7 Consultation

This chapter provides an overview of the consultation activities undertaken before and during the preparation of this environmental impact statement (EIS), and outlines the activities planned for the public exhibition of the EIS as well as the construction stage of the M4 East project (the project).

The Secretary of the NSW Department of Planning and Environment (DP&E) has issued a set of environmental assessment requirements for the project; these are referred to as Secretary's Environmental Assessment Requirements (SEARs). **Table 7.1** sets out these requirements as they relate to consultation with government, relevant stakeholders and community groups, and identifies where they have been addressed in this environmental impact statement (EIS).

Table 7.1 Secretary's Environmental Assessment Requirements – consultation

Secretary's environmental assessment requirements	Addressed in EIS section
During the preparation of the EIS, you must consult with the relevant local, State or Commonwealth Government authorities, service providers, community groups and affected landowners.	Consultation activities carried out and information provided to stakeholders during the preparation of the EIS is provided throughout this chapter. It includes the broad range of engagement and consultation activities undertaken with the relevant local, State and Commonwealth Government authorities, service providers, community groups and affected landowners.
local, State and Commonwealth government authorities, including the: • Environment Protection Authority, • Office of Environment and Heritage (including Heritage Division), • The Heritage Council of NSW, • Department of Primary Industries, • NSW Office of Water, • NSW Health (including Local Health Districts), • Transport for NSW, • UrbanGrowth NSW, • Sydney Olympic Park Authority, • Ashfield City Council, • Auburn Council, • Burwood Council, • City of Canada Bay Council, and • Strathfield Municipal Council.	Consultation with local, State and Commonwealth government authorities is described in section **7.3.2** of this chapter. Issues raised by government agencies are identified in **Table 7.8** and issues raised by local councils are identified in **Table 7.9**.
specialist interest groups, including Local Aboriginal Land Councils, Aboriginal stakeholders, and pedestrian and bicycle user groups;	Consultation with Aboriginal stakeholders is outlined in **section 7.3.3**. Further details are provided in **Chapter 22** (Aboriginal heritage).
utilities and service providers; and	Consultation with utilities and service providers is outlined in **section 7.3.2.4**.
the public, including community groups and adjoining and affected landowners.	Consultation with the public, including community groups and adjoining and affected landowners, is outlined in **section 7.3.2**.

Secretary's environmental assessment requirements	Addressed in EIS section
The EIS must describe the consultation process and the issues raised, and identify where the design of the project has been amended in response to these issues. Where amendments have not been made to address an issue, a short explanation should be provided.	The consultation process is outlined in **section 7.3.2**. **Section 7.4.3** outlines the issues raised by government agencies, local councils and the community and provides a response to these issues raised. Consideration of feedback received in the development of the project is outlined in **section 7.5**.

7.1 Community and stakeholder engagement overview

Community and stakeholder engagement during the preparation of this EIS was undertaken in accordance with the SEARs outlined above.

The communication and consultation activities have been identified and implemented to build on early consultation conducted during the development of the WestConnex Strategic Environmental Review (Sydney Motorways Project Office 2013b) and the WestConnex Business Case (Sydney Motorways Project Office 2013a)).

The State significant infrastructure application for the project was lodged with Department of Planning and Environment (DP&E) on 28 November 2013, which coincided with the preliminary concept design announcement. This announcement marked the commencement of the dedicated consultation program for the project. Consultation and engagement activities across all stakeholder segments have included the provision of project-specific information as well as opportunities for stakeholders to raise questions and provide suggestions and feedback.

Feedback received during the preliminary concept design display (November 2013) was considered in the development of the selected preferred design (June 2015) for the project.

Figure 7.1 provides an overview of the consultation activities undertaken for the M4 East.

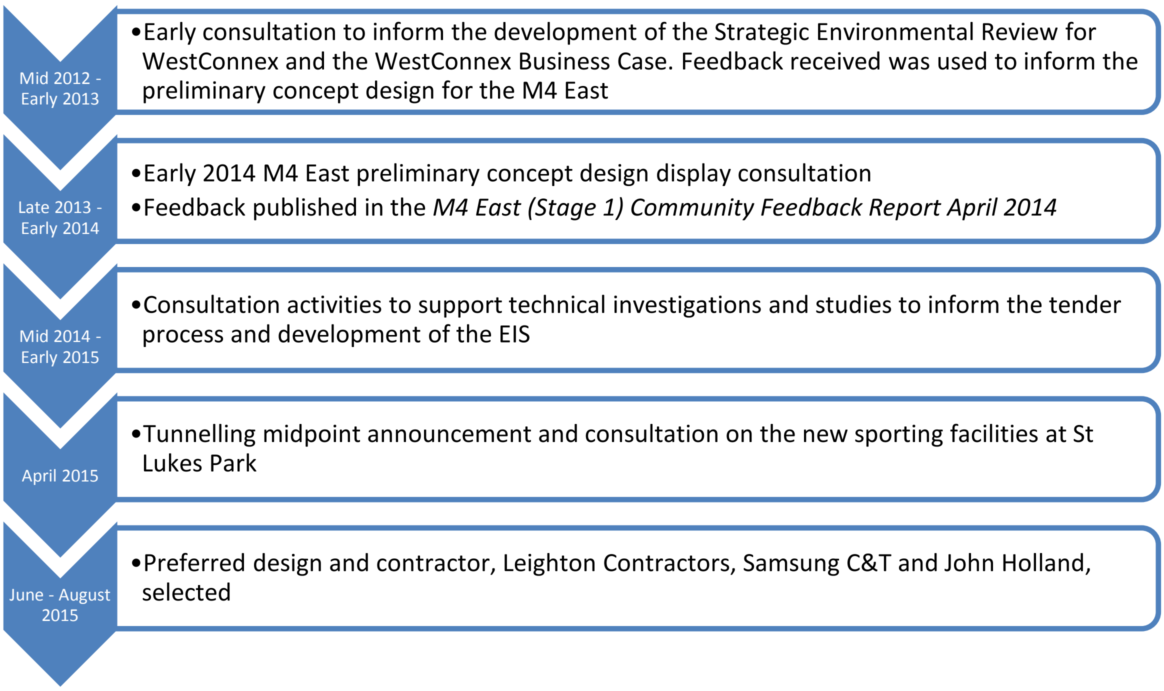

Figure 7.1 Overview of the consultation activities for the M4 East

A detailed stakeholder analysis was undertaken to ensure information was provided and opportunities for consultation were identified during the preparation of the EIS. Stakeholders were categorised into the following groups:

- Government – including local, State and Federal representatives and officers
- Local Aboriginal stakeholders
- Interest groups – industry, business, community groups, pedestrian and bicycle user groups
- Residents and businesses along the project corridor
- Utilities and service providers – including water, gas, electricity and telecommunications
- Broader community - including potential future users of the project.

Sections 7.4.1, 7.4.2 and 7.4.3 outline the issues raised by government agencies, local councils and the community and identify where these issues have been addressed within this EIS.

7.2 Consultation objectives

The objectives of the community and stakeholder consultation program during the preparation of the EIS have been to:

- Ensure an open, accountable and transparent community involvement process
- Increase community and stakeholder awareness of the need for the project
- Increase community and stakeholder awareness of the project development and environmental assessment process and opportunities for participation
- Provide accessible information on the project and ensure appropriate consultation tools are used taking into account demographics such as language, literacy and access to the internet
- Engage stakeholders and affected local communities early in the planning process, so that issues raised can help refine the design and inform the EIS
- Engage early with property owners regarding the potential need for property acquisition for the development of the project
- Ensure the views of the community and stakeholders are considered and addressed during the preparation of the EIS
- Provide timely responses to the community and other stakeholders in relation to environmental assessment outcomes.

7.3 Consultation process and activities to date

7.3.1 Consultation undertaken before preparation of the EIS

Communication and consultation activities commenced during the development of the WestConnex Strategic Environmental Review and the WestConnex Business Case in mid-2012. A summary of these activities is provided in **Table 7.2**.

Table 7.2 Communication and consultation activities prior to the preparation of the EIS

Activity	Summary
Research program	A research program involving community members, business owners, road users and stakeholders was conducted to identify strategic issues.
Project website	A WestConnex project website (www.westconnex.com.au) was established with background information, maps, videos, customer surveys and details on how to provide feedback.
Project information line	A project information line (1300 660 248) was established to answer questions and gather feedback.

Activity	Summary
Project email address	A dedicated project email address (info@westconnex.com.au) was created to notify registered stakeholders, encourage comment and respond to community feedback.
Postal address	A postal address (Locked Bag 928, North Sydney NSW 2059) was registered to receive stakeholder input and correspondence.
Advertising	Broad advertising of the WestConnex scheme was placed in major metropolitan publications such as the Sydney Morning Herald and the Daily Telegraph, along with advertising targeting public transport users in mX magazine, and online advertising targeting road users.
Media announcements	Media announcements were widely covered in metropolitan television, radio, print and digital news outlets, along with trade and advocacy publications such as NRMA's Open Road magazine.
Stakeholder discussions	Targeted stakeholder discussions were held with advocacy groups, local councils, elected representatives, government agencies, peak bodies and community members.
Roundtable discussions	Discussions were held with stakeholders such as councils, the freight industry and business groups.
Online engagement survey	An online community and stakeholder survey sought feedback on how stakeholders would like to receive information on the project and engage with the project team, and what tools and technologies they would like to see used during the planning and development of the project.
Industry partners involvement	Four leading Australian and international design and construction companies were selected as development partners during the preparation of the Business Case to develop and improve design and construction solutions for specific sections of the northern and southern corridors.
Industry briefings	Market briefings and workshops were undertaken to inform industry and get feedback on the scope, program, reference delivery model and timing alternatives.
Other	Awareness raising activities included the provision of information about WestConnex in motor vehicle registration renewals, postcards and M2 upgrade community updates.

The early consultation and feedback was used to inform the preliminary concept design development for the project, and supplemented the ongoing consultation program undertaken as part of the environmental assessment activities and preparation of the EIS.

7.3.2 Consultation undertaken during preparation of the EIS

Consultation at key project milestones

A range of activities has been undertaken to align with major project milestones, including the display of the preliminary concept design, the announcement of the midway tunnelling point location and the display of the preferred design following the selection of a contractor to build the M4 East.

Table 7.3 provides an overview of the key communication and consultation activities undertaken during these key consultation periods.

Table 7.3 Project milestone announcements and consultation

Activity	Summary	Date
Preliminary concept design display		
Community update	The M4 East preliminary concept design community update was distributed to more than 105,000 residences and businesses. Copies were also made available on the project website, at local councils, libraries and motor registries.	November 2013

Activity	Summary	Date
Email broadcast	An email broadcast was sent to more than 1,800 registered stakeholders to inform them of the details of the preliminary concept design display and invite them to attend the community information sessions.	28 November 2013
Property acquisition notification letters and phone calls	Notification letters and property acquisition information guides were sent to owners of properties required and potentially required to build the project. Property owners were provided with the option to commence voluntary acquisition if preferred.	Ongoing since November 2013
Individual property meetings	More than 80 individual meetings were held with property owners and nearby neighbours to discuss the potential impact of the project on individual properties and to explain the property acquisition process following the announcement of the preliminary concept design.	December 2013 to April 2014
Door knock	A door knock was undertaken by the project team when contact could not be made with property owners, to discuss the potential acquisition of properties.	Week commencing 2 December 2013
Advertisements	Eleven advertisements were placed in English language and non-English language newspapers during the preliminary concept design display period to promote the display of the concept design and the community information sessions.	December 2013 and January 2014
Community information sessions	Seven community information sessions were held at various locations along the project corridor to discuss the preliminary concept design with community members, answer questions and gather feedback. Up to 12 project team members were available at each of the information sessions from a range of technical backgrounds. More than 600 people attended the information sessions.	7, 9 and 14 December 2013 4, 6, 9 and 12 February 2014
Email broadcast	An email broadcast was sent to more than 2,400 registered stakeholders reminding them of upcoming information sessions for the project.	29 January 2014
Community feedback report	The M4 East Community Feedback Report was prepared and published on the project website. This report included feedback maps for Homebush, Concord and Haberfield/Ashfield	April 2014
Email broadcast	An email broadcast was sent to more than 2,600 registered stakeholders providing a link to the published community feedback report on the WestConnex website.	30 April 2014
Midway tunnelling point announcement		
Community Update	The M4 East midway tunnelling point community update was distributed to around 1,800 residents in Concord around Concord Oval, Cintra Park, St Lukes Park and St Lukes Park North. A copy of this update was also made available on the project website.	April 2015
Email broadcast	A link to the midway tunnelling point community update was broadcast to more than 2,600 stakeholders who registered their interest in receiving updates on the project.	29 April 2015

Activity	Summary	Date
Door knock	Approximately 90 residences around Cintra Park and the midway tunnelling point were door knocked to notify residents of the upcoming investigations and works. Residences door knocked were located in Loftus Street, Gipps Street, Burwood Road, Taylor Street, Stanley Street, Crane Street and Burton Street.	27-28 April 2015
Advertisement	An advertisement was placed in the Burwood Scene to invite residents to attend the community information sessions held on 8 May 2015.	6 May 2015
Community information sessions	Drop-in information sessions were held at Club Burwood RSL in Burwood, from 11.00 am to 2.00 pm and from 4.30pm to 6.30pm, to discuss the midway tunnelling point and relocation of the Cintra Park hockey facilities to St Lukes Park. Project team members were available to answer questions and discuss the plans with the community. A total of 47 people attended the information sessions.	8 May 2015
Stakeholder meetings and briefings	Several meetings were held with City of Canada Bay Council and Briars Hockey Club in 2014 and early 2015 to discuss the potential location of a construction site at Cintra Park. WestConnex Delivery Authority (WDA) offered briefings to users of St Lukes Park including West Juniors Rugby Club, West Harbour Rugby Club, West Tigers, Concord High School and Rosebank College to discuss the project and the new sporting fields and facilities.	Ongoing since late 2014
Preferred design display		
Community update	The M4 East preferred design community update was distributed to more than 105,000 residences and businesses. Copies were also made available at the WestConnex information kiosks at Westfield Burwood, Westfield Parramatta, Westfield Hurstville and Centro Roselands.	June 2015
Email broadcast	An email broadcast was sent to more than 2,600 registered stakeholders outlining the selection of the preferred design and construction contractor to build the project.	4 June 2015
Website update	The project website was updated to include the preferred design community update, frequently asked questions and details of the contract awarded to design and build the project.	4 June 2015
Property acquisition door knock	Project team members carried out door knocks at properties identified for acquisition.	4 June 2015
Property acquisition notification letters	Notification letters and property acquisition information guides were sent to owners following the identification of the preferred design and confirmation of properties required to build the project.	4 June 2015
Phone calls regarding property acquisition	Phone calls were made to property owners identified for acquisition.	4 June 2015
Meetings regarding property acquisition	Following the preferred design announcement, meetings were held with property owners and tenants to discuss the process and timing of property acquisition.	June 2015

