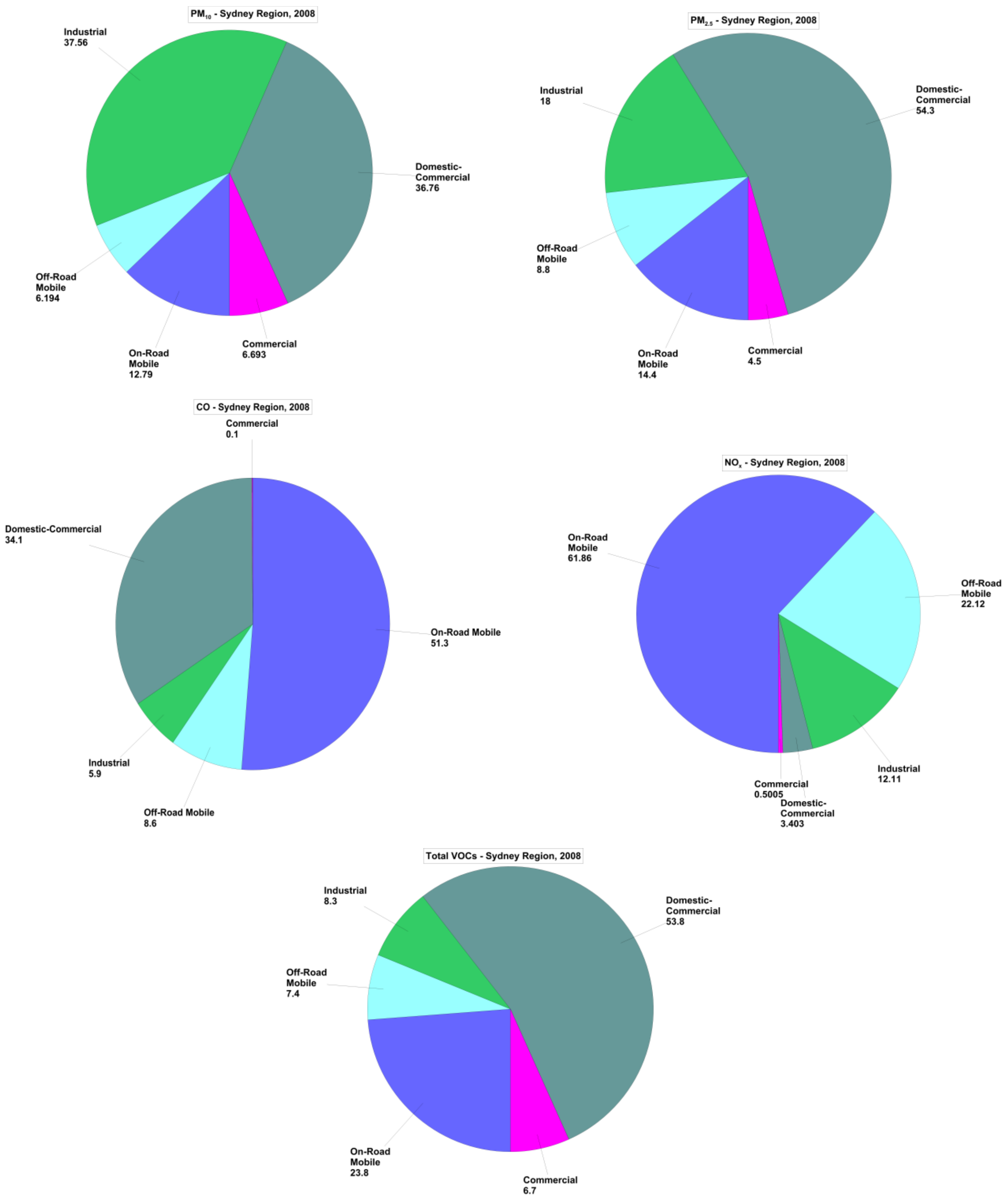
The results from this study is presented graphically below in **Figure 5-11**.

As displayed, the EPA (2012b) found that the 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. 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.



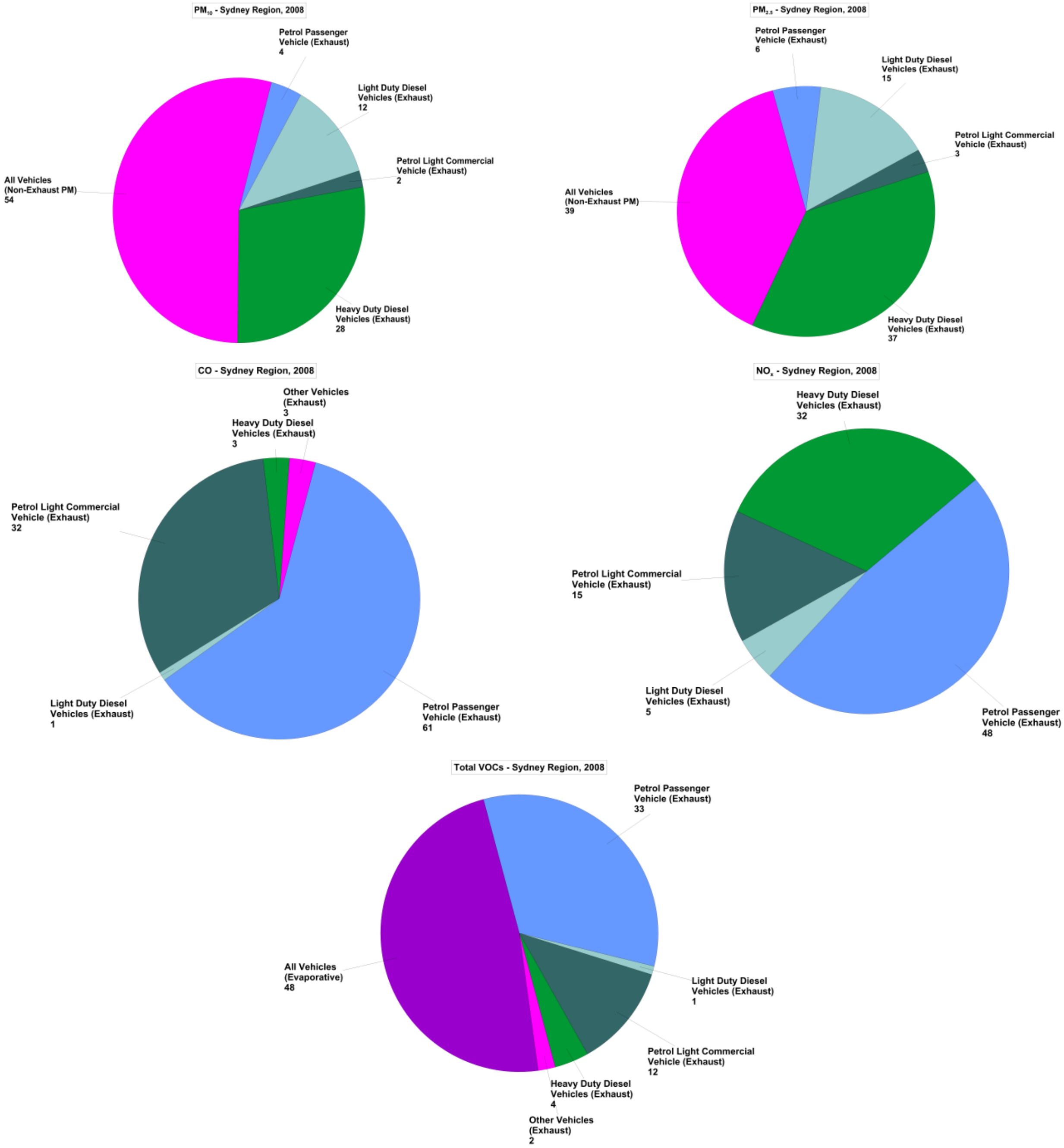
Source: EPA, 2012a

Figure 5-9 Natural and anthropogenic (human-made) contributions to air quality in the Sydney Region (2008)



Source: EPA, 2012a

Figure 5-10 Sources of anthropogenic (human-made) contributions to air quality in the Sydney Region (2008)



Source: EPA, 2012b

Figure 5-11 Sources of mobile on-road contributions to air quality in the Sydney Region (2008)

5.2.4 Local measured air quality conditions

To understand how ambient air quality conditions may change as a result of the project, a review of the background concentrations of key traffic-related pollutants (ie particulate matter, NO_2, CO and VOCs) was completed. This involved gathering and analysing information collected from nearby air quality monitoring stations managed by the EESG.

The EESG operates a state-wide air quality monitoring network which provides information on current and historical air quality. The network includes numerous air quality stations across NSW. Data from the two nearest stations at Bringelly and Liverpool (four kilometres and seven kilometres from the construction footprint respectively) were used to characterise ambient air quality conditions for the available pollutants of potential concern identified above in **Section 2.3**. The pollutants of concern measured at the two stations are listed in **Table 5-2**.

Table 5-2 Summary of pollutants measured at nearby EESG monitoring stations

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

The most recent (2014 - 2018) publicly available monitoring results measured at Bringelly and Liverpool stations were reviewed and are presented in tabular and graphical format in **Annexure C**. This approach is consistent with assessment requirements outlined in the Approved Methods.

These data indicate that the maximum 24-hour average PM_{10} concentrations occasionally exceeded the 50 µg/m^3 criterion. The term '95th percentile' refers to the value exceeded five per cent of the time and has historically been applied to account for the small number of regional events including those discussed to provide a more representative indication of typical 24-hour particulate matter pollutant concentrations. The 95th percentile values 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 percentile 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. Collection of $PM_{2.5}$ data at the Bringelly station only commenced in 2016, so only two full calendar years (2017 and 2018) were available.

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

5.2.5 Application of background air quality conditions in assessment

Considering the monitoring data presented in **Annexure C**, background concentrations were established for the receiving environment in both the construction and operation study area. The values adopted are presented in **Table 5-3** and includes details of the selection rationale for each value which was applied as consistent with Section 5.1 of the Approved Methods. 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 DPIE's (Environment, Science and Energy) Bringelly and Liverpool monitoring stations. The annually averaged PM_{10} concentration was also used to characterise the sensitivity of nearby receivers to dust-related health effects during construction.

Table 5-3 Adopted background concentrations

Pollutant	Averaging time	Adopted background concentration	Justification
PM_{10}	24-hour	38 µg/m^3	Highest 2014 to 2018 95th percentile 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 percentile 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

6. Assessment of potential impacts

6.1 Construction impacts

As outlined in **Section 4.3**, 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 4-7** 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 has been applied to reduce the impact to the extent practicable.

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

6.1.1 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 intent of this step is to identify whether there are human and ecological receivers nearby which have the potential to be impacted by the proposed work. 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.

The nearest human and ecological receivers in relation to the project are shown in **Figure 6-1**, and shown in more detail (including assessment segments) in **Figure 6-2**. As displayed, there are a number of human and ecological receivers located within the conservatively adopted 500 metre construction assessment study area. As such, it was determined that the next stages of the assessment would be required.

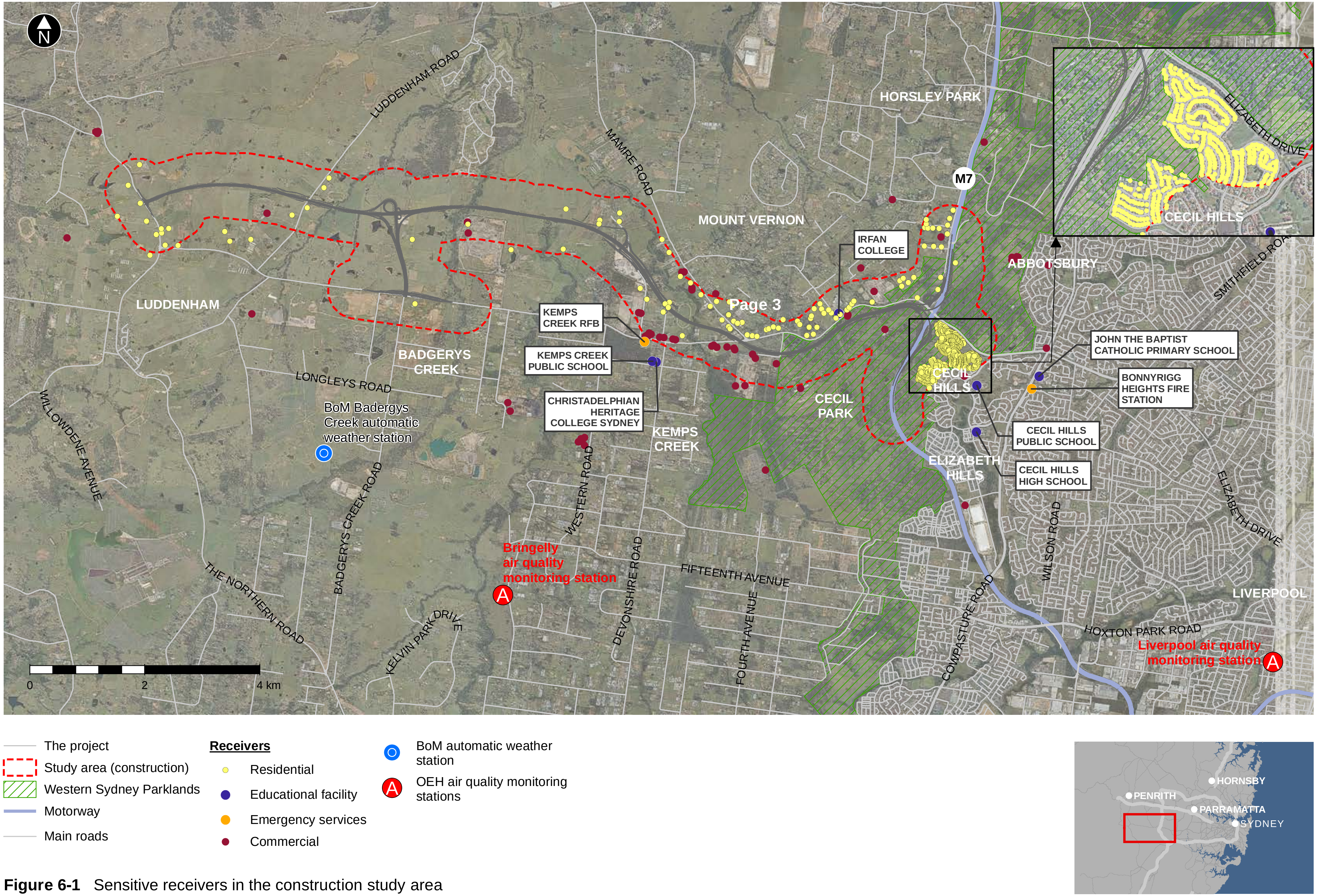
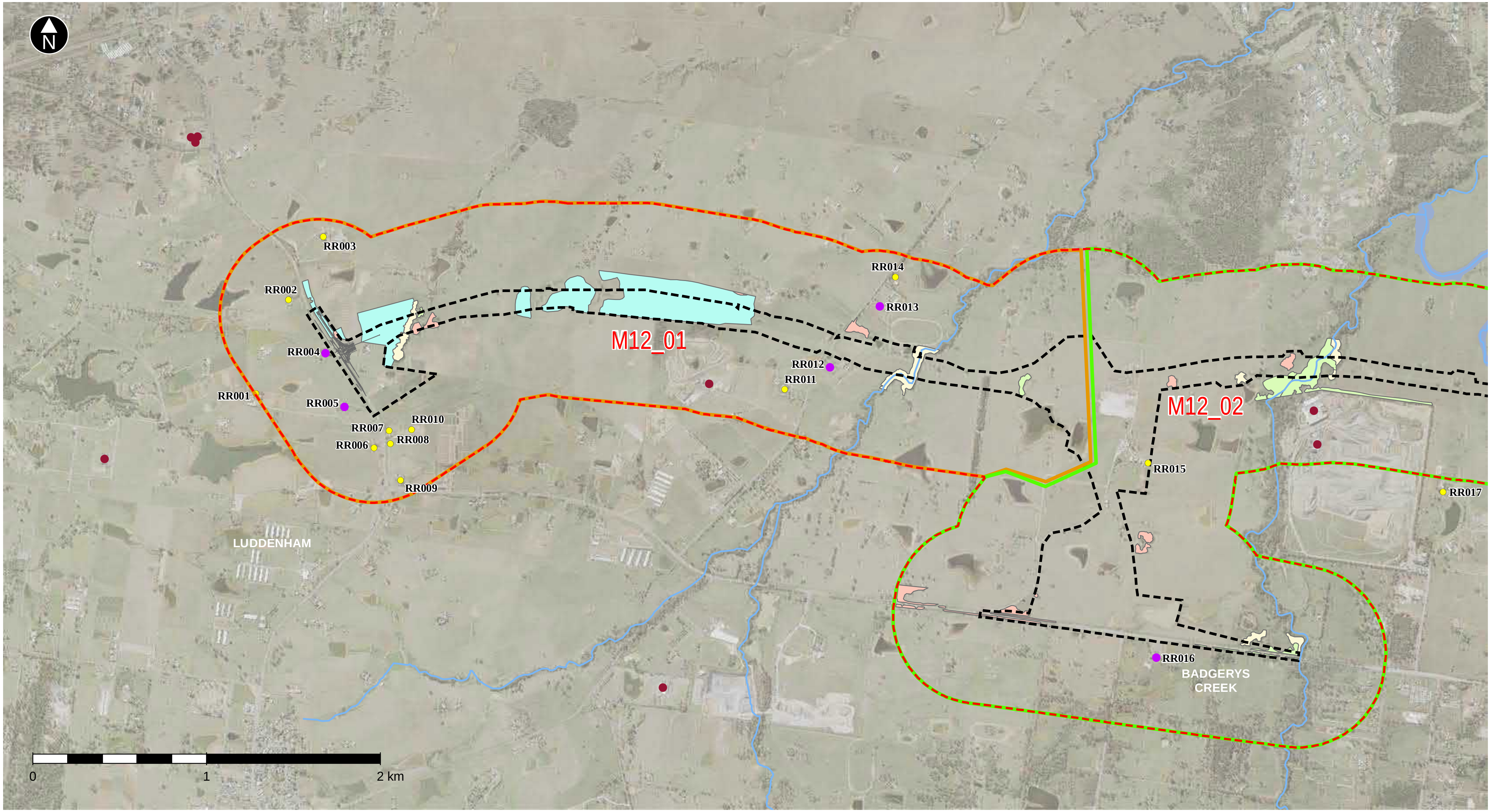


Figure 6-1 Sensitive receivers in the construction study area

Date: 3/09/2019 Path: J:\IE\Projects\04_Eastern\IA145100\08 Spatial\GIS\Directory\Templates\MXDs\Figures\EIS\SpecialistReports\AirQuality\FinalEIS\JAJV_EIS_AirQuality_F002_Fig6_1_Overview_r5v1.mxd
Created by : AA | QA by : NS



The project construction footprint

Study area (construction)

Construction segments

M12_01

M12_02

Receivers

Residential

Nearest receivers

Commercial

Threatened Ecological Communities (TEC)

Cumberland Plain Woodland in the Sydney Basin Bioregion

Cumberland Plain Woodland in the Sydney Basin Bioregion (derived grassland form)

River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

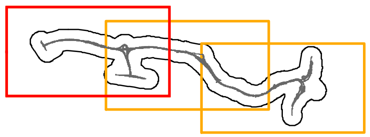
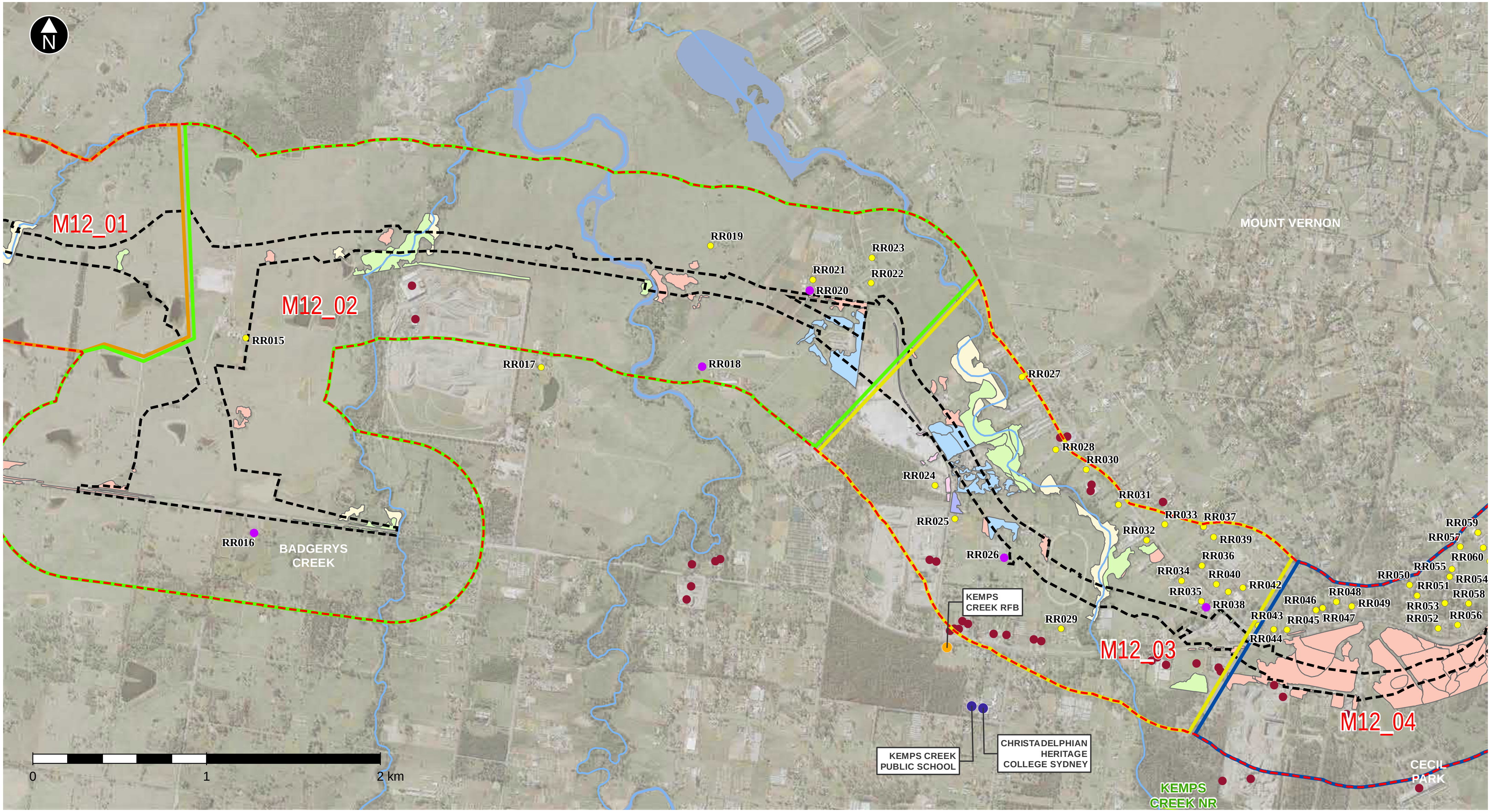


Figure 6-2 Construction air quality study area and assessment segments



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

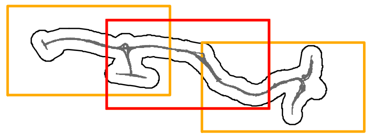
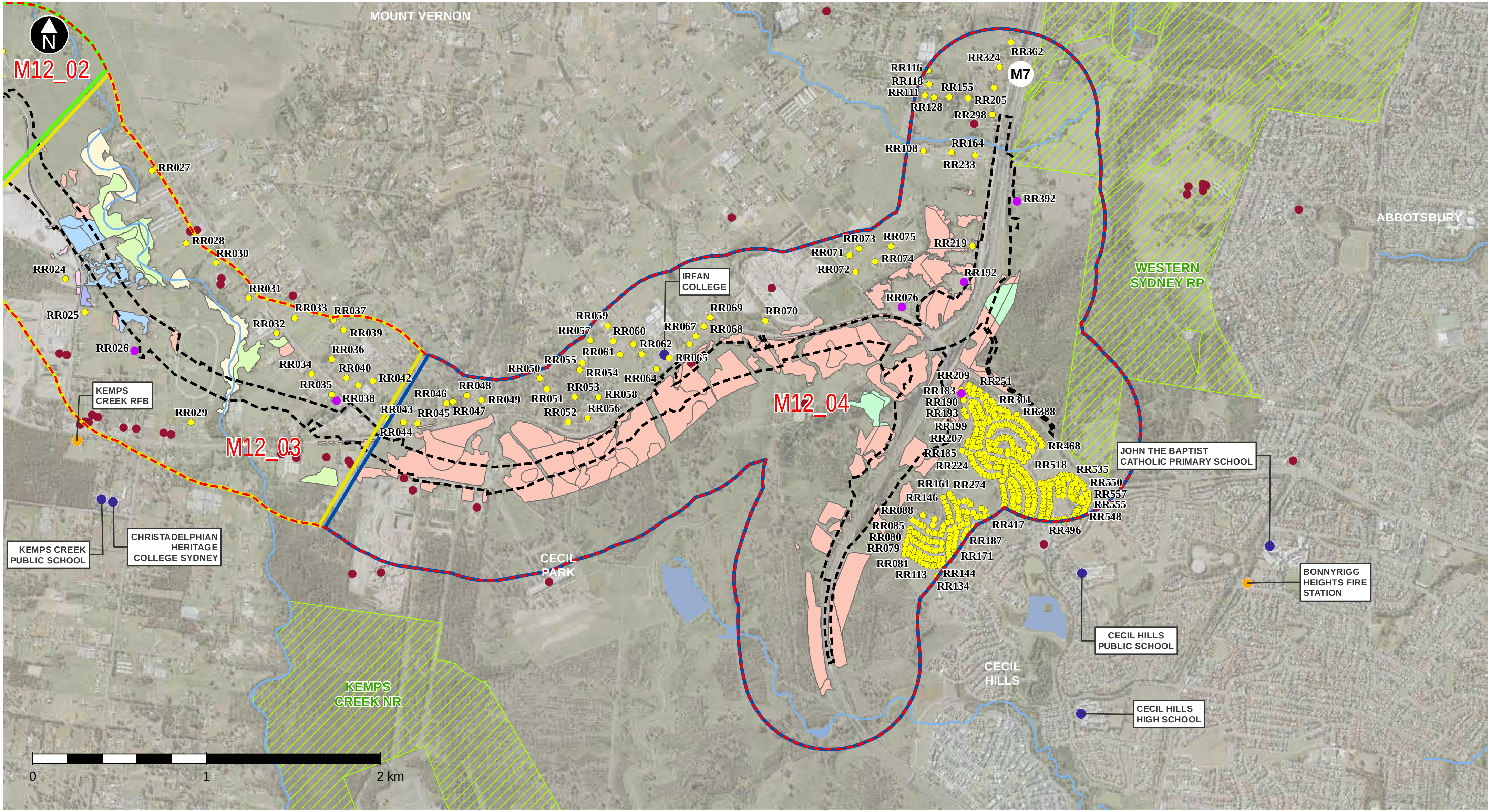


Figure 6-2 Construction air quality study area and assessment segments



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

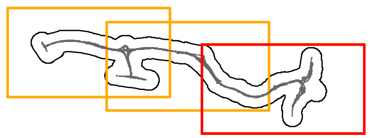


Figure 6-2 Construction air quality study area and assessment segments

6.1.2 Step 2 – Risk assessment

The second step in the UK IAQM methodology involves evaluating the risk of dust impacts during construction. This step is further divided into three steps which are described in the following sections.

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 have been reproduced in **Table 6-1**. Colour-coding was added in **Table 6-1** as well as subsequent tables for ease of interpretation of the results. 'Orange' shading was added for large or high classifications, with 'yellow' and 'green' shading applied for medium and low or small classifications respectively.

Table 6-1 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 2,500 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 2,500 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	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.

Source: UK IAQM, 2014

Using the descriptions of proposed construction activities for the project outlined in Chapter 5 of the EIS, the potential dust emission magnitude classifications were developed for the project. These are listed in **Table 6-2**.

Table 6-2 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).

The UK IAQM method considers how sensitive surrounding receiver areas may be to the effects of dust soiling, human health, and ecosystem impacts. Guidance on how the sensitivity of the receiving environment to these different dust effects were classified is listed in **Table 6-3**.

The techniques used to determine the respective sensitivities of nearby receivers to these effects have been reproduced in **Table 6-4**, **Table 6-5** and **Table 6-6**. In **Table 6-5** it is noted that the annual PM_{10} background concentration adopted for the assessment was 21 µg/m^3, as was determined from monitoring data for the local environment around the project in **Section 5.2.5**.

Using the method outlined above and land use mapping around each site, the following dust soiling, human health, and ecological area sensitivity classifications were developed. It is noted that the project construction footprint was divided into the same four segments as were applied in the operational assessment (see **Section 4.4.5** above), noting the differences in receiver types, proximity and density along these different parts of the project.

Sensitivity to dust soiling impacts

Considering the definitions in **Table 6-3** above, the 'receiver sensitivity' to dust soiling around all construction areas was assumed to be high, noting that land uses other than residential (ie commercial, educational, medical, place of worship, sporting venues) would also satisfy this definition. Using mapping, the number of high sensitivity human receiver locations were counted and grouped into the group sizes listed in **Table 6-4**. **Table 6-7** lists the results from this review. It is noted that the UK IAQM method considers the number of receiver locations, not the number of potential human receivers.

As shown, receiver sensitivity to dust soiling was determined to be 'low' around the M12_01 and M12_03 work areas. Receiver sensitivity to dust soiling was determined to have a 'medium' risk around the M12_02 and M12_04 work areas. This is due to the higher density of receivers in closer proximity to the construction footprint.

Table 6-3 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

Table 6-4 Step 2B - Method for determining sensitivity of receiving area to dust soiling effects

Receiver sensitivity	Approximate number of receptors	Distance of receptors from the source (m)			
		Less than 20 m	20 to 50 m	50 to 100 m	100 to 350 m
High	More than 100	High	High	Medium	Low
	10 to 100	High	Medium	Low	Low
	1 to 10	Medium	Low	Low	Low
Medium	More than 1	Medium	Low	Low	Low
Low	More than 1	Low	Low	Low	Low

Source: UK IAQM, 2014

Table 6-5 Step 2B - Method for determining sensitivity of receiving area to human health impacts

Receiver sensitivity	Annual mean PM_{10} concentration[(a)]	Approximate number of receptors	Distance of receptors from the source (m)				
			> 20 m	20 to 50 m	50 - 100 m	100 - 200 m	200 - 350 m
High	Greater than 20 µg/m³	More than 100	High	High	High	Medium	Low
		10 to 100	High	High	Medium	Low	Low
		1 to 10	High	Medium	Low	Low	Low
	17.5 to 20 µg/m³	More than 100	High	High	Medium	Low	Low
		10 to 100	High	Medium	Low	Low	Low
		1 to 10	High	Medium	Low	Low	Low
	15 to 17.5 µg/m³	More than 100	High	Medium	Low	Low	Low
		10 to 100	High	Medium	Low	Low	Low
		1 to 10	Medium	Low	Low	Low	Low
	Less than 15 µg/m³	More than 100	Medium	Low	Low	Low	Low
		10 to 100	Low	Low	Low	Low	Low
		1 to 10	Low	Low	Low	Low	Low
Medium	Greater than 21 µg/m³	More than 10	High	Medium	Low	Low	Low
		1 to 10	Medium	Low	Low	Low	Low
	17.5 to 20 µg/m³	More than 10	Medium	Low	Low	Low	Low
		1 to 10	Low	Low	Low	Low	Low
	15 to 17.5 µg/m³	More than 10	Low	Low	Low	Low	Low
		1 to 10	Low	Low	Low	Low	Low
	Less than 15 µg/m³	More than 10	Low	Low	Low	Low	Low
		1 to 10	Low	Low	Low	Low	Low
Low	-	More than 1	Low	Low	Low	Low	Low

Source: UK IAQM, 2014

(a) scaled for project, according to the ratio of NSW and UK annual average PM_{10} standards (25 µg/m³ and 40 µg/m³ respectively)

Table 6-6 Step 2B - Method for determining sensitivity of receiving area to ecological impacts

Receiver sensitivity	Distance of receptors from the source (m)	
	Less than 20 m	20 to 50 m
High	High	Medium
Medium	Medium	Low
Low	Low	Low

Source: UK IAQM, 2014

Table 6-7 Results for sensitivity of areas to dust soiling effects

Construction area	Activity	Receiver sensitivity	Number of receptors by distance from source (m)				Sensitivity to dust soiling impacts of area
			> 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

Sensitivity to human health impacts

For human health impacts, ‘receiver sensitivity’ was estimated based on the proximity and density of different types of receivers as outlined in **Table 6-3**. Using mapping, the number of high sensitivity human receiver locations were counted and grouped into the group sizes listed in **Table 6-5**. **Table 6-8** lists the results from this review. As above, it is noted that the UK IAQM method considers the number of receiver locations, not the number of potential human receivers.