Activity	Summary	Date
Door knocking	A program of door knocking at nearby residential properties was carried out around the portal locations in Homebush, around Cintra Park, Concord, Haberfield, Ashfield and along the tunnel alignment in Croydon. The purpose of this program of door knocking was to introduce the place managers from the Leighton−Samsung−John Holland Joint Venture (JSJH JV) team and inform community members about the preferred design and consultation activities. During the door knock residents were also informed about the EIS process and the opportunity to make a formal submission. Residents were encouraged to register their contact details so that they could be informed when the EIS was placed on public exhibition. Nearly 1,000 properties were door knocked during this stage.	July−August 2015
Business consultation	Face to face discussions and phone calls with businesses along the project corridor have been carried out to provide information about the project and discuss any concerns relating to potential impacts of the project.	July 2015
Advertisements	Advertisements were placed inviting community members to attend the drop-in information sessions in July 2015 to discuss the preferred design with members of the project team. Advertisements were placed in the Inner West Courier, Strathfield Scene and Burwood Scene.	July 2015
Email broadcast	An email broadcast was sent to more than 3,000 registered stakeholders, inviting them to the July 2015 community information sessions on the concept design.	10 July 2015
Information sessions	The following sessions were held to provide information and answer questions on the concept design: • 13 July 2015 between 4.00 pm and 7.00 pm, West Ashfield Leagues Club Auditorium, 116 Liverpool Road, Ashfield. The focus of this session was on the Parramatta Road and City West Link Interchange. Attended by 192 people • Two sessions on 15 July 2015, from 1.00 pm to 3.00 pm and from 4.00 pm to 6.00 pm, at Club Burwood RSL Auditorium, Nirranda Street, Concord West. The focus of these sessions was on the Concord Road interchange. Attended by 68 people • 18 July 2015 between 11.00 am and 2.00 pm, at Club Concord RSL Auditorium, Nirranda Street, Concord West. The focus of this session was on the western entry and exit point and tunnel corridor. Attended by 58 people. Project team members including technical specialists attended each session to answer questions, provide more information and capture feedback.	13, 15 and 18 July 2015

Activity	Summary	Date
Burwood kiosk	The WestConnex information kiosk at Westfield Burwood has been open since February 2015 and has been a location where community members could find out information about the project and ask questions. Following the announcement of the preferred design, a project team member from the LSJH JV was available to answer questions on the design on Mondays, Wednesday, Fridays and Saturdays between 10.00 am and 6.00 pm. Since the June 2015 announcement more than 3,100 people have visited the Burwood kiosk.	Ongoing since February 2015

Other ongoing communication and consultation activities

Table 7.4 outlines other communication and consultation activities that have been ongoing during the preparation of the EIS.

Table 7.4 Ongoing communication and consultation activities

Activity	Details
Media announcements	Media announcements, events and briefings have occurred at key project milestones. Media releases and news items have also been regularly released, as well as uploaded onto the project website. Responses to media enquiries have been provided on a daily basis.
WestConnex project website updates	The WestConnex website is regularly updated following major project milestones and as new information has become available. The website also provides details of translation services available in Arabic, Greek, Italian, Korean, Chinese, Vietnamese and Hindi.
Project information line and email address	The 1300 660 248 project information line is managed between 8.30 am and 5.00pm Monday to Friday. As of July 2015, calls made to the WestConnex project information line have been answered by Service NSW 24 hours a day. More technical and detailed project questions are transferred directly to WDA. The project email has been a mechanism for community feedback and project team responses.
'Have your say' online feedback form	The online 'Have your say' form has provided a channel for feedback on specific stages of WestConnex, including the project.
Subscribe to updates	Community members have been invited to register their interest in subscribing to updates via the online form, over the phone or during face to face discussions.
Stakeholder database	A contact and issues database was established to record contacts made, stakeholder contact details, feedback received, issues raised and responses provided.
Letters	Written correspondence has been prepared by the project team to clarify project information and respond to enquiries received directly and via the Minister and Premier's offices.
Email broadcasts	More than 4,330 community members and stakeholders have registered to receive email project updates. In addition to the project milestone broadcasts outlined above, updates have also been provided on the project delivery strategy, tender assessment and technical investigations underway.

Activity	Details
WestConnex information kiosks	A network of WestConnex information kiosks was established in key shopping precincts throughout western and south-western Sydney to provide residents with up to date and accurate information about WestConnex and its component parts. The kiosks, at Westfield Parramatta, Westfield Burwood, Westfield Hurstville and Centro Roselands, are open during regular shopping hours, seven days a week. The kiosks were established in February 2015 and Westfield Burwood, Westfield Hurstville and Centro Roseland kiosks are still operating. More than 26,700 people have visited the kiosks to find out more about the project.
Attendance at New Parramatta Road consultation events	WDA had a two day a week presence at the New Parramatta Road Public Display Office (Suite 6, Level 1, 22 George Street, North Strathfield) during the display of the New Parramatta Road Draft Strategy. WDA also attended two community information sessions, on 31 January at the Granville Town Hall and 7 February 2015 at Ashfield Town Hall. Over 200 community members attended these sessions.
National Translation and Interpreting Service	Details of the translation services available for members of the community who speak languages other than English have been promoted on the WestConnex website and on all communication materials distributed to the community.
WestConnex Assist counselling services	WestConnex has engaged an independent organisation to provide free and confidential counselling services to support members of the community.
Environmental and technical investigation notification and engagement	Activities to notify community members and key stakeholders of environmental and technical investigations have included notification letters, phone calls to property owners and tenants, and door knocking.
Stakeholder meetings and briefings	More than 70 stakeholder meetings and briefings have been held with local state and federal members, resident groups, industry, local businesses, local schools, community groups and pedestrian and cyclists groups. A summary of these meetings is outlined below.
State and Federal Member meetings and briefings	Meetings, briefings and other correspondence with the Federal Member for Reid, Craig Laundy, have been carried out during the preparation of the EIS.
	Meetings, briefings and other correspondence with the State Member for Drummoyne, John Sidoti, have been carried out during the preparation of the EIS to discuss the design, potential impacts and concerns raised by constituents.
	Meetings, briefings and other correspondence with the (former) State Member for Strathfield, Charles Casuscelli, have been carried out during the preparation of the EIS.
	Project briefings, meetings to discuss the air quality assessment, property acquisition process, construction impacts and other correspondence with the State Member for Strathfield, Jodi McKay, have been carried out during the preparation of the EIS.
	A meeting with State Member for Summer Hill, Jo Haylen, was held with a particular focus on the air quality assessment, property acquisition process and construction impacts.
	A project briefing was provided to State Member for Newtown, Jenny Leong, including details on the tender design.

Activity	Details
Industry meetings and briefings	A program of meetings and briefings with industry has been held to provide details on the project and timing for the planning and delivery of each of the WestConnex components. Industry events have been held with the Road Freight Industry Council, NRMA, Infrastructure Partnerships Australia, NSW Freight Advisory Council, Roads Australia, Engineers Australia, Italian Chamber of Commerce Infrastructure Forum, NeTC Tolling Forum, Cement, Concrete and Quarry Industry Forum, Sydney Metropolitan Business Forum Breakfast, Sydney Olympic Park Business Association, Spanish Chamber of Commerce and Sydney Airport Community Forum.
Resident meetings	A meeting with Loftus Street residents was held on 6 December 2013 to discuss the preliminary concept design, answer questions and listen to concerns. Approximately 10 residents attended the meeting.
	A meeting with Homebush West residents was held on 9 February 2014 to discuss the preliminary concept design, answer questions and listen to concerns. Approximately 12 residents attended the meeting.
	A site meeting was held with Concord residents around Franklyn Street on 30 January 2014 to discuss the preliminary concept design, answer questions and listen to concerns. Approximately 25 residents attended the meeting.
	A resident meeting coordinated by Strathfield MP Jodi McKay and Burwood Councillor Lesley Furneaux-Cook was held in Centenary Park, Croydon on 18 July 2015, with project team members and approximately 30 residents. The purpose of this meeting was to discuss concerns relating to the tunnel alignment and tunnel impacts including noise and vibration.
	A meeting with Taylor Street residents was held on 20 July 2015 to discuss the tender design and location of the mid tunnelling site. Eleven residents attended the meeting.
	Ashfield Council hosted potentially affected property owners and tenants at a meeting regarding the acquisition process on 29 July 2015. Representatives from WDA were invited to attend and answer questions. Council's solicitor provided an overview of the RMS acquisition process and answered questions from the community. The meeting was independently facilitated and was attended by approximately 40 community members, the Mayor and Councillors as well as key Council staff including the General Manager. WDA representatives answered questions relating to the project's development.
	A resident meeting coordinated by Strathfield MP Jodi McKay was held on 22 August and approximately 30 residents attended. The purpose of the meeting was to provide information and answer questions relating to tunnel alignment, property acquisition (surface and sub-stratum), property values, effects of tunnelling on properties, noise and vibration during construction, air quality and ventilation outlets, filtration, design development, EIS process and project approval process.
Community, business, interest and user group briefings and meetings	Project briefings have been held with Strathfield Rotary Club during the preparation of the EIS, on 12 February 2014 and 29 April 2015. Following these briefings questions were answered by WDA.
	A briefing was held for Five Dock Rotary Club members on 4 May 2015 to provide information on the project and answer questions.
	A combined briefing was provided to the Burwood Business Chamber, Strathfield Chamber of Commerce and Croydon Park Business Chamber on 31 March 2015 to provide an update on the project and answer questions.

Activity	Details
	A project briefing was provided to the Haberfield Public School School/P&C joint executive meeting on 19 June 2015. The main discussion topics included air quality, road safety and construction impacts.
	A briefing with Yasmar Training Facility was held to provide an update on the project and answer questions on 1 July 2015. Main discussion topics included access to public transport, impacts on local trainee accommodation and pedestrian access.
	A briefing with Willows Private Nursing Home was held on 1 July 2015 to provide an update on the project and answer questions. Main discussion topics included construction impacts, construction timeframes and access to public transport.
	A meeting with Ashfield Bowling Club was held on 1 July 2015 to provide a briefing on the proposed works along Parramatta Road, discuss concerns and answer questions.
	A briefing with the Presbyterian Aged Care facility was held on 2 July 2015 to provide a project update and answer questions. Main topics discussed included potential construction impacts.
	A briefing with Jehovah's Witnesses Kingdom Hall was held on 7 July 2015 to provide an update on the project, discuss access and answer questions.
	A meeting with the CEO, board members and other senior staff and advisors of the Infants Home at Haberfield was held on 8 July 2015 to provide a project overview, briefing on air quality and answer questions. An additional meeting was held on 21 August 2015 with a member of the board that was unable to attend the previous meeting. Information relating to the projects development, EIS process and air quality was provided.
	A briefing with St Anthony's Family Care at 9 Alexandra Avenue, Croydon was held on 3 August 2015 to introduce the team and provide an overview of the project.
	A meeting with Rosebank College was held on 6 August 2015 to provide a project update, discuss the concept design and answer questions. Topics discussed included the changes to St Lukes Park and moving the existing hockey field, impacts on air quality, traffic on Parramatta Road, heavy vehicle movements, public transport considerations and the EIS submissions process.
	A briefing with St Marys Catholic Primary School was held on 5 August 2015 to discuss the concept design and potential impacts of the project. Topics discussed included potential impacts of vibration from tunnelling on their older buildings, impacts from heavy vehicles, pedestrian safety, access to school drop off and pick up areas.
	A briefing with McDonald College was held on 9 August 2015 to discuss the project and the upcoming EIS exhibition period.
	A briefing with St Josephs Maronite Catholic Church in Acton Street, Croydon was held on 5 August 2015 to provide an overview of the project.
Bicycle and pedestrian user groups meetings and briefings	A meeting with the Pedestrian Council of Australia was held on 6 August 2015 to provide a briefing on the project with a focus on pedestrian activities along the corridor. Discussed pedestrian crossings at various locations and footpath standards.

Activity	Details
	A briefing with Canada Bay Bicycle User Group (BayBUG) was held on 6 August 2015 to discuss the design. Topics discussed included north–south access across the project corridor, standards of new bicycle and footpaths, signage and a discussion around future bike paths and connections.
	A briefing with Ashfield Bicycle User Group (AshBUG) was held on 10 August 2015 to discuss the design. Topics discussed included important bike routes in the area, request for widened footways to accommodate shared paths, consideration of cycle priority measures to be installed and other access and connectivity requests.
	A briefing with Bicycle NSW was held on 11 August 2015 to discuss the design. Topics discussed included the importance of engagement with local bicycle user groups, concerns about existing bicycle facilities and requests for the project to provide improved connections and facilities for cyclists not just maintain existing conditions. The briefing also discussed strategic cycle routes in the project area and requested clearer project drawings of how the cycle paths between the M4 Widening and the project will integrate.
	A briefing with Bicycle Network was held on 14 August 2015 to discuss the design. Discussed north−south access along the corridor, access through Concord Oval and Cintra Park, impacts on cyclists during construction and the need for clear signage and alternative routes.

More than 37,600 contacts have been made with WDA since September 2013. **Table 7.5** provides an overview of the number and type of contacts received regarding WestConnex over this time.

Table 7.5 Summary of community contacts during the preparation of the EIS

Method of contact	Number of contacts
Project information line	Over 6,000
Email	Over 2,900
Stakeholder meetings and briefings	Over 70
Face to face discussions during community information sessions for the M4 East	Over 960
Door knocking for the M4 East project	Nearly 1,000
Visits to WestConnex kiosks	Over 26,700
TOTAL	Over 37,630

Consultation with local, state and Commonwealth government authorities

Table 7.6 is a summary of the consultation activities undertaken with local, State and Commonwealth government authorities during the development of the EIS. In addition to the meetings outlined in **Table 7.6** regular correspondence via phone calls and emails has taken place.

Table 7.6 Meetings and briefings with local, State and Commonwealth government authorities

Agency	Summary of details
Planning focus meeting with relevant agencies	The planning focus meeting was held on 12 December 2013 with relevant government agencies to provide a briefing and approach to the preparation of the environmental impact statement.
DP&E, EPA, NSW Health and UrbanGrowth NSW	A bus tour of the project corridor was carried out in July 2015 to discuss the preferred design and technical aspects addressed in the EIS.

Agency	Summary of details
Department of Planning and Environment (DP&E)	Regular meetings with DP&E have been held to discuss project timings, EIS development, agency engagement and draft EIS chapters. Specific meetings have also been held with DP&E to discuss: • Traffic and transport modelling, results and mitigation measures • Health impact assessment and proposed mitigation measures • Air quality assessment methodology, modelling results and proposed mitigation • Noise and vibration assessment, modelling results and proposed mitigation.
Environment Protection Authority	Meetings and briefings with EPA have been held during the development of the EIS to present the proposed air quality assessment methodology, health impact assessment methodology and proposed mitigation measures.
Office of Environment and Heritage	Meetings with OEH officers, including from the Heritage Division, have been held to provide project briefings and to discuss the approach to the non-Aboriginal heritage impact assessment and findings.
The Heritage Council of NSW	Meeting held to discuss the findings of the non-Aboriginal heritage impact assessment.
DPI − Water (formerly NSW Office of Water)	Meeting held to provide a project briefing and discuss groundwater impact assessment and groundwater monitoring network.
DPI − Crown Lands	WDA has met with Crown Lands during the development of the project with a focus on potential impacts to Crown Land within the project corridor including Cintra Park.
NSW Health	More than four meetings and briefings with NSW Health, including representatives from the Local Health Districts, have been held to discuss the health impact assessment methodology, air quality assessment methodology, modelling results and mitigation measures proposed. NSW Health also attended a bus tour following the preferred design announcement.
Transport for NSW and UrbanGrowth NSW	Regular meetings between WDA, Transport for NSW and UrbanGrowth have been held to ensure a coordinated approach to workstreams and to discuss project timeframes and interaction with the Parramatta Road Transformation Program.
Roads and Maritime Services	Regular meetings with various RMS divisions have been held during the preparation of the EIS. Discussions have focused on EIS coordination and network performance.
NSW Fire and Rescue	Four meetings have been held with NSW Fire and Rescue to discuss design and safety measures for the project.
Sydney Olympic Park Authority (SOPA)	Meetings were held to provide a briefing on the project. The discussion focused on the proposed cycleway through SOPA land. SOPA were identified in the updated SEARs (issued in June 2015) due to the proposed cycleway through SOPA land.
Auburn Council	Meetings with Auburn Council were held to provide a project briefing and discuss the proposed cycleway through SOPA land. Auburn Council was identified in the updated SEARs (issued in June 2015) due to the proposed cycleway entering their local government area (LGA).

Agency	Summary of details
Strathfield Municipal Council	Regular meetings with Strathfield Municipal Council have been held throughout the development of the project and EIS to provide updates on design. Other topics discussed have included acquisition of property including Council owned land, air quality assessment and proposed location of ventilation outlets within the LGA, construction impacts and technical investigations. In addition to meetings with Council's General Manager and Directors, WDA has also provided briefings on the project to Councillors.
Burwood Council	Meetings and briefings with Burwood Council's General Manager, Directors and senior officers have been held to provide updates on the project, discuss the design, potential impacts and technical investigations.
City of Canada Bay Council	Meetings and briefings with Councillors and Council staff including the General Manager and Directors have been held to discuss the design and provide updates on the project at regular intervals. Meetings have also been held to discuss air quality monitoring stations and assessment, impacts on Council owned land, the mid-tunnel site at Cintra Park, technical investigations and construction impacts.
Ashfield City Council	Meetings and briefings with Councillors and Council staff including the General Manager and Directors have been held to discuss the project design and provide updates on the delivery strategy, air quality monitoring and assessment, property acquisition, impacts on Council owned land, technical investigations, location of project infrastructure, heritage impacts, construction impacts, traffic and local road impacts. WDA also attended a public meeting hosted by Council in December 2013 following the release of the preliminary concept design to answer questions. This event was attended by more than 400 people. WDA also attended a meeting hosted by Council in July 2015 to discuss property acquisition and answer questions. This meeting was attended by more than 40 people. WDA attended a Council meeting on 17 August 2015 to provide Councillors, Council staff and 20 community members with a project overview and answer questions. Concerns raised included future use of residual land, haulage routes, local road impacts, traffic congestion, construction impacts, heritage impacts, air quality, environmental impacts, property acquisition, project development and justification and Council land acquisition.
Marrickville Council	WDA has met with Marrickville Council officers including the General Manager to provide a briefing on the project.

Consultation with utility and service providers

Consultation with utility and service providers has been carried out to discuss potential impacts on utility supply, adjustments and project timing. The EIS assesses the impacts on providing services to the construction and operation phases of the project. The relocation of existing services does not form part of the EIS. **Table 7.7** below provides a summary of the consultation with utilities and service providers.

Table 7.7 Consultation with utility and service providers

Stakeholder	Issues and project requirements discussed
Ausgrid	• Met with Ausgrid and described the project, its timing and potential impacts on utilities; and identified Ausgrid's concerns and processes for relocating transmission, distribution and overhead services and for power during construction • During the tender development process, collated tenderers' questions and liaised with Ausgrid to provide a coordinated response to each tenderer • Identified essential infrastructure locations • Continuing to meet with Ausgrid to refine the partial acquisition of Ausgrid land at the intersection of Homebush Bay Drive and the M4 • Confirmed that local substations have the required capacity to supply the construction sites without affecting the local supply network.
Sydney Trains	• Met with Sydney Trains and described the project, its timing and location of tunnels under the Northern Line; and identified Sydney Train's concerns and process for developing an Interface Agreement.
Jemena	• Met with Jemena and described the project, its timing and, potential impacts on utilities; and identified Jemena's concerns and processes for relocating high and low pressure gas services • During the tender development process, collated tenderers' questions and liaised with Jemena to provide a coordinated response to each tenderer.
NBNCo	• Met with NBNCo and described the project, its timing and potential impacts on utilities; and identified NBNCo's concerns and processes for relocating services • During the tender development process, collated tenderers' questions and liaised with NBNCo to provide a coordinated response to each tenderer.
Sydney Water Corporation	• Met with Sydney Water and described the project, its timing and potential impacts on water supply, sewer and stormwater assets; and identified Sydney Water's concerns and processes for relocating services • During the tender development process, collated tenderers' questions and liaised with SWC to provide a coordinated response to each tenderer.
Telstra	• Met with Telstra and described the project, its timing and potential impacts on utilities; and identified Telstra's concerns and processes for relocating services • During the tender development process, collated tenderers' questions and liaised with Telstra to provide a coordinated response to each tenderer.
Nextgen	• Contacted Nextgen and described the project, its timing and potential impacts on utilities; and identified Nextgen's concerns and processes for relocating services • During the tender development process, collated tenderers' questions and liaised with Nextgen to provide a coordinated response to each tenderer.
Optus	• Met with Optus and described the project, its timing and potential impacts on utilities; and identified Optus' concerns and processes for relocating services • During the tender development process, collated tenderers' questions and liaised with Optus to provide a coordinated response to each tenderer.
Powertel	• Contacted Powertel and described the project, its timing and potential impacts on utilities; and identified Powertel's concerns and processes for relocating services • During the tender development process, collated tenderers' questions and liaised with Powertel to provide a coordinated response to each tenderer.
UEComm	• Contacted UEComm and described the project, its timing and potential impacts on utilities; and identified UEComm's concerns and processes for relocating services • During the tender development process, collated tenderers' questions and liaised with UEComm to provide a coordinated response to each tenderer.

Stakeholder	Issues and project requirements discussed
Visionstream	• Contacted Visionstream and described the M4 East Project, its timing, potential impacts on utilities; and identified Visionstream's concerns and processes for relocating services • During the tender development process, collated tenderers' questions and liaised with Visionstream to provide a coordinated response to each tenderer.
Vocus	• Contacted Vocus and described the project, its timing and potential impacts on utilities; and identified Vocus' concerns and processes for relocating services • During the tender development process, collated tenderers' questions and liaised with Vocus to provide a coordinated response to each tenderer.

7.3.3 Aboriginal cultural heritage consultation

Aboriginal cultural heritage consultation has been carried out in accordance with the Procedure for Aboriginal Cultural Heritage Consultation and Investigation (PACHI) (Roads and Maritime 2011c). A site survey along the project route was held on 8 and 9 April 2015 with members of the Metropolitan Local Aboriginal Land Council. No items of significance and no specific issues were raised by these representatives.

Chapter 22 (Aboriginal heritage) provides further information relating to Aboriginal heritage.

7.4 Summary of issues raised

Issues raised by government agencies, local government and the community have been recorded and considered during the preparation of the EIS and throughout the development of the project. **Table 7.8**, **Table 7.9** and **Table 7.10** list the issues according to these broad stakeholder groups and indicate where these issues have been addressed in this document.

7.4.1 Issues raised by government agencies

Table 7.8 summarises the issues raised by government agencies during the preparation of the EIS and provides a response to these issues or indicates where in the EIS this issue has been addressed.

Table 7.8 Issues raised by government agencies

Issue	Details	Response
DPI – Water (NSW Office of Water)		
Assessment process	• Relevant policies and guidelines to be taken into account: - Guidelines for Controlled Activities on Waterfront Land (2012) - Aquifer Interference Policy (2012) - NSW State Groundwater Policy Framework Document (1997) - NSW State Groundwater Quality Protection Policy (1998) - NSW State Groundwater Dependent Ecosystems Policy (2002) - Department of Primary Industries Risk Assessment Guidelines for Groundwater Dependent Ecosystems (2012) - NSW Water Extraction Monitoring Policy (2007) - Australian Groundwater Monitoring Guidelines (2012)	**Chapter 2** (Assessment process) Methodology section of **Chapter 8** through to **Chapter 28**
Groundwater assessment	Assess the impact of the project on all groundwater sources	**Section 18.3** **Section 18.4**
	Where potential impacts are identified, identify limits to the level of impact and contingency measures, including proposed monitoring programs	**Section 18.5**

Issue	Details	Response
Groundwater dependent ecosystems	Identify potential impacts on groundwater dependent ecosystems as a result of the project	**Section 18.4.4**
	Provide safeguard measures for any groundwater dependent ecosystems	**Section 18.4.4**
Licensing considerations	Identify water requirements for the life of the project, and provide details of surface water and groundwater supply sources	**Section 23.3** **Section 23.4**
	Consider water allocation account management rules, total daily extraction limits, and rules governing environmental protection and access licence dealings	**Section 15.1** **Section 18.1** **Section 18.5**
Legislation	Take into account the objectives and requirements of the *Water Act 1912* and *Water Management Act 2000* (WM Act) as applicable, in particular section 3 and section 5 of the WM Act	**Section 15.1** **Section 18.1**
Water sharing plans	Demonstrate how the project is consistent with the relevant rules of the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011 and the Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011, including rules for access licences	**Section 18.1** **Section 18.4** Sections 4 and 6 of **Appendix R**
	Provide a description of site water use and management, including a detailed and consolidated site water balance	**Section 6.10** **Appendix R**
Watercourses and riparian land	Consider the NSW Office of Water Guidelines for Controlled Activities on Waterfront Land (2012)	**Section 15.1.2**
	Provide details of all watercourses potentially affected by the project	**Section 15.2.2** **Section 17.2**
	Address the potential impacts of the project on all watercourses likely to be affected, existing riparian vegetation and the rehabilitation of riparian land	**Section 15.3.2** **Section 15.4.2** **Section 20.3.1**
DPI – Crown Lands		
Crown land impacts	Clearly identify impacts on all Crown land including Crown road and waterway areas and the extent of those impacts	**Section 12.3**
	Crown Lands has an application process associated with compulsory acquisition of Crown land	**Section 2.3.1** **Section 12.3**
EPA		
Acid sulfate soils	Assess the potential impacts of the project on acid sulfate soils in accordance with the *Acid Sulfate Soils Manual* (Stone et al. 1998) and the *Acid Sulfate Soils Laboratory Methods Guidelines* (Ahern et al. 2004)	**Sections 16.4** **Section 16.5**
	Describe management options that will be used to prevent, control, abate or minimise potential impacts from the disturbance of acid sulfate soils	**Section 16.6**
Air quality	Include a detailed air quality impact assessment	**Chapter 9** (Air quality) **Appendix H**
	Assess the risk associated with potential discharges of fugitive and point source emissions for all stages of the project	**Section 9.6** **Section 9.7**
	Describe the receiving environment in detail (local, regional and inter-regional as appropriate)	**Section 9.5**
	Consider worst case emission scenarios and impacts at proposed emission limits and points, including emergency and abnormal activities	**Section 9.6** **Section 9.7**

Issue	Details	Response
	Account for cumulative impacts	**Section 9.8**
	Include air dispersion modelling, conducted in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (2005). Modelling scenarios should be discussed with relevant agencies	**Section 9.2**
	Demonstrate ability to comply with the *Protection of the Environment Operations Act 1997* (NSW) (POEO Act) and the Protection of the Environment Operations (Clean Air) Regulation 2010 (NSW)	**Appendix H**
	Assess the project in terms of the priorities and targets adopted under the *NSW State Plan* (2010) and *Action for Air* (2009)	**Section 3.1**
	Detail emission control techniques and practices that will be employed	**Section 9.9**
	Conduct a qualitative construction air quality impact assessment if managing spoil underground and/or within sheds on the surface. A quantitative construction air quality impact assessment is required if there is substantial handling of spoil on the surface and not inside sheds	**Section 9.6**
Contaminated sites assessment and remediation	Assess contaminated sites in accordance with: • Contaminated Land Management Act 1997 (NSW) • Guidelines for Consultants Reporting on Contaminated Sites (EPA 2000) • Guidelines for the NSW Site Auditor Scheme – 2nd edition (DEC 2006) • Sampling Design Guidelines (EPA 1995) • National Environment Protection (Assessment of Site Contamination) Measure 1999 (or update)	**Section 16.1**
	Provide details on how site contamination will be remediated and/or managed so that the site is suitable for the proposed use	**Section 16.6**
Greenhouse gas	Include a comprehensive assessment of the project's predicted greenhouse gas emissions (tCO_2e)	**Chapter 21** (Greenhouse Gas)
	Emissions should be estimated using an appropriate methodology in accordance with NSW, Australian and international guidelines, and broken down as: • Direct emissions (Scope 1) • Indirect emissions from electricity (Scope 2) • Upstream and downstream emissions (Scope 3)	**Section 21.1**
	Emissions should be reported before and after implementation of the project, including annual emissions for construction, operation and decommissioning	**Section 21.2** **Section 21.3** **Section 21.4** **Section 21.5**
	Evaluate and report on the feasibility of measures to reduce greenhouse gas emissions associated with the project	**Section 21.6**
Licensing requirements	It appears the project will require an Environment Protection Licence if approval is granted	**Section 2.3.1**
	Address the requirements of section 45 of the POEO Act determining the extent of each impact	This EIS
Noise and vibration	Assess construction noise using the *Interim Construction Noise Guideline* (DECC 2009)	**Section 10.4**