Table 6-8 Results for sensitivity of areas to human health effects

Construction area	Activity	Receiver sensitivity	Number of receptors by distance from source (m)					Sensitivity to dust soiling impacts of area
			Less than 20 m	20 to 50 m	50 to 100 m	100 to 200 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

As shown, receiver sensitivity to human health effects was determined to 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 construction footprint.

Sensitivity to ecological impacts

Sensitivity of the receiving environment to ecological impacts was classified by reviewing the presence of any ecologically sensitive areas within 50 metres of construction areas, consistent with **Table 6-6**. As displayed in **Figure 6-1** and **Figure 6-2**, protected ecological habitat areas are located within 20 metres of each construction area. On this basis, as displayed in **Table 6-9**, the ecological sensitivity around each construction area was determined to be ‘high’.

Table 6-9 Results for sensitivity of areas to ecological impacts

Construction area	Activity	Receptor sensitivity	Distance from source	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

Summary

Table 6-10 summarises the receiver sensitivity ratings determined for dust soiling, human health effects and ecological impacts.

Table 6-10 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

Construction area	Sensitivity to potential impact	Surrounding receiver sensitivity rating
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 (presented in **Table 6-2**) and the surrounding area sensitivity classifications determined in Step 2B (summarised in **Table 6-10**) were combined in Step 2C using the guidance below in **Table 6-11** to 'determine the risk of impacts with no mitigation applied' (UK IAQM, 2014).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 6-12**.

Table 6-11 Step 2C - 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

Source: UK IAQM, 2014

Table 6-12 Unmitigated construction dust risk values for the project

Construction area	Activity	Potential impact		
		Dust soiling	Human health impacts	Ecological effects
M12_01 – M12 Motorway between The Northern Road and Western Sydney Airport entrance/exit	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 – M12 Motorway between Western Sydney Airport entrance/exit road and Clifton Avenue	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 – M12 Motorway between Clifton Avenue and Elizabeth Drive near Mamre Road	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 – M12 Motorway between Elizabeth Drive near Mamre Road and the M7 Motorway	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

As presented in **Table 6-12**, the highest unmitigated risk rating determined for each construction area was ‘high risk’. This classification related to the potential for ecological impacts during earthworks, construction and trackout activities for M12_01, M12_03 and M12_04; with a ‘high risk’ of human health impacts also determined during earthworks, construction and trackout activities at construction area M12_02.

6.1.3 Step 3 – Mitigation and management

As shown in **Table 6-12**, 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 have been recommended from guidance in the UK IAQM method. These are presented below in **Chapter 8**.

6.1.4 Step 4 – Residual risks

It is expected that with the application of the measures detailed in **Chapter 8**, risks from construction (ie residual risks) would be reduced to the extent where impacts could be effectively managed. Significant residual impacts are therefore not anticipated.

6.1.5 Other impacts during construction

In addition to construction dust, there are a range of other potential air quality issues identified that have the potential to impact on sensitive receivers during construction. These include exhaust emission from the combustion of fossil fuels generated by equipment and construction plant, odours arising from uncovered contaminated and/or hazardous materials, and airborne hazardous materials (eg asbestos and fungal spores), which may be generated during demolition and excavation activities. Potential impacts from construction plant and equipment exhaust emissions are not anticipated, owing to the expected intensity of construction operations, setback distances from surrounding sensitive receivers, and the linear nature of the project. Regarding odours and airborne hazardous materials, there is potential for these effects to arise during demolition activities. These risks may also be present during excavation works, noting the presence of potentially contaminated soils and areas of illegal dumping within the construction study area.

Measures to effectively manage these risks as they are encountered are included in **Section 8.1**. Provided the effective implementation of these measures. significant impacts associated with exhaust emissions, odours, and airborne hazardous materials are not anticipated.

6.1.6 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.

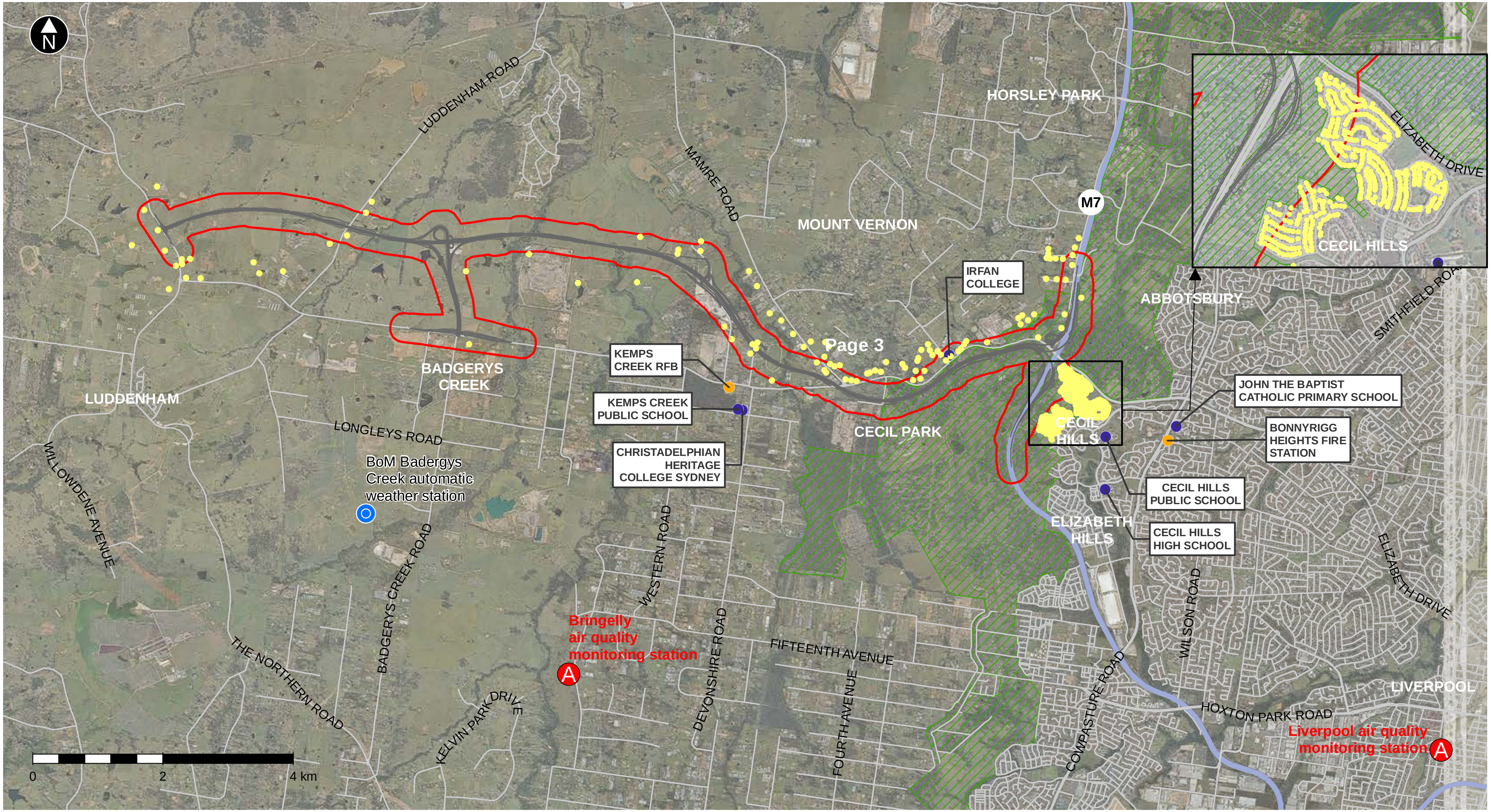
6.2 Operational impacts

6.2.1 Overview

Using the approach and inputs described above in **Section 4.4**, potential changes in local air quality as a result of the project at receivers that would be near the new M12 Motorway, as well as receivers affected by associated traffic changes along The Northern Road, the M7 Motorway and Elizabeth Drive were assessed. The sub-sections below discuss the results for each of the key pollutants, along each of these roadways. Where contributions from traffic associated with the project resulted in concentrations above the impact assessment criteria from the EPA’s Approved Methods at the nearest, most-affected receiver, further review of the spatial extents of these changes was completed.

6.2.2 Sensitive receivers

Figure 6-3 displays sensitive receiver locations in and around the operational air quality study area, with more detail (including assessment segments) shown in **Figure 6-4**. Further detail of how the operational air quality study area was developed is available above in **Section 4.4.2**.

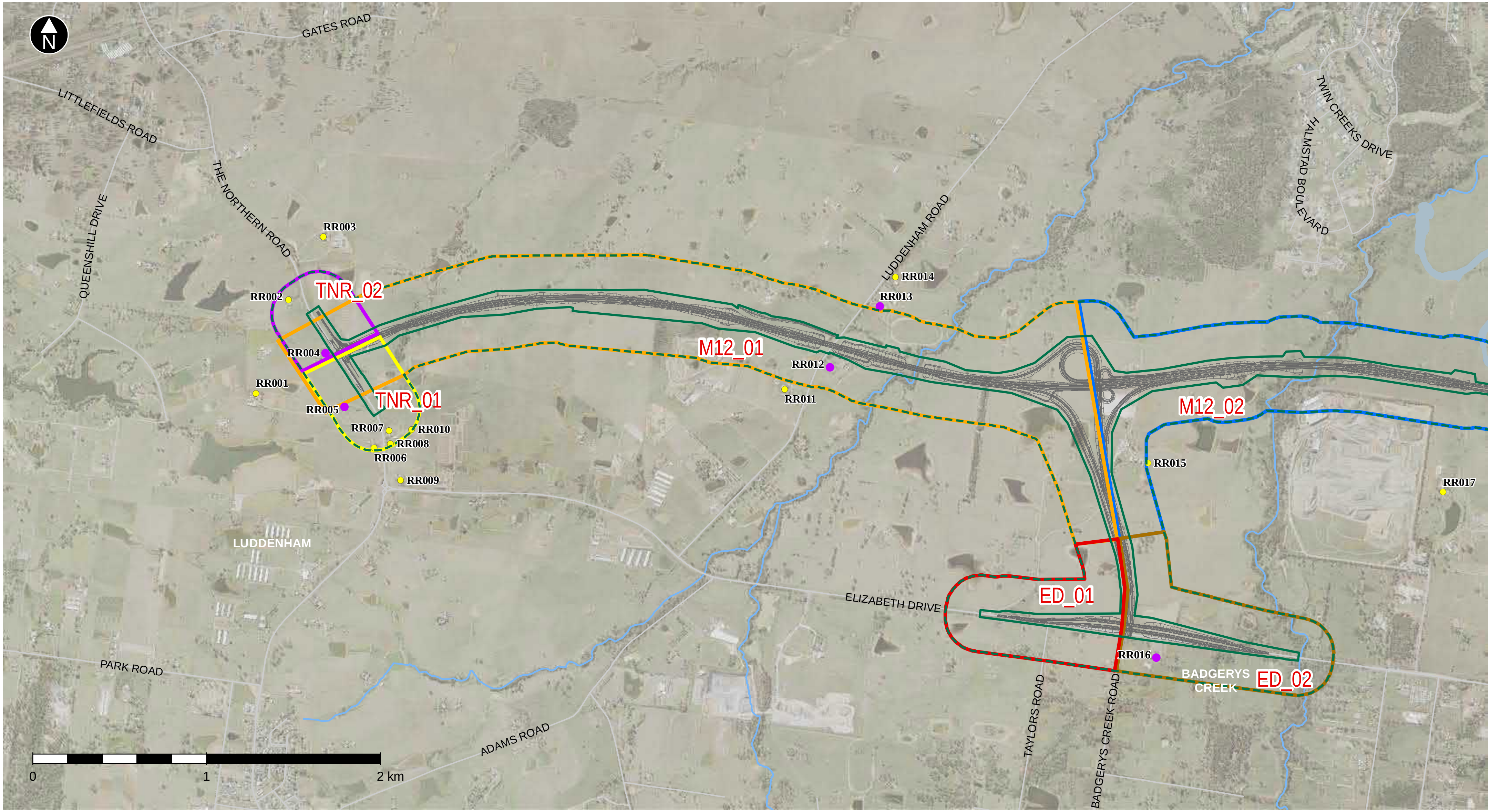


The project
Study area (operation)
Western Sydney Parklands
Motorway
Main roads

Receivers
Residential
Educational facility
Emergency services

BoM automatic weather station
OEH air quality monitoring stations

Figure 6-3 Sensitive receivers within the operational study area



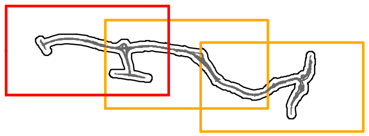
The project
The project operational footprint
Study area (operation)

Operational segments

M12_01
TNR_01
TNR_02
M12_02
ED_02
ED_01

Receivers

Residential
Nearest receivers



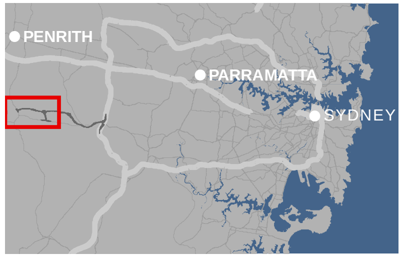
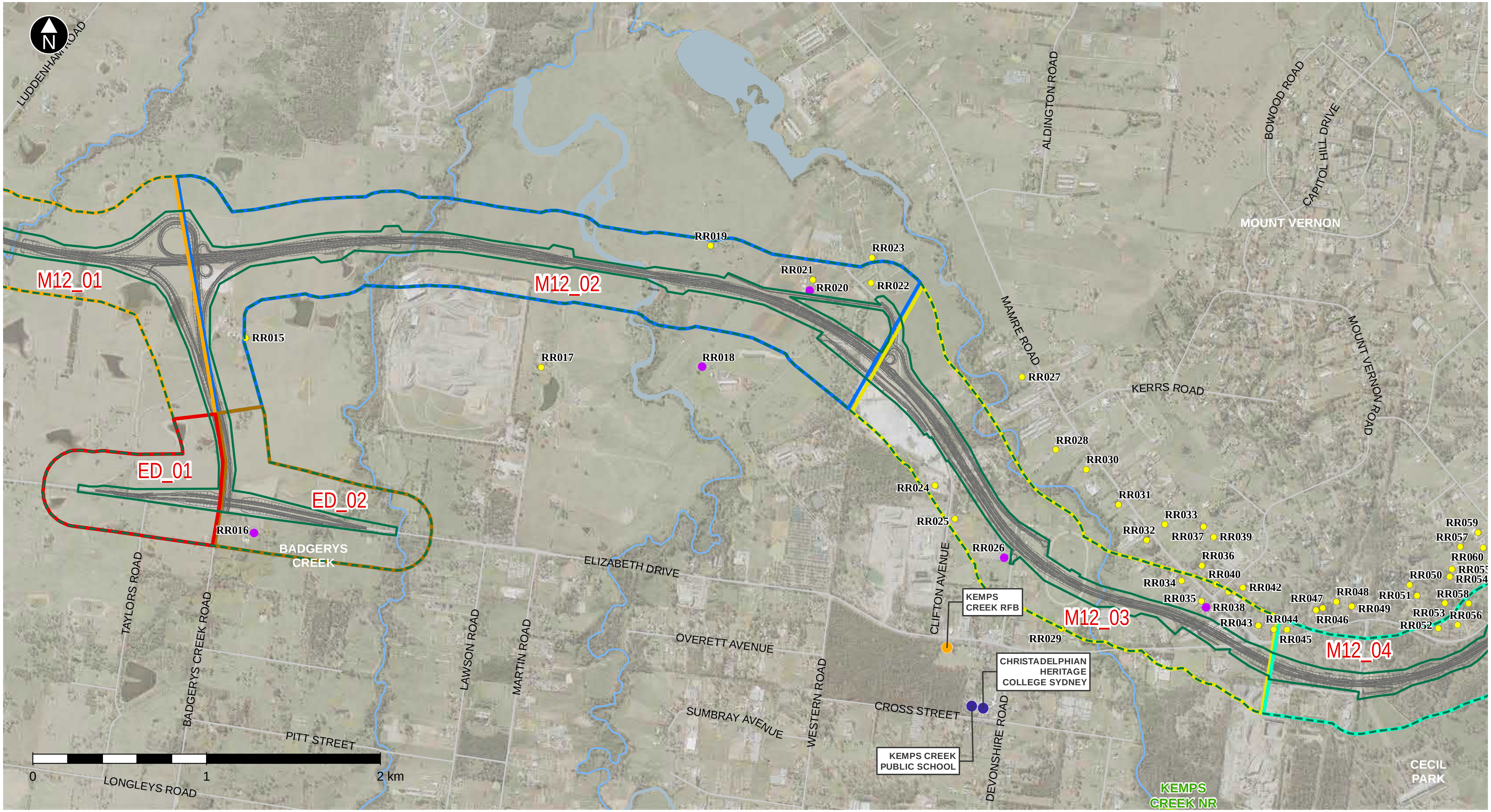


Figure 6-4 Operation air quality study area and assessment segments



The project
The project operational footprint
Study area (operation)
NPWS estate / reserves

Operational segments

M12_01
M12_02
M12_03
ED_02
ED_01
M12_04

Receivers

Residential
Educational facility
Emergency services
Nearest receivers

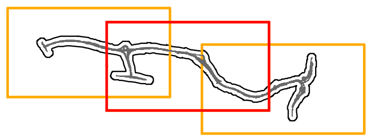


Figure 6-4 Operation air quality study area and assessment segments

Date: 3/09/2019 Path: J:\IE\Projects\04_Eastern\IA145100\08 Spatial\GIS\Directory\Templates\MXDs\Figures\EIS\SpecialistReports\AirQuality\FinalEIS\JAJV_EIS_AirQuality_F005_AQSegments_OF_r2v1.mxd
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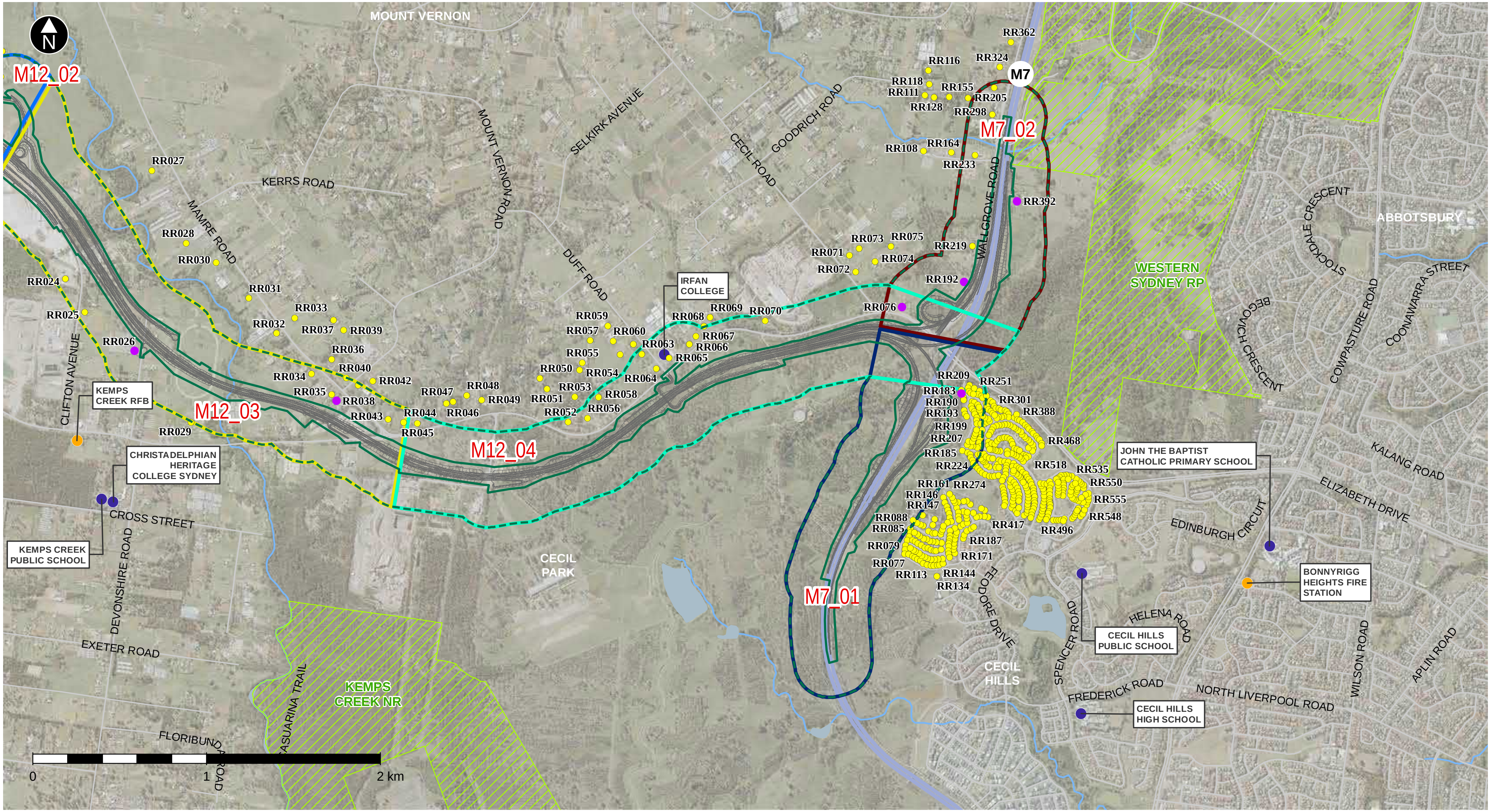

The project
The project operational footprint
Study area (operation)
NPWS estate / reserves

Operational segments

M12_02
M12_03
M12_04
M7_01
M7_02

Receivers

Residential
Educational facility
Emergency services
Nearest receivers

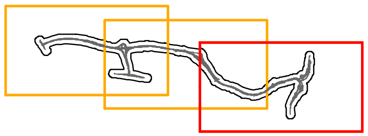

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Figure 6-4 Operation air quality study area and assessment segments

As detailed in **Section 3.6**, the Approved Methods requires a review of the potential for impacts at the nearest existing or likely future sensitive receiver areas in relation to the project. The Growth Centres SEPP, *State Environmental Planning Policy (Sydney Region Growth Centres) Amendment (Miscellaneous) 2010*, and The Western Sydney Aerotropolis Land Use and Infrastructure Implementation Plan, Stage 1: Initial Precincts (LUIIP) (NSW Department of Planning and Environment, 2018) only show zones where particular types on land uses are intended. The level of detail of the specific locations of future sensitive receivers in relation to the project is not available. For the purpose of the assessment, it was considered that these future receivers would not be any nearer than existing sensitive receivers.

6.2.3 Predicted results – Overview

The following sub-sections present results predicted from the quantitative assessment of operational air quality impacts using TRAQ as described in detail above in **Section 4.4**. Results have been evaluated by considering how road traffic contributions to air pollutant concentrations at sensitive receivers would change relative to existing operations; compared with applicable no project scenarios, and with the project between year of opening (2026) and 10 years' after opening (2036) scenarios. Although the impact assessment criteria from the Approved Methods do not specifically apply to road projects, they were also considered to provide an indication of the significance of the project's effect on air quality during operations.

6.2.4 Predicted results – Particulate matter

M12 Motorway

24-hour averaged PM_{10} concentrations at the nearest receiver along segments M12_01, M12_02, M12_03 and M12_04 of the project for existing operations (Scenario 1), year of opening (2026) (Scenario 2) and future design year (2036) (Scenario 4) with the project are displayed in **Figure 6-5**. These nearest receiver locations are displayed above in **Figure 6-3** and **Figure 6-4**.

Figure 6-5 indicates that 24-hour averaged PM_{10} contributions from the roadway at the nearest, most-affected receivers would change compared with existing conditions as follows:

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

As noted above, 24-hour averaged PM_{10} roadway contributions at the nearest, most-affected receivers were predicted to increase from year of opening (2026) to 10 years' after opening (2026) along all four M12 Motorway road assessment segments. This is attributable to increases in forecast traffic flows between 2026 and 2036 as is displayed in **Figure 4-3** and **Figure 4-5** respectively. The increase presented and discussed above 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.

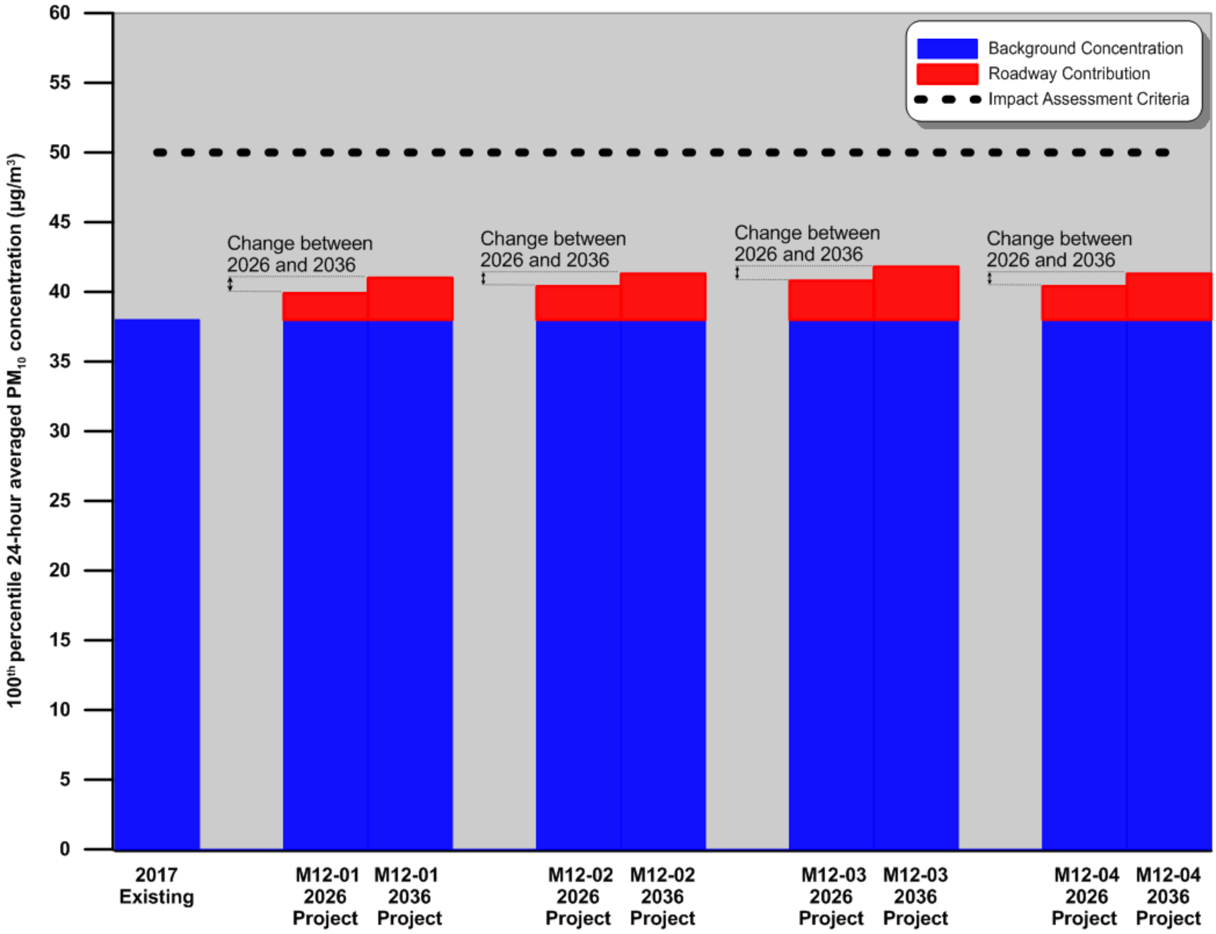


Figure 6-5 Predictions of 24-hour averaged PM_{10} at nearest receivers – M12 Motorway (Design)

The resulting total (ie background plus road contribution) 24-hour averaged PM_{10} concentrations are predicted to remain below the 50 µg/m^3 impact assessment criteria from the EPA's Approved Methods, although it is noted that it doesn't strictly apply to road projects.

Annually averaged PM_{10} concentrations at the nearest receiver along segments M12_01, M12_02, M12_03 and M12_04 of the new M12 Motorway for existing operations (Scenario 1), year of opening (2026) (Scenario 2) and future design year (2036) (Scenario 4) are displayed in **Figure 6-6**. These nearest receiver locations are displayed above in **Figure 6-3** and **Figure 6-4.**

Figure 6-6 indicates that 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.

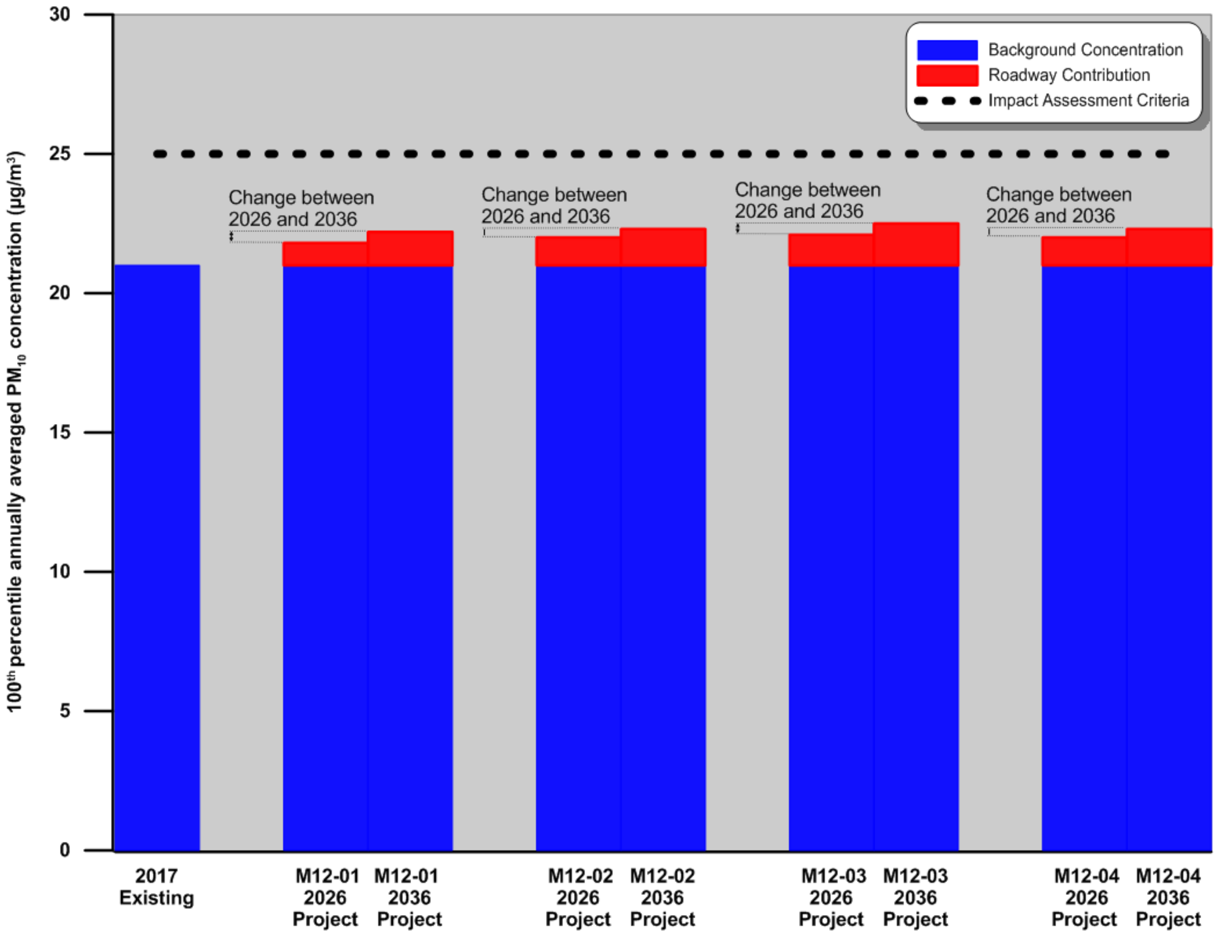


Figure 6-6 Predictions of annually averaged PM_{10} at nearest receivers – M12 Motorway (Design)

As for 24-hour averaged PM_{10}, annually averaged PM_{10} roadway contributions at the nearest, most-affected receivers assessed were predicted to increase from year of opening (2026) to 10 years' after opening (2026) 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. Like 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 annually averaged PM_{10} concentrations are predicted to be below the 25 µg/m^3 impact assessment criteria from the EPA's Approved Methods, although it is noted that it doesn't strictly apply to road projects.