Issue	Details	Response
	Vibration from all activities (including construction and operation) should be assessed using *Assessing Vibration: a technical guideline* (DEC 2006)	**Section 10.1.4** **Section 10.4**
	If blasting is required during construction or operation, demonstrate that blast impacts are capable of complying with the Australian and New Zealand Environment Council's *Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration* (ANZEC 1990)	**Section 10.4**
	Assess noise and vibration from ventilation stacks, and describe mitigation and management measures that will be used to prevent or minimise potential impacts	**Section 10.5** **Section 10.7**
	Assess operational noise from all industrial activities (including private haul roads and private rail lines) using the NSW Industrial Noise Policy (EPA 2000)	**Section 10.5**
	Assess noise on public roads from increased road traffic using the *Environmental Criteria for Road Traffic Noise* (EPA 1999)	**Sections 10.4** **Section 10.5**
	Assess noise from new or upgraded roads using the *Environmental Criteria for Road Traffic Noise* (EPA 1999)	**Section 10.5**
Soils	Assess potential impacts on soil and land resources, being guided by *Soil and Landscape Issues in Environmental Impact Assessment* (DLWC 2000)	**Section 15.1.2**
	Identify the nature and extent of any significant impacts, giving particular attention to: • Soil erosion and sediment transport • Mass movement (landslides) • Urban and regional salinity	**Section 15.3.1** **Section 15.4.1** **Section 18.3.2** **Section 18.3.3** **Section 15.4.3**
	Describe the management options that will be used to prevent, control, abate or minimise identified soil and land resource impacts	**Section 15.5** **Section 18.5**
Waste	Identify, characterise and classify all waste for reuse, recycling or disposal in accordance with the EPA's *Waste Classification Guidelines* (EPA 2014), including proposed quantities and disposal locations	**Chapter 23** (Resource use and waste minimisation)
	Include a detailed plan for in situ classification of waste material	**Section 23.3.2**
	Provide details of how waste will be handled and managed onsite to minimise pollution, including: • Stockpile location and management • Erosion, sediment and leachate control	**Section 23.5**
	Provide details of how waste will be handled and managed during transport. If the waste possesses hazardous characteristics, provide details of how the waste will be treated or immobilised to render it suitable for transport and disposal	**Section 25.1** **Section 25.2**
	Include details of all procedures and protocols to ensure that any waste leaving the site is transported and disposed of lawfully and does not pose a risk to human health or the environment	**Section 25.1** **Section 25.2**
Water	Describe the position of any intakes and discharges, volumes, water quality and frequency of water discharges, and demonstrate that all practical options to avoid discharges have been implemented	**Section 5.8.3** **Section 5.10.2** **Section 6.10** **Chapter 15** (Soils and water quality)

Issue	Details	Response
	Describe existing surface and groundwater quality, and assess any water resource likely to be affected by the project	**Section 15.2** **Section 18.2**
	Describe the nature and degree of impact that any proposed discharges may have on the receiving environment	**Section 15.3** **Section 15.4** **Section 18.3** **Section 18.4**
	Assess impacts against the relevant ambient water quality outcomes, and demonstrate how the project will be designed and operated to meet water quality objectives	**Section 15.3** **Section 15.4** **Section 18.3** **Section 18.4**
	Assess impacts on groundwater and groundwater dependent ecosystems	**Section 18.3** **Section 18.4**
	Describe how stormwater will be managed both during and after construction	**Section 17.5**
	Describe how predicted impacts will be monitored	**Section 15,1** **Section 15.5** **Section 18.5**
Heritage Council of NSW		
Further assessments	Identify through field survey any buildings, works, relics, gardens, landscapes, views, trees or places of non-Aboriginal heritage significance	**Section 22.3**
	Undertake a statement of significance and an assessment of the impact of the project on the heritage significance of these items, in accordance with the *NSW Heritage Manual*	**Section 19.3**
General heritage impacts	Avoid and minimise demolition and significant impacts on heritage items, conservation areas and historic buildings, structures, landscape and public domain elements	**Section 4.4** **Section 4.5**
	Incorporate the urban design policies set out in *Beyond the Pavement* (RMS 2014) and the *Landscaping Guideline* (RTA 2008)	**Chapter 13** (Urban design and visual amenity) **Appendix L**
	Where portals, acoustic walls and new roads will adjoin heritage properties, provide appropriate materials, treatments and finishes to minimise impact and complement heritage areas	**Appendix S** (non-Aboriginal heritage)
	Conduct relevant assessments to ensure that vibration, excavation and works will not cause any damage or structural issues to nearby heritage items	**Section 11.4**
Impacts on archaeology	Carry out appropriate archaeological assessments, having regard to any applicable archaeological zoning plans and archaeological management plans	**Chapter 19** (Non-Aboriginal heritage)
	Include future mitigation strategies for all identified archaeological impacts	**Section 19.4**
	Include detail on the use of Concord Oval as a construction site and potential impacts on archaeology associated with the 1838–1843 Longbottom Stockade	**Section 19.3**
Impact on Ashfield Park, local heritage	Undertake further route assessment to avoid impacts on the park. Document and assess all tunnel entry options in the vicinity of Ashfield Park	**Chapter 4** (Project development and alternatives) **Section 19.3**

Issue	Details	Response
item possibly of State significance	If Ashfield Park is affected, provide a detailed heritage assessment of all affected landscape elements. Provide photomontages with views to and from the park. The formal axis and plantings must be reinstated	**Chapter 4** (Project development and alternatives)
Impact on Yasmar, State Heritage Register item	The route and location of exit portals should be deviated to avoid any physical or visual impact on the significant landscape setting including the formal entry gates and mature Moreton Bay figs	**Chapter 4** (Project development and alternatives) **Section 19.3**
	Undertake an assessment of significance, including an assessment of all affected landscape elements, in accordance with the policies in the Conservation Management Plan for Yasmar (prepared by Godden Mackay Logan) along with any other relevant policy documents for Yasmar	**Section 19.2**
	If Yasmar is affected, document all alternative route options and justify the preferred route with measures to mitigate and manage impacts. It is expected that the significant landscape setting at the front of Yasmar would be reinstated, and transplanting of the figs would be investigated	**Section 19.3**
	If a ventilation outlet is required, consider location away from Yasmar and integration with other buildings or structures to minimise visual impact. If portal emissions are proposed, consider design and heritage impacts in conjunction with operational requirements	**Chapter 4** (Project development and alternatives)
NSW Health		
Air quality – general	Provide a comprehensive assessment of the human health risks associated with the tunnel's impact on local and regional air quality during construction and operation	**Chapter 11** (Human Health)
	Address both incremental changes in exposure from existing background levels and cumulative impacts	**Section 11.3** **Section 11.4**
Air quality impacts during construction	Describe potential emissions sources during construction	**Section 9.6**
	Consider all feasible mitigation measures	**Section 9.9**
Air quality impacts during operation	Provide a detailed description of the location, configuration and design of all emissions sources including ventilation stack(s) and tunnel portals	**Section 5.6**
	Model emissions for the range of potential ventilation scenarios and for a range of traffic conditions, accounting for the range of expected climatic conditions	**Section 9.2**
	Consider all feasible mitigation measures in addition to stack ventilation, such as filtration, and provide a rational for inclusion or exclusion of these measures	**Section 9.9**
	Assess in-tunnel air quality and the human health effects of potential exposure scenarios for vehicle occupants and motorcyclists using the tunnel	**Section 9.7**
	Assess the impact of operation of the tunnel on regional air quality	**Section 9.7**
Noise and vibration	Consider sleep disturbance	**Section 10.4**
Traffic and transport	Consider opportunities to integrate cycleway and pedestrian elements with surrounding networks, to preserve and enhance opportunities for physical activity for commuters and residents	**Section 5.9.2**

Issue	Details	Response
Office of Environment and Heritage (OEH)		
Aboriginal heritage	Address Aboriginal heritage in accordance with the Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (2005)	**Chapter 22** (Aboriginal heritage)
	Avoid impacts on Aboriginal cultural heritage where possible. Where this is not possible, explore mitigation strategies in consultation with Aboriginal stakeholders	**Section 22.4**
Biodiversity	Address the impacts on flora and fauna in accordance with OEH's *Threatened Species Survey and Assessment Guidelines*	**Chapter 20** (Biodiversity)
	Include consideration of potential indirect impacts on the Grey-headed Flying-fox camp at Duck River	**Section 20.3**
	Detail steps taken to mitigate or offset identified impacts	**Section 20.6**
Floodplain management	Prepare a hydrology and hydraulic assessment for mainstream and overland flow paths associated with major drainage sub-catchments including Powells Creek, Hen and Chicken Bay, and Dobroyd Canal (Iron Cover Creek)	**Chapter 17** (Flooding and drainage)
	Consider locating tunnel openings outside flood prone land taking into account both mainstream flooding and local overland flow paths	**Chapter 17** (Flooding and drainage) **Section 4.4**
	Address flooding behaviour for existing and developed conditions for the full range of flood sizes up to and including the probable maximum flood (PMF) in both construction and operational phases	**Chapter 17** (Flooding and drainage)
	Include a sensitivity analysis to determine the potential impacts from climate change on flooding behaviour	**Section 17.4**
	Identify appropriate mitigation measures to offset potential flood risk arising from the project, including temporary mitigation measures during construction	**Section 17.5**
	Assess the impacts of potential stockpile areas on flood behaviour and the surrounding environment	**Section 17.3**
Sydney Olympic Park Authority (SOPA)		
Active transport	Concerns about potential conflicts and safety with the proposed cycleway being diverted through the bus tunnel under Homebush Bay Drive. Concerns about the width of the tunnel being able to accommodate buses and a cycling lane	This would be resolved during detailed design. A description of the proposed cycleway is located in **Chapter 5** (Project description)
	Consider adequate lighting, flooding and appropriate gradients of the cycle path	This would be resolved during detailed design. A description of the proposed cycleway is located in **Chapter 5** (Project description)
	Request for more detail on the design of the cycleway including widths, pedestrian use, directional flows, surface types, edge treatments and signage	This would be resolved during detailed design. A description of the proposed cycleway is located in **Chapter 5** (Project description)
	On event days, vehicles can exit Car Park 4 (P4) directly onto the M4 off-ramp (westbound to Homebush Bay Drive). Concern about a conflict with the cycle path near the south-east corner of the car park.	Consultation with SOPA would occur to determine how this potential conflict would be managed.

Issue	Details	Response
	Consult further on the cycle path across SOPA land.	Noted. Consultation would occur during detailed design.

7.4.2 Issues raised by local government

Table 7.9 is a summary of the issues raised by local government during the preparation of the EIS and provides a response to these issues or indicates where in the EIS this issue has been addressed.

Table 7.9 Issues raised by local government

Issue	Details	Response
Auburn Council		
Active transport	Consideration to be given to alternative cycle connections along the corridor	**Section 5.9**
Strathfield Municipal Council		
Air quality	Assess and mitigate air quality and air pollution impacts from additional vehicles on surface roads and tunnels and details on the type, number, location and effectiveness of the ventilation stacks	**Chapter 9** (Air quality)
	Clarify the location of the tunnel ventilation outlets and assess and mitigate adverse impact on air quality and visual amenity. Consider potential locations away from residential areas	**Section 5.6** **Section 9.9**
	Opposition to location of the Homebush ventilation outlet and concern about the lack of filtration	**Section 9.10**
	Detail the environmental impact of the Homebush ventilation outlet	**Section 9.7**
Construction	Address dust, noise and construction traffic impacts	**Section 9.6** **Section 10.4** **Section 8.3**
	Detail proposed construction works and haulage routes	**Section 6.9**
Economic	Assess the impact of toll costs on local residents	**Chapter 14** (Social and economic)
Environment	Assess and mitigate drainage and flooding impacts of any construction or earthworks near Powells Creek catchment	**Section 17.3** **Section 17.5**
	Council raised contamination issues at Powells Creek and emphasised the importance of rigorous safety procedures when carrying out geotechnical work on this site	Any geotechnical investigations to be undertaken in line with the required safety requirements. Discussion of this contaminated site is in **Chapter 16** (Contamination)
	Minimise loss of tree canopy and impact on habitat for threatened species of plants and animals, and maximise the use of vegetation to minimise the visual impacts on surrounding land uses	**Chapter 13** (Urban design and visual amenity)
Heritage	Undertake a heritage impact assessment to safeguard and protect heritage items	**Chapter 19** (Non-Aboriginal heritage) **Chapter 22** (Aboriginal heritage)

Issue	Details	Response
Noise and vibration	Assess and mitigate noise and vibration impacts from increased traffic noise at tunnel entry/exit points and along regional and local roads	**Section 10.7**
Property	Address the impact on property values of properties adjacent to project infrastructure including construction compounds, ventilation outlets and ramps	Property values are determined by a range of factors which are not limited to the project.
	Address the impact on amenity of nearby residents	**Section 14.3** **Section 14.4**
	Concern about the acquisition of Council owned land including important community green open space	Two council properties would be impacted by the project. These impacts are discussed in **Chapter 14** (Social and economic)
	Consider open space be added to other areas in Strathfield to offset the loss of open space	The project would only result in permanent impacts on a small area of Arnotts Reserve. All other land required during construction would be returned to Strathfield Council. The project would result in areas of residual land following construction. The exact use of this land has not be determined and would be considered by Roads and Maritime. This could potentially include the inclusion of additional open space.
	Where land is acquired for construction purposes without a permanent requirement, land to be used for community use after completion of construction	**Section 14.6**
Traffic and transport	Assess and manage the impact on traffic congestion caused by the time difference between completion of M4 Widening and the project	**Chapter 8** (Traffic and transport)
	Assess and mitigate impact on local and regional roads	**Chapter 8** (Traffic and transport)
	Address north–south congestion along the Parramatta Road corridor, particularly along routes such as Leicester Avenue, Subway Lane, Bridge Road, Underwood Road and the intersection of Arthur Street and Centenary Drive	**Section 8.3** **Section 8.4**
	Maintain access for residents and commercial operations including pedestrian, cycle or local vehicle access	**Section 6.6** **Section 8.6**
	Assess and mitigate the impact of changes in traffic movements and congestion from drivers trying to avoid tolls	**Chapter 8** (Traffic and transport) **Appendix D**
	Investment in public transport including support for the Parramatta to Strathfield light rail project to improve transport amenity for Strathfield LGA residents	**Section 3.1**

Issue	Details	Response
Urban design	Assess and mitigate urban design and visual impacts of the motorway and associated infrastructure	**Chapter 13** (Urban design and visual amenity)
	Assess and mitigate the impact of the M4 on the character of the area, particularly surrounding the tunnel entry/exit points	**Chapter 13** (Urban design and visual amenity)
Burwood Council		
Construction and operation impacts	Manage potential adverse impacts of the construction and operation stages of the project, including noise and vibration, construction traffic and heritage impacts	**Chapter 6** through to **28**
Heritage	Avoid adverse impacts on the rich heritage of the area including Mosely and Roberts Street Conservation Area, Phillip Street Conservation Area, and Wychbury and Alexandra Avenue Conservation Area, and ensure that the existing setting is maintained	**Chapter 13** (Urban design and visual amenity) **Chapter 19** (Non-Aboriginal Heritage)
Process	Assess impact if tolls force trucks back onto Parramatta Road	**Chapter 8** (Traffic and transport) **Appendix D**
Socio economic	Properties identified for acquisition should be negotiated with those residents affected, and adequate consultation and compensation provided	**Chapter 14** (Social and economic)
	Clarify extent of land acquisition along the corridor	**Chapter 14** (Social and economic) **Chapter 12** (Land use and property)
Traffic and transport	Assess and mitigate the traffic impact on the local road network in the Burwood LGA	**Chapter 8** (Traffic and transport)
	Consider impact on Shaftesbury and Wentworth Roads, which will play a vital role in the future in diverting high traffic volumes from Burwood Road	**Section 8.3** **Section 8.4**
	Council would like to ensure there is less motor vehicle traffic along Burwood Road but would encourage more buses	**Section 8.3** **Section 8.4**
	The WestConnex project should not impede on current initiatives including the implementation of the 40 km/h zone in the Burwood Town Centre	**Section 8.3** **Section 8.4**
	Opportunities for improving public transport for residents should have greatest priority	**Section 4.2**
Urban renewal	Council must have planning powers or at least a significant voice in any redevelopment affecting on its residents	Beyond the scope of this EIS
	Council would not like the WestConnex project to significantly change the provisions contained within the Burwood Local Environmental Plan and the Burwood Development Control Plan	The WestConnex project would not significantly change the provisions of the Burwood Local Environmental Plan or the Burwood Development Control Plan.
	Any higher density development along Parramatta Road should consider potential impacts of overshadowing and overlooking, amenity impacts and any other adverse impacts on the low rise residences adjacent	The project does not include any redevelopment on Parramatta Road.