Regarding 24-hour averaged $PM_{2.5}$, concentrations at the nearest receivers along segments M12_01, M12_02, M12_03 and M12_04 of the new M12 Motorway for existing operations (Scenario 1), year of opening (2026) (Scenario 2) and future design year (2036) (Scenario 4) are displayed in **Figure 6-7**. These nearest receiver locations are displayed above in **Figure 6-3** and **Figure 6-4**.

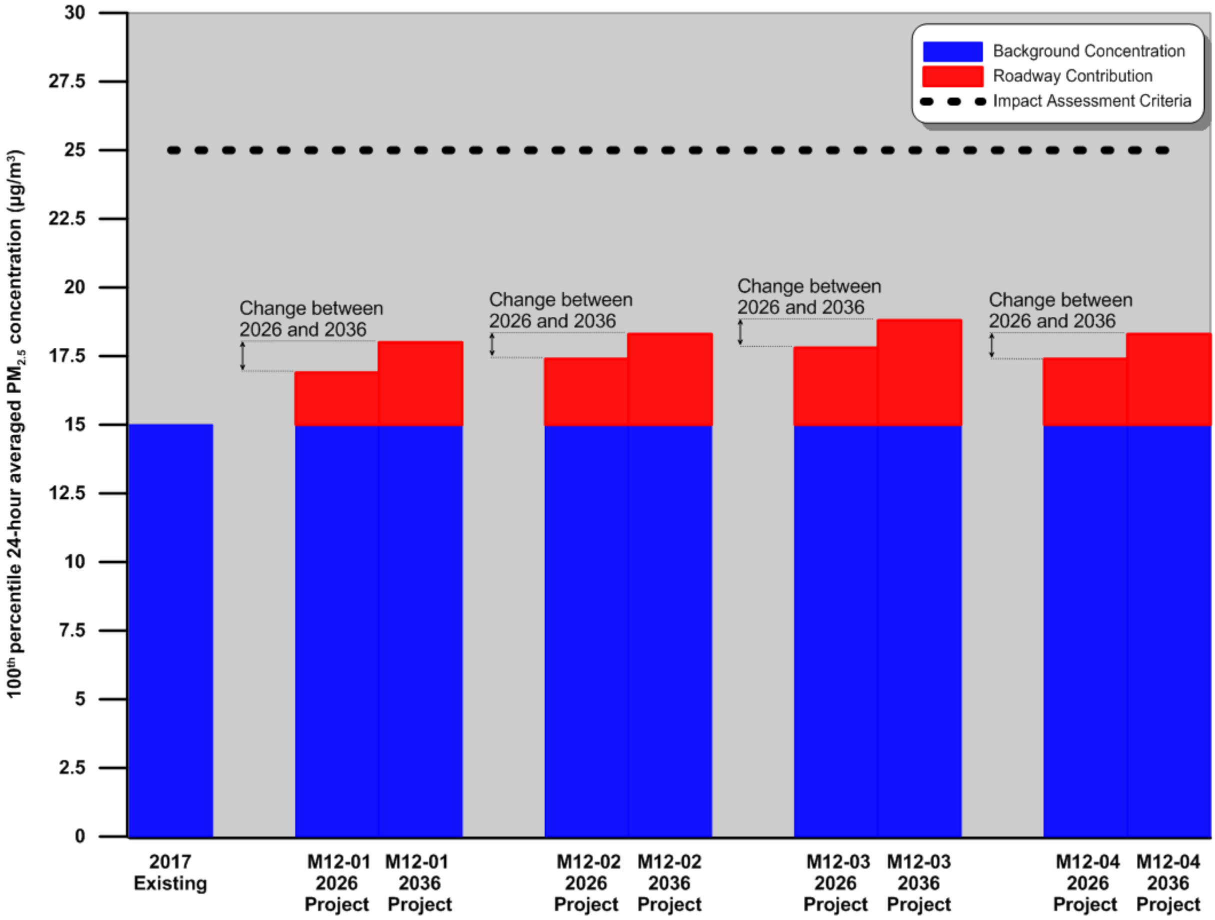


Figure 6-7 Predictions of 24-hour averaged $PM_{2.5}$ at nearest receivers – M12 Motorway (Design)

As **Figure 6-7** indicates, 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.

As for 24-hour averaged PM_{10}, 24-hour averaged $PM_{2.5}$ roadway contributions at the nearest, most-affected receivers assessed were predicted to increase from year of opening (2026) to 10 years' after opening (2026) 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. Like for 24-hour averaged PM_{10}, roadway contributions of 24-hour averaged $PM_{2.5}$ increases were highest at the nearest receiver along M12_03 owing to its proximity and high relative traffic flows compared with the other M12 Motorway segments.

The highest resulting total (ie background plus road contribution) 24-hour averaged $PM_{2,5}$ concentration was about 19 µg/m^3 which would be below the 25 µg/m^3 impact assessment criteria from the EPA's Approved Methods, noting that this value doesn't strictly apply to road projects.

Finally, annually averaged $PM_{2.5}$, concentrations at the nearest receivers along segments M12_01, M12_02, M12_03 and M12_04 of the new M12 Motorway for existing operations (Scenario 1) and year of opening (2026) (Scenario 2) and future design year (2036) (Scenario 4) are displayed in **Figure 6-8**. These nearest receiver locations are displayed above in **Figure 6-3** and **Figure 6-4**. Results for Scenario 3 and Scenario 5 (DoMin') scenarios are noted to be the same as Scenario 1, given that the M12 Motorway would be a new road.

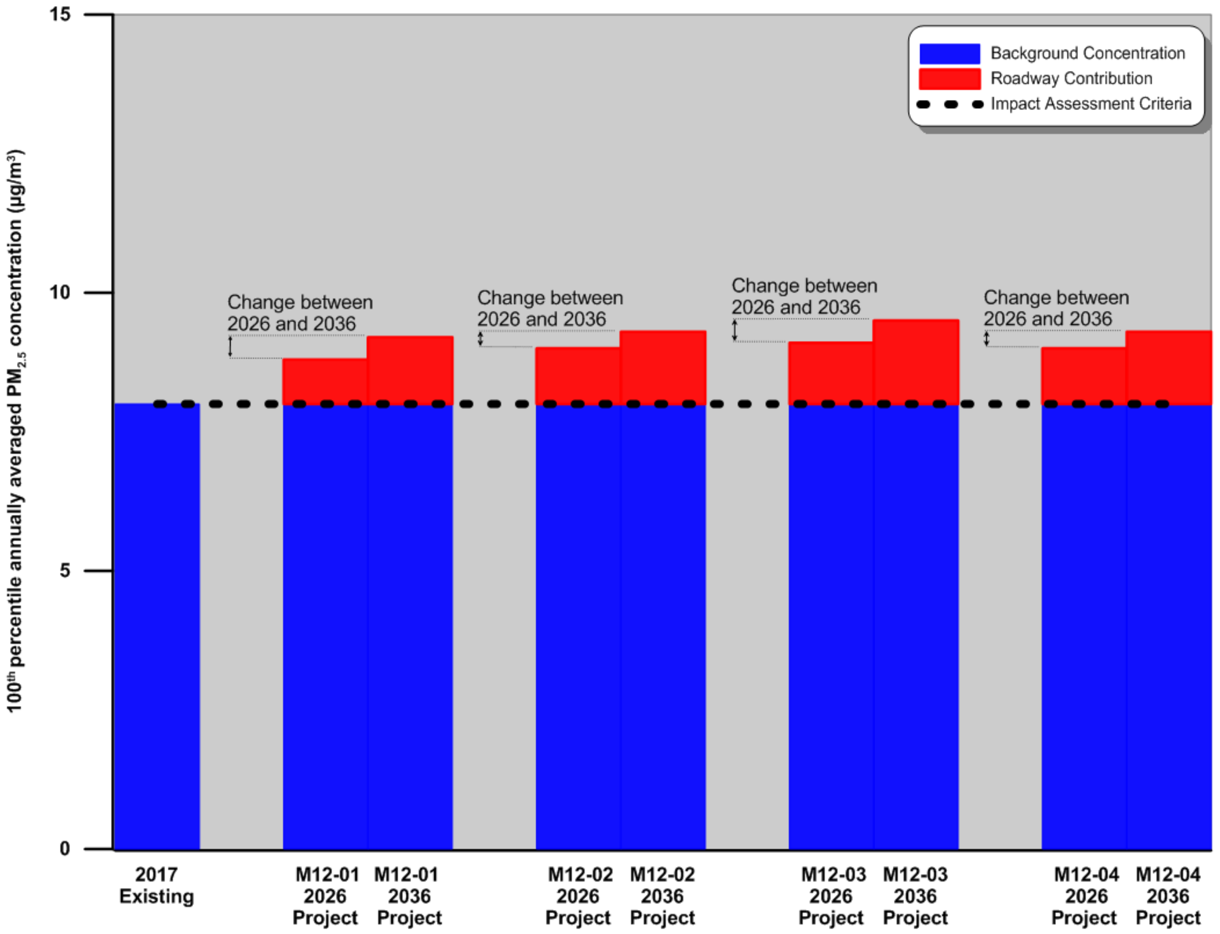
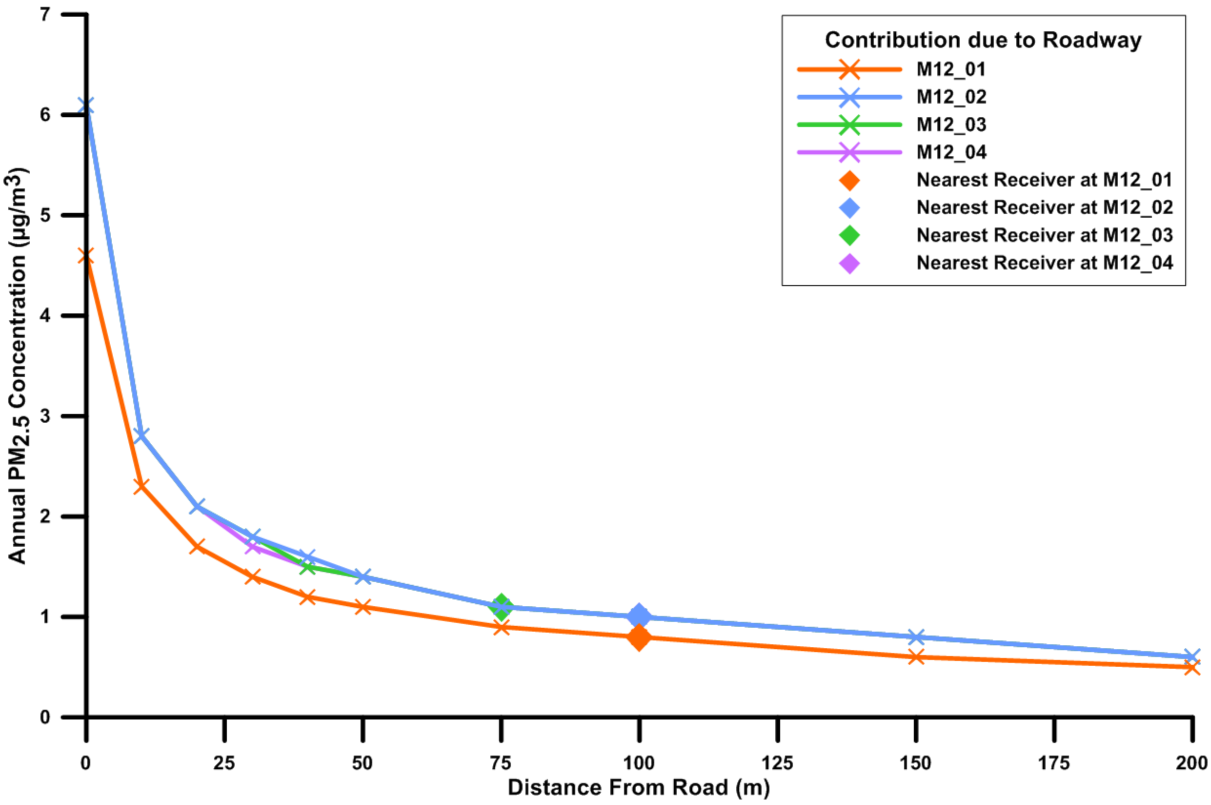


Figure 6-8 Predictions of annually averaged $PM_{2.5}$ at nearest receivers – M12 Motorway (Design)

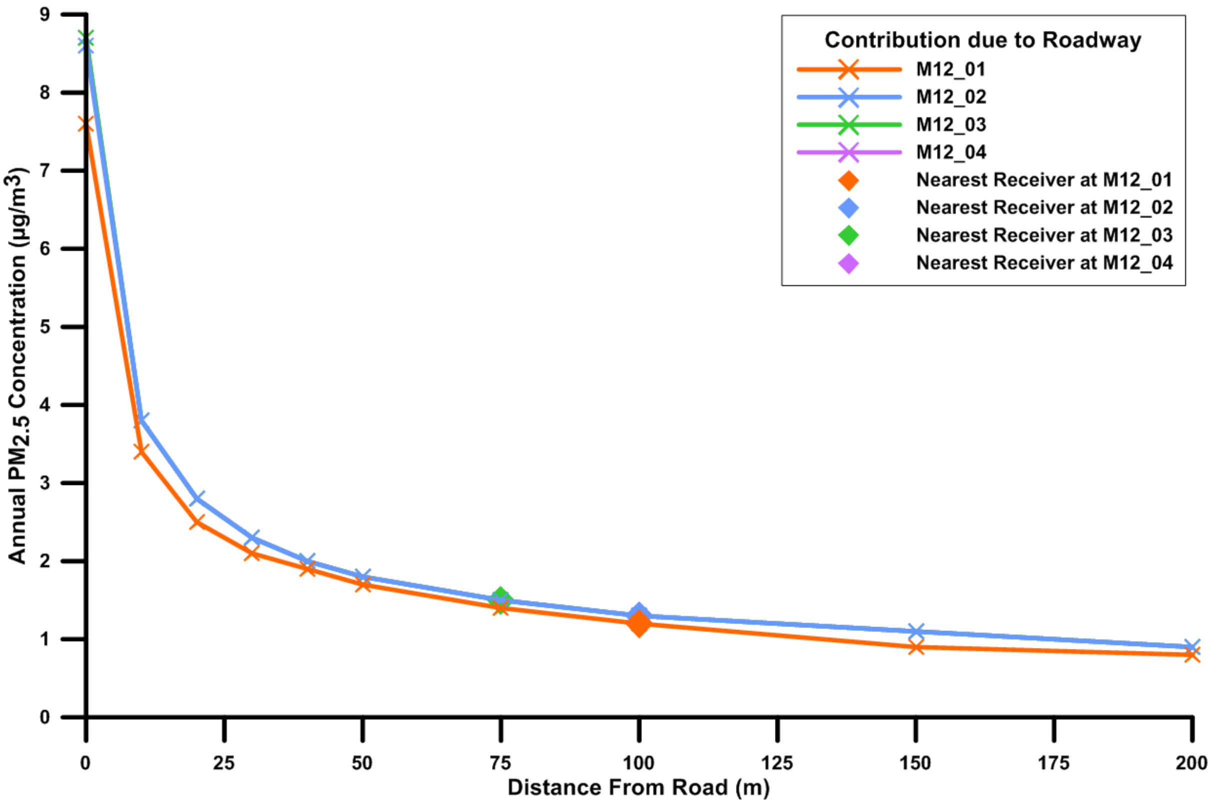
As **Figure 6-8** shows, and presented above in **Section 5.2**, annually averaged $PM_{2.5}$ background concentrations were already predicted to be at the eight µg/m^3 impact assessment criteria from the EPA's Approved Methods. Increases ranging from 0.8 µg/m^3 to 1.1 µg/m^3 were predicted at the nearest, most-affected receivers along the four 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 outlined, although the eight µg/m^3 impact assessment criteria from the Approved Methods does not strictly apply to road projects, it has been used as the basis for triggering further investigation of the spatial extent of changes when exceeded at the nearest, most-affected receiver. **Figure 6-9** and **Figure 6-10** show how annually averaged $PM_{2.5}$ contributions from the different assessment segments of the new M12 Motorway reduce with distance from the roadway for year of opening (2026) and 10 years' after opening (2036) respectively.



Note: Nearest receiver for segment M12_04 is 100 metres, (node is obscured under M12_02)

Figure 6-9 Annual PM2.5 contribution from roadway (2026, year of opening) within the operational study area – M12 Motorway (Design)



Note: Nearest receiver for segment M12_04 is 100 metres, (node is obscured under M12_02)

Figure 6-10 Annual $PM_{2.5}$ contribution from roadway (2036, 10 years' after opening) within the operational study area – M12 Motorway (Design)

The information above in **Figure 6-9** and **Figure 6-10** were used with aerial imagery to identify the number of sensitive receivers within the study area predicted to experience different magnitudes of change in annually averaged $PM_{2.5}$ concentrations. **Table 6-13** presents the outcome of this review.

Table 6-13 Number of receivers predicted to experience change in annually averaged $PM_{2.5}$ concentrations

Road segment	Approximate number of sensitive receivers predicted to experience changes in annually averaged $PM_{2.5}$ due to changes in surface traffic in the study area					
	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**

As shown, no sensitive receivers were predicted to experience changes more than two µg/m³ above existing levels. However, 11 receivers are predicted to experience an increase of annually averaged $PM_{2.5}$ road contributions from less than one µg/m³ up to one to two µg/m³ from 2026 to 2036.

The Northern Road

24-hour 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 6-11**. These nearest receiver locations are displayed above in **Figure 6-3** and **Figure 6-4**. For the existing scenario, the background concentration component comprises of the background concentration from the local EESG air quality monitoring station adopted for the assessment. Even though emissions from the road are already taking place, the location of the monitoring station from where the background air quality was derived is sufficiently away that it would not reflect the background conditions at receivers nearest to The Northern Road. At these locations, concentrations would be higher with road emissions being a contributing factor. To reflect this, contributions from existing traffic were incorporated into the total concentration at these receivers.

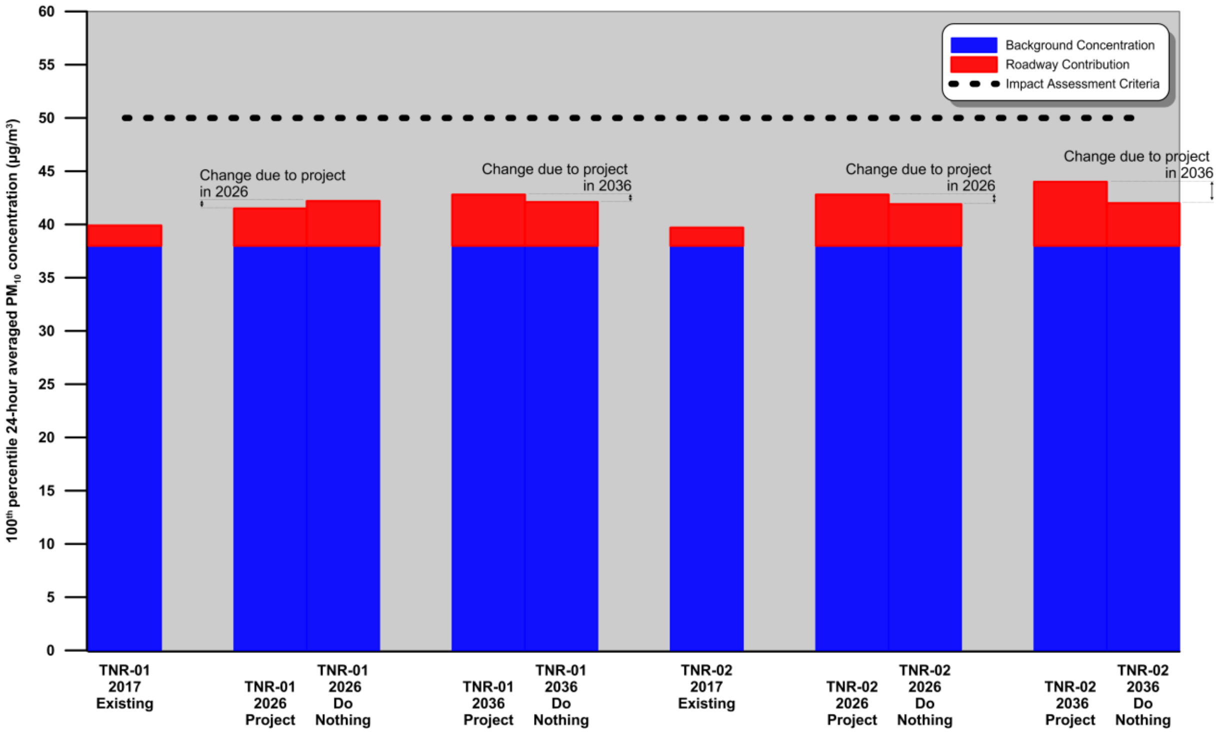


Figure 6-11 Predictions of 24-hour averaged PM_{10} at nearest receivers – The Northern Road (Design)

As displayed, 24-hour averaged PM_{10} 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_{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.

It was predicted that the resulting total concentrations associated with the project scenarios would remain below the 50 µg/m^3 impact assessment criteria from the EPA's Approved Methods.

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 6-12**.

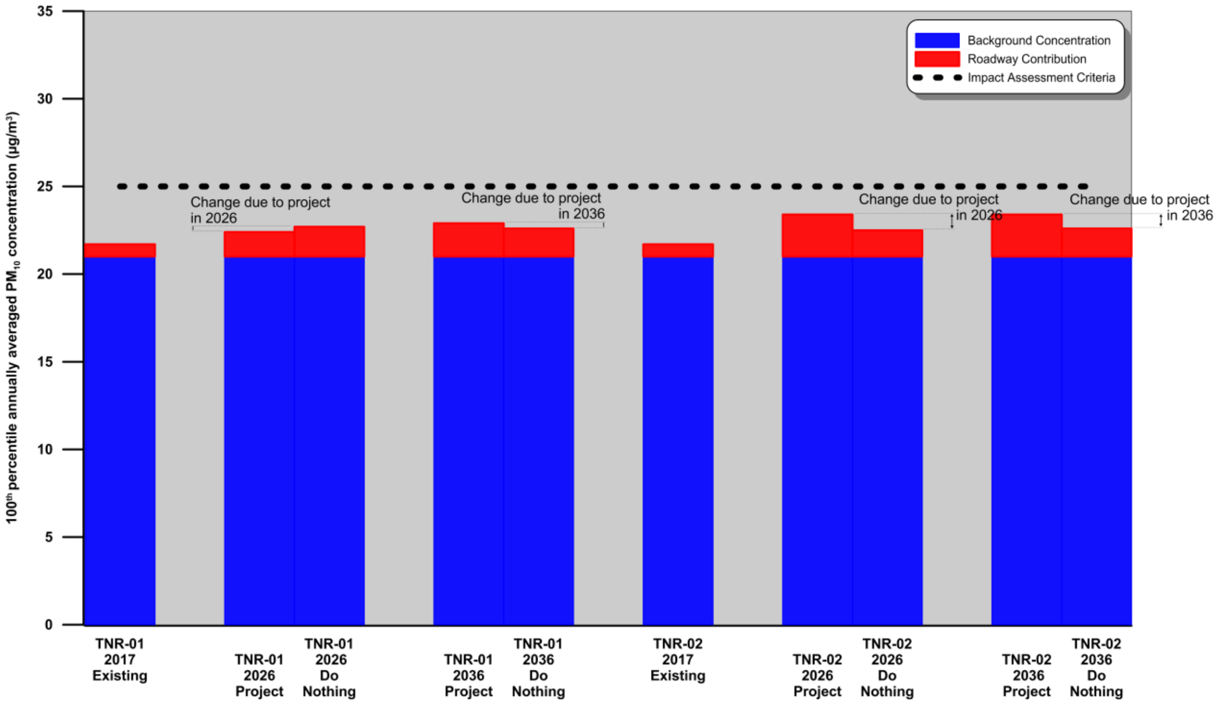


Figure 6-12 Predictions of annually averaged PM_{10} at nearest receivers – The Northern Road (Design)

As **Figure 6-12** shows, annually averaged PM_{10} roadway contributions were predicted to change compared with existing at the nearest, most-affected receivers 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 concentrations associated with the project would remain below the 25 µg/m^3 impact assessment criteria from the EPA's Approved Methods.

Regarding $PM_{2.5}$, 24-hour averaged, concentrations at the nearest receivers 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 6-13**.

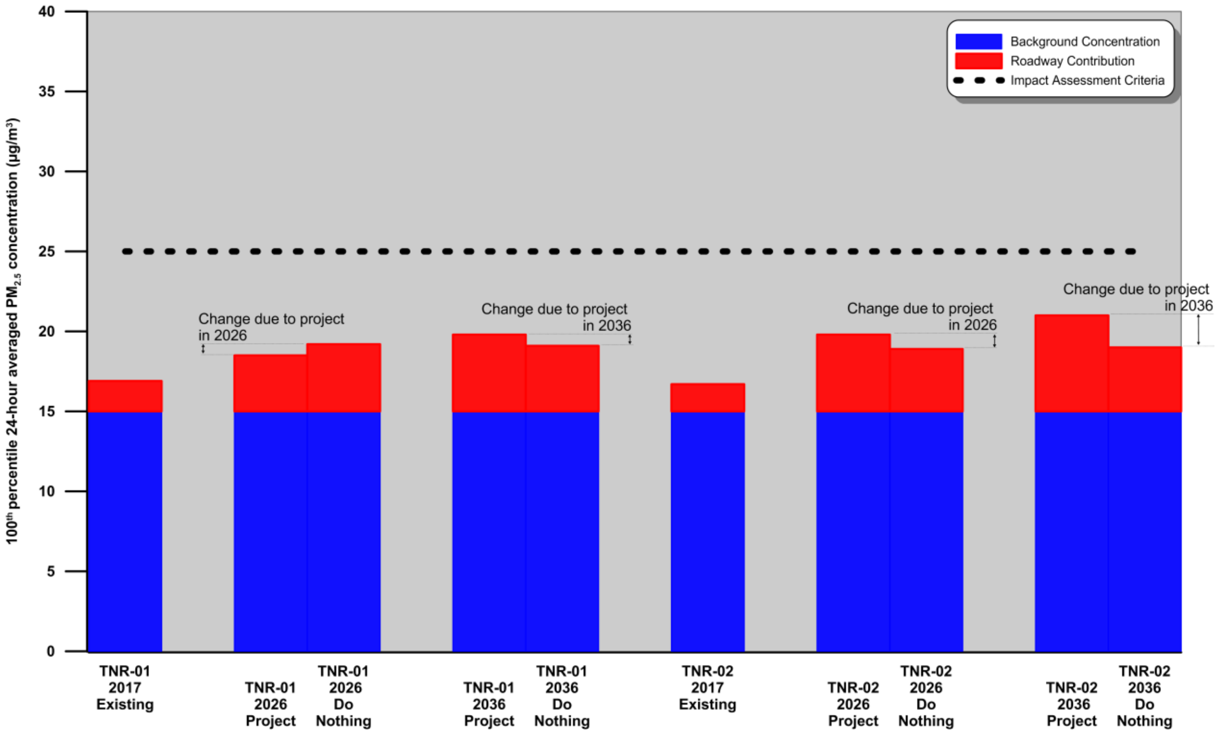


Figure 6-13 Predictions of 24-hour averaged $PM_{2.5}$ at nearest receivers – The Northern Road (Design)

As displayed in **Figure 6-13**, 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 EPA's Approved Methods.

Finally, annually averaged $PM_{2.5}$, concentrations at the nearest receivers 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 6-14**.

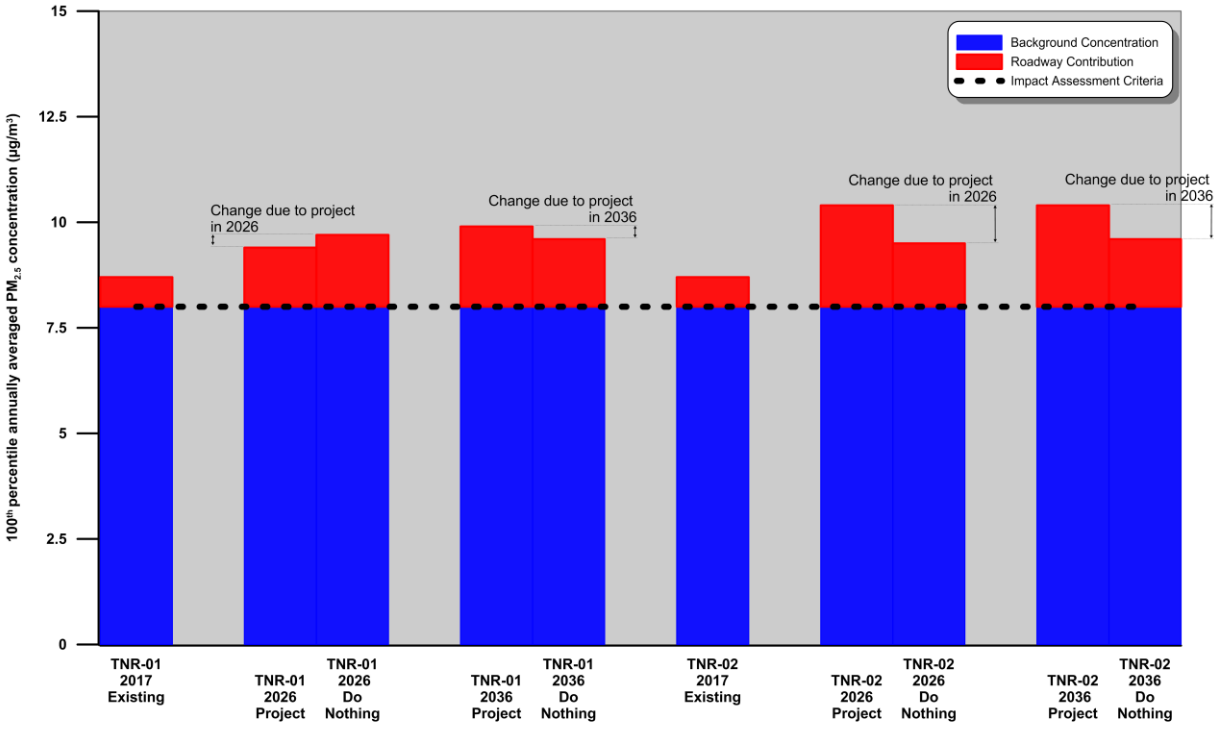


Figure 6-14 Predictions of annually averaged $PM_{2.5}$ at nearest receivers – The Northern Road (Design)

As shown in **Figure 6-14** and presented above in **Section 5.2**, annually averaged $PM_{2.5}$ background concentrations were already predicted to be at the eight µg/m^3 impact assessment criteria from the EPA's Approved Methods.

Changes in roadway contributions between the 2026 project and no project options were 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.

As outlined, although the eight µg/m^3 impact assessment criteria from the Approved Methods does not strictly apply to road projects, it has been used as the basis for triggering further investigation of the spatial extent of changes when exceeded at the nearest, most-affected receiver. **Figure 6-15** and **Figure 6-16** show how annually averaged $PM_{2.5}$ contributions from the different assessment segments of The Northern Road vary with distance from the roadway for project and no project options at year of opening (2026) and 10 years' after opening (2036) respectively.

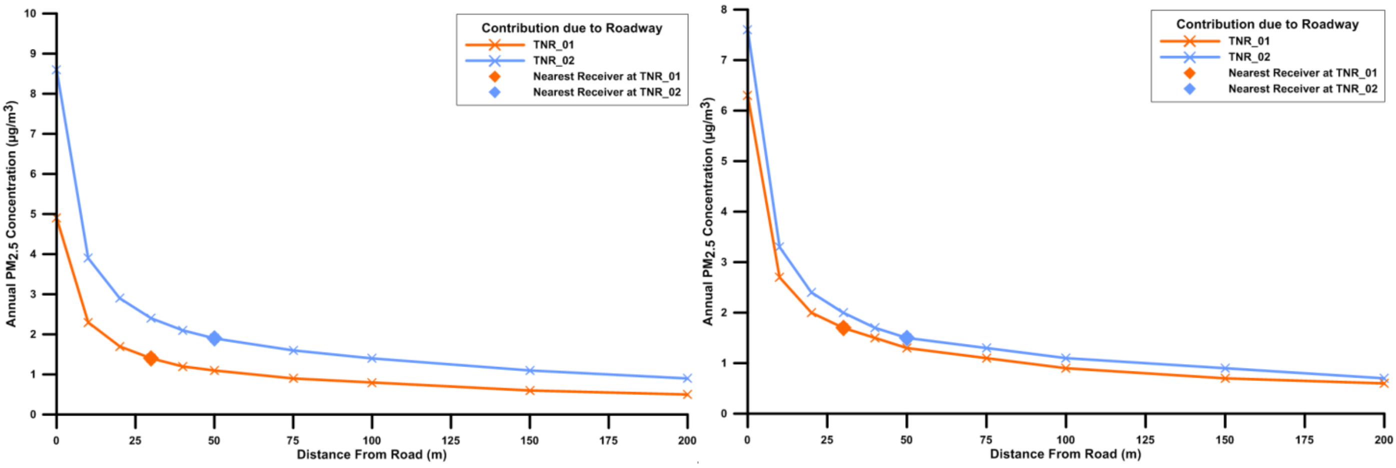


Figure 6-15 Annual $PM_{2.5}$ contribution from roadway (2026, year of opening) within the operational study area, The Northern Road (Left, project; right no project)

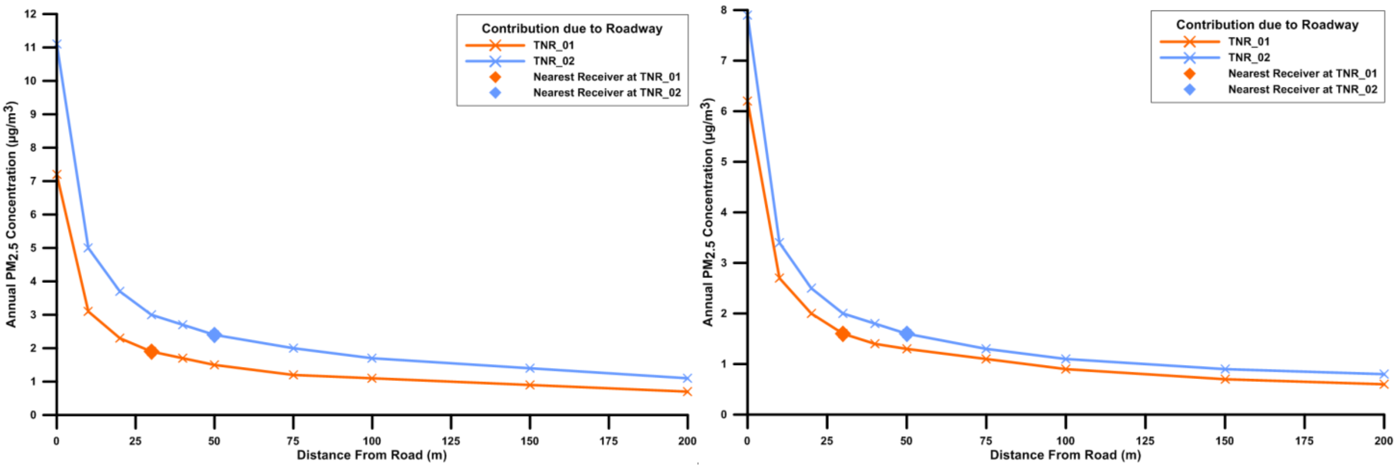


Figure 6-16 Annual $PM_{2.5}$ contribution from roadway (2036, 10 years' after opening) within the operational study area, The Northern Road (Left, project; right no project)

The information above in **Figure 6-15** and **Figure 6-16** were used with mapping information to identify the number of sensitive receivers within the study area predicted to experience different magnitudes of change in annually averaged $PM_{2.5}$ concentrations. **Table 6-14** lists the outcome of this review.

Table 6-14 Number of receivers predicted to experience change in annually averaged $PM_{2.5}$ concentrations as a result of the project, The Northern Road

Road segment	Approximate number of sensitive receivers predicted to experience changes in annually averaged $PM_{2.5}$ due to changes in surface traffic in the study area											
	Greater than 2 µg/m³				1 to 2 µg/m³				Less than 1 µg/m³			
	2026		2036		2026		2036		2026		2036	
	No project	Project	No project	Project	No project	Project	No project	Project	No project	Project	No project	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
Total	**0**	**1**	**0**	**1**	**3**	**2**	**3**	**3**	**4**	**4**	**4**	**3**

As shown, the project was predicted to result in one additional sensitive receiver within the operational study area experiencing annually averaged $PM_{2.5}$ contributions 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.

M7 Motorway

24-hour averaged PM_{10} concentrations at the nearest receiver along segments of the M7 Motorway 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 6-17** These nearest receiver locations are displayed above in **Figure 6-3** and **Figure 6-4**. As described above for The Northern Road, for the existing scenario, the background concentration component comprises of the background concentration from the local EESG air quality monitoring station adopted for the assessment. Even though emissions from the M7 Motorway are already taking place, the location of the monitoring station from where the background air quality was derived is sufficiently away that it would not reflect the background conditions at the receivers nearest to the roadway. At these locations, concentrations would be higher with road emissions being a contributing factor. To reflect this, contributions from existing traffic were incorporated into the total concentration at these receivers.

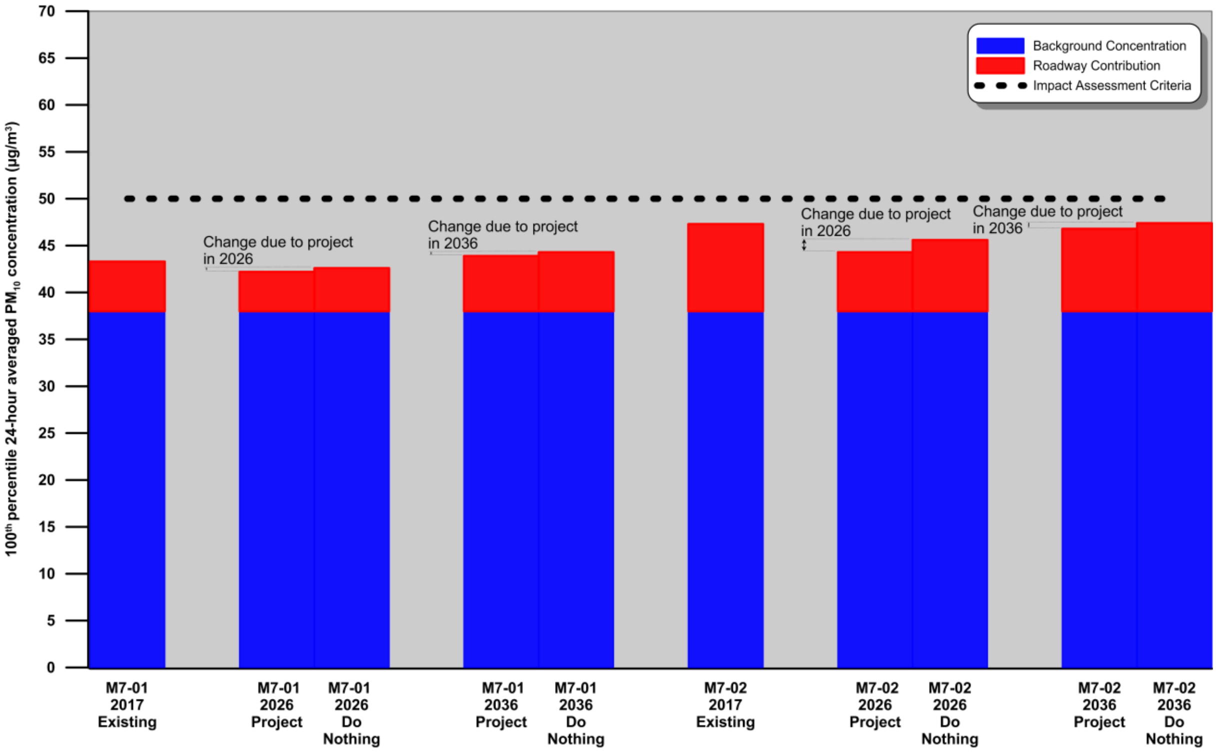


Figure 6-17 Predictions of 24-hour averaged PM_{10} at nearest receivers – M7 Motorway (Design)

As shown, 24-hour averaged PM_{10} 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 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.

It was predicted that the resulting total concentrations would remain below the 50 µg/m^3 impact assessment criteria from the EPA's Approved Methods.

Annually averaged PM_{10} concentrations at the nearest receiver along segments of the M7 Motorway 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 6-18**.

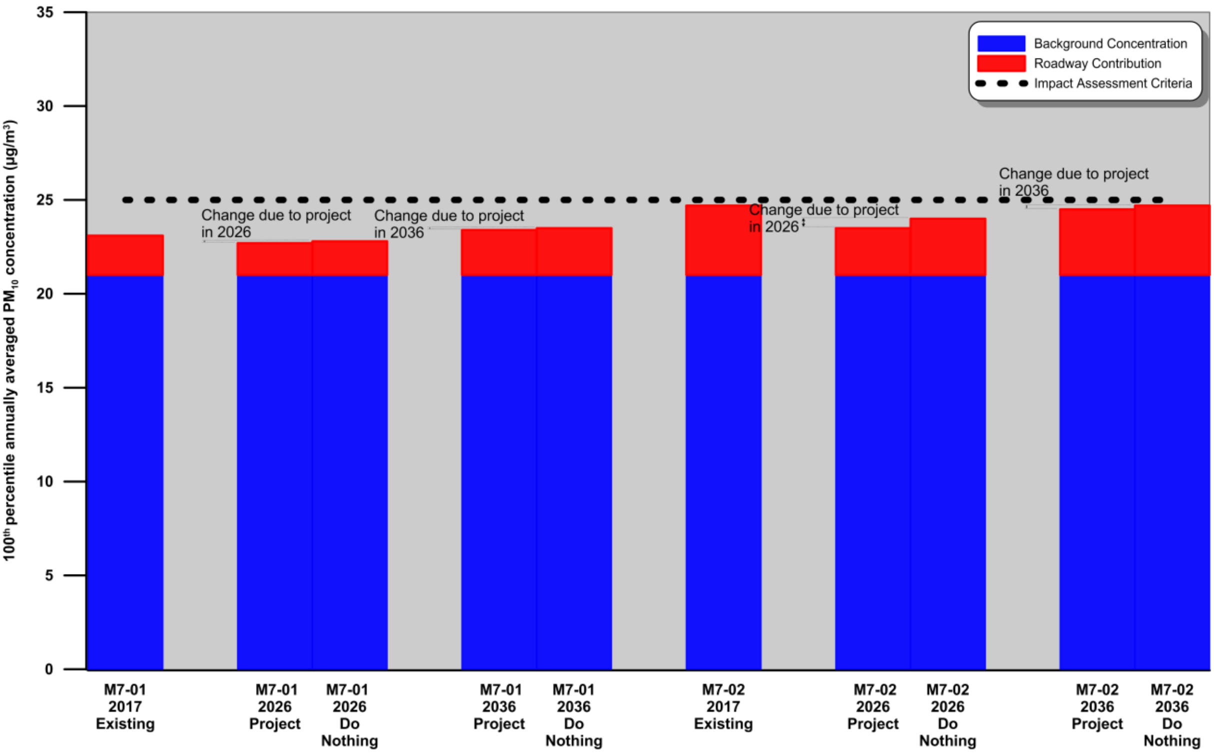


Figure 6-18 Predictions of annually averaged PM_{10} at nearest receivers – M7 Motorway (Design)

As **Figure 6-18** shows, annually averaged PM_{10} roadway contributions were predicted to change compared with existing at the nearest, most-affected receivers 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 concentrations would remain below the 25 µg/m^3 impact assessment criteria from the EPA's Approved Methods.

With respect to $PM_{2.5}$, 24-hour averaged, concentrations at the nearest receivers along segments of the M7 Motorway 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 6-19**.

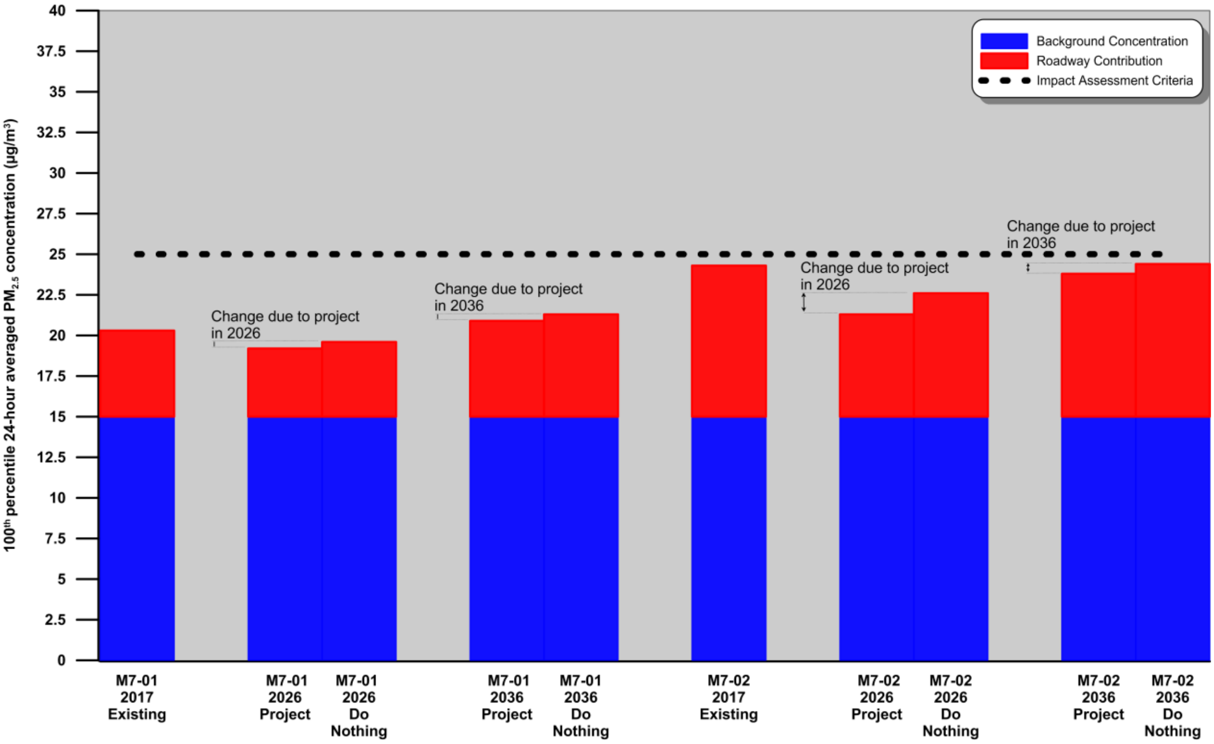


Figure 6-19 Predictions of for 24-hour averaged $PM_{2.5}$ at nearest receivers – M7 Motorway (Design)

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/m³ and increase of 0.6 µg/m³ relative to existing in 2026 and 2036 respectively
- M7_02: A decrease of 3.0 µg/m³ and 0.5 µg/m³ 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/m³ and 0.4 µg/m³ between 2026 and 2036 project and no-project options respectively
- M7_02: A decrease of 1.3 µg/m³ and 0.6 µg/m³ between 2026 and 2036 project and no-project options respectively.

It was predicted that the resulting total concentrations would remain below the 25 µg/m³ impact assessment criteria from the EPA's Approved Methods.

Finally, annually averaged $PM_{2.5}$, concentrations at the nearest receivers along segments of the M7 Motorway 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 6-20**.

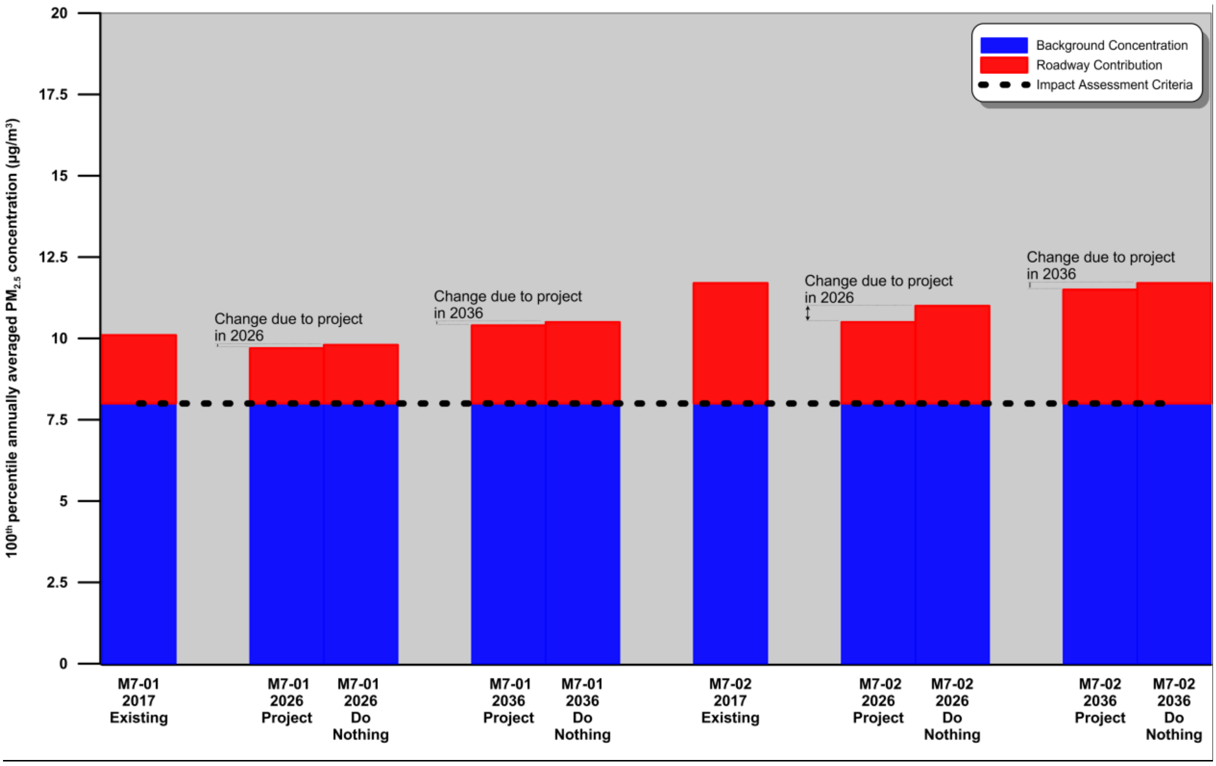


Figure 6-20 Predictions of annually averaged $PM_{2.5}$ at nearest receivers – M7 Motorway (Design)

As **Figure 6-20** shows, and presented above in **Section 5.2**, annually averaged $PM_{2.5}$ background concentrations were already measured to be at the eight µg/m^3 impact assessment criteria from the EPA's Approved Methods. Contributions from 2026 project at the nearest receivers along segments M7_01 and M7_02 decreased by 0.1 µg/m^3 compared with the and 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 outlined, although the eight µg/m^3 impact assessment criteria from the Approved Methods does not strictly apply to road projects, it has been used as the basis for triggering further investigation of the spatial extent of changes when exceeded at the nearest, most-affected receiver. **Figure 6-21** and **Figure 6-22** show how annually averaged $PM_{2.5}$ contributions from the different assessment segments of the M7 Motorway vary with distance from the roadway for project and no project options at year of opening (2026) and 10 years' after opening (2036) respectively.

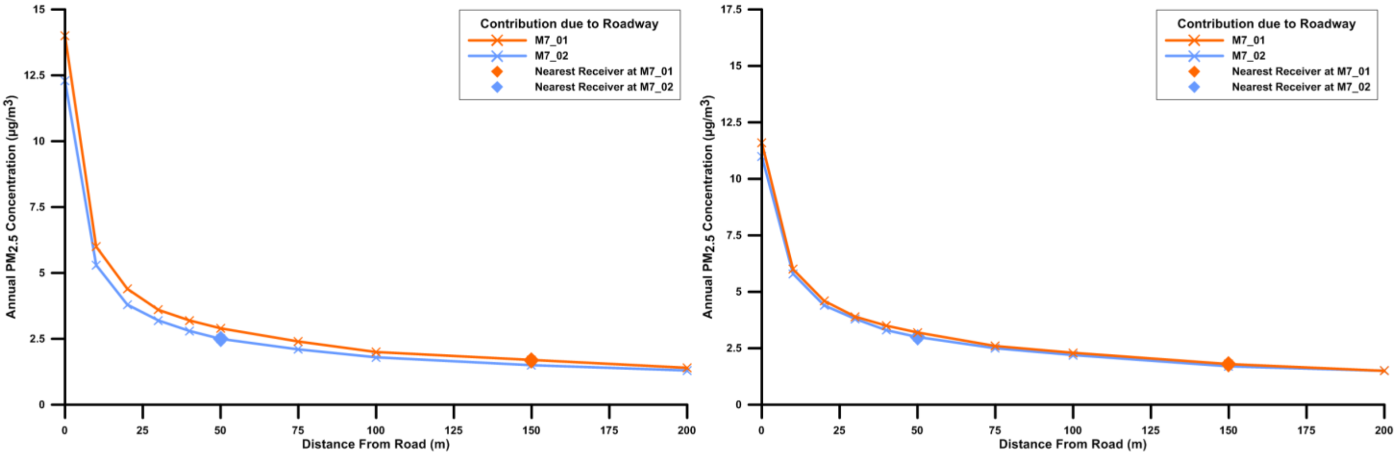


Figure 6-21 Annual $PM_{2.5}$ contribution from roadway (2026, year of opening) within the operational study area, M7 Motorway (Left, project; right no project)

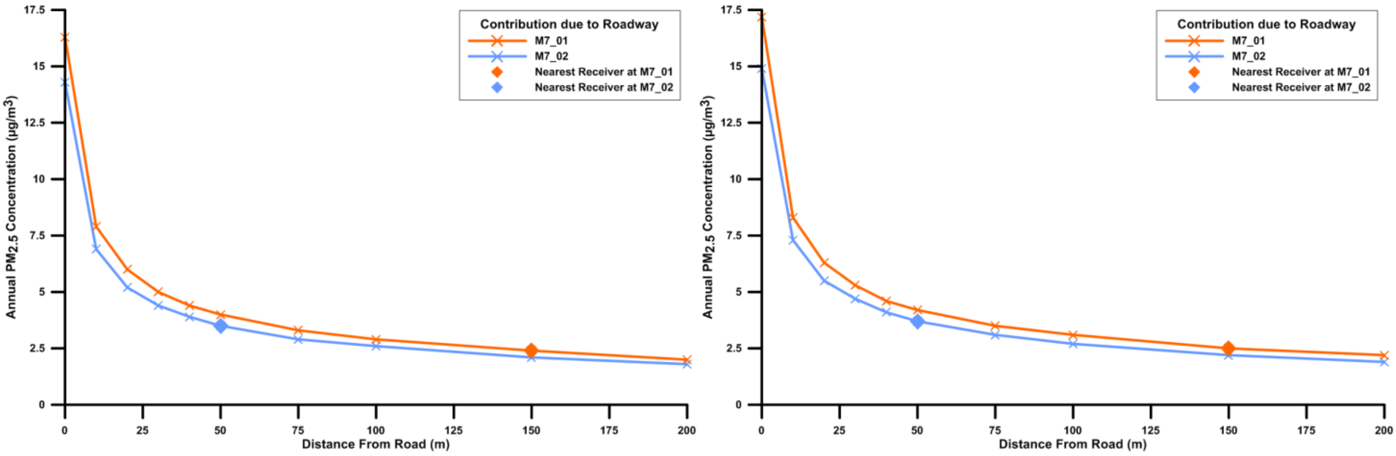


Figure 6-22 Annual $PM_{2.5}$ contribution from roadway (2036, 10 years' after opening) within the operational study area, M7 Motorway (Left, project; right no project)

The information above in **Figure 6-21** and **Figure 6-22** were used with aerial imagery to identify the number of sensitive receivers within the study area predicted to experience different magnitudes of change in annually averaged $PM_{2.5}$ concentrations. **Table 6-15** lists the outcome of this review.

Table 6-15 Number of receivers predicted to experience different magnitudes of change in annually averaged $PM_{2.5}$ concentrations as a result of the project, M7 Motorway

Road segment	Approximate number of sensitive receivers predicted to experience changes in annually averaged $PM_{2.5}$ due to changes in surface traffic in the study area											
	Greater than 2 µg/m³				1 to 2 µg/m³				Less than 1 µg/m³			
	2026		2036		2026		2036		2026		2036	
	No project	Project	No project	Project	No project	Project	No project	Project	No project	Project	No project	Project
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**	**14**	**61**	**60**	**47**	**47**	**0**	**1**	**0**	**0**	**0**	**0**

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

Elizabeth Drive

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 (see **Figure 6-4**). 24-hour averaged PM_{10} concentrations at this receiver 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 6-23**. As for The Northern Road and the M7 Motorway, contributions from existing traffic were incorporated into the total concentration at this receiver, noting that road emissions being a contributing factor to background conditions at this location.

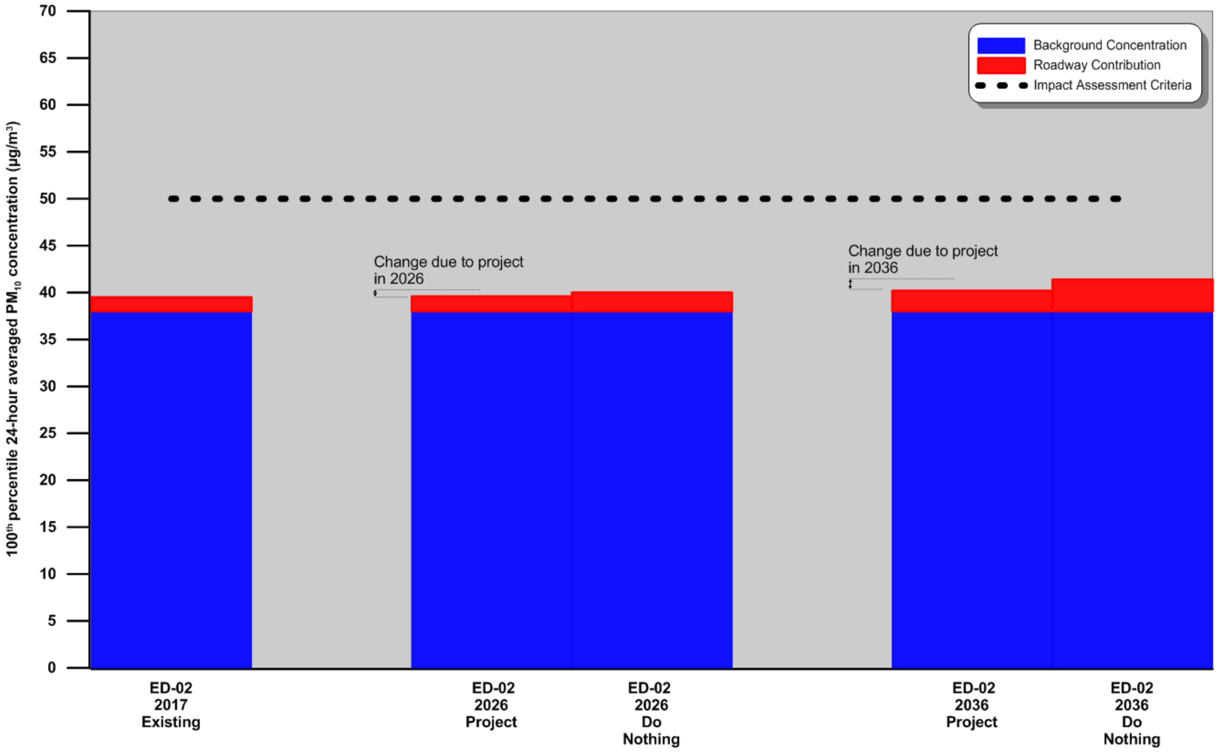


Figure 6-23 Predictions of 24-hour averaged PM_{10} at nearest receiver – Elizabeth Drive (Design)

As displayed, 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.

It was predicted that the resulting total concentrations would remain below the 50 µg/m^3 impact assessment criteria from the EPA's Approved Methods.

Changes in annually averaged PM_{10} concentrations at this receiver 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 6-24**.

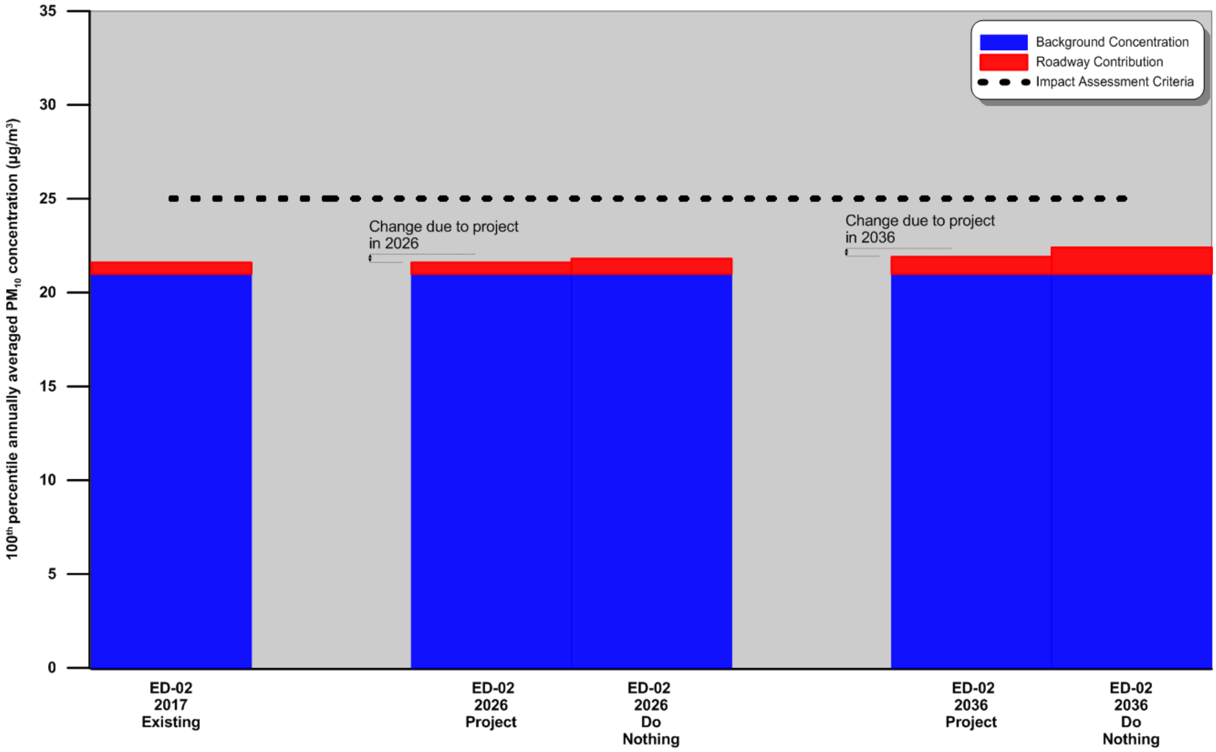


Figure 6-24 Predictions of annually averaged PM_{10} at nearest receiver – Elizabeth Drive (Design)

As **Figure 6-24** shows, 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.