Issue	Details	Response
	The development of the Parramatta Road corridor must consider integration with the Burwood major centre to ensure consistency of high quality outcomes in the application of zones and development standards	The project does not include any redevelopment of the Parramatta Road corridor.
City of Canada Bay Council		
Air quality	Utilise 'world's best practice' in the treatment of any emissions from the tunnel	**Section 9.9**
Construction	Opposed to the use of Concord Oval for any purpose related to WestConnex	**Chapter 4** (Project development and alternatives)
	Greenspace links through Council's current recreational areas are important to the community and should not be overwhelmed	**Section 14.3.5**
	Impact of truck movements on local roads and in residential streets	**Section 8.3**
Noise	Utilise 'world's best practice' in noise abatement measures	**Chapter 10** (Noise and vibration)
Social	WDA to assist with reconnecting communities with services	**Section 14.6**
	Legacy opportunities to consider include provision of new sporting facilities, water harvesting for the use in Council's water treatment plant and oval, and prefabricated construction sheds that could be reused for other facilities such as netball/basketball courts	As part of WestConnex the Cintra Park hockey field would be relocated to allow the site to be used during construction. Further legacy opportunities would be considered during detailed design.
Traffic and transport	Provide access from residential areas to Parramatta Road on an even basis, eliminating unacceptable delays at Burwood Road, Burton Street and around Crane Street	**Section 8.3** **Section 8.4**
	Opportunity to improve the frequency and connectedness of the public transport system	**Section 4.2**
	Construct light rail along Parramatta Road from Concord to link with the existing Inner West Light Rail	**Section 4.2**
	Bus operations: • Improve routes from Abbotsford and Mortlake to the CBD • Extend the M50 route from the current Drummoyne terminus to Concord Hospital to link with the M41 service • Improve services from Burwood Station to the north across Parramatta Road and to better link with Rhodes and Macquarie Park	**Section 4.2**
	WestConnex to assist with the immediate improvement to the east–west bicycle link along Queens Road and Patterson Street	**Section 5.9.2**
	Impacts on property access and local road network	**Section 5.11** **Section 6.6** **Section 8.3** **Section 8.4**

Issue	Details	Response
Ashfield City Council		
Air quality	Assess and mitigate impact from tunnel portal emissions and ventilation outlets	**Chapter 9** (Air quality)
	Apply best practice filtration system for the tunnel ventilation outlet	**Section 9.9**
	Concern about the Haberfield ventilation outlet dispersing emissions from this project and the M4−M5 Link project	**Section 9.8**
	Confirm the height of the ventilation outlet	**Section 5.6.2**
	Oppose the location of the ventilation outlet in Haberfield	**Section 4.5**
Construction	Assess and mitigate noise impacts during construction on nearby residents, schools, aged care facilities, commercial properties, parks and properties of heritage significance	**Section 11.7**
	Assess and mitigate vibration impacts on nearby buildings and other structures close to tunnel construction works	**Section 11.7**
	Assess and mitigate traffic impacts on local and regional road networks in Ashfield	**Chapter 8** (Traffic and transport)
	Assess and mitigate construction traffic impacts along spoil haulage routes	**Chapter 8** (Traffic and transport)
	Assess and mitigate impacts on public transport operations	**Chapter 8** (Traffic and transport)
	Assess and mitigate dust and air quality impacts on residents and businesses	**Chapter 9** (Air quality)
Consultation	Community consultation to include more details of the project including locations of the proposed tunnel entry/exit points, access and egress ramps, ventilation outlets, road closures and changes to surface road alignments	**Chapter 5** (Project description)
	Extend the length of the EIS public exhibition period to 90 days	**Section 7.6** (Future Consultation)
Economic	Assess and mitigate business impacts and disruptions during construction and from new access arrangements	**Chapter 14** (Social and economic)
Environment	Assess hydrology and flooding impacts from the tunnel portal on Dobroyd Canal (Iron Cover Creek) and on current local flood flows	**Chapter 17** (Flooding and drainage)
	Retain mature trees on their land at Reg Coady Reserve where possible	**Section 20.3**
Health	Impacts on health as a result of: • Adverse air quality • Increased traffic noise • Increased danger from traffic • Loss of open space for passive and active recreation • Community severance and dislocation • Reduced neighbourhood amenity	**Chapter 11** (Human health)
Heritage	Avoid impacts on Ashfield Park, Yasmar and other individual heritage listed properties within the LGA	**Chapter 4** (Project development and alternatives)
	Avoid impacts on the Haberfield Heritage Conservation Area	**Chapter 4** (Project development and alternatives)

Issue	Details	Response
Noise and vibration	Assess and mitigate impacts of the project on nearby residents, schools, aged care facilities, commercial properties, parks and properties of heritage significance	**Chapters 8** to **27**
Project development and design	Oppose the project and request evidence of traffic modelling that justifies project development	**Chapter 3** (Strategic context and project need)
	Concern motorists will not use the tunnel and the project will not meet tolling target	**Chapter 8** (Traffic and transport) **Appendix D**
	Concern revenue from tolls will not be sufficient to finance the completion of the M4-M5 Link. Clarify how the M4-M5 Link will be financed if the revenue from tolls is not realised	Beyond the scope of this EIS
	Concern about ongoing burden on taxpayers to finance project	**Section 3.1.8**
	Ensure the project does not prevent future development of public transport along the WestConnex corridor	**Section 8.4.3** **Chapter 3** (Strategic context and project need)
Property and land use	Consider compensation for impacts on property values	**Chapter 14** (Social and economic)
	Detail how many and which properties are to be acquired for the project	**Chapter 12** (Property and land use)
	Request fairness, courtesy and respect towards residents in the acquisition of homes and businesses	**Chapter 12** (Property and land use)
	Concern residents being acquired will not be able to buy a property back in the LGA because of a lack of housing supply and because it will be unaffordable	**Chapter 14** (Social and economic)
	Concern business owners will not be able to purchase/rent suitable sites nearby and may be forced out of business or need to establish in another area	**Chapter 14** (Social and economic)
	Update Council's section 149 register	**Chapter 16** (Contamination)
	Work site areas marked on the maps as 'future land use to be determined' to be provided to Ashfield Council for open space with a contribution towards an indoor sports stadium	**Chapter 14** (Social and economic)
Social	Assess and mitigate impact on passive and active recreation uses in Ashfield Park and Reg Coady Reserve	**Chapter 14** (Social and economic)
	Assess and mitigate short- and medium-term severance impacts from temporary and permanent changes to pedestrian, cycle and vehicular access	**Chapter 14** (Social and economic) **Section 6.6**
Traffic and transport	Traffic modelling to be broad and go beyond the immediate Parramatta Road corridor	**Section 8.1**
	Assess impacts of increased through traffic after completion of M4 East, and identify what improvements will be seen following completion of the WestConnex scheme	**Section 8.4**
	Document details and impacts of road closures	**Section 8.3** **Section 8.4**
	Detail how impacts on local suburban streets and Frederick Street will be mitigated	**Section 8.6**
	Ability of the network to cope with increased traffic at key pinch point areas in Haberfield and Ashfield	**Section 8.3** **Section 8.4**

Issue	Details	Response
	Maintain or improve accessibility for pedestrians and cyclists in Ashfield and maintain connectivity to Ashfield Park	**Section 6.6** **Section 5.9**
	Assess impacts on public transport operations following completion of the project	**Section 8.4.2**
	Asses impacts on vehicle, pedestrian and bicycle connectivity across the City West Link and Parramatta Road	**Section 8.3.7** **Section 8.4.3**
	Increase public transport services for Western Sydney and establish major park-and-ride hubs	**Section 4.2**
Urban design and amenity	Assess adverse impacts on local amenity and detail mitigation measures proposed	**Chapter 13** (Urban design and visual amenity)
	Assess visual impact of ventilation outlets	**Section 13.4**
	Consider appropriate design of noise mitigation measures and screening devices	**Chapter 13** (Urban design and visual amenity) Section 6.3 of **Appendix L**
	Assess impacts from the loss of open space including Reg Coady Reserve	**Chapter 14** (Social and economic) **Chapter 12** (Property and land use
Leichhardt Council		
Air quality	Concerned about air quality impacts from increased traffic as well as from tunnel ventilation outlets	Chapter 9 (Air quality)
Concept design	Provide background studies, designs and assumptions that have informed the development of WestConnex, including the cost benefit analysis	**Chapter 3** (Strategic context and project need) **Chapter 14** (Social and economic)
	Document mode share assumptions and measures proposed	**Chapter 8** (Traffic and transport)
Consultation	A comprehensive consultation program with more detailed information is required for both the M4 and urban renewal projects	**Section 7.6** (Future Consultation)
Economic	Undertake urban economic modelling in relation to the route covering matters such as floor space ratios and value capture	Beyond the scope of this EIS as the project does not include urban renewal
Funding	Detail financial modelling carried out in relation to the route, in particular modelling that relates to the proposed toll	Refer to the WestConnex Business Case
Traffic and transport	Assess traffic modelling relating to vehicle numbers using the tunnel and vehicle numbers using surface roads	**Section 8.3** **Section 8.4**
	Assess impact on local roads	**Chapter 8** (Traffic and transport) **Appendix D**
	Detail information on the testing of toll scenarios and impact on surface traffic volumes	**Chapter 8** (Traffic and transport) **Appendix D**
Urban renewal	Detail scenarios being tested in relation to residential densities, land use mix and population in UrbanGrowth's proposed Integrated Land Use and Transport Structure Plan	Beyond the scope of this EIS

Issue	Details	Response
	Identify the implementation timetable for the Parramatta Road Urban Revitalisation Program	Beyond the scope of this EIS
	Detail the locations and population growth being considered for urban activation precincts along the Parramatta Road corridor	**Chapter 3** (Strategic context and project need)
	Detail density assumptions for the designated 'investigation areas' as identified by UrbanGrowth	**Chapter 3** (Strategic context and project need)
	Detail urban design/built form analysis completed in relation to the route	**Chapter 13** (Urban design and visual amenity)
	All scenarios and supporting information prepared as part of UrbanGrowth's Integrated Land Use and Transport Structure Plan process should be placed on public exhibition prior to finalisation	Beyond the scope of this EIS as the project does not include urban renewal
City of Sydney		
Consultation	Meet the standards envisaged in the current NSW planning reforms	**Section 7.6** (Future Consultation)
	Consultation to be undertaken with more detailed project information	**Chapter 7** (Consultation)
Economic	Use an appropriate value capture mechanism to ensure that the positive and negative impacts of WestConnex can be balanced between communities	Beyond the scope of this EIS as the project does not include urban renewal
Environment	Locations of ventilation outlets and entry/exit portals need to be carefully considered and appropriate mitigation measures implemented to help minimise impacts on surrounding environments	**Chapter 4** (Project development and alternatives) **Chapter 13** (Urban design and visual amenity)
Project scope	Consider the opportunity to provide innovative public transport and freight priority measures	**Section 3.2** (Why is the project needed)
Project development	Concern about the award of the construction contract prior to EIS approval	Beyond the scope of this EIS
Traffic and transport	Assess and manage additional traffic in an already constrained traffic environment that services the CBD and the broad City of Sydney	**Chapter 8** (Traffic and transport)
Urban renewal	Extent of the urban revitalisation will not be achieved without significant removal of surface traffic from arterial roads and commitment to an appropriate budget for the necessary improvements	**Chapter 8** (Traffic and transport)
SSROC		
Air quality	Air quality monitoring and mitigation of potential impacts on local residents from tunnel emissions and ventilation outlets	**Section 9.9**
	Detail location of the ventilation outlets, their height and visual treatments and proposed emission treatment method	**Section 4.5** **Section 5.6**
Amenity	Assess impacts of the project on residential amenity, business viability and overall social and economic outcomes	**Chapter 14** (Social and economic)
	Assess and document design and visual impact of noise screening walls and devices, treatment of any residual land, screening of portals or ramps, and landscaping treatments around portal sites, ramps and ventilation outlets	**Chapter 13** (Urban design and visual amenity)

Issue	Details	Response
Construction	Identify appropriate mitigation measures for sensitive receivers affected by construction and operation along the corridor	**Chapter 11** (Human health) **Section 9.9** **Section 10.7**
Consultation	Require further detailed information for consultation with the community	**Section 7.6** (Future Consultation)
	Request councils to be involved in the development of the EIS	**Chapter 7** (Consultation)
	Extend length of the EIS public exhibition	**Section 7.6** (Future Consultation)
Economic	Use a value capture mechanism to ensure both the positive and negative impacts of the proposal are equally balanced	Beyond the scope of this EIS as the project does not include urban renewal
	Assess impacts of additional traffic on councils creating an ongoing cost burden	Traffic volumes on council roads are outlined **Chapter 8** (Traffic and transport). Traffic on a number of council roads would reduce and therefore potentially reduce councils ongoing costs. Increase in traffic would be experienced on Roads and Maritime roads.
Environment	Hydrology and flooding impact around Dobroyd Canal (Iron Cove Creek) in Haberfield	**Chapter 17** (Flooding and drainage)
Health	Assess impact on health from any adverse air quality, construction noise and vibration, increased danger from traffic, and loss of open space for active and passive recreation. Assess impact on business and local economic outcomes, and changes to access resulting in community severance and dislocation, increased rates of depression and other mental health impacts from property acquisition and loss of amenity	**Chapter 11** (Human health) **Chapter 14** (Social and economic)
Noise and vibration	Confirmation of 24 hour tunnelling impact and required out of hours works	**Chapter 10** (Noise and vibration)
	Undertake noise modelling for sensitive receivers	**Section 10.1**
	Mitigate increased noise impact around tunnel portals and major construction sites	**Section 10.7**
	Assess and manage vibration impacts on nearby buildings and structures close to tunnel construction works	**Chapter 10** (Noise and vibration)
Process	Coordination between the urban revitalisation program and the project, and further assurances the urban revitalisation program will go ahead	**Chapter 3** (Strategic context and project need)

Issue	Details	Response
Traffic and transport	Traffic modelling to include population projections associated with urban renewal and to consider other infrastructure projects including a second Sydney airport at Badgerys Creek	Traffic modelling includes trip generation, trip distribution and mode choice modules and incorporates demographic data related to land uses including population, employment and education enrolment projections
	Identify and manage impacts on public transport operations during and after construction	**Chapter 8** (Traffic and transport)
	Consider how future traffic volumes on Parramatta Road and the capacity of WestConnex will allow for increases in active and public transport modes	**Section 8.4**

7.4.3 Issues raised by the community

Table 7.10 provides a summary of the issues raised by the community, community groups, businesses, and adjoining and affected landowners during preparation of the EIS. It consolidates the issues raised for the purpose of the EIS. Further details on feedback received from the community and stakeholders during the display of the Preliminary Concept Design can be found in the Community Feedback Report (WDA 2014). The table also provides a response to these issues or indicates where in the EIS this issue has been addressed.