As shown, it was predicted that the resulting total concentrations associated with the project would remain below the EPA's 25 µg/m^3 impact assessment criteria.

Regarding $PM_{2.5}$, changes in 24-hour averaged concentration at the identified nearby receiver within the study area 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 6-25**.

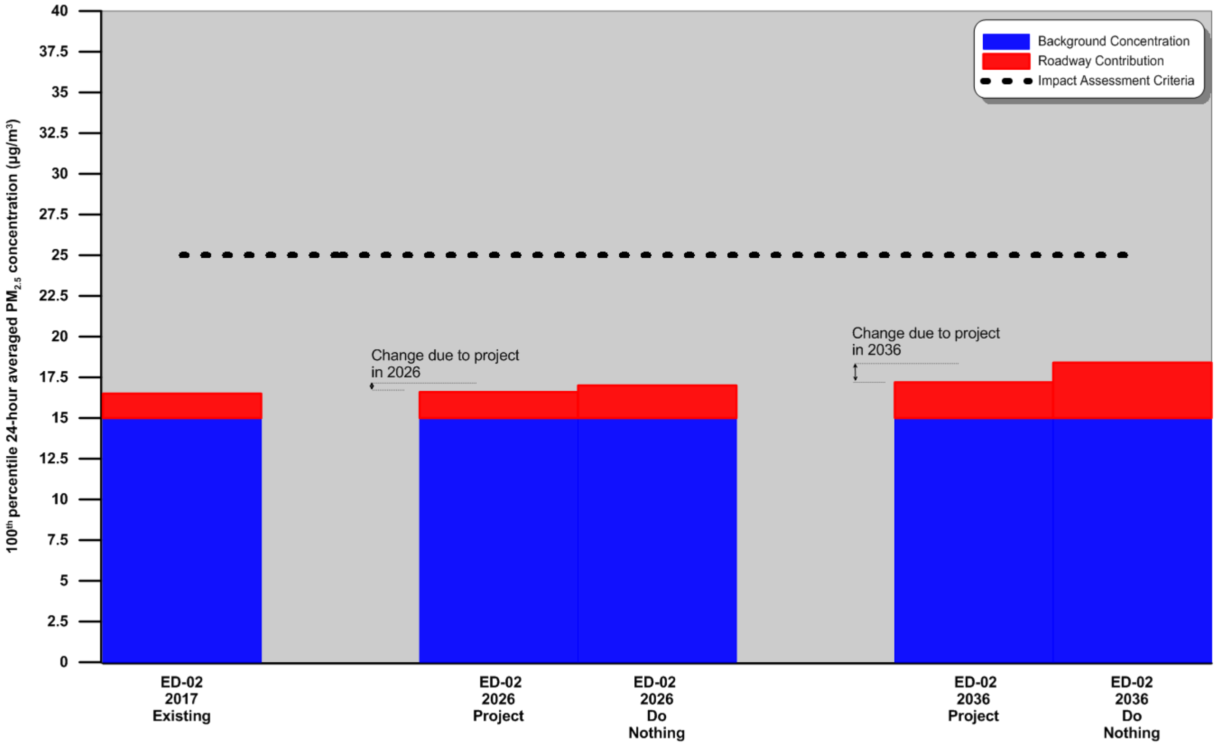


Figure 6-25 Predictions of 24-hour averaged $PM_{2.5}$ at nearest receiver – Elizabeth Drive (Design)

As displayed, 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 EPA's Approved Methods.

Finally, changes in annually averaged $PM_{2.5}$ at the identified nearby receiver within the study area 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 6-26**.

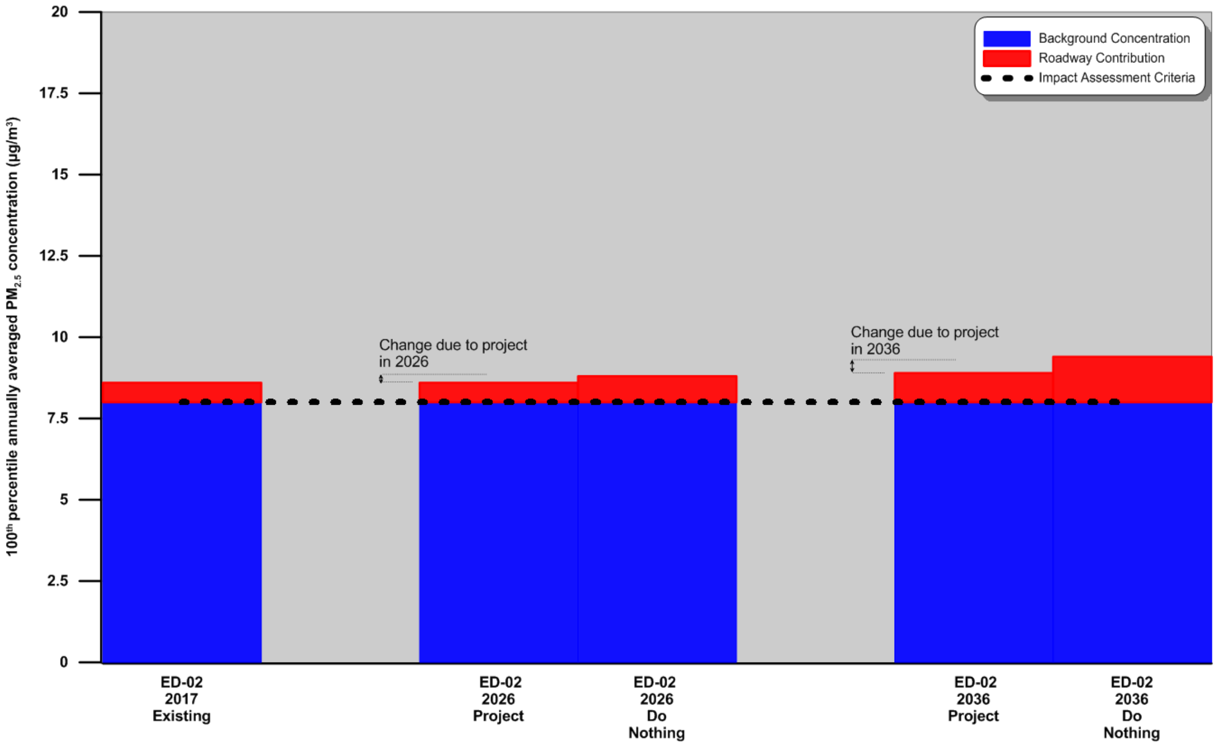


Figure 6-26 Predictions of annually averaged $PM_{2.5}$ at nearest receiver – Elizabeth Drive (Design)

As shown in **Figure 6-26** and presented above in **Section 5.2**, annually averaged $PM_{2.5}$ background concentrations were already measured at the eight µg/m^3 impact assessment criteria from the EPA's Approved Methods. With the project, contributions were predicted to decrease by 0.2 µg/m^3 and 0.5 µg/m^3 between 2026 and 2036 project and no project options. The highest

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

6.2.5 Gases (Carbon monoxide and nitrogen dioxide)

M12 Motorway

Existing one-hour and eight-hour averaged CO concentrations, and those including contributions from the M12 Motorway at the nearest receivers are summarised below in **Table 6-16**, with graphical plots equivalent to those shown for particulate matter displayed in **Annexure D**. is noted that one-hour and eight-hour averaged background CO concentrations were determined to be three mg/m^3 and two mg/m^3 respectively.

Table 6-16 Summary of predictions of CO at nearest receivers in operational study area – M12 Motorway

Pollutant	Av. 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
CO	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**

As shown above, the project would result in increases in one-hour and eight-hour averaged CO concentrations at the nearest receivers compared with existing conditions as follows:

- M12_01: Increases in one-hour averaged CO of 0.2 mg/m^3 and 0.4 mg/m^3 relative to existing in 2026 and 2036 respectively
- M12_01: Increases in eight-hour averaged CO of 0.2 mg/m^3 and 0.3 mg/m^3 relative to existing in 2026 and 2036 respectively
- M12_02: Increases in one-hour averaged CO of 0.3 mg/m^3 and 0.5 mg/m^3 relative to existing in 2026 and 2036 respectively
- M12_02: Increases in eight-hour averaged CO of 0.2 mg/m^3 and 0.3 mg/m^3 relative to existing in 2026 and 2036 respectively
- M12_03: Increases in one-hour averaged CO of 0.4 mg/m^3 and 0.6 mg/m^3 relative to existing in 2026 and 2036 respectively
- M12_03: Increases in eight-hour averaged CO of 0.3 mg/m^3 and 0.4 mg/m^3 relative to existing in 2026 and 2036 respectively
- M12_04: Increases in one-hour averaged CO of 0.3 mg/m^3 and 0.5 mg/m^3 relative to existing in 2026 and 2036 respectively
- M12_04: Increases in eight-hour averaged CO of 0.2 mg/m^3 and 0.3 mg/m^3 relative to existing in 2026 and 2036 respectively.

The resulting total concentrations are noted to be well below the one-hour 30 mg/m^3 and eight-hour 10 mg/m^3 impact assessment criteria from the EPA's Approved Methods.

Existing one-hour and annually averaged NO_2 concentrations, and those including contributions from the new M12 Motorway are summarised below in **Table 6-17**. Graphical plots for NO_2 equivalent to those shown for particulate matter displayed in **Annexure D**. It is noted that one-hour and annually averaged background NO_2 concentrations were determined to be 74 $\mu g/m^3$ and 12 $\mu g/m^3$ respectively.

Table 6-17 Summary of predictions of NO_2 at nearest receivers in operational study area – M12 Motorway

Pollutant	Av. period	Segment	Existing 2017 (µg/m³)	2026, project (µg/m³)		2036, project (µg/m³)	
				Road contribution	Background + Road contribution	Road contribution	Background + Road contribution
NO_2	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**
	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**

As shown, the project would result in increases in the following increases in one-hour and annually averaged NO_2 concentrations at the nearest receivers compared with existing conditions:

- M12_01: Increases in one-hour averaged NO_2 of six µg/m³ and six µg/m³ relative to existing in 2026 and 2036 respectively
- M12_01: Increases in annually averaged NO_2 of one µg/m³ and one µg/m³ relative to existing in 2026 and 2036 respectively
- M12_02: Increases in one-hour averaged NO_2 of 7 µg/m³ and six µg/m³ relative to existing in 2026 and 2036 respectively
- M12_02: Increases in annually averaged NO_2 of one µg/m³ and one µg/m³ relative to existing in 2026 and 2036 respectively
- M12_03: Increases in one-hour averaged NO_2 of eight µg/m³ and 7 µg/m³ relative to existing in 2026 and 2036 respectively
- M12_03: Increases in annually averaged NO_2 of two µg/m³ and one µg/m³ relative to existing in 2026 and 2036 respectively
- M12_04: Increases in one-hour averaged NO_2 of 7 µg/m³ and six µg/m³ relative to existing in 2026 and 2036 respectively
- M12_04: Increases in annually averaged NO_2 of one µg/m³ and one µg/m³ relative to existing in 2026 and 2036 respectively.

The resulting total concentrations are noted to be well below the one-hour 246 µg/m³ and annually averaged 62 µg/m³ impact assessment criteria from the EPA's Approved Methods.

The Northern Road, M7 Motorway and Elizabeth Drive

Results for CO and NO_2 at the nearest receivers along The Northern Road, the M7 Motorway and Elizabeth Drive are summarised below in **Table 6-17** and **Table 6-18** respectively, and are also shown graphically in **Annexure D**. As with M12 Motorway segments, one-hour and eight-hour averaged background CO concentrations were determined to be three mg/m³ and two mg/m³; and one-hour and annually averaged background NO_2 concentrations were determined to be 74 µg/m³ and 12 µg/m³ respectively.

Table 6-18 Summary of predictions of CO at nearest receivers in operational study area – The Northern Road, M7 Motorway and Elizabeth Drive

Pollutant	Av. period	Seg.	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
CO	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**

As **Table 6-18** shows, project would result in the following changes in one-hour and annually averaged CO concentrations at the nearest receivers:

1-hour averaged CO:

- TNR_01: An increase of 0.2 mg/m^3 and 0.2 mg/m^3 relative to existing in 2026 and 2036 respectively
- TNR_01: No change between 2026 and 2036 project and no-project options respectively
- TNR_02: An increase of 0.3 mg/m^3 and 0.3 mg/m^3 relative to existing in 2026 and 2036 respectively
- TNR_02: An increase of 0.1 mg/m^3 and no change, between 2026 and 2036 project and no-project options respectively
- M7_01: An increase of 0.1 mg/m^3 and 0.1 mg/m^3 relative to existing in 2026 and 2036 respectively
- M7_01: An increase of 0.1 mg/m^3 and 0.1 mg/m^3 between 2026 and 2036 project and no-project options respectively
- M7_02: An increase of 0.4 mg/m^3 and 0.4 mg/m^3 relative to existing in 2026 and 2036 respectively
- M7_02: An increase of 0.4 mg/m^3 and 0.2 mg/m^3 between 2026 and 2036 project and no-project options respectively
- ED_02: An increase of 0.1 mg/m^3 and 0.1 mg/m^3 relative to existing in 2026 and 2036 respectively
- ED_02: No change, and a decrease of 0.1 mg/m^3 between 2026 and 2036 project and no-project options respectively.

8-hour averaged CO:

- TNR_01: An increase of 0.1 mg/m^3 and 0.1 mg/m^3 relative to existing in 2026 and 2036 respectively
- TNR_01: No change between 2026 and 2036 project and no-project options respectively
- TNR_02: An increase of 0.2 mg/m^3 and 0.2 mg/m^3 relative to existing in 2026 and 2036 respectively
- TNR_02: No change between 2026 and 2036 project and no-project options respectively
- M7_01: An increase of 0.1 mg/m^3 and 0.1 mg/m^3 relative to existing in 2026 and 2036 respectively
- M7_01: An increase of 0.1 mg/m^3 and 0.1 mg/m^3 between 2026 and 2036 project and no-project options respectively
- M7_02: An increase of 0.2 mg/m^3 and 0.2 mg/m^3 relative to existing in 2026 and 2036 respectively
- M7_02: An increase of 0.2 mg/m^3 and 0.1 mg/m^3 between 2026 and 2036 project and no-project options respectively
- ED_02: An increase of 0.1 mg/m^3 and 0.1 mg/m^3 relative to existing in 2026 and 2036 respectively
- ED_02: No change between 2026 and 2036 project and no-project options respectively.

Resulting total one-hour and eight-hour concentrations at the most affected receiver were below the one-hour 30 mg/m^3 and eight-hour 10 mg/m^3 impact assessment criteria from the EPA's Approved Methods.

Table 6-19 Summary of predictions of NO_2 at nearest receivers in operational study area – The Northern Road, M7 Motorway and Elizabeth Drive

Pollutant	Average period	Segment	Existing 2017 (µg/m^3)		2026, project (µg/m^3)		2026, no project (µg/m^3)		2036, project (µg/m^3)		2036, no project (µg/m^3)	
			Road	Bg + Road	Road	Bg + Road	Road	Bg + Road	Road	Bg + Road	Road	Bg + Road
NO_2	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**

For NO_2, **Table 6-19** shows the following changes:

One-hour averaged NO_2:

- TNR_01: A decrease of two µg/m^3 and two µg/m^3 relative to existing in 2026 and 2036 respectively
- TNR_01: An increase of four µg/m^3 and two µg/m^3 between 2026 and 2036 project and no-project options respectively
- TNR_02: An increase of seven µg/m^3 and seven µg/m^3 relative to existing in 2026 and 2036 respectively
- TNR_02: An increase of six µg/m^3 and 11 µg/m^3 between 2026 and 2036 project and no-project options respectively
- M7_01: A decrease of 15 µg/m^3 and 15 µg/m^3 relative to existing in 2026 and 2036 respectively
- M7_01: An increase of one µg/m^3 and six µg/m^3 between 2026 and 2036 project and no-project options respectively
- M7_02: A decrease of 32 µg/m^3 and 32 µg/m^3 relative to existing in 2026 and 2036 respectively
- M7_02: A decrease of two µg/m^3 and an increase of six µg/m^3 between 2026 and 2036 project and no-project options respectively
- ED_02: A decrease of one µg/m^3 and one µg/m^3 relative to existing in 2026 and 2036 respectively
- ED_02: A decrease of one µg/m^3 and one µg/m^3 between 2026 and 2036 project and no-project options respectively.

Annually averaged NO_2:

- TNR_01: No change and a decrease of one µg/m^3 relative to existing in 2026 and 2036 respectively
- TNR_01: A decrease of one µg/m^3 and no change between 2026 and 2036 project and no-project options respectively
- TNR_02: An increase of one µg/m^3 and one µg/m^3 relative to existing in 2026 and 2036 respectively
- TNR_02: An increase of one µg/m^3 and two µg/m^3 between 2026 and 2036 project and no-project options respectively
- M7_01: A decrease of three µg/m^3 and three µg/m^3 relative to existing in 2026 and 2036 respectively
- M7_01: No change and a decrease of one µg/m^3 between 2026 and 2036 project and no-project options respectively
- M7_02: A decrease of seven µg/m^3 and seven µg/m^3 relative to existing in 2026 and 2036 respectively
- M7_02: A decrease of one µg/m^3 and one µg/m^3 between 2026 and 2036 project and no-project options respectively
- ED_02: No change relative to existing in 2026 or 2036
- ED_02: No change between 2026 and 2036 project and no-project options respectively.

As **Table 6-19** shows, the resulting total concentrations associated with the project are predicted to be below the one-hour 246 µg/m^3 and annually averaged 62 µg/m^3 impact assessment criteria from the EPA's Approved Methods.

6.2.6 Volatile organic compounds

1-hour averaged VOCs (as benzene) concentrations predicted at the nearest receivers along the new M12 Motorway, The Northern Road, the M7 Motorway and Elizabeth Drive are summarised below in **Table 6-20.** 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/m3 and 4.2 µg/m3 were measured at St Marys respectively. Annual benzene concentrations of 1.4 µg/m3 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/m3 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. Further, the results in Table 6-20 also 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/m3, and that contributions would be well below the 29 µg/m3 from the Approved Methods.

Table 6-20 Summary of predicted results for VOCs as benzene at nearest receivers in operational study area

Pollutant	Av. period	Segment	Roadway contribution (µg/m^3)				
			Existing 2017	2026, project	2026, no project	2036, project	2036, no project
VOCs as benzene	one-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

6.2.7 Regional air quality

As illustrated for the case of $PM_{2.5}$ in **Figure 6-7**, **Figure 6-8**, **Figure 6-15**, **Figure 6-16**, **Figure 6-21** and **Figure 6-22**, 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 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.

That being said, as presented in the Traffic Assessment Report (Appendix F of the EIS), 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.

7. Cumulative impacts

7.1 Overview

As identified above in **Section 4.5,** where activities that would be associated with the project take place at the same time as other nearby projects which also have the potential to affect air quality conditions at the same surrounding receivers, there is the potential for local cumulative impacts to occur. Similarly, where two or more projects take place at the same time and their emissions to air are significant, there is the potential for wider regional cumulative impacts.

Cumulative impacts were reviewed by considering the impacts predicted in publicly available environmental impact assessments for nearby approved projects, in conjunction with those predicted for the project. As outlined in **Section 4.4**, 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 Western Sydney Airport having already been included in the traffic inputs applied in the assessment.

The projects listed in **Table 7-1** are in varying stages of delivery and planning. This chapter provides an assessment of the potential for cumulative local and regional air quality impacts based on the predictions for the project presented in **Section 6.1** (construction) and **Section 6.2** (operation), and the most current and publicly available information on the projects in **Table 7-1**, overleaf. A quantitative assessment is provided below in **Section 7.2** for construction and aircraft-related operational impacts for the Western Sydney Airport (noting that traffic from the airport have already applied in the assessment). A high-level qualitative assessment is provided for the remaining projects, as limited information is presently available. This is presented in **Table 7-1** overleaf.

7.2 Western Sydney Airport

7.2.1 Construction cumulative impacts

The air quality assessment in the Western Sydney Airport EIS identified the following potential for impacts at receivers around the project during different phases of construction of the Airport:

- During bulk earthworks at Western Sydney Airport:
  - 24-hour averaged PM_{10} concentrations ranging from around five to one µg/m^3
  - Annually averaged PM_{10} concentrations ranging from around one to 0.25 µg/m^3
  - 24-hour averaged $PM_{2.5}$ concentrations ranging from about 10 to three µg/m^3
  - Annually averaged PM_{10} concentrations ranging from around 0.2 to 0.05 µg/m^3
- During construction of aviation infrastructure at Western Sydney Airport:
  - 24-hour averaged PM_{10} concentrations ranging from around five to one µg/m^3
  - Annually averaged PM_{10} concentrations ranging from around 0.5 to 0.125 µg/m^3
  - 24-hour averaged $PM_{2.5}$ concentrations ranging from about 10 to 0.5 µg/m^3
  - Annually averaged PM_{10} concentrations ranging from around 0.25 to 0.025 µg/m^3.

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.

Table 7-1 Projects considered as part of the cumulative air quality impact assessment

Project and status	Relevance to the M12 Motorway project	Brief Description	Cumulative construction impacts	Cumulative operation impacts
Western Sydney Airport Approved Under construction	Project is expected to have concurrent/ consecutive construction and operation Project is adjacent and has overlapping footprints	The Australian Government is currently constructing the Western Sydney Airport on the 1,780-hectare Commonwealth-owned land at Badgerys Creek. The airport will service both domestic and international markets and development will be staged in response to ongoing growth in aviation demand. Construction of Western Sydney Airport is under way and the airport is set to open in 2026. Construction of the project is expected to commence in quarter 1, 2022 and conclude in 2025. Construction of the Western Sydney Airport and the project will therefore overlap and have the potential to cause cumulative impacts. The EIS for the Western Sydney Airport was placed on display in October 2015 and finalised on 15 September 2016 with a Revised Draft Airport Plan. The assessment found that the airport would result in some adverse impacts on the environment and community, including to air quality. Mitigation measures were proposed to reduce these potential impacts during construction.	Discussed in **Section 7.2.1**.	Discussed in **Section 7.2.2**.
Sydney Metro Greater West Not yet approved	Project is expected to have concurrent construction and operation Project is adjacent and	Transport for NSW recently identified recommended corridors for a rail option to provide a major transport link between the North West Growth Area, Western Sydney Airport, and the South West and Greater MacArthur Growth Area. This rail option would connect the existing Main South Line (T8)	Construction of both projects could have overlaps. During this time, local dust emissions and the potential for impacts would be increased. While the environmental assessment for the Sydney Metro Greater West has not yet been carried out, it is likely that the	Sydney Metro Greater West would use electrified trains, which have no local emissions. The cumulative air quality impacts would only be those associated with the operation of the

Project and status	Relevance to the M12 Motorway project	Brief Description	Cumulative construction impacts	Cumulative operation impacts
	has overlapping footprints	near Macarthur Station to the existing Main Western Line (T1) near St Marys Station, via the Western Sydney Airport. Planning for this project is currently underway and subject to separate environmental assessment and approval. As such, environmental assessment results are not yet available.	primary construction-related air quality risk would also be dust emissions. Like for the project, it is expected that measures would be developed and implemented commensurate to the level of potential impacts determined from the assessment. Therefore, it is expected that although there would be the potential for cumulative, localised dust impacts when both project are being constructed, emissions from both project 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. Noting the likely level of controls to ensure that localised impacts during construction would be minimised, it is not expected that cumulative regional, construction-related air quality issues would occur as a result of the project and the Sydney Metro Greater West.	project. The Sydney Metro Greater West would not contribute any material operational air emissions locally. Emissions associated with operation of the Sydney Metro Greater West would only occur where the electricity used is generated if this is source is non-renewable (ie coal-fired power station).

Project and status	Relevance to the M12 Motorway project	Brief Description	Cumulative construction impacts	Cumulative operation impacts
The Northern Road Upgrade • Stage 5 (Littlefields Road to Glenmore Park) • Stage 6 (Littlefields Road to Eaton Road) Approved Construction commenced	Project is expected to have concurrent construction and operation Project is adjacent and has overlapping footprints	An upgrade of The Northern Road was approved in May 2018 as part of the Western Sydney Infrastructure Plan. The upgrade will improve the capacity of the existing road and create about eight kilometres of new road between Mersey Road, Bringelly and just south of the existing Elizabeth Drive, Luddenham to realign the section of The Northern Road that currently runs through the Western Sydney Airport site. Once the upgrade is complete, The Northern Road will connect the project and the M4 Western Motorway and improve connectivity with the Western Sydney Airport (Roads and Maritime Services, 2017). The upgrade is being carried out in six stages. Construction activities associated with Stages 5 and 6 may overlap with the project construction.	Where The Northern Road construction activities occur around the vicinity of the intersection with the new M12 Motorway there is the potential for some receivers to be affected by dust from these activities as well as the project under certain meteorological conditions (ie winds blowing in a direction from both construction sites in the direction of sensitive receivers). As such, it was determined that there would be moderate potential for cumulative air quality impacts associated with the construction of the project and The Northern Road Upgrade Stages 5 and 6. The scale of the impacts would be dependent on the timing and location of concurrent construction activities for both projects. The relative contribution from the project and The Northern Road Upgrade Stages 5 and 6 construction activities would be equivalent. Again, controls for both projects have been 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 assessment (**Section 6.2**).

Project and status	Relevance to the M12 Motorway project	Brief Description	Cumulative construction impacts	Cumulative operation impacts
Other existing road network upgrades and potential road projects, including: • Elizabeth Drive Upgrade • Mamre Road Upgrade • Outer Sydney Orbital Not yet approved	Projects have the potential for overlapping construction Projects are expected to have concurrent operation Project is adjacent and has overlapping footprints	• Elizabeth Drive upgrade – Roads and Maritime has started site investigations, including preliminary engineering, preliminary/strategic designs, environmental field investigations, and strategic modelling. • Mamre Road upgrade – the NSW Government has started early planning for a future upgrade of a 10 kilometre section of Mamre Road, between the M4 Motorway and Kerrs Road • Outer Sydney Orbital – a future north-south motorway and freight rail line in Sydney's West. It would provide connections to the Western Sydney Airport. These projects are currently at varying stages of planning and no design or environmental assessment information is currently publicly available.	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 other road 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 expected that controls for all these projects would be developed to ensure that localised impacts during construction would be minimised. Considering this, 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. There is the potential for air quality impacts associated with the changes in traffic from what has been assessed as a result of the Outer Sydney Orbital project, although the extent of these changes would depend on how it affects the traffic inputs considered in this assessment.

Project and status	Relevance to the M12 Motorway project	Brief Description	Cumulative construction impacts	Cumulative operation impacts
Major land releases, including: • Western Sydney Aerotropolis • South West Growth Area • Western Sydney Employment Area. Future strategic government project	Projects have the potential for overlapping construction Projects are expected to have concurrent operation The Aerotropolis and the Western Sydney Growth Area have overlapping footprints The Sydney Employment Area is in the vicinity of the project	The project would traverse the South West Growth Area and service the Western Sydney Aerotropolis, and indirectly, the Western Sydney Employment Area. The project would serve and facilitate the growth by providing increased road capacity and reducing congestion and travel times in the area. Preliminary investigations and consultation is underway for each area. The land within the areas above will be developed by individual developers at varying timeframes. Each will be subject to their own environmental assessments, based on the scale and potential impact of each project. There are currently no defined plans available for the individual developments within these growth areas.	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. As above, it is expected that controls for all these projects would be developed to ensure that localised impacts during construction would be minimised. Considering this, cumulative regional, construction-related air quality are not expected.	Over time, there is the potential that these projects may influence local air quality conditions around the project. The extent of the impacts of the operational air quality would depend on the extent to which they alter the traffic inputs considered in this assessment (see **Annexure B**). The relative contribution between the project and these projects would also depend on the extent to which these projects alter the traffic conditions applied in the assessment.

However, a high risk of dust impacts during construction at receivers within the construction study area was determined for the project (see **Section 6.1.3**). It is estimated that the magnitude of emissions from bulk earthwork activities at the Western Sydney Airport also represent a high risk of impacts to 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 **Chapter 8** 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 have been 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 have been 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.

7.2.2 Operation cumulative impacts

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 7-2**.

Table 7-2 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 could cause 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 (see **Section 6.2.7**) Emissions to air from operations at 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 Western Sydney Airport.

7.3 Conclusion

Overall, it was determined that there is potential for local cumulative construction-related and operational air quality impacts at receivers from the project and the other nearby projects reviewed. Noting the level of controls committed for the project, as well as committed or expected from the other projects, it was concluded that this would present a limited level of risk. Wider regional cumulative impacts during construction would not be expected from the project and these other projects.

Regarding operations, cumulative impacts from several of these other projects was also considered within the traffic inputs applied in the assessment. It was determined that there was the potential for local cumulative operational air quality impacts from several of these projects with the most notable being the Western Sydney Airport. It was not concluded that the project would materially contribute to any regional cumulative air quality impacts. Additional measures are recommended below in **Chapter 9** to ensure co-ordination to further mitigate the potential for cumulative local impacts during concurrent project construction activities.

8. Environmental management measures

8.1 Construction

Using the UK IAQM method, as described above in **Section 6.1.3**, it was determined that the new M12 Motorway project presents a 'high' risk of dust impacts during construction. Based on this level of risk, the method recommends the implementation of specific measures which are listed in **Table 8-1**. In addition to these measures, the method also recommends a range of other standard measures for all construction projects. These recommendations are listed below in **Table 8-2**. The measures presented in **Table 8-1** and **Table 8-2** would be reviewed by the construction contractor once detailed design has been completed and updated as necessary. Additionally, a suite of project specific environmental management measures has been developed to address specific air quality risks as presented in

Table 8-3.

A Construction Air Quality Management Plan (CAQMP) will be prepared within the Construction Environmental Management Plan (CEMP) for the project. The CAQMP will outline all requirements for the project with respect to air quality, and detail actions and how and by whom they would be completed to prevent and control all air quality-related risks (ie dust, odour, other hazardous substances). Measures from the UK IAQM in **Table 8-1** and **Table 8-2** apply to all types of construction projects. Noting that the nature of each construction project varies, measures and management approaches that achieve the same intent of those listed could also be incorporated into the CAQMP.

8.2 Operations

As assessed in **Section 6.2**, the assessment found that the project would not result in unacceptable changes in air quality for receivers near the new M12 Motorway and would result in traffic-related contributions comparable to, or less than the scenario of not proceeding with the project. In practice, it is also difficult to manage emissions to air from surface roads. As such it was determined that no operational air quality environmental measures would be required.