Table 7.10 Issues raised by the community

Issue	Details	Response
Active transport	Assess impact on cycling and pedestrian access and connectivity along the corridor, including links to green spaces	**Section 6.6** **Section 5.9** **Section 8.3** **Section 8.4**
	Maintain and improve pedestrian and cyclist connectivity along the corridor and consider additional signalised crossings and pedestrian bridges at key locations, new paved paths and other cycle priority measures.	**Section 6.6** **Section 5.9**
	Request for 3 metre wide paths where the project builds or replaces existing paths and improved directional signage and road markings for cyclists and pedestrians	**Chapter 5** (Project description)
Air quality and ventilation	Undertake air quality impact assessment, particularly around tunnel entry/exit points, ventilation outlets and construction sites	**Chapter 9** (Air quality)
	Detail management of emissions at tunnel entry/exit points and at ventilation outlets	**Section 9.9**
	Undertake 24/7 monitoring and live reporting of air quality results	The tunnel includes 24/7 monitoring of air quality. Reporting frequency is yet to be developed
	Justify the choice of ventilation outlet locations, ventilation design and no filtration	**Section 4.5** **Section 9.9.3**
	Request to use world's best practice ventilation design and request for the ventilation outlets to be filtered	**Section 4.5** **Section 9.9**

Issue	Details	Response
	Consider more ventilation outlets along the route to further disperse emissions	**Section 4.5**
	Address in-tunnel ventilation	**Section 4.5** **Section 9.9**
	Address smoky vehicles using the tunnel	Roads and Maritime run a program to target smoky vehicles on the road network. The tunnels would also include a smoky vehicle detection system.
	Detail dust abatement and screening around construction sites	**Section 9.9**
Amenity	Assess and mitigate visual impact of project infrastructure including tunnel entry/exit ramps, acoustic sheds and ventilation outlets	**Chapter 13** (Urban design and visual amenity)
	Consider potential uses of residual land acquired to build the project but available for development following construction	**Chapter 13** (Urban design and visual amenity) **Chapter 14** (Social and economic)
	Assess and mitigate loss of amenity from proximity of tunnel entry/exit points, road widening, tunnel support facilities and ventilation outlets to residences	**Chapter 13** (Urban design and visual amenity) **Chapter 14** (Social and economic)
	Provide landscaping around portals and use of planting to screen nearby residents	**Section 13.5**
	Loss of views across green spaces	**Chapter 13** (Urban design and visual amenity)
	Concern about potential overshadowing impacts on properties from project infrastructure such as acoustic sheds	**Chapter 12** (Property and land use
	Concern the sedimentation pond at the mid tunnel facility would create a mosquito problem and unpleasant odours	The positioning of the water quality basin at Cintra Park would be considered further during detailed design.
Concept design and alternatives considered	Detail alternative motorway designs and options considered	**Chapter 4** (Project development and alternatives)
	Consider public transport improvements as an alternative to this project	**Chapter 4** (Project development and alternatives)
	Assess the impact on the project if the second Sydney airport is built	**Chapter 3** (Strategic context and project need)
	Clarify the depth of the tunnel, grades of entry/exit points and speed limits in the tunnel	**Chapter 5** (Project description)
	Clarification of any changes to surface roads including Parramatta Road	**Chapter 5** (Project description)

Issue	Details	Response
	Alternatives should be considered to reduce impacts on residential areas, heritage conservation areas and green spaces	**Chapter 4** (Project development and alternatives)
	Explain why the alignment and other project details have changed from the preliminary concept design	**Chapter 4** (Project development and alternatives)
	Justify why Cintra Park, rather than Concord Oval, was selected as the mid tunnel location	**Chapter 4** (Project development and alternatives)
	Request the tunnel support facilities be moved away from Taylor Street residents	The positioning of operational facilities at Cintra Park would be considered further during detailed design.
Construction	Maintain safety of residents living near construction sites	**Chapter 25** (Hazard and risk)
	Concern about the safety of residents living above the tunnel	**Chapter 25** (Hazard and risk)
	Clarify construction hours	**Chapter 6** (Construction work)
	Concern about noise and vibration impacts from tunnelling under residential properties and heavy vehicle movements	**Chapter 10** (Noise and vibration)
	Assess and mitigate construction noise and vibration impacts including out of hours and night works	**Chapter 10** (Noise and vibration)
	Assess and mitigate impacts of construction traffic and construction worker parking on local roads	**Chapter 10** (Noise and vibration) **Chapter 8** (Traffic and transport)
	Clarify the type and timing of construction activities along the corridor	**Chapter 6** (Construction work)
	Manage construction fatigue	**Section 14.5**
	Clarify the location of construction compounds and construction traffic haulage routes	**Chapter 6** (Construction work)
	Request that haulage routes be moved away from residential areas	**Chapter 6** (Construction work)
	Conduct condition surveys on properties near tunnelling works and compensate for any damage caused	**Section 11.7**
	Concern about stockpiling of spoil on site	**Chapter 25** (Hazard and risk)
	Clarify monitoring process of construction activities and actions to be taken if conditions of approval are breached	This is the responsibility of the NSW Department of Planning and Environment
Consultation	More detailed information to be provided including 3D model	**Section 7.6** (Future Consultation)
	Length of the EIS public exhibition period to be extended	**Section 7.6** (Future Consultation)
	Provide for a broad range of consultation opportunities during the public exhibition of the EIS	**Section 7.6** (Future Consultation)
	Scope for feedback to influence design and alignment changes with a contract being awarded	**Chapter 7** (Consultation)

Issue	Details	Response
	Provide information to property owners about subsurface acquisition	Section 12.3 **Section 7.6** (Future Consultation)
	Concern the community was not consulted on the location of project infrastructure	**Chapter 7** (Consultation)
	Detail how formal submissions can be made during the exhibition of the EIS	**Chapter 7** (Consultation)
Economic	Concern about loss of passing trade on Parramatta Road	**Section 14.4**
	Concern about impact on access to businesses across the corridor from construction activities and increased congestion	**Section 14.3**
Environment	Undertake assessment of impact on flora and fauna, loss of trees and tree canopy, and impact on habitat for threatened species	**Chapter 20** (Biodiversity)
	Undertake drainage and flooding impact assessment including Powell's Creek catchment area and Dobroyd Canal (Iron Cove Creek)	**Chapter 17** (Flooding and drainage)
	Assess impact on rainwater collection systems from adverse air quality impacts	**Chapter 9** (Air quality)
Health and safety	Address potential health impacts on residents living close to tunnel exit/entry points, ventilation outlets, other project infrastructure and close to construction activities	**Chapter 11** (Human health)
	Address health impacts from loss of open space, increased traffic and the uncertainty about the project	**Chapter 11** (Human health) **Chapter 14** (Social and economic)
	Concern the sedimentation pond at the mid tunnel facility will be a safety hazard for children	The water quality basin at Cintra Park would not be accessible to the public and would include security fencing around its perimeter.
	Concern for the safety of pedestrians and cyclists during construction and operation, from construction traffic movements and increased traffic on local roads	**Chapter 8** (Traffic and transport)
Heritage	Undertake impact assessment and consider alternative options to avoid or minimise impacts on heritage conservation area and other individual heritage items	**Chapter 4** (Project development and alternatives)
	Impact on the Haberfield Heritage Conservation Area	**Chapter 19** (Non-Aboriginal heritage)
Land use and property	Concern property values will be affected during construction and by the development of project infrastructure. Assess and address property value impacts	Sections 6 and 7 of **Appendix N** (Economic impact assessment)
	Concern the project will affect development potential for properties in the corridor	**Chapter 4** (Project development and alternatives) **Chapter 12** (Property and land use)
	Address insufficient compensation to buy 'like for like' properties in the same area	**Chapter 14** (Social and economic)

Issue	Details	Response
	Concern about discrepancies between valuations received from Roads and Maritime and independent valuers	**Chapter 14** (Social and economic)
	Impact of partial acquisitions	**Chapter 12** (Property and land use)
	Consider voluntary property acquisition for nearby properties that will be very close to project infrastructure	Properties to be acquired are discussed in **section 5.11.** Acquisition of properties is only occurring for properties which are directly impacted by the project during both construction and operation.
	Consider compensation for sub-surface acquisition	**Chapter 12** (Property and land use)
	Clarify acquisition process, valuation and timing	**Chapter 14** (Social and economic)
	Clarify what development or land use will occur at the grey areas on the tender design maps	**Chapter 12** (Property and land use)
Noise and vibration	Undertake noise assessment including monitoring of noise prior to, during and after construction	**Chapter 10** (Noise and vibration)
	Clarification on noise abatement strategies and design of treatments proposed	**Chapter 10** (Noise and vibration) Section 11.7
	Assess and mitigate operational noise impacts from increased traffic, loss of screening from property acquisition and increased proximity to tunnel exit/entry points and ramps	**Chapter 10** (Noise and vibration)
	Assess and mitigate operational noise impacts from tunnel support facilities including ventilation outlets, substations and water treatment plants	**Chapter 10** (Noise and vibration)
	Assess impact of tunnelling on nearby properties	**Chapter 10** (Noise and vibration)
	Undertake property condition surveys prior to construction and provide guarantees of compensation or remediation if damage is caused	**Chapter 10** (Noise and vibration) Section 11.7
Project development	Concern about the award of the construction contract prior to EIS approval	Beyond the scope of this EIS
	Clarify what scope there is for design changes following the EIS exhibition	**Chapter 2** (Assessment process)
Project scope	Clarification on the cost of tolling	**Section 3.1.8**
	Request for further information on the M4−M5 Link	M4 -M5 Link will be subject to separate planning approval
Socio-economic	Assess and mitigate displacement of long established local communities along the project corridor with strong connections to the area	**Section 14.3** **Section 14.4**

Issue	Details	Response
	Address community severance and isolation from project infrastructure including access ramps and tunnel entry/exit points	**Section 14.3**
	Assess and minimise impacts on child care facilities, preschools, schools, places of worship, aged care facilities and recreational facilities along the project corridor	**Chapter 14** (Social and economic)
	Consider opportunities for replacing any loss of open space	**Section 14.6**
Strategic need and project justification	Release detail in the business case including the cost benefit analysis for the project	**Section 3.1.8**
	Provide justification that sufficient vehicle volumes will use the tunnel to warrant construction	**Chapter 3** (Strategic context and project need)
	Demonstrate how the project will meet the population predictions for Western Sydney	**Chapter 3** (Strategic context and project need)
Traffic and transport	Manage traffic safety including consideration of ramp bends, barriers between residences and the roadway, and increased traffic around tunnel entry/exit points	Road safety has been considered as part of the preferred design and would continue to be considered during detailed design.
	Tunnel monitoring and warning systems for oversized trucks to be considered	**Chapter 8** (Traffic and transport) Section 5.8
	Inclusion of breakdown bays and emergency lanes within the tunnels and consideration of emergency service access	**Chapter 5** (Project description)
	Address impact of increased traffic on local roads from vehicles avoiding tolls and congestion	Traffic modelling undertaken as part of **Appendix G** (Traffic and Transport) has considered driver behaviour in relation to tolls.
	Undertake a peer review of traffic modelling and traffic assumptions	**Chapter 8** (Traffic and transport)
	Assess and mitigate traffic congestion along the already congested City West Link and Parramatta Road at the tunnel exits	**Chapter 8** (Traffic and transport)
	Assess and manage the impact on traffic congestion caused by the time difference between completion of M4 Widening and the project	The 'do minimum' scenario modelled for the year 2021 in the traffic and transport assessment (**Chapter 8**) takes into account the completion of M4 Widening.

Issue	Details	Response
	Assess and mitigate traffic congestion impacts in Ashfield between the completion of the project and the M4−M5 Link	The ‘do minimum’ scenario modelled for the year 2021 in the traffic and transport assessment (**Chapter 8**) takes into account the completion of M4 Widening.
	Clarification and impact assessment of temporary and permanent road closures and changes to surface road alignments	**Chapter 8** (Traffic and transport)
	Address on-street parking impacts from construction activities and construction worker parking	**Section 6.6**
	Maintain emergency services access	**Section 6.6** **Section 5.11**
	Maintain access to properties	**Section 6.6** **Section 5.11**
	Assess the impact on access to public transport services	**Section 8.3** **Section 8.4**
Urban renewal	Address impact or clarify improvements to public transport operations	**Chapter 8** (Traffic and transport)
	Clarify surface traffic reduction	**Chapter 8** (Traffic and transport)
	Ensure urban renewal process is collaborative and includes local councils and the community	Beyond the scope of this EIS
	Clarify proposed density changes, land use mix and population projections	Beyond the scope of this EIS
	Ensure development remains in keeping with heritage suburbs of the inner west	**Chapter 13** (Urban design and visual amenity)

7.5 Design considerations in response to early feedback

Shortlisted tenderers for the design and construction of the project were required to review the M4 East Preliminary Concept Design (November 2013) and the Community Feedback Report (WDA 2014) to identify opportunities for innovations and improvements. **Section 4.3** and **Section 4.4** of this EIS provide details on the motorway and interchange design options considered and details why the preferred design was selected.

Further to information provided in these sections, **Table 7.11** provides a summary of how the concept design by the selected contractor, the Leighton−Samsung C&T−John Holland Joint Venture, has considered and responded to early feedback received on the project. This table has been divided into key project locations.

Table 7.11 Design considerations in response to early feedback

Issue	Concern/recommendation received from community and stakeholders	Response/mitigation in the preferred design announced June 2015
Homebush		
Access	Request for the pedestrian footbridge over the M4 at Homebush to be maintained	The design retains the pedestrian footbridge from Pomeroy Street to Park Road, between Derowie Avenue and Hillcrest Street. Access to the footbridge would be maintained during construction, with the works not encroaching upon the access ramps to the bridge.

Issue	Concern/recommendation received from community and stakeholders	Response/mitigation in the preferred design announced June 2015
Air quality	Concern about location of a ventilation outlet near residents at Underwood Road and potential negative impacts on local air quality	The design has two ventilation outlets. The western ventilation outlet is located at the western portal near Underwood Road. The outlets allow for the efficient dispersion of air from the tunnel. When designing the ventilation outlets, various scenarios were modelled to ensure that air quality, both externally and within the tunnel, would comply with air quality guidelines, the likely Planning Approval Conditions and the National Environmental Protection Measures. These guidelines ensure air quality in the area is not reduced and the community is not negatively impacted. During operation, air quality would be monitored both externally and within the tunnel to confirm that air quality guidelines are met. The monitoring locations are selected in consultation with community and government departments noted in the Planning Approval Conditions. The monitoring results would be available on a website.
	Concern about health impacts on residents at the tunnel entry/exit points and request for monitoring around the tunnel entry/exit points	The tunnel ventilation system has been designed to avoid emissions at the tunnel portals. The outlets are located near the western portal and at Haberfield on the corner of Parramatta Road and Wattle Street. Monitoring will be conducted to ensure regulatory requirements are met. The monitoring locations will be selected in consultation with the community and government departments or as noted in the Planning Approval Conditions
Amenity	Concern about visual impact from the ventilation outlet	To reduce visual impacts, the proposed location of the western ventilation outlet is directly adjacent to the existing M4. The ventilation outlet will be screened by tree planting. The proposed planted courtyard and vehicle circulation to the north of the site ensure that the building is recessed from Underwood Road and Short Street East as far as possible.
	Concern about visual impact from the additional lanes and access ramps at Homebush. Concern about removal of trees that currently act as a screen to the M4	In addition to the noise walls along the M4, screening vegetation would be planted along the north and south of the M4 to match existing roadside landscape treatments. Replanting is proposed in Bill Boyce Reserve and in the corridor to the west of Wentworth Road South. The western portal has been designed to blend in with established adjoining landscape and the cut-and-cover tunnel roof, which would be revegetated as open parkland. Additional lanes in this section of the M4 would allow for traffic to access ramps into the new tunnel and provide connection to the widened M4.

Issue	Concern/recommendation received from community and stakeholders	Response/mitigation in the preferred design announced June 2015
Construction impacts	Concern about noise and dust impacts from construction compounds	The layouts and activities at the following construction compounds have been designed to minimise noise to residents: • C1 Homebush Bay Drive civil site • C2 Pomeroy Street civil site • C3 Underwood Road civil and tunnel site • C4 Powells Creek civil site. Noise modelling has been completed for the tunnelling sites to identify the specifications required for the noise barriers and acoustic sheds to meet noise goals. These and other acoustic treatments may be applied. Noise would be monitored during construction in line with the Construction Environmental Management Plan and Environmental Protection Licence. Dust, noise and vibration would be minimised and monitored on site during construction. Noise modelling has identified that acoustic sheds are required at some tunnelling locations. At these locations spoil handling would occur within the acoustic sheds, minimising noise and dust impacts on the community. In line with the construction contractor's community engagement commitments local residents, businesses and other stakeholders would be informed of upcoming activities. A 24 hour contact line and email address would be available for enquiries or complaints.
	Health concerns regarding air quality for residents living near the construction compounds (locations were not determined in the preliminary concept design information)	Air quality would be managed and monitored throughout construction to ensure airborne dust is contained. Controls may include dust suppression, acoustic sheds, hardstand areas and wheel wash facilities or rumble grids at site exit points. Regular air quality monitoring would confirm the effectiveness of mitigation measures.
Environment	Concern that construction works in the vicinity of Powells Creek will impact on creek quality and local flooding levels Concern about construction activities changing the flood levels and flow distribution of Powells Creek	Construction and operation of the project would not affect the flow of Powells Creek or flooding levels. There would be no in-stream works and no changes to catchment sizes or the waterway area. The new Station Street entry ramp has been designed to mitigate impacts on Powells Creek, utilising an elevated cantilever structure that does not have piers within the creek. During construction of this structure, control measures would minimise erosion and maximise on-site sedimentation, ensuring that the water quality of the creek is not negatively impacted.

Issue	Concern/recommendation received from community and stakeholders	Response/mitigation in the preferred design announced June 2015
Noise	Concern about noise impacts on residents during construction	The layouts and activities at the following construction compounds have been designed to minimise noise to residents: • C1 Homebush Bay Drive civil site • C2 Pomeroy Street civil site • C3 Underwood Road civil and tunnel site • C4 Powells Creek civil site. Noise modelling has been completed for the tunnelling sites to identify the specifications required for the noise barriers and acoustic sheds to meet noise goals. These and other acoustic treatments may be applied. Noise would be monitored during construction in line with the Construction Environmental Management Plan and Environmental Protection Licence. Dust, noise and vibration would be minimised and monitored on site during construction. Noise modelling has identified that acoustic sheds are required at some tunnelling locations. At these locations spoil handling would occur within the acoustic sheds, minimising noise and dust impacts on the community. In line with the LSJH JV's community engagement commitments local residents, businesses and other stakeholders would be informed of upcoming activities. A 24 hour contact line and email address would be available for enquiries or complaints.
	Concern about increased noise for residents along the M4 and near the tunnel entry/exit points	Extensive noise modelling for both 2021 and 2031 conditions has been undertaken as part of the tender assessment and EIS. Noise barriers and other mitigation measures would be employed to minimise noise impacts on residents in the operations phase.
Parking	Request for streets around construction sites to be limited to two hour parking except for residents	A range of measures will be carried out by the contractor to provide viable options for workers to get to their place of work without adversely affecting neighbouring residents and businesses. Measures will include a range of communication and education activities with employees to encourage use of public transport, review the capacity of LSJH sites to provide bicycle and motorbike parking, explore 'park and ride' options and working with councils to discourage workers from parking in local streets by introducing construction phase resident parking restrictions.
Project design	Request for clarity on where the new westbound access ramp merges with the M4	The design does not alter how westbound traffic accesses the M4 at the Homebush Bay Drive overpass.
	Request for clear signage and easy access to the M4 and Parramatta Road	The design has simplified the road geometry of on- and off-ramps for the M4, resulting in logical and clear access within the area. The final signage and line marking design will meet Roads and Maritime and Australian Standards to deliver a safe, efficient road.

Issue	Concern/recommendation received from community and stakeholders	Response/mitigation in the preferred design announced June 2015
	Suggest straightening the eastbound ramp, Homebush	The design of the eastbound ramp is now straighter to allow for better traffic merging and bus access.
	Request for the M4 westbound exit ramp to be retained	The design retains the M4 westbound exit ramp.
	Request to move tunnel entry/exit point further west Clarification on the extent of cut-and-cover	The location of the tunnel portal has been selected to reduce the risk of flooding in the tunnel. The cut-and-cover tunnel starts adjacent to Bill Boyce Reserve and transitions to tunnel at Ismay Avenue. It has been designed to minimise impacts on the surrounding community, including minimising impact on Pomeroy Street, minimising land acquisition and maintaining access to the pedestrian foot bridge.
	Consider if a ventilation outlet can be located in either a commercial area or the 'informal recreation area' mid-way between Allen Street and the M4 overpass	Council has prepared the Powell Street masterplan for development of the 'informal recreation area' mid-way between Allen Street and the M4 overpass. Greater efficiencies in the ventilation system are achieved with the location of the outlets identified in the preferred design.
Property impacts	Concern about potential land acquisition for the Station Street entry ramp	The design locates a new entry ramp at Station Street entirely within land currently owned by Strathfield Council. No additional residential or commercial land acquisitions are required.
Traffic and local road impacts	Request for more information on construction vehicle access at Underwood Road, Homebush Request existing congested traffic routes are not used for construction vehicles or to divert traffic during the construction period Request for construction vehicles to use the M4 to remove spoil rather than local roads	The haulage routes have been designed to minimise potential impacts on Underwood Road and Pomeroy Street residents. The haulage routes would be confined to the M4 and other main roads, including Parramatta Road. The section of Underwood Road south of Short Street East to Parramatta Road would be used. Trucks and heavy vehicles would turn around on the construction sites located adjacent to Underwood Road and the M4, gaining access by either the M4 or Parramatta Road. All transport haulage routes would be designated and drivers would be monitored to ensure compliance.
	Concern about traffic congestion on roundabout at DFO, Homebush Bay Drive	A construction traffic management plan will be prepared by LSJH in consultation with the relevant road authority and stakeholders to assess impacts of the construction works on this intersection and to determine if the potential route through the roundabout should be used.
	Safety concern traffic may veer through barriers into properties	The design would not create any greater risk than the current M4. The design along this section of road provides for suitable merge lengths, and either road easement spacing or safety barriers. A road safety audit would be completed for the project to highlight areas where additional mitigation measures should be installed.

Issue	Concern/recommendation received from community and stakeholders	Response/mitigation in the preferred design announced June 2015
Concord		
Access	Request to maintain local vehicle access during and after construction	The design would limit impacts on residents in this area during the construction phase. The Concord Road ramp solution would require the creation of one new cul-de-sac at Sydney Street (east of Concord Road), and the shortening of two existing cul-de-sacs at Alexandra Street and Edward Street.
	Request that local vehicle access into Sydney Street (west of Concord Road) be maintained	There would be no change to access to Sydney Street West. The Concord Road ramp solution includes the creation of a new cul-de-sac at Sydney Street East due to the alignment of the proposed tunnel entry ramps. By removing the left hand turn from Concord Road (southbound) into Sydney Street, the traffic impact of 'rat running' would be reduced.
	Maintain safe pedestrian and vehicle access to St Mary's Catholic Primary School	Access would not be affected at St Mary's Catholic Primary School. Tunnelling works would occur approximately 40 metres below the surface, which would not affect the area at the surface.
	Request to maintain pedestrian footpaths on Concord Road, in the vicinity of the bus stops	Pedestrian access, including traffic light crossings, would be maintained throughout the construction period. A bus stop on Concord Road northbound would be moved (subject to design) from its current location, to a new location north on Concord Road near Carrington Street, to ensure safety. Southbound bus stops would have upgraded access footpaths.
	Request to maintain safe and efficient pedestrian access to Strathfield Station for residents living north of Parramatta Road	Pedestrian access to Strathfield Station from north of Parramatta Road would not be altered.
Air quality	Concern about air quality and health impacts around the concept design tunnel entry/exit points Request for air quality monitoring	The preferred design has tunnel entry points directly adjacent to Concord Road, between Edward and Sydney Streets, lessening the impact on the local community. There would be no emissions from the tunnel portals. Monitoring would be conducted during the commissioning phase to ensure the tunnel meets with regulatory requirements. The monitoring locations would be selected in consultation with the community and government departments, as per the Conditions of Approval.
Amenity	Concern about visual impact of an elevated entry ramp to the M4 westbound	The design has an elevated M4 entry ramp that would be visually consistent with other bridges in this area. It would have a uniform appearance and be constructed from tapered steel, giving it a slender appearance. The structure would incorporate noise reducing features.

Issue	Concern/recommendation received from community and stakeholders	Response/mitigation in the preferred design announced June 2015
Construction	Concern about construction impacts including noise, dust, vibration and traffic on local residents and stakeholders including the Concord Sydney Chiel Korean Uniting Church	Dust, noise and vibration would be monitored on site during construction in line with the Construction Environmental Management Plan and Environmental Protection Licence. In line with the LSJH JV's community engagement commitments local residents, businesses and other stakeholders would be informed of upcoming activities. A 24 hour contact line and email will be available for enquiries or complaints.
	Concern about vibration and settlement impacts on residential properties to the south of Parramatta Road in Strathfield, Burwood and Croydon	Vibration and settlement as a result of various construction activities has been modelled. The LSJH JV would undertake property condition surveys before work commences. Vibration and settlement would be monitored during construction, with results made publicly available and compared to the guidelines.
	Concern about noise and dust impacts from the construction compounds (locations were not determined in the preliminary concept design information)	The following construction compounds have been designed to minimise noise to residents: • C5 Concord Road civil and tunnel site • C6 Cintra Park tunnel site. Noise modelling has been completed for the tunnelling sites to identify specifications for the noise barriers and acoustic sheds in order to meet noise goals. These and other acoustic treatments would be applied. Dust, noise and vibration would be monitored on site during construction. Noise modelling has identified that acoustic sheds are required at some tunnelling locations. At these locations spoil handling would occur within the acoustic sheds, minimising noise and dust impacts on the community. Local residents would be informed of upcoming activities and be provided with access to a 24 hour contact line to raise questions or complaints.
	Health concerns regarding air quality for residents living near the construction compounds (locations were not determined in the concept information)	Air quality would be managed throughout construction to ensure airborne dust is contained. Controls may include dust suppression, acoustic sheds, hardstand areas, wheel wash facilities and rumble grids at site exit points. Regular air quality monitoring would confirm the effectiveness of mitigation measures.

Issue	Concern/recommendation received from community and stakeholders	Response/mitigation in the preferred design announced June 2015
	Opposed to the use of Concord Oval as a construction compound Concern over noise and access impacts on St Lukes Park during construction	Concord Oval is no longer nominated as a construction compound. The adjacent Cintra Park would be used for this purpose. New hockey facilities are being developed at St Lukes Park to ensure the important local venue for first grade and all age competitions could still be accommodated in Concord, along with the provision of upgraded sporting facilities. All haulage and heavy construction vehicles would enter and leave the site via Parramatta Road, avoiding impact on local streets. Sites have been designed to minimise noise to residents during construction. The layouts and activities have been modelled and, where required, acoustic treatments would be used. Access and egress from the bus depot would be maintained during construction.
Noise	Operational noise impacts	Noise modelling has been undertaken as part of the design. Mitigation measures, including treatment of individual properties, are described in Chapter 11 (Noise and vibration).
Parking	Concern about loss of on-street parking in local areas Request to consider construction worker parking at the back of Concord Oval	A construction worker parking strategy would be implemented with a policy of no worker parking on local streets, and would encourage the use of public transport to avoid impacts on local residents and businesses. The design would upgrade existing parking at the rear of Concord Oval, which would be used by construction personnel during the project. On weekends when games are scheduled, some parking would be delineated for construction, with the rest to be made available for the public.
Project design	Recommended the tunnel exit/entry ramps surface on the western side of Concord Road	The exit ramps now surface on the western side of the Concord Road.
	Concerns from residents in the areas around Franklyn Street, Ada Street, Inverary Street, Alexandra Street, Daly Avenue and Lloyd George Avenue regarding the concept design: • Anticipated visual and noise impacts from new road • Concern ramps will sever residents from local neighbourhood and community • Clarification sought on the extent of cut-and-cover of ramps • Request for entry/exit ramps to be shortened to minimise impacts on residents	The tunnel portals are now located directly adjacent to Concord Road. The design has substantially shortened entry/exit ramps to reduce impacts on residents. In particular the solution removed the 380 metre-long cut-and-cover ramps between Concord Road and Ada Street, eliminating the need for substantial property acquisition and avoiding division of communities.