Table 8-1 UK IAQM Step 3 specific construction air quality recommended mitigation measures

Mitigation measure
Demolition
Ensure effective water suppression is used during demolition operations. Hand held sprays are more effective than hoses attached to equipment as the water can be directed to where it is needed. In addition, high volume water suppression systems, manually controlled, can produce fine water droplets that effectively bring the dust particles to the ground.
Bag and remove any biological debris or damp down such material before demolition.
Earthworks
Re-vegetate excavated and exposed areas/soil stockpiles to stabilise surfaces as soon as practicable
Use Hessian, mulches or tackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable.
To the extent practical, only remove the cover in small areas during work and not all at once
Construction
Ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place.
Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery.
For smaller supplies of fine power materials ensure bags are sealed after use and stored appropriately to prevent dust.
Trackout
Use water-assisted dust sweeper(s) on the access and local roads, to remove, as necessary, any material tracked out of the site. This may require the sweeper being continuously in use.
Avoid dry sweeping of large areas.
Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport.
Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable.
Record all inspections of haul routes and any subsequent action in a site log book.
Install hard surfaced haul routes, which are regularly damped down with fixed or mobile sprinkler systems, or mobile water bowsers and regularly cleaned.
Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable).
Ensure there is an adequate area of hard surfaced road between the wheel wash facility and the site exit, wherever site size and layout permits.
Access gates to be located at least 10 metres from receivers where possible.

Table 8-2 UK IAQM Standard air quality measures during construction

Mitigation measure
Communications
Develop and implement a stakeholder communications plan that includes community engagement before work commences on-site.
Display the name and contact details of person(s) accountable for air quality and dust issues on the site boundary.
Display the primary contractor head or regional office contact information.
Site management
Record all dust and air quality complaints, identify cause(s), take appropriate measures to reduce emissions in a timely manner, and record the measures taken.
Make the complaints log available to the applicable determining authority when requested.
Record any exceptional incidents that cause dust and/or air emissions, either on- or off-site, and the action taken to resolve the situation.
Hold regular liaison meetings with other construction sites within 500 metres of the site boundary, to ensure plans are co-ordinated and dust and particulate matter emissions are minimised. It is important to understand the interactions of the off-site transport/deliveries which might be using the same strategic road networks.
Monitoring
Carry out regular site inspections to monitor compliance with the CAQMP, record inspection results, and make these records available to the determining authority as requested.
Increase the frequency of site inspections by the person accountable for air quality and dust issues on-site when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions.
Install dust deposition, dust flux, or real-time PM_{10} continuous monitoring devices at locations instructed by the determining authority.
Preparing and maintaining site
Plan site layout so that machinery and dust causing activities are located away from receivers, as far as is possible.
Erect solid screens or barriers around the site boundary that are at least as high as any stockpiles on-site.
Remove materials that have a potential to produce dust from site as soon as possible, unless being re-used on site. If being re-used on-site, covered until required to be used.
Cover, seed or fence stockpiles to limit wind erosion.
Operating vehicle/machinery
Ensure all vehicles, plant, and equipment operate in a proper and efficient manner.
Switch off all vehicles, plant and equipment when not in-use.
Avoid the use of diesel or petrol-powered generators and use mains electricity or battery powered equipment where practicable.
Impose and signpost suitable maximum on-site speed limits to limit the generation of dust.

Mitigation measure
Construction activities
Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction.
Minimise drop heights from loading and handling equipment.
Ensure equipment is readily available to clean any dry spillage and clean up as soon as reasonably practicable after the event.

Table 8-3 Additional air quality measures during construction

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
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	Contractor	During construction

Impact	Reference	Environmental management measure	Responsibility	Timing
		• 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 prior to the commencement of general demolition works.		
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

9. Summary and Conclusions

9.1 Overview

This report provides an assessment of the potential air quality impacts the proposed M12 Motorway. Details of the project were reviewed to identify the key air quality-related risks during the construction and operational phases of the project.

9.2 Air quality considerations and existing environment

Regarding operations, exhaust emissions from the combustion of fossil fuels in vehicles (CO, NO_x, PM_{10}, $PM_{2.5}$ and VOCs), as well as fugitive emissions or particulate matter from the wearing of tyres, vehicle braking and wearing of the road surface, re-entrained particles from traffic flows and VOCs evaporated from oils, lubricants and fuels were determined to be the key emission pathways.

Key features of the existing environment including prevailing climate and meteorological conditions and regional and local air quality conditions were reviewed. Climate and meteorological conditions were reviewed to identify times of the year and day when emissions might typically require a greater level of management, and prevailing local wind directions to understand receivers might most often experience winds blowing in the direction from the project. Local and regional air quality conditions were reviewed by analysing historical investigations and recent ambient air quality monitoring data, to understand existing background conditions.

9.3 Impacts during construction

The potential for dust impacts during construction was assessed using the semi-quantitative, risk-based assessment method developed by the UK IAQM. This approach was selected in preference to quantitative modelling as modelling approaches which have high levels of uncertainty about when, where and how intensively specific activities would be completed, and the corresponding weather conditions; and as such as less reliably able to predict the potential for air quality impacts. The IAQM provides robust mitigation and management measures which are aligned to the assessed levels of unmitigated risk.

Following an initial screening review to confirm the presence of sensitive human and ecological receivers within the vicinity of the project, the UK IAQM method reviews the potential for three types of dust-related impacts from construction projects; annoyance from dust soiling, human health exposure issues, and ecological harm. The issues are evaluated for four broad phases of construction being demolition, earthworks, construction and tracking. The potential risk for each type of impact from each phase was determined by combining the emission magnitude potential of the construction phase and the sensitivity of the receiving environment to dust soiling, human health and ecological impacts.

The project was divided into four segments, consistent with the operational assessment for the purpose of this assessment. This was completed to account for the different receiving environments surrounding the project. Along all four segments, it was determined that there was a high potential for ecological dust-related impacts owing to the close proximity of ecologically sensitive areas. A high risk of human health impacts was determined for segment M12_02, whereas a medium rating was determined for the other segments, with M12_02 having a higher density of receivers in closer proximity to the construction area. Regarding dust soiling, a medium risk was determined for segment M12_02, with a low risk determined for the other areas, on the same basis as for human health impacts. These different risk categories trigger the need for different mitigation and management measures, consistent with the UK IAQM guideline.

The overall risk rating of construction areas was determined based on the highest risk rating from identified dust soiling, human health and ecological impacts. The project as a whole was determined to have a 'high' potential for dust impacts during construction. This means that all measures detailed in the UK IAQM were recommended for the project. These measures include appropriate work practices and scheduling, consultation/co-ordination of works around other nearby projects such as the Sydney Metro Greater West and Western Sydney Airport construction activities to limit any localised cumulative impacts, equipment selection, monitoring and preventative controls.

Measures were also developed for other potential air quality risks during construction including odours and hazardous substances. With the recommended measures implemented, it is likely that air quality impacts during construction would be able to be effectively managed, such that impacts would be minimal.

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. As such, it was determined that regional air quality issues were unlikely to result from the project.

9.4 Impacts during operations

Air quality during operation of the project was modelled using the Roads and Maritime Tool for Roadside Air Quality (TRAQ) screening-level dispersion model. Changes in traffic conditions along the adjoining road network, including The Northern Road, M7 Motorway and Elizabeth Drive, were used to inform the assessment. Potential local changes in air quality at surrounding receivers as a result of the new M12 Motorway were quantified.

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

For the project, the following key results were predicted:

- **M12 Motorway:**
  - 24-hour averaged PM_{10} and $PM_{2.5}$ concentrations were predicted to increase by up to around 10 per cent and 25 per cent respectively compared with existing contributions experienced. Total (ie background plus roadway contributions) concentrations were predicted to remain below the respective NSW EPA impact assessment criteria.
  - Annually averaged PM_{10} concentration were predicted to increase by up to 7 per cent compared with existing, with total concentrations also predicted to remain below the criteria from the Approved Methods.
  - Background annually averaged $PM_{2.5}$ was already measured at the EPA's impact assessment criteria. Additional contributions from the roadway were predicted to be 1.5 µg/m^3 or less at the surrounding receivers within the study area.

- **The Northern Road:**
  - 24-hour averaged PM_{10} and $PM_{2.5}$ concentrations were predicted to change by two µg/m^3 or less compared with the equivalent no project timescales. Total (ie background plus roadway contributions) concentrations were predicted to remain below the respective NSW EPA impact assessment criteria.
  - Annually averaged PM_{10} concentration were predicted to increase by up 0.9 µg/m^3 compared with the equivalent no project timescales, with total concentrations also predicted to remain below the criteria from the Approved Methods.
  - Background annually averaged $PM_{2.5}$ was already measured at the EPA's impact assessment criteria. One further receiver was predicted to experience roadway contributions of more than two µg/m^3 compared with the equivalent no project timescales.
- **M7 Motorway:**
  - 24-hour averaged PM_{10} and $PM_{2.5}$ concentrations were predicted to decrease by up to 1.3 µg/m^3 compared with the equivalent no project timescales. Total (ie background plus roadway contributions) concentrations were predicted to remain below the respective NSW EPA impact assessment criteria.
  - Annually averaged PM_{10} concentration were predicted to decrease by up 0.5 µg/m^3 compared with the equivalent no project timescales, with total concentrations also predicted to remain below the criteria from the Approved Methods.
  - Background annually averaged $PM_{2.5}$ was already measured at the EPA's impact assessment criteria. One less receiver was predicted to experience roadway contributions of more than two µg/m^3 compared with the equivalent no project timescales.
- **Elizabeth Drive:**
  - 24-hour averaged PM_{10} and $PM_{2.5}$ concentrations were predicted to decrease by up to 1.2 µg/m^3 compared with the equivalent no project timescales. Total (ie background plus roadway contributions) concentrations were predicted to remain below the respective NSW EPA impact assessment criteria.
  - Annually averaged PM_{10} concentration were predicted to decrease by up 0.5 µg/m^3 compared with the equivalent no project timescales, with total concentrations also predicted to remain below the criteria from the Approved Methods.
  - Background annually averaged $PM_{2.5}$ was already measured at the EPA's impact assessment criteria. Roadway contributions were predicted to decrease by up to 0.5 µg/m^3 compared with the equivalent no project timescales.

Concentrations of carbon monoxide (CO), nitrogen dioxide (NO_2) and volatile organic compounds (VOCs) as benzene in the vicinity of the new M12 Motorway were predicted to increase by up to about 17 per cent relative to existing conditions, at the nearest sensitive receivers. However, the predicted concentrations were well below EPA impact assessment criteria. A similar outcome was determined for receivers around The Northern Road, the M7 Motorway and Elizabeth Drive. It is also noted that levels of carbon monoxide, nitrogen dioxide and volatile organic compounds, as well as levels of particulate matter, are predicted to be lower at the nearest sensitive receivers in the future due to increased efficiency of engines and a higher prevalence of electric and hybrid vehicles.

Any changes in air quality due to the project need to be considered in context, with the forecast changes in traffic on existing major roads in the area due to the Western Sydney Airport and other projects and developments; as well as expected changes in background concentrations over time from those applied in the assessment. Still, it was concluded that 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 air quality monitoring stations. Therefore, it was considered unlikely that the project would have a measurable effect on regional background conditions during operation.

9.5 Cumulative impacts review

The potential for local and regional cumulative impacts during the construction and operation of the project with other ongoing and planned developments in the area was assessed. It was determined that there would be potential for local cumulative construction-related and operational air quality impacts at receivers from the project and the other nearby projects reviewed. Noting the level of controls committed for the project, as well as committed or expected from the other projects, it was concluded that this would present a limited level of risk. Wider regional cumulative impacts during construction would not be expected from the project and these other projects.

Cumulative impacts during operation of several of the other projects assessed were considered within the traffic inputs applied to the overall air quality assessment. It was determined that there would be the potential for local cumulative operational air quality impacts from several of these projects. The most notable would be the Western Sydney Airport. It was concluded that the project would not materially contribute to any regional cumulative air quality impacts.

9.6 Conclusion

It has been 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 to 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.

10. References

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The Northern Road Upgrade – Mersey Road, Bringelly to Glenmore Parkway, Glenmore Park Final Environmental Impact Statement, (Jacobs, 2017)

Tool for Roadside Air Quality (TRAQ) User Manual', (Roads and Maritime, 2012)

Variation to the National Environment Protection (Ambient Air Quality) Measure (National Environment Protection Council, 2015)

Western Sydney Airport EIS – Local Air Quality and Greenhouse Gas Assessment, (Pacific Environment Limited, 2016)

WHO Air Quality Guidelines for Europe, 2nd Edition, (World Health Organisation, 2000)

Annexure A TRAQ operational model set-up details

Key technical details for the operational air quality model applied in the assessment are as follows:

Table 1 Model setup details

Model setting	Model inputs
Model version	TRAQ version 1.3 (2017)
Modelled meteorological conditions	Worst-case meteorological conditions assumed (that is, wind speed of 1 metre per second, Pasquil atmospheric stability Class F (ie highly stable), and 15 degrees Celsius).
Road geometry and distances to nearest receivers	Project design alignment, including key receiving roads
Traffic inputs	Forecast traffic volume, speed and composition data was sourced from the traffic assessment carried out for the EIS
Vehicle emissions	2026 NSW EPA emission factors were applied for the ‘year of opening’ scenario, with 2036 factors applied in the ‘design year’ scenario. Zero gradient was assumed. Emissions included worst-case cold start effects.

Annexure B TRAQ operational model traffic inputs

Traffic inputs applied in the operational air quality assessment are summarised below:

Table 2 TRAQ traffic input data, ultimate project

Road segment	Direction	No. Lanes	Peak hourly speed (km/h)	Average 24-hour speed (km/h)	Total traffic volume per day (24-hour)	Maximum one-hour traffic volume	per cent daily traffic volume light vehicles	per cent daily traffic volume heavy vehicles
Existing								
TNR_01	North bound	2	70	80	7,960	799	96%	4%
	Southbound	2	65	80	7,637	735	96%	4%
TNR_02	NB	2	70	80	7,957	795	96%	4%
	SB	3	74	80	7,650	735	96%	4%
M7_01	NB	2	90	100	29,131	2,769	74%	26%
	SB	2	90	100	27,572	2,916	76%	24%
M7_02	NB	2	87	100	28,750	2,799	73%	27%
	SB	2	91	100	30,318	3,314	78%	22%
ED_01	Eastbound	1	73	80	4,030	574	93%	7%
	Westbound	1	72	80	4,363	570	89%	11%
ED_02	EB	1	67	80	6,207	905	91%	9%
	WB	1	71	80	6,530	869	81%	19%
No Project, 2026								
TNR_01	NB	2	71	80	24,074	2,712	93%	7%
	SB	2	74	80	12,091	1,378	92%	8%
TNR_02	NB	2	72	80	24,672	2,779	93%	7%
	SB	3	75	80	11,881	1,354	92%	8%
M7_01	NB	2	78	100	41,033	3,965	83%	17%
	SB	2	84	100	38,383	4,281	85%	15%
M7_02	NB	2	73	100	39,943	3,900	84%	16%
	SB	2	84	100	38,549	4,277	87%	13%
ED_01	EB	1	69	80	9,974	1,326	98%	2%
	WB	1	69	80	14,050	1,743	93%	7%
ED_02	EB	1	68	80	11,347	1,372	95%	5%
	WB	1	65	80	15,233	1,723	87%	13%
Project, ‘Year of opening’ ie 2026								
M12_01	EB	2	90	100	12,346	1,252	88%	12%
	WB	2	93	100	10,393	1,295	83%	17%
M12_02	EB	2	91	100	20,004	1,942	92%	8%

Road segment	Direction	No. Lanes	Peak hourly speed (km/h)	Average 24-hour speed (km/h)	Total traffic volume per day (24-hour)	Maximum one-hour traffic volume	per cent daily traffic volume light vehicles	per cent daily traffic volume heavy vehicles
	WB	2	92	100	13,750	1,612	86%	14%
M12_03	EB	2	91	100	20,361	1,968	92%	8%
	WB	2	93	100	13,097	1,530	86%	14%
M12_04	EB	2	91	100	20,545	1,994	92%	8%
	WB	2	93	100	12,820	1,495	86%	14%
TNR_01	NB	2	72	80	18,492	2,140	95%	5%
	SB	2	70	80	11,357	1,160	90%	10%
TNR_02	NB	2	73	80	23,535	2,693	91%	9%
	SB	3	75	80	17,072	2,006	90%	10%
M7_01	NB	2	81	100	44,061	4,265	84%	16%
	SB	2	85	100	45,201	4,814	86%	14%
M7_02	NB	2	83	100	44,050	4,240	88%	12%
	SB	2	89	100	36,849	4,176	88%	12%
ED_01	EB	1	70	80	6,896	918	97%	3%
	WB	1	72	80	6,725	904	93%	7%
ED_02	EB	1	70	80	8,050	1,016	94%	6%
	WB	1	67	80	9,977	1,125	86%	14%
No Project, 2036								
TNR_01	NB	2	69	80	29,708	3,239	98%	2%
	SB	2	73	80	17,142	2,033	96%	4%
TNR_02	NB	2	71	80	30,439	3,321	98%	2%
	SB	3	74.	80	16,824	1,995	96%	4%
M7_01	NB	2	19.11	100	62,490	6,265	84%	16%
	SB	2	79.6	100	60,469	6,707	85%	15%
M7_02	NB	2	82.89	100	60,193	5,878	83%	17%
	SB	2	79.29	100	52,790	5,905	85%	15%
ED_01	EB	1	71.95	80	23,919	2,872	97%	3%
	WB	1	73.43	80	23,770	3,154	96%	4%
ED_02	EB	1	67.33	80	32,824	3,277	96%	4%
	WB	1	69.22	80	32,689	3,499	94%	6%
Project, ‘Design year’ ie 2036								
M12_01	EB	2	87	100	26,142	2,617	92%	8%

Road segment	Direction	No. Lanes	Peak hourly speed (km/h)	Average 24-hour speed (km/h)	Total traffic volume per day (24-hour)	Maximum one-hour traffic volume	per cent daily traffic volume light vehicles	per cent daily traffic volume heavy vehicles
	WB	2	91	100	18,114	2,305	87%	13%
M12_02	EB	2	88	100	34,541	3,666	94%	6%
	WB	2	89	100	27,363	3,055	92%	8%
M12_03	EB	2	88	100	35,175	3,748	94%	6%
	WB	2	90	100	26,190	2,938	92%	8%
M12_04	EB	2	85	100	35,535	3,781	94%	6%
	WB	2	92	100	25,646	2,873	92%	8%
TNR_01	NB	2	67	80	32,248	3,537	97%	3%
	SB	2	68	80	19,220	2,221	94%	6%
TNR_02	NB	2	72	80	28,144	3,032	94%	6%
	SB	3	74	80	21,420	2,362	93%	7%
M7_01	NB	3	72	100	66,364	6,566	84%	16%
	SB	3	85	100	68,717	7,478	87%	13%
M7_02	NB	3	84	100	63,887	6,370	86%	14%
	SB	3	89	100	50,009	5,586	87%	13%
ED_01	EB	1	74	80	13,923	1,398	97%	3%
	WB	1	76	80	13,217	1,813	91%	9%
ED_02	EB	1	71	80	18,223	1,946	95%	5%
	WB	1	70	80	16,494	1,748	89%	11%

Annexure C Background air quality statistics

The term ‘95th percentile’ refers to the value exceeded 5 per cent of the time and has historically been applied to account for the small number of regional events including those discussed to provide a more representative indication of typical 24-hour particulate matter pollutant concentrations. Values exceeding the relevant criteria are displayed in **bold** text.

Table 4 Summary of air quality monitoring data from nearby OEH monitoring stations (2014-2018)

Year	Bringelly	Liverpool	Impact assessment criterion (µg/m^3 unless stated)
Maximum 24-hour average PM_{10} in µg/m^3			
2014	43	41	50
2015	**57**	**69**	
2016	**62**	**69**	
2017	**84**	**74**	
2018	**93**	**102**	
95th percentile of 24-hour average PM_{10} in µg/m^3			
2014	29	33	50
2015	28	31	
2016	30	33	
2017	37	35	
2018	38	44	
Number of days average PM_{10} concentration exceeding 50 µg/m^3			
2014	0	0	0
2015	**1**	**1**	
2016	**3**	**3**	
2017	**6**	**2**	
2018	**8**	**13**	
Annual average PM_{10} in µg/m^3			
2014	17	19	25
2015	16	19	
2016	17	20	
2017	20	21	
2018	21	24	
Maximum 24-hour average $PM_{2.5}$ in µg/m^3			
2014	-	24	25
2015	-	**32**	
2016	22*	**51**	
2017	**53**	**56**	

Year	Bringelly	Liverpool	Impact assessment criterion (µg/m^3 unless stated)
2018	**56**	**45**	
95th percentile of 24-hour average $PM_{2.5}$ in µg/m^3			
2014	-	16	25
2015	-	17	
2016	13*	16	
2017	15	17	
2018	15	19	
Number of days average $PM_{2.5}$ concentration exceeding 25 µg/m^3			
2014	-	0	0
2015	-	**2**	
2016	0*	**4**	
2017	**2**	**3**	
2018	**4**	**8**	
Annual average $PM_{2.5}$ in µg/m^3			
2014	-	**8.6**	8
2015	-	**8.4**	
2016	-	**8.7**	
2017	7.5	**8.9**	
2018	8.0	**10.1**	
Maximum one-hour averaged NO_2 in µg/m^3			
2014	47	83	246
2015	51	113	
2016	56	88	
2017	68	120	
2018	74	127	
Annual average NO_2 in µg/m^3			
2014	9	19	62
2015	8	19	
2016	10	22	
2017	10	23	
2018	12	25	
Maximum one-hour averaged CO in mg/m^3			
2014	-	3	30

Year	Bringelly	Liverpool	Impact assessment criterion (µg/m³ unless stated)
2015	-	3	
2016	-	3	
2017	-	3	
2018	-	3	
Maximum eight-hour averaged CO in mg/m³			
2014	-	2	10
2015	-	2	
2016	-	2	
2017	-	2	
2018	-	2	

Particulate matter

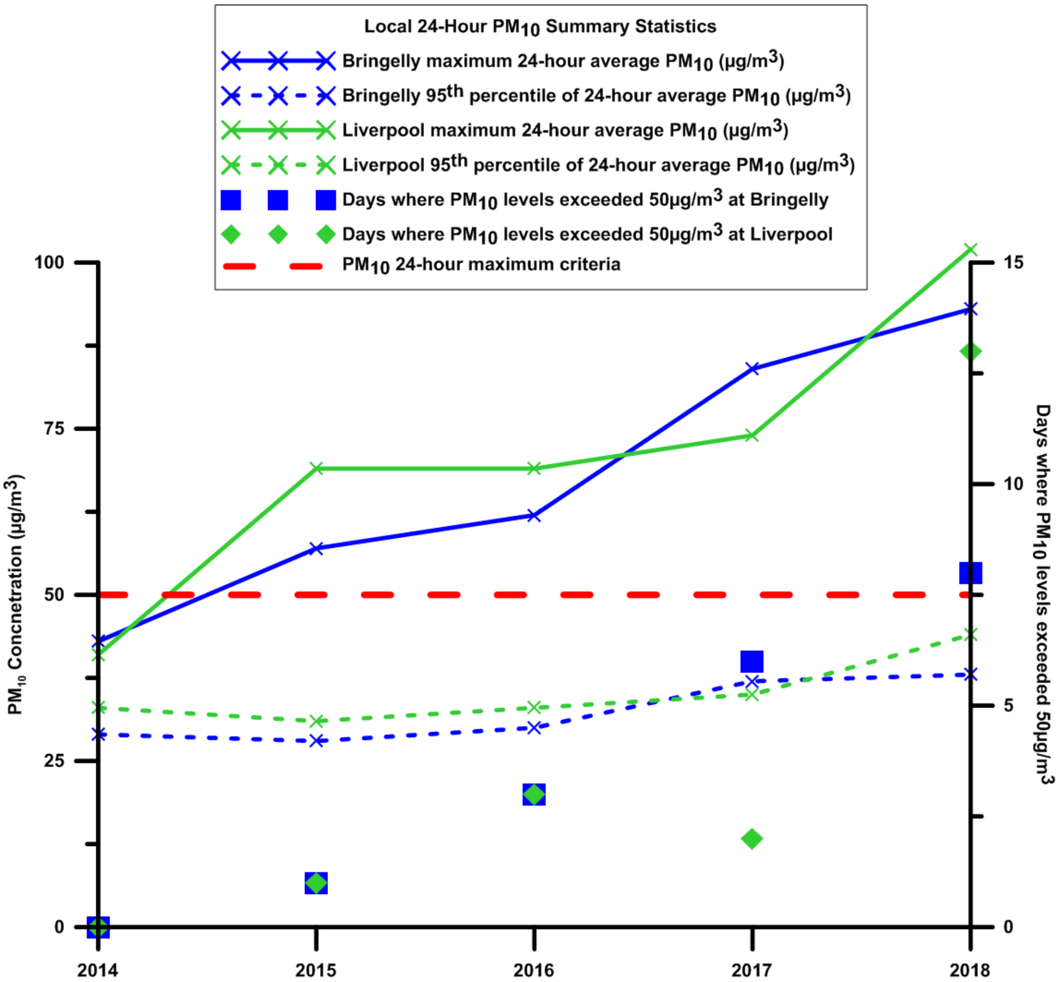

Figure 1 Monitoring statistics for 24-hour averaged PM_{10}

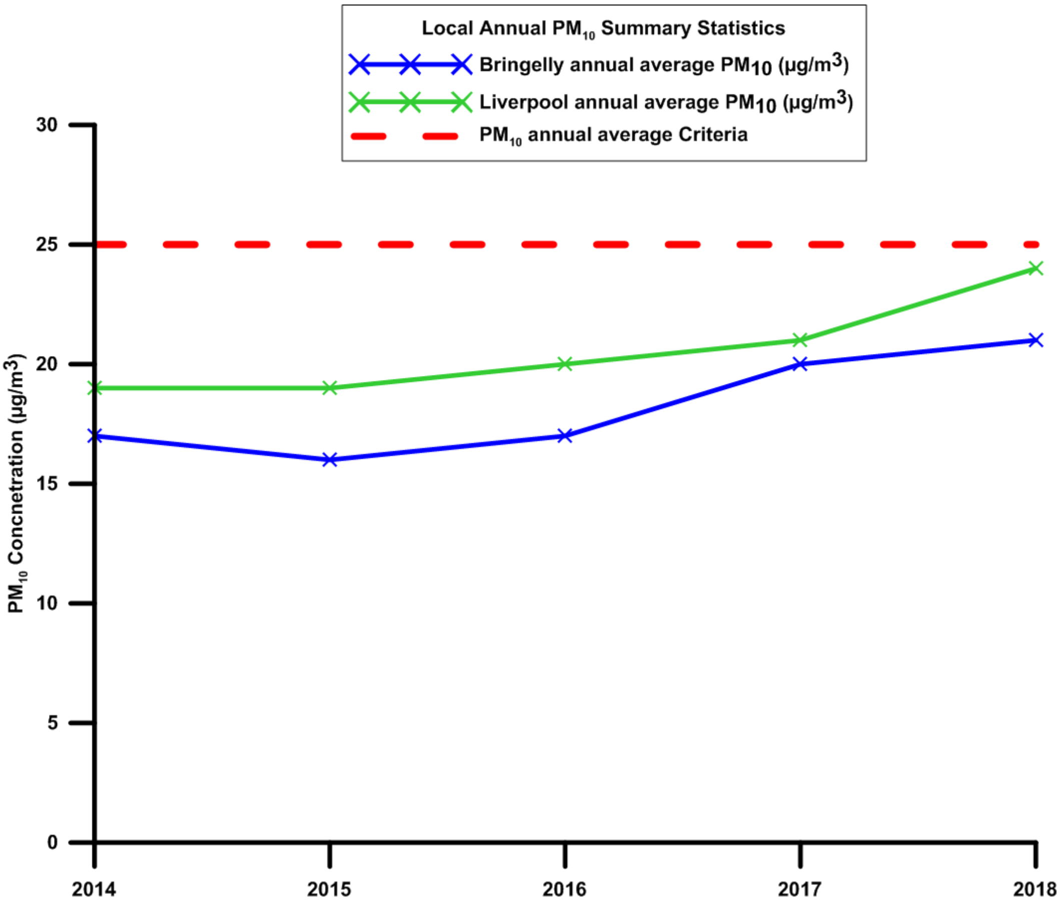

Figure 2 Monitoring statistics for annually averaged PM_{10}

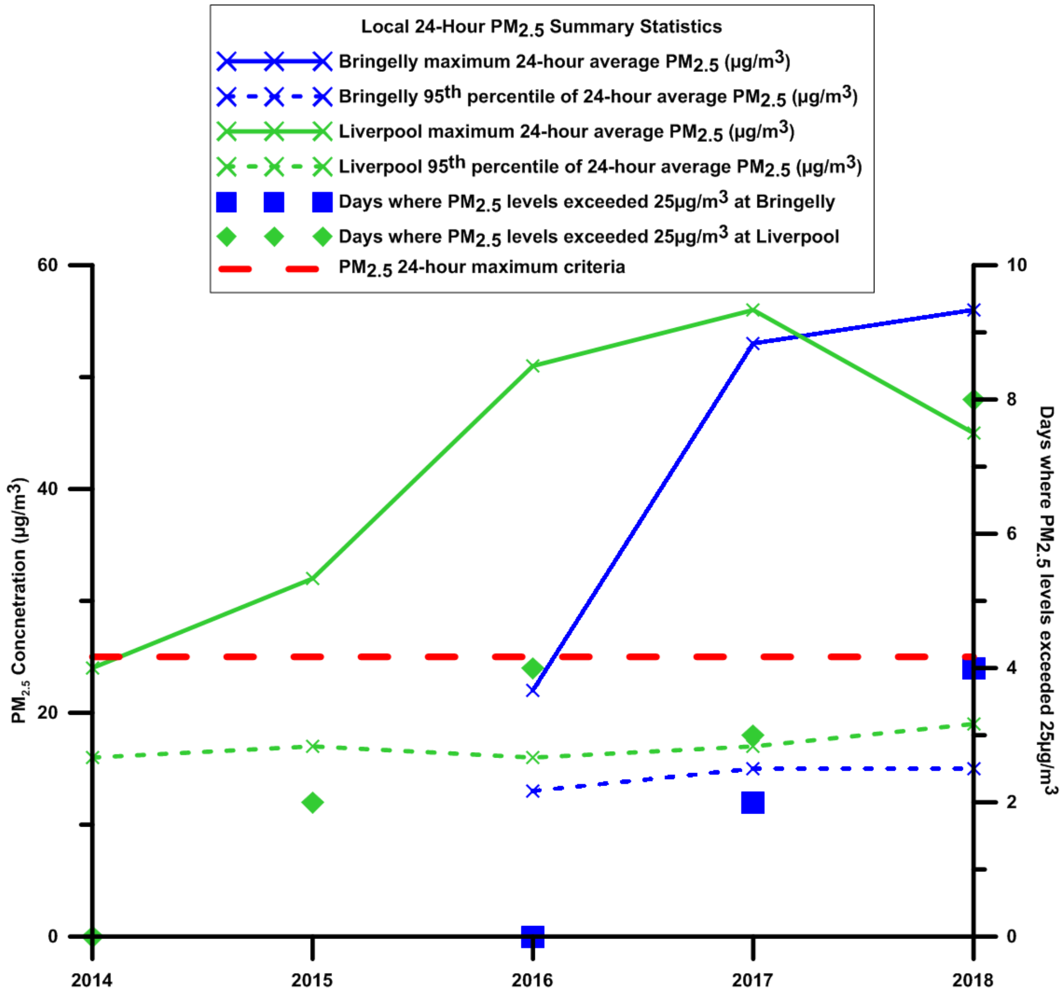

Figure 3 Monitoring statistics for 24-hour averaged $PM_{2.5}$

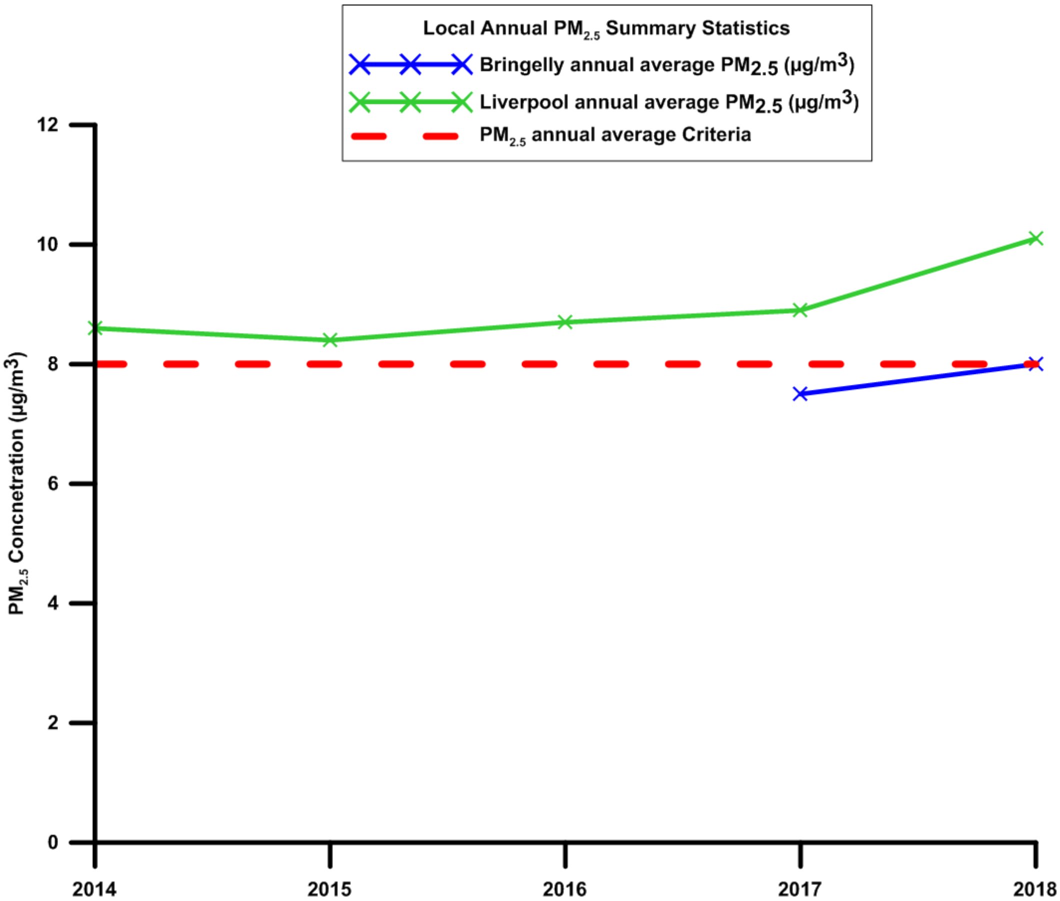

Figure 4 Monitoring statistics for annually averaged $PM_{2.5}$

Carbon monoxide (CO)