Issue	Concern/recommendation received from community and stakeholders	Response/mitigation in the preferred design announced June 2015
	Request for information on grades of access ramps and the depths of tunnels	The uphill grades of ramps range from 2% to 6% and downhill grades of ramps range from –7% to –8%. The ramps have been designed to avoid affecting the existing substation on the corner of Lloyd George Avenue and Parramatta Road, which was recognised as a constraint during the design.
	Request for information on design of the tunnel exit	The westbound exit was moved to feed directly onto Concord Road northbound and southbound. This allows for exiting traffic to head north or south along Concord Road, avoiding right turns across Concord Road.
	Concern about direct impacts on the Concord Sydney Chiel Korean Uniting Church	The Concord Road ramp solution reduces the amount of land to be acquired from the Concord Sydney Chiel Korean Uniting Church. The land to be acquired is currently used as a garden and car park, with the church building not affected by acquisition. Discussions with the Church are ongoing.
Social	Concern about residents' security in remaining properties	The design minimises the construction footprint to keep communities connected. The design approach is to consolidate land acquisitions and avoid isolating and sterilising land. The design solution at Concord Road achieves this. Properties directly adjacent to the exit/entry ramp noise walls would have adequate security, as there would be no pedestrian access to the rear of the property. During the detailed design phase a Crime Prevention Through Environmental Design (CPTED) assessment would be undertaken to identify further measures to maintain the security of these areas.
Traffic and local road impacts	Concern about an increase in traffic congestion between M4 Widening completion and M4 East completion	Activities scheduled for either project would be coordinated to minimise impacts on traffic and to avoid direct impacts on the local community. The community relations team would work closely with the project's traffic management specialists to ensure clear, accurate and timely information about traffic conditions on the M4. Communication with stakeholders would use a variety of media, and would include descriptions of alternative travel options during the construction phase.
	Concern about increased congestion caused by the right hand turn from Concord Road into the M4 East tunnel eastbound	The design resolves this issue, with a left hand turn for southbound traffic on Concord Road to access the tunnel entry ramp now located to the east. The northbound traffic on Concord Road would also access the tunnel via a left hand turn through another entry ramp portal.
	Concern that the left hand turn movement from Parramatta Road eastbound to the M4 will be removed	The design includes a new entry ramp at Station Street which would be used by drivers on Parramatta Road (both directions) to enter the M4 westbound. An additional entry ramp would be constructed for Concord Road southbound drivers to enter the M4 westbound.

Issue	Concern/recommendation received from community and stakeholders	Response/mitigation in the preferred design announced June 2015
	Concern about increased traffic on Concord Road, Patterson Street and Gipps Street Concern about noise, dust, parking and access impacts during construction and operation Concern about safety of residents during construction	The design would keep heavy vehicles off local streets. The construction haulage routes are confined to arterial roads including Concord Road south of Sydney Street, Parramatta Road, M4 and other main roads, avoiding the use of local streets such as Gipps Street and Patterson Street. Sydney Street would be used to access the Concord Road civil and tunnel site (C5) from the M4. Trucks would exit the M4 eastbound at Sydney Street, travel over the Concord Road overpass, turn left onto Parramatta Road and re-enter the M4 opposite Swan Avenue. All transport haulage routes would be designated and drivers would be monitored to ensure compliance.
Urban design and landscaping	Request for landscaping and other treatments to minimise the impacts of new access ramps on Sydney Street residents	The design is a compact solution that avoids dividing or isolating existing residential areas and reduces impacts on residents to the east of Concord Road. The proposed urban and landscape design for the Sydney Street area includes retained pedestrian connectivity, tree planting, architectural treatments and the placement of a deck north of Sydney Street that can potentially be used for future development.
Haberfield/Ashfield		
Access	Request to maintain safe pedestrian and vehicle access to Dobroyd Point Public School	Safe access to Dobroyd Point Public School would continue, with all current traffic and pedestrian access maintained around the work area. Alternative pedestrian routes would be maintained on the southern bank of Iron Cove Creek.
	Request to retain pedestrian footbridge over Parramatta Road, Ashfield	The pedestrian bridge across Parramatta Road near Bland Street would be retained.
	Request for traffic access to be maintained from Wattle Street to Ramsay Street, Haberfield	All current traffic manoeuvres would be maintained, with a new signalised right hand turn lane for traffic travelling northbound along Wattle Street.
	Request for safe pedestrian access across the tunnel lanes/ramps from Reg Coady Reserve to Waratah Street, Haberfield Request for a pedestrian bridge	At-grade pedestrian and cyclist access from the Reg Coady Reserve to Waratah Street would be maintained through pedestrian lights at that intersection. No bridge is included in the design.

Issue	Concern/recommendation received from community and stakeholders	Response/mitigation in the preferred design announced June 2015
	Concern about the right turn access to Martin Street, Haberfield	The Martin Street and Wattle Street intersection would continue to operate as it currently does, with the exception of eastbound traffic on Wattle Street not being able to turn right into Martin Street. Instead, this traffic would proceed to the intersection at Ramsay Street where traffic lights would enable a right hand turn, allowing access to Martin Street. During construction there would be some temporary changes to traffic arrangements on Martin Street. Residents would be able to access their houses, traffic flow would be maintained, detours would be clearly signposted and advance notification provided.
	Concern about loss of access to Parramatta Road due to local road closures at Chandos Street, Bland Street, Rogers Street and Orpington Street at Haberfield	The preferred design would not change access to Parramatta Road from Chandos Street, Bland Street, Rogers Street or Orpington Street. During construction there would be some temporary closures of local streets to allow some construction works to occur. At these times, traffic control and detours would be in place to maintain access to properties and advance notification provided.
	Request closure of Ormond Street at Ashfield to traffic and buses	Ormond Street is outside the project boundary and would not be affected. The design maintains connections on Ormond Street to Ashfield Station and Ashfield Boys High School.
	Request to maintain pedestrian access across Parramatta Road from Haberfield to Ashfield Park	There is no change to pedestrian access at this location as the design does not extend east of Dalhousie Street.
	Concern about a loss of pedestrian and cycle connectivity to Ashfield Park	The design retains the footpath on the northern side of Parramatta Road and maintains access to the pedestrian overpass at Bland Street. At-grade pedestrian signals would be maintained at Bland Street and Dalhousie Street. During the construction of the tunnel portal in Ashfield, the footpath to the south of Parramatta Road would be closed. A detour on Loftus Street would maintain safe access to Ashfield Park. The Parramatta Road footpath would be reinstated following completion of the works.
	Request to create a cul-de-sac at Rogers Avenue and Chandos Street	Creating a cul-de-sac at Rogers Avenue or at Chandos Street is not part of this design. The design would improve traffic flow along Parramatta Road, decreasing the likelihood of cars using local streets to avoid congestion.

Issue	Concern/recommendation received from community and stakeholders	Response/mitigation in the preferred design announced June 2015
Air quality	Concern about location of ventilation station near residents and Haberfield Primary School and negative impacts on air quality Concern about potential impacts on Haberfield Primary School from ventilation outlet emissions	Various designs and outlet heights were modelled to ensure that air quality, both externally and within the tunnel, would comply with air quality guidelines, the Conditions of Approval and the National Environmental Protection Measures. The outlets provide efficient dispersion of air from the tunnel. There would be no emissions from the portals. These scenarios considered both the M4 East project and future M4–M5 Link tunnel, ensuring that another ventilation outlet would not need to be constructed in the area at a later date. Compliance with these guidelines would ensure that air quality in the area is not worsened and that the community is not adversely affected. During operation, air quality would be monitored both externally and within the tunnel to confirm that air quality guidelines were not exceeded. The monitoring locations would be based on the baseline locations selected by WDA, through consultation with community groups and with government departments highlighted in the Planning Approval Conditions. The monitoring results would be available on the project website.
Amenity	Concern about noise increase, vibration and amenity once the tunnel portal at Ashfield is completed	Noise modelling has been undertaken as part of the design and would be further developed as part of the detailed design. This modelling identifies noise impacts and mitigation measures for this area, including any treatment requirements at individual properties. The operational tunnel would not affect vibration levels experienced by residents. An urban design plan for this area examines ways to minimise amenity impacts. Planting is planned between the tunnel ramps and the eastbound Parramatta Road lanes. Planting large trees would improve the amenity of the area, provide screening and balance the scale of the ventilation outlet.
Congestion	Concern about congestion from traffic exiting the tunnel at Ashfield onto an already congested Parramatta Road	Traffic modelling, assessing the level of service and travel time, has been completed to optimise lane numbers and to sequence traffic lights to improve traffic flow. The modelling has found that the level of service at the Parramatta Road and Dalhousie Street intersection would be not adversely affected by the project.
Construction impact	Concern about vibration impacts on properties as the tunnel surfaces at Ashfield	Vibration levels from various construction activities have been modelled to plan to avoid impact on properties. Vibration and settlement monitoring would be undertaken during construction to confirm compliance with vibration guidelines. Property condition surveys would be undertaken for nearby properties.

Issue	Concern/recommendation received from community and stakeholders	Response/mitigation in the preferred design announced June 2015
	Concern about construction impacts on Walker Avenue properties at Haberfield	A construction compound would be located at Walker Avenue, with access from Parramatta Road. The ventilation outlet on Parramatta Road would require the acquisition of 14 properties on Walker Avenue. This period of construction would complete all civil and tunnelling works at this site, including ramps and tunnel stubs connecting to the M4−M5 Link, thereby minimising disruption to this community in the later stage of the project. Noise modelling has been completed for the tunnelling sites to identify specifications for the noise barriers and acoustic sheds, in order to meet noise goals. These and other acoustic treatments would be applied. Dust, noise and vibration would be monitored on site during construction. Noise modelling has identified that acoustic sheds are required at some tunnelling locations. At these locations spoil handling would occur within the acoustic sheds, minimising noise and dust impacts on the community. Local residents would be informed of upcoming activities and be provided with access to a 24 hour contact line to raise questions or complaints.
	Concern about impact on the Presbyterian Aged Care facility, Parramatta Road, Haberfield	Surface work would occur to the south of Parramatta Road, opposite the aged care facility, to construct the tunnel portal. This would reduce land take and traffic impacts during construction of the portal. The driven tunnel does not extend this far east. Construction at this location would carefully consider impacts on the aged care facility through the following means: • Noise modelling of the site layout and activity to identify mitigation measures • Early implementation of operational noise mitigation measures (where possible). An urban design plan has been drafted for this area to minimise amenity impacts, with planting planned between the tunnel ramps and the eastbound Parramatta Road lanes to provide amenity and screening and a wider verge at the front of the property.
	Concern about noise impacts from the Northcote Street Haberfield construction site	The design shows a site layout that minimises noise impacts on residents. This layout and the proposed construction activities would be modelled and, where required, acoustic treatments would be applied, including temporary noise barriers and an acoustic shed. Haulage routes from this site have been selected to avoid impacts on residents on Northcote Street and Wolseley Street, with all vehicles using Parramatta Road and Wattle Street.

Issue	Concern/recommendation received from community and stakeholders	Response/mitigation in the preferred design announced June 2015
	Concern about the impact on properties on Wattle Street and Ramsay Street at Haberfield	During construction, impacts on residents at Wattle Street and Ramsay Street would be minimised through: • Noise modelling of the site layout and activity to identify mitigation measures, eg noise barriers • Early implementation of operational noise mitigation measures (where possible) • Limiting haulage routes in this area to Wattle Street, with no heavy vehicle access on local roads. Extensive noise modelling was undertaken as part of the tender design (and would be further developed as part of the detailed design) to identify noise impacts and mitigation measures for this area, including treatment at individual properties.
Environment	Concern that construction works for the Wattle Street realignment will impact upon Iron Cove Creek	The construction works within this area would not encroach upon Iron Cove Creek. The design of the tunnel takes the creek into account. During construction, control measures would minimise soil erosion and maximise onsite water detention, ensuring the water quality of the creek is not adversely affected.
Heritage	Concern about impacts on Yasmar Training Facility	The design has avoided impact on Yasmar. Proposed landscaping includes a wider front verge and tree plantings to provide shade and amenity for pedestrians.
	Concern about impacts on the Bunyas, Rogers Avenue Haberfield	The design does not affect the Bunyas, a privately owned, heritage listed house. There are no surface works near Bunyas and no driven tunnel in this area.
	Concern about impacts on the Ashfield Bowling Club	The design does not directly affect the bowling club. During construction, Orpington Street would be closed at Parramatta Road (requiring a detour) and the bus stop on Parramatta Road relocated. No works would take place in Ashfield Park or at the Ashfield Bowling Club.
	Request that Ashfield Park should not be considered as a location for a construction staging area or a ventilation outlet	The design does not impact Ashfield Park, which would not be a location for construction staging or a ventilation outlet.
	Request to move tunnel entry either further east or west to avoid impact on Ashfield Park or the removal of trees	The design avoids impacts on Ashfield Park.

Issue	Concern/recommendation received from community and stakeholders	Response/mitigation in the preferred design announced June 2015
Social	Concern that the Wattle Street access ramps will divide and isolate some community members	The Wattle Street design now incorporates a combined tunnel portal and shorter cut-and-cover section. Moving the portal to the southern side of Wattle Street improves amenity for residents on the northern side of Wattle Street, providing a conventional streetscape and landscaping, instead of facing the dive structure. Traffic staging has been simplified. The Ramsay Street signalised pedestrian crossing point would be maintained. To reduce community disruption in the future a portion of the M4–M5 Link project, including tunnel ramps and tunnel stub, would be constructed as part of the project.
Noise	Operational noise impacts	Noise modelling has been undertaken as part of the design. Mitigation measures, including treatment of individual properties, are described in **Chapter 11** (Noise and vibration).
Project design	Clarification sought on the extent of cut-and-cover on Parramatta Road at Ashfield	The design is for a cut-and-cover tunnel between Chandos Street and Bland Street, on the southern side of Parramatta Road. During construction Chandos