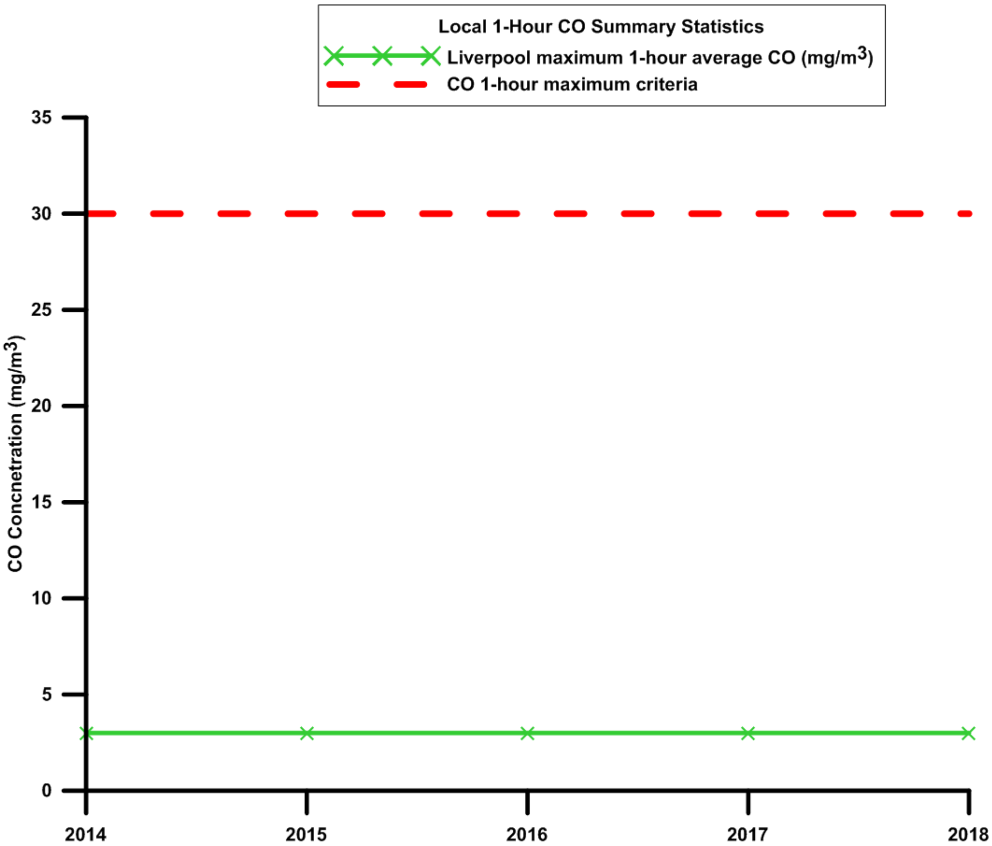

Figure 5 Monitoring statistics for one-hour averaged CO

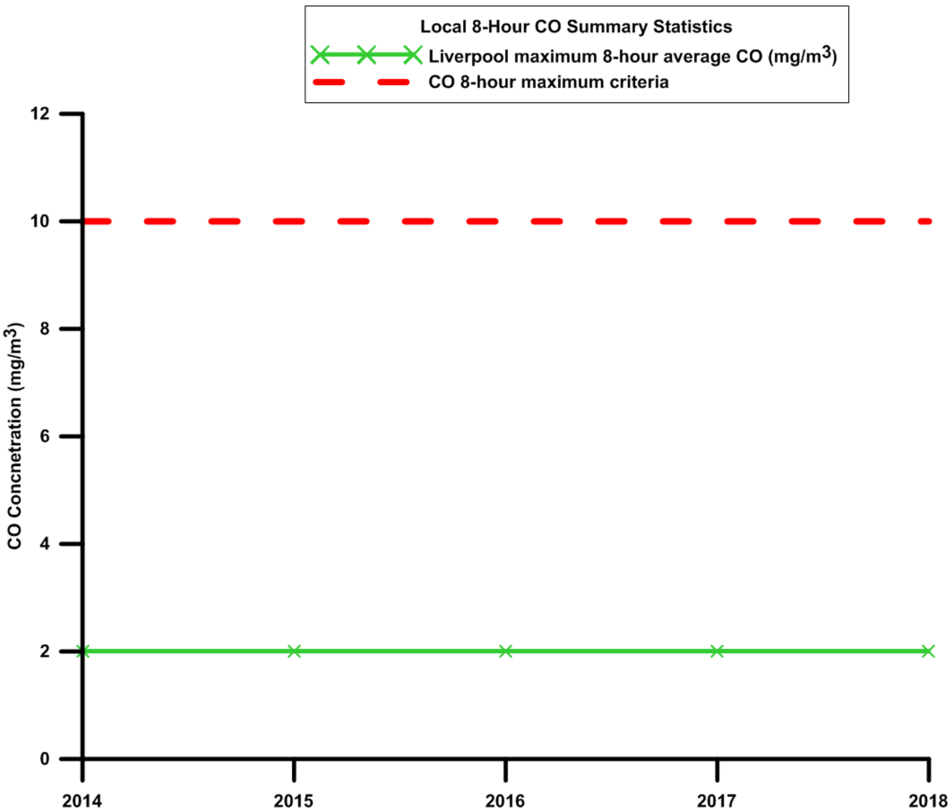

Figure 6 Monitoring statistics for eight-hour averaged CO

Nitrogen dioxide (NO_2)

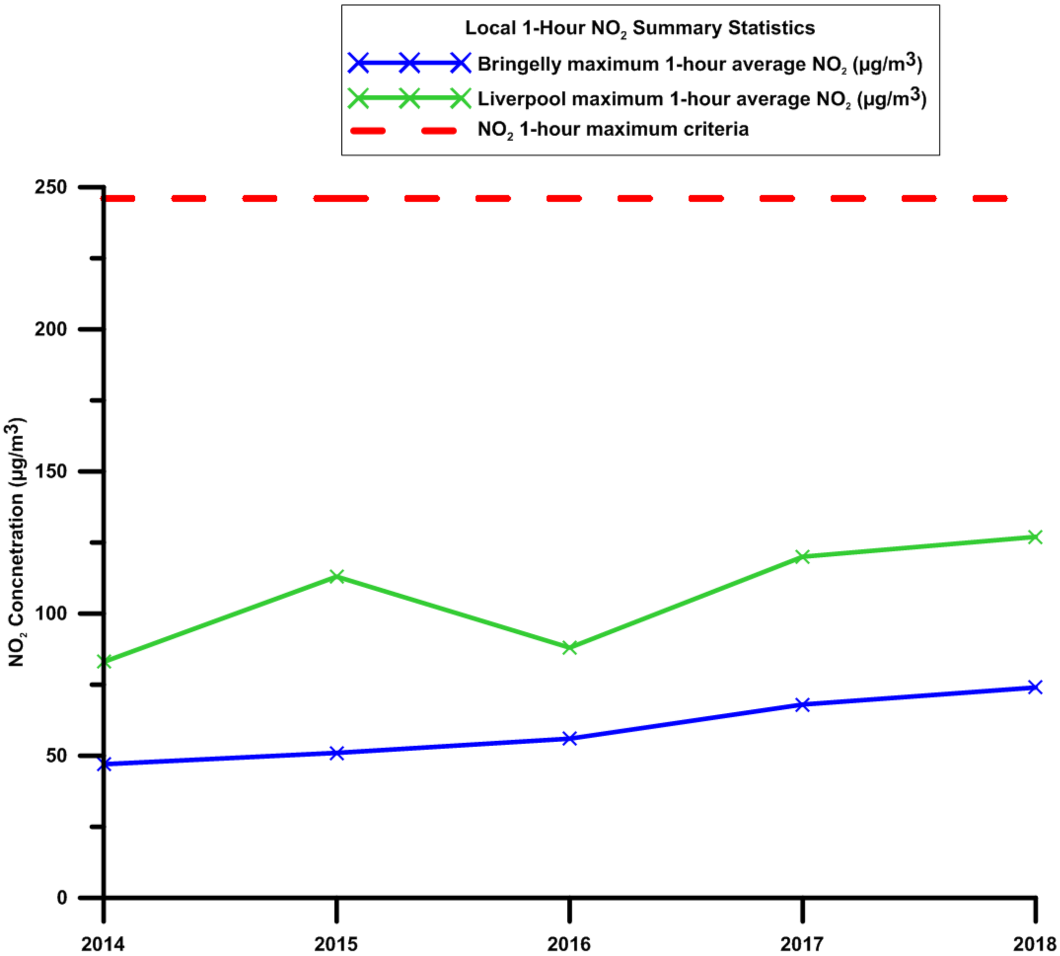

Figure 7 Monitoring statistics for one-hour averaged NO_2

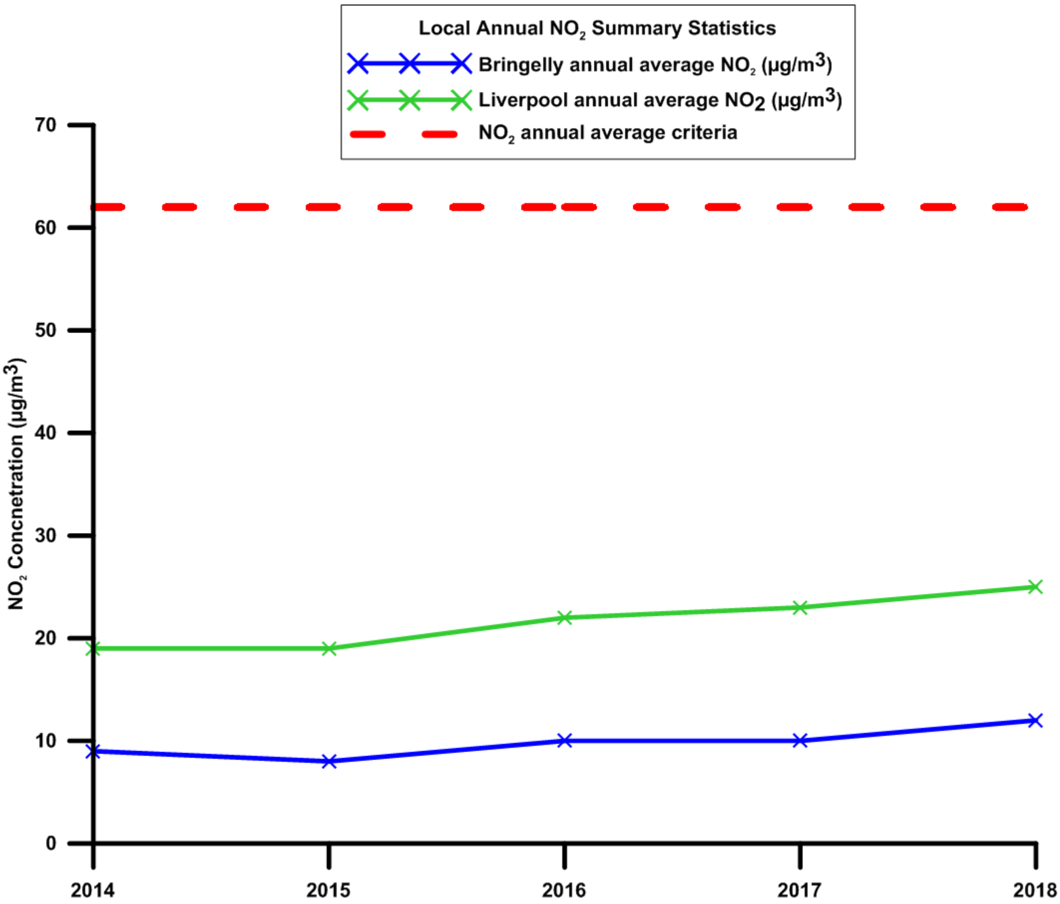

Figure 8 Monitoring statistics for annually averaged NO2

Annexure D Operational assessment – plots for CO and NO2

Plots showing predictions for gases (CO and NO_2) from the operational assessment are included below by roadway:

M12 Motorway

Design

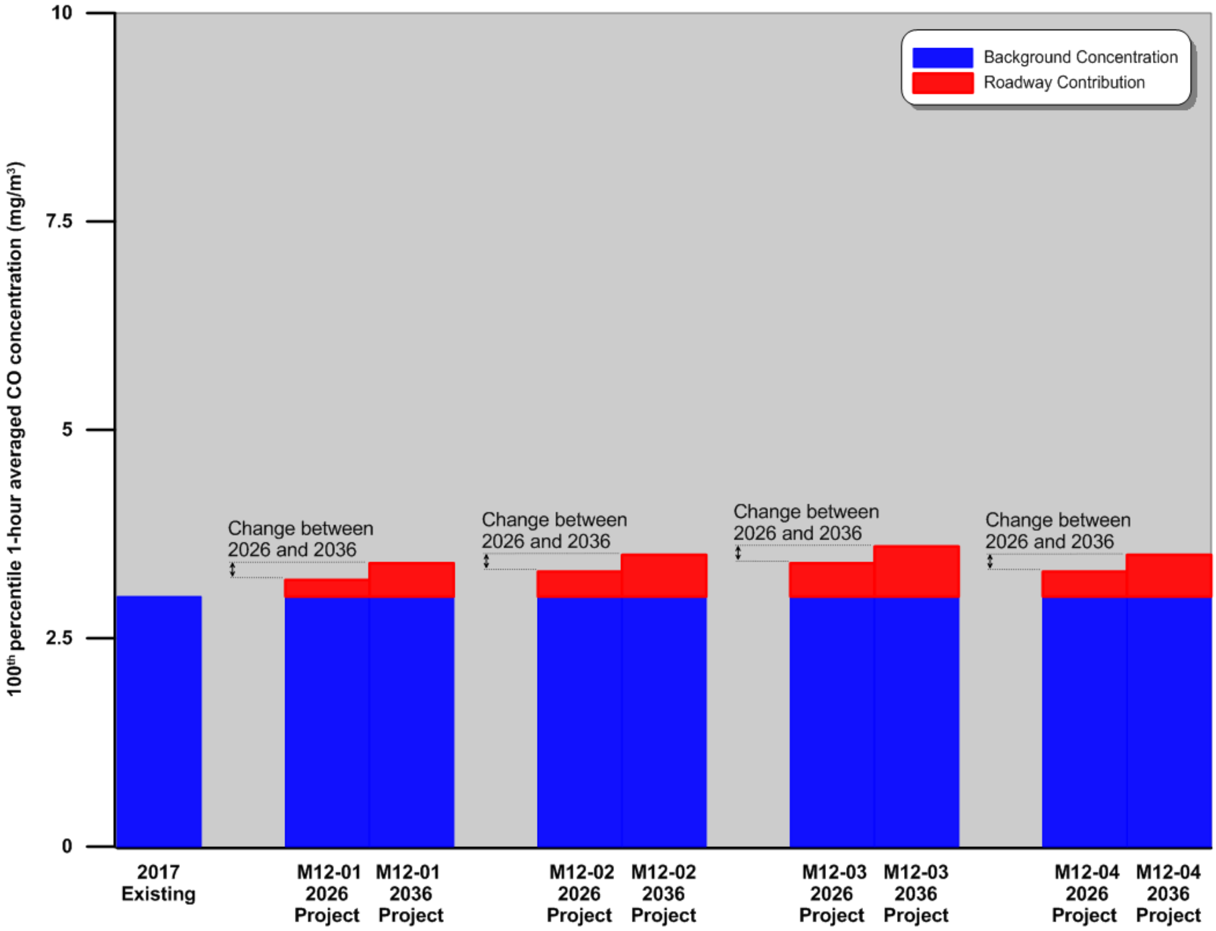

Figure 9 Predictions of 1-hour averaged CO at nearest receivers – M12 Motorway (Design)

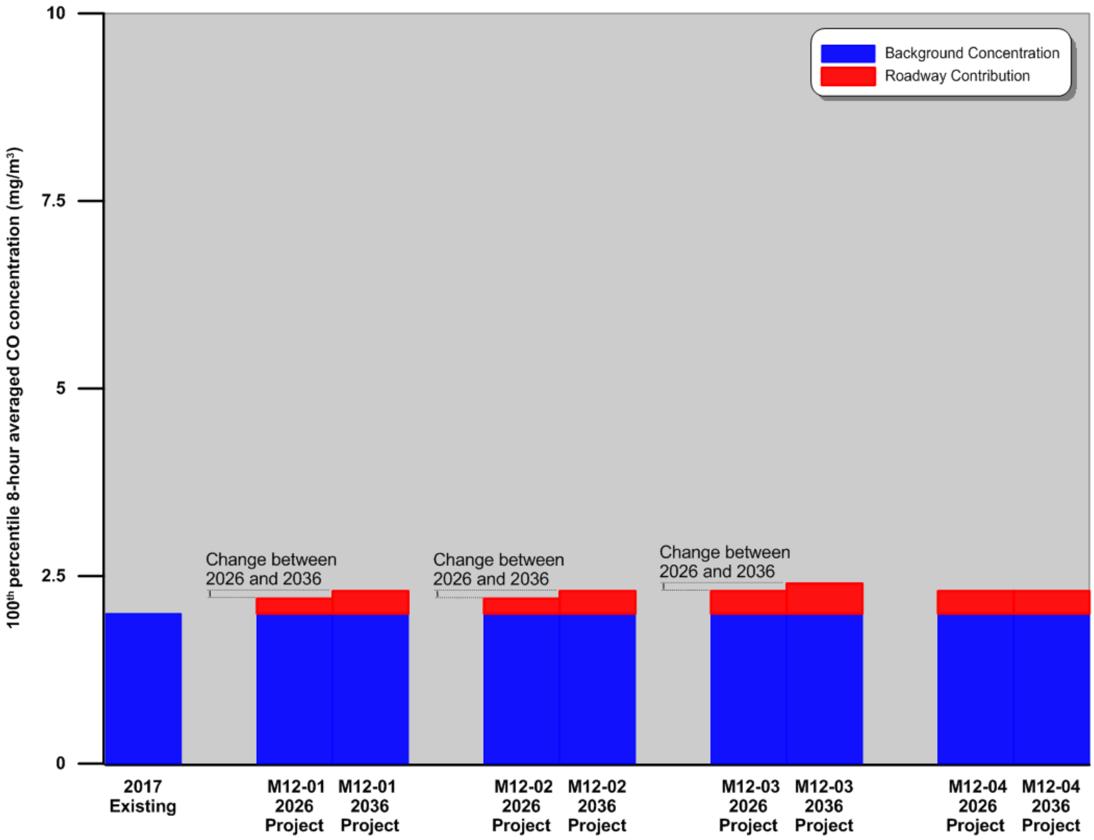

Figure 10 Predictions of 8-hour averaged CO at nearest receivers – M12 Motorway (Design)

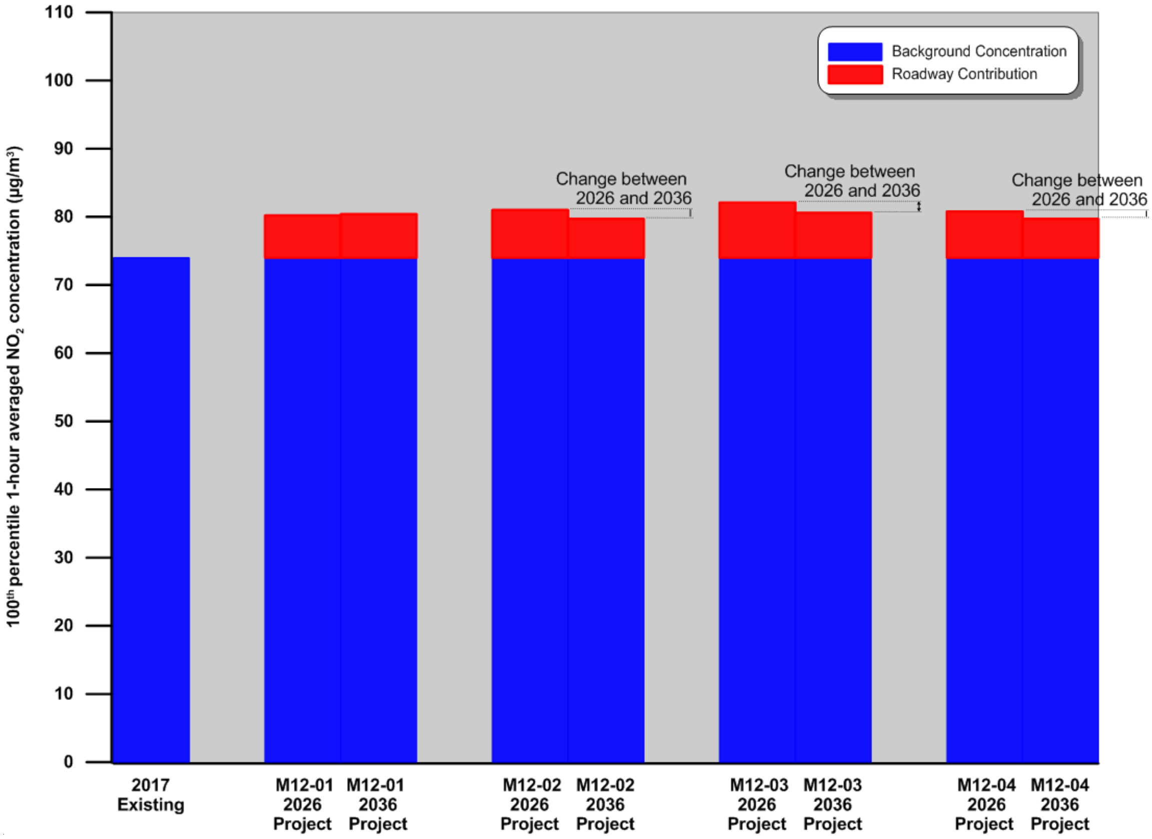

Figure 11 Predictions of 1-hour averaged NO_2 at nearest receivers – M12 Motorway (Design)

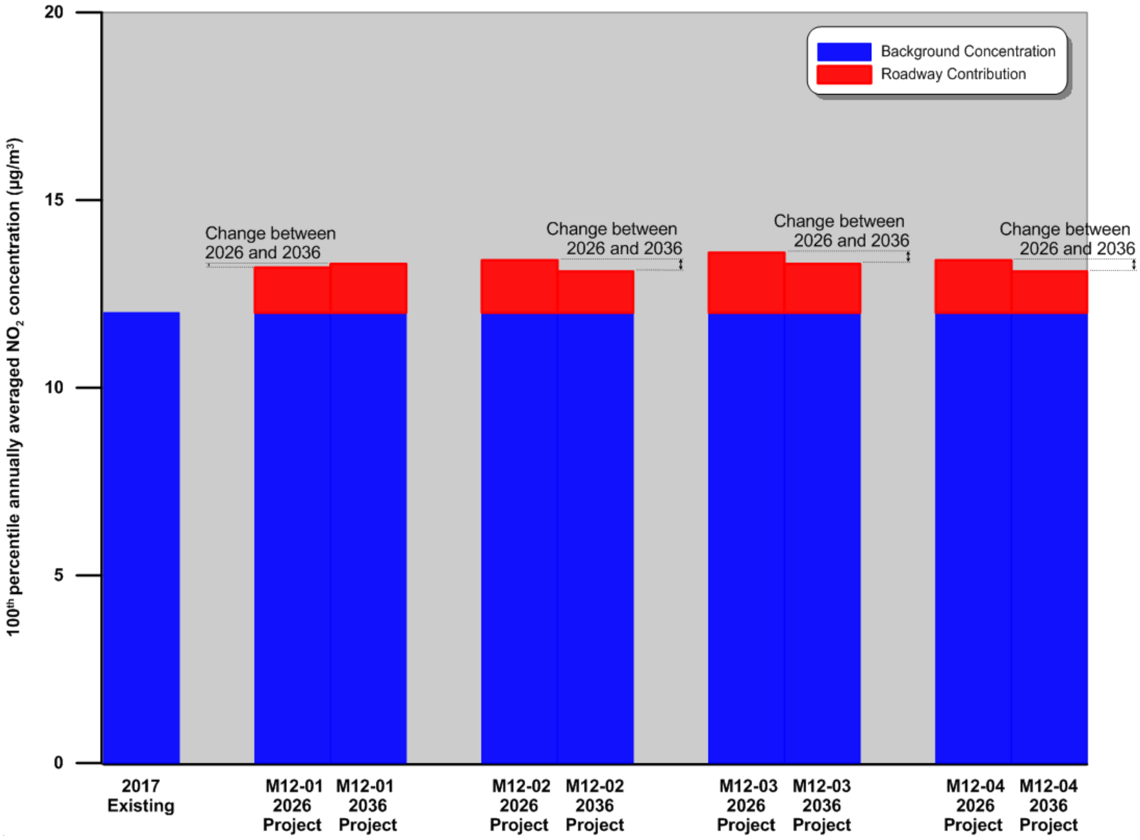

Figure 12 Predictions of annually averaged NO_2 at nearest receivers – M12 Motorway (Design)

The Northern Road

Design

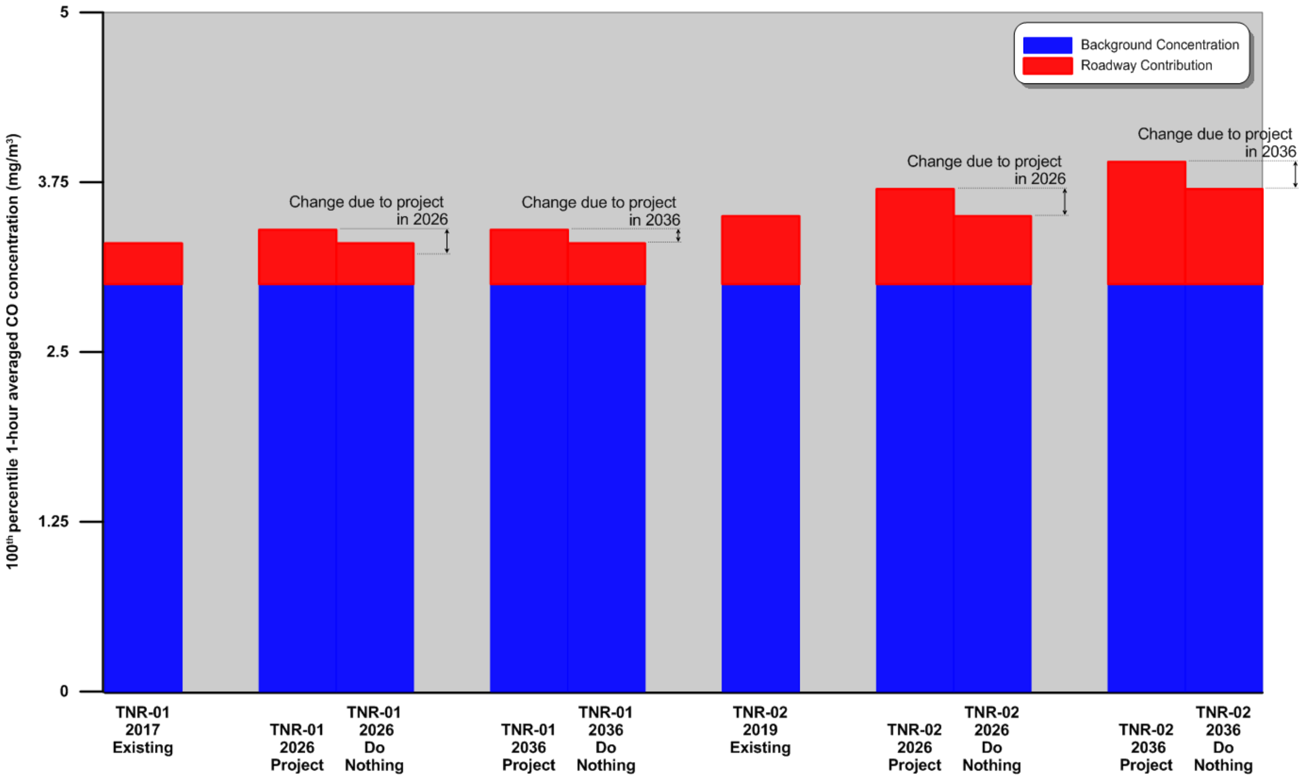

Figure 17 Predictions of 1-hour averaged CO at nearest receivers – The Northern Road (Design)

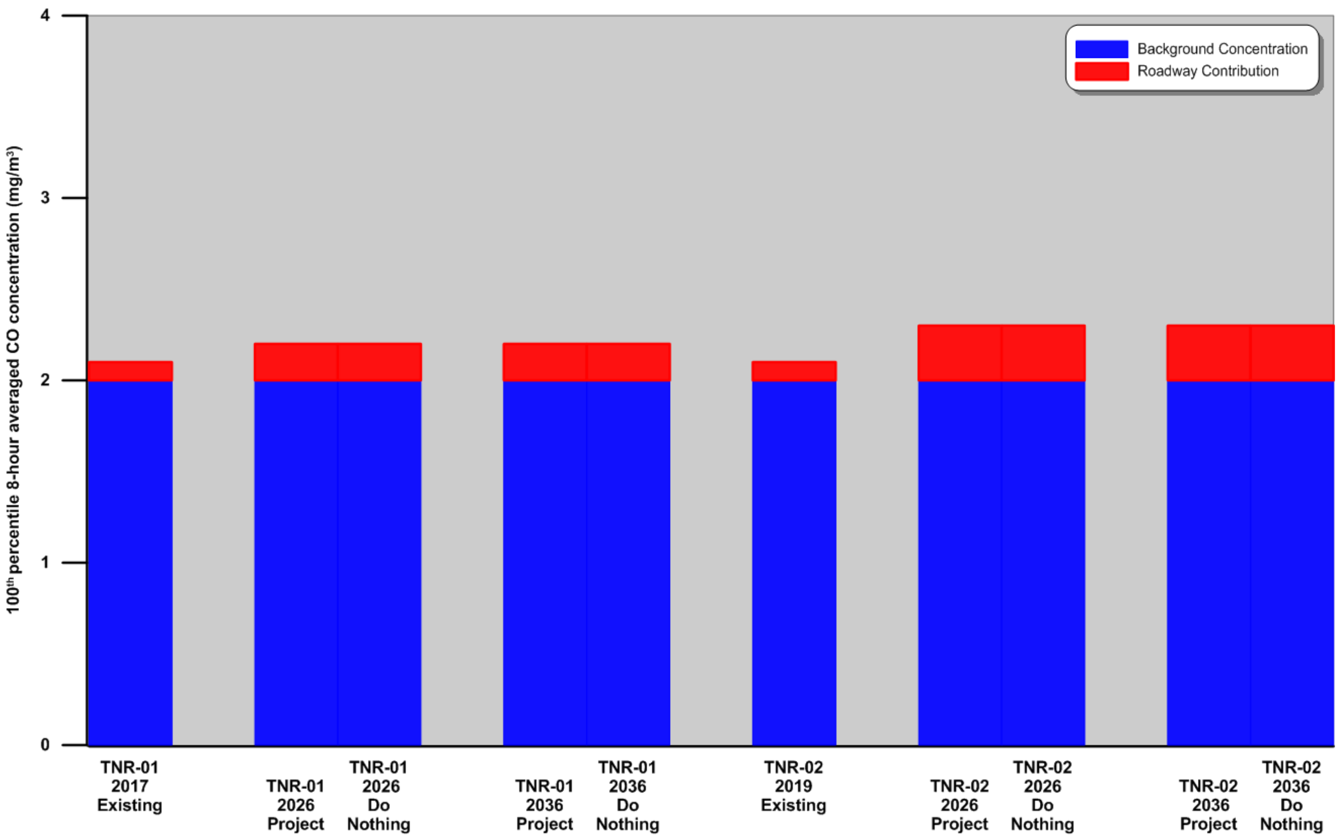

Figure 18 Predictions of 8-hour averaged CO at nearest receivers – The Northern Road (Design)

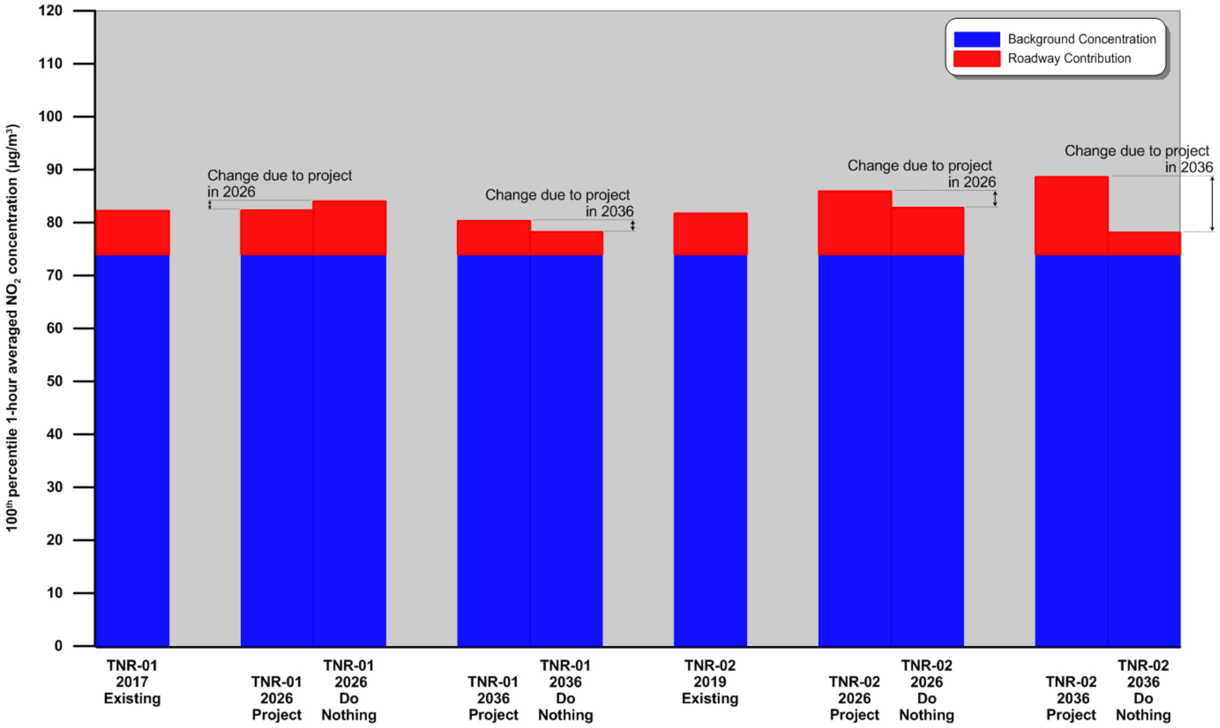

Figure 19 Predictions of 1-hour averaged NO_2 at nearest receivers – The Northern RoadFigure 20 (Design)

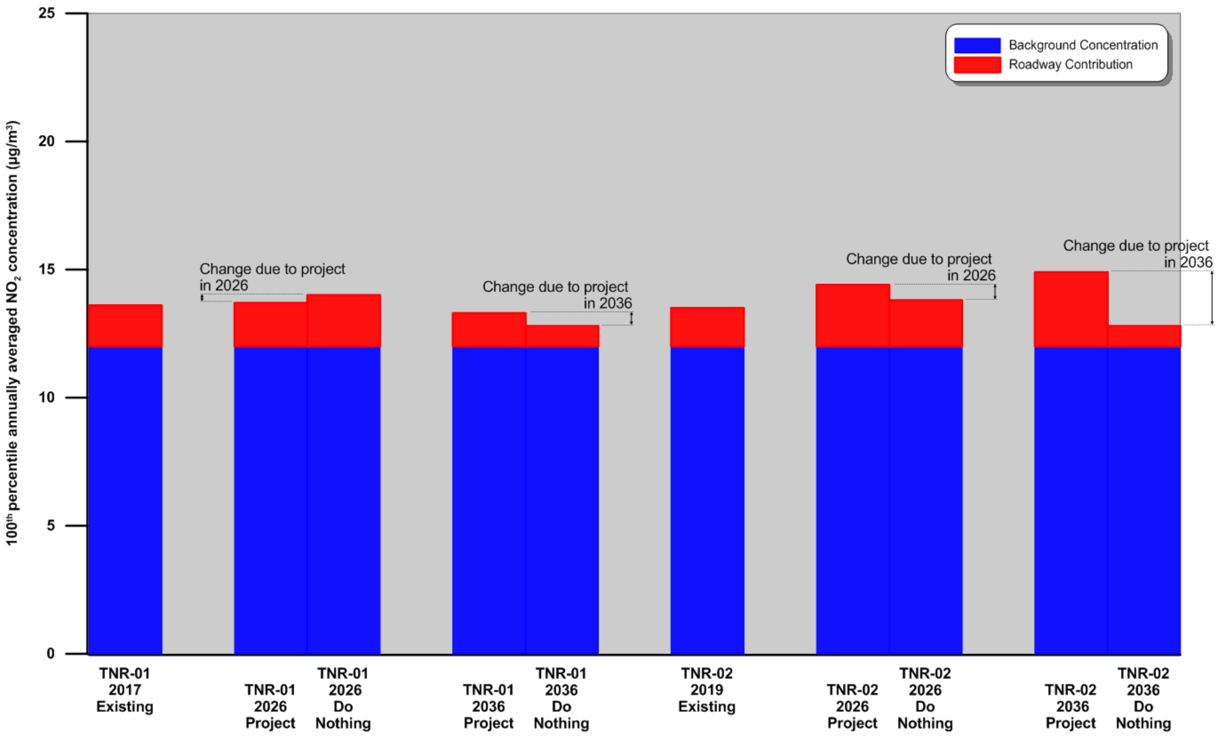

Figure 21 Predictions of annually averaged NO_2 at nearest receivers – The Northern Road (Design)

M7 Motorway

Design

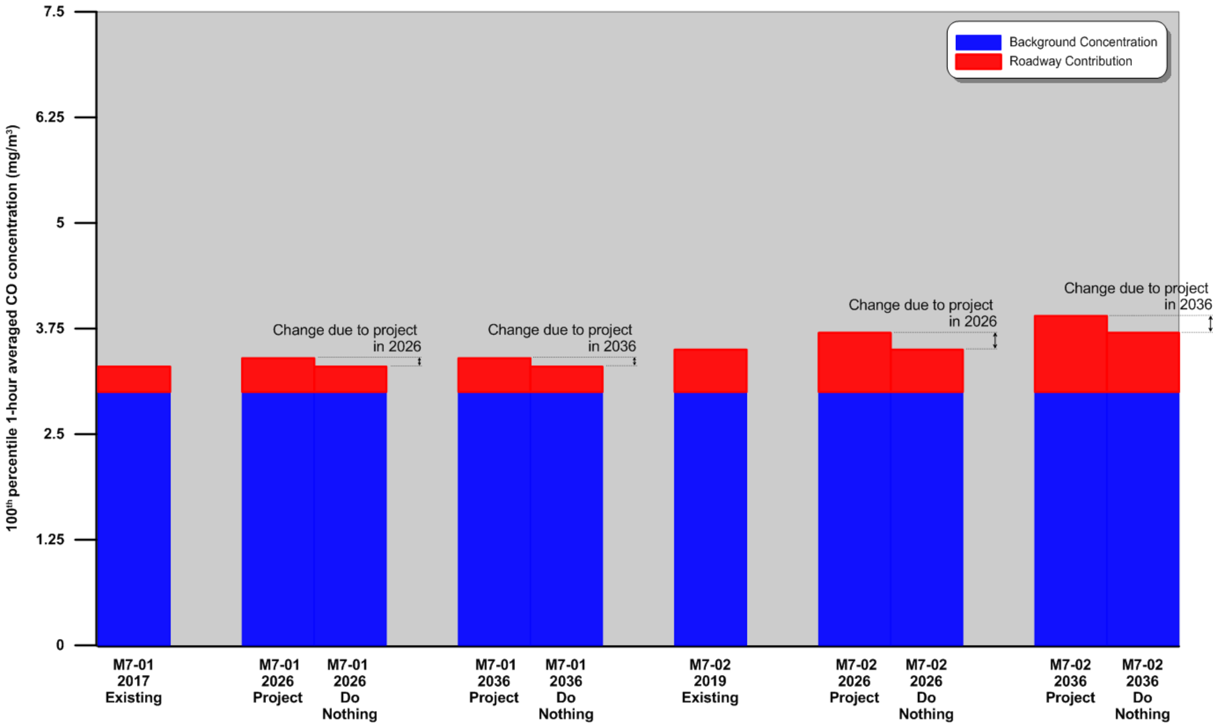

Figure 22 Predictions of 1-hour averaged CO at nearest receivers – M7 Motorway (Design)

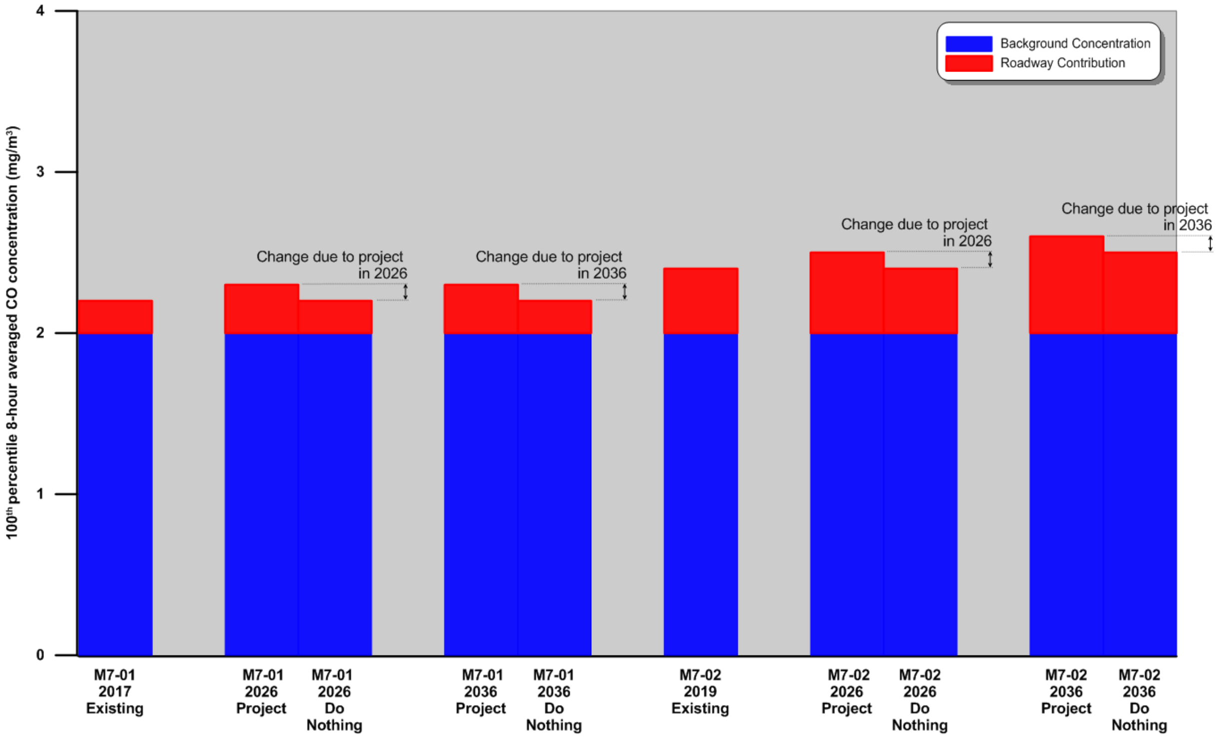

Figure 23 Predictions of 8-hour averaged CO at nearest receivers – M7 Motorway (Design)

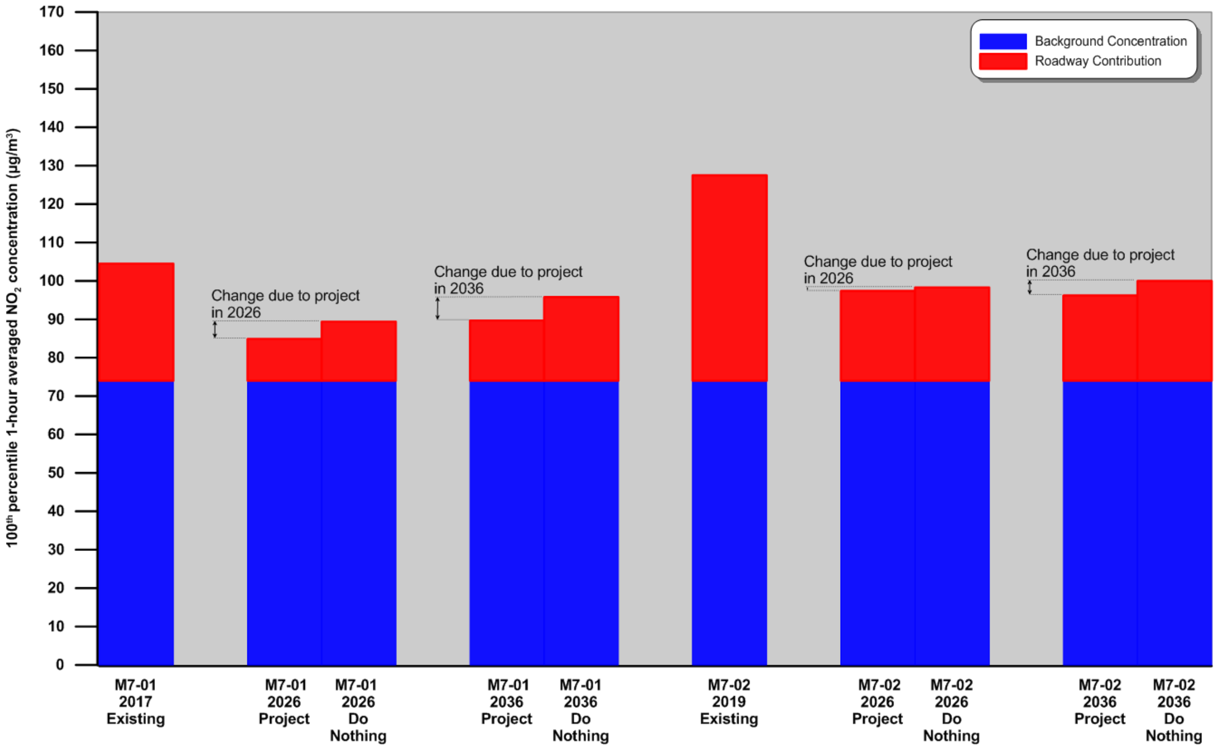

Figure 24 Predictions of 1-hour averaged NO_2 at nearest receivers – M7 Motorway (Design)

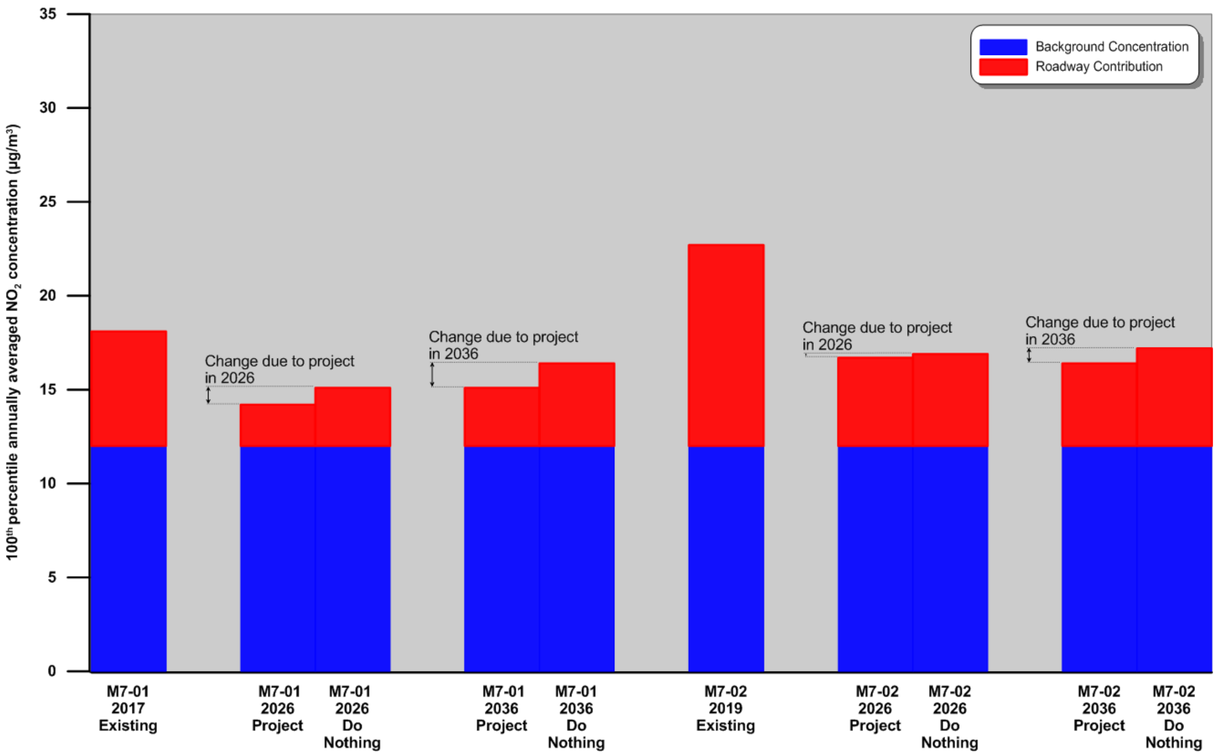

Figure 25 Predictions of annually averaged NO_2 at nearest receivers – M7 Motorway (Design)

Elizabeth Drive

Design

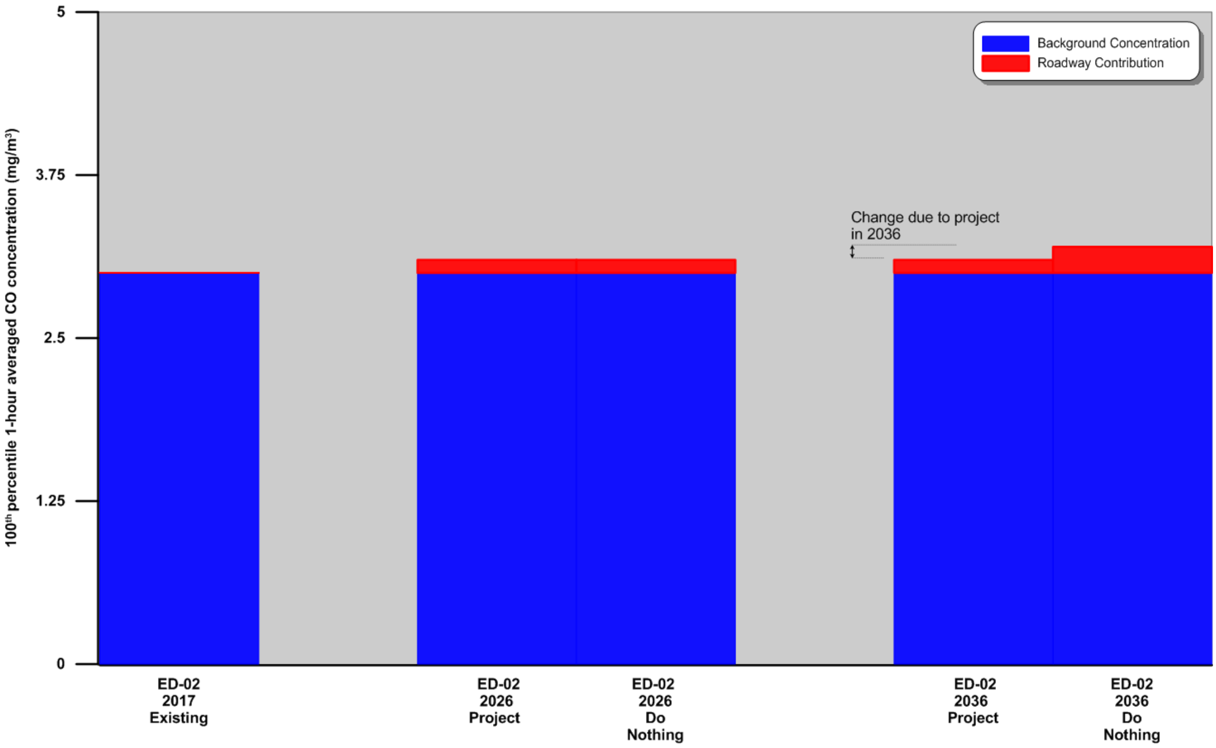

Figure 30 Predictions of 1-hour averaged CO at nearest receiver – Elizabeth Drive (Design)

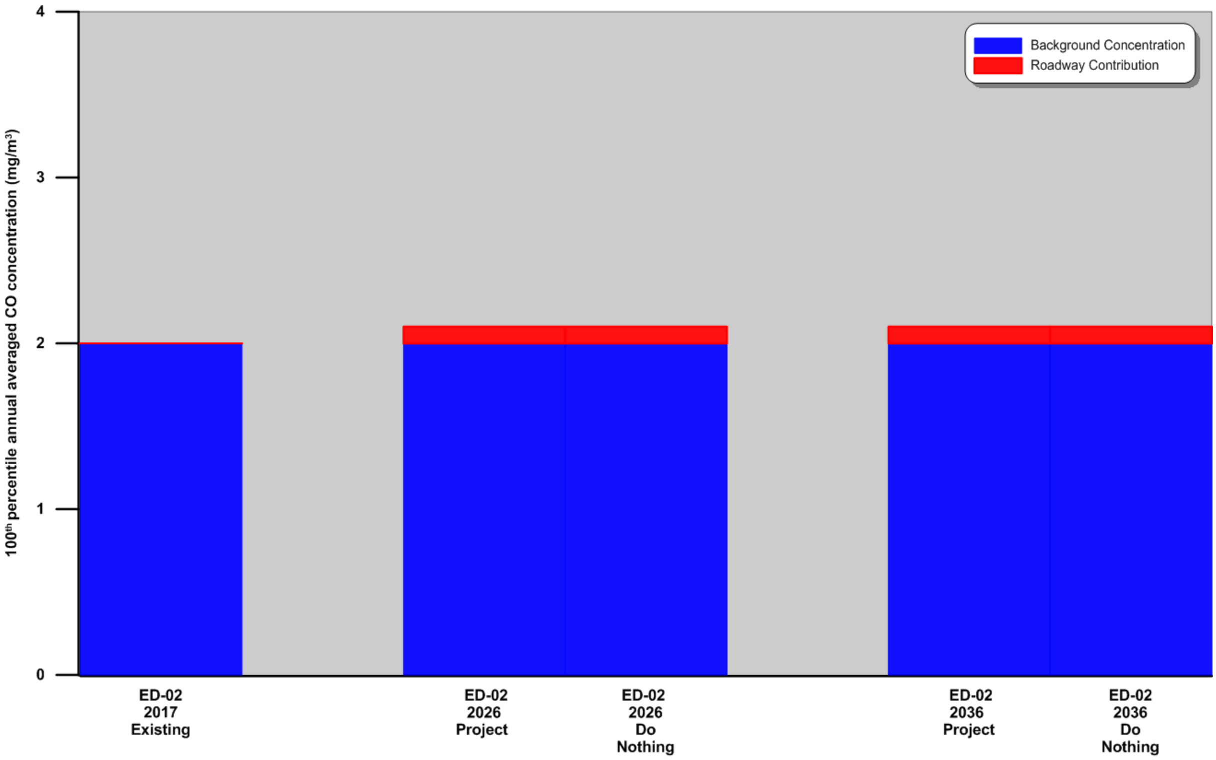

Figure 31 Predictions of 8-hour averaged CO at nearest receiver – Elizabeth Drive (Design)

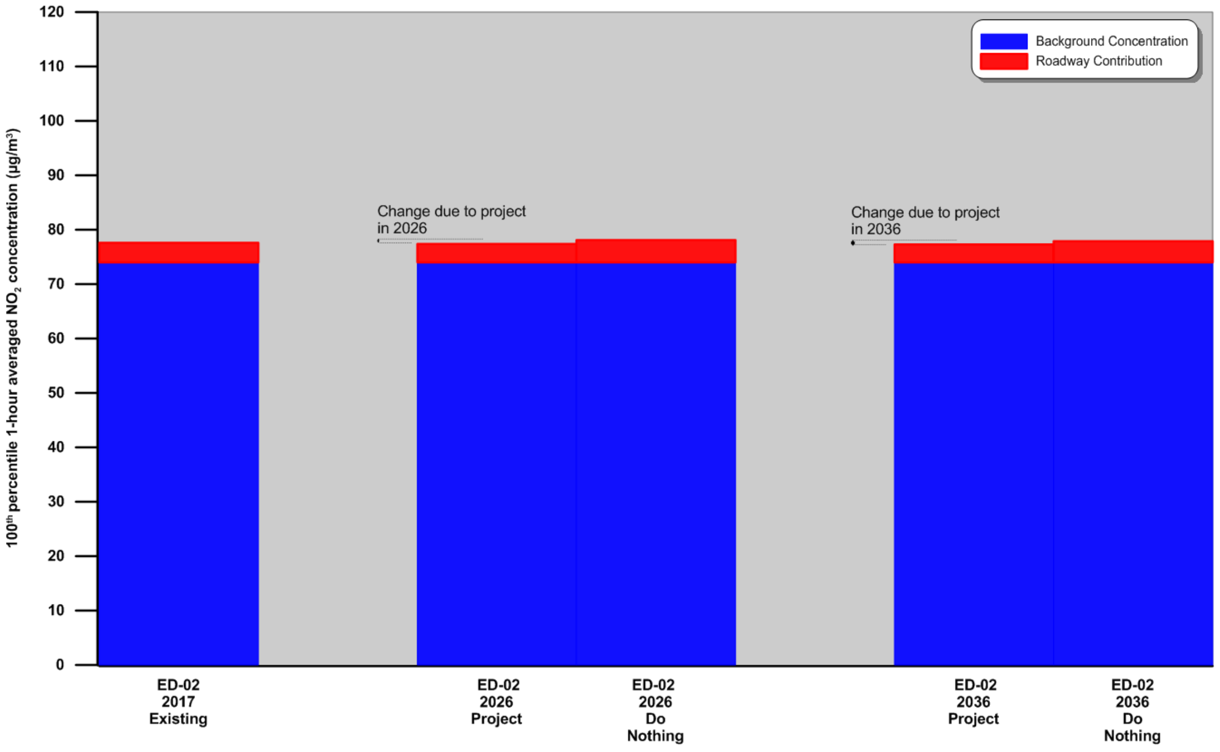

Figure 32 Predictions of 1-hour averaged NO_2 at nearest receiver – Elizabeth Drive (Design)

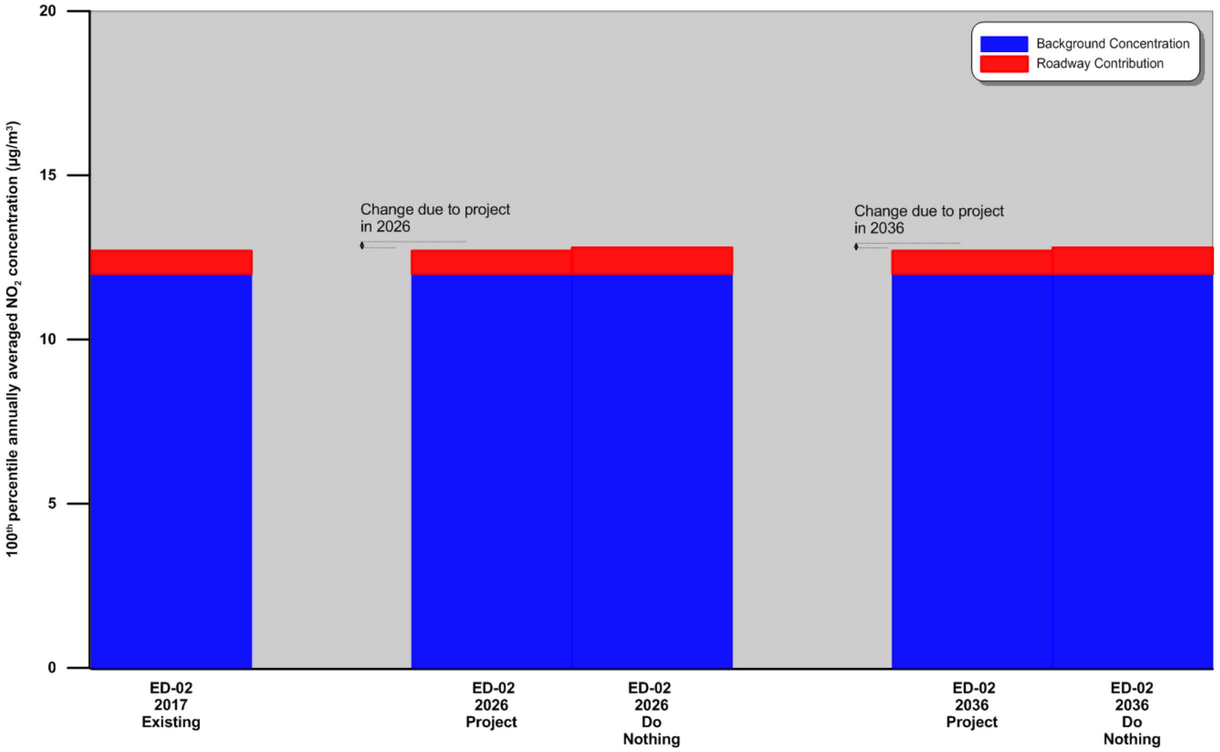

Figure 33 Predictions of annually averaged NO_2 at nearest receiver – Elizabeth Drive (Design)

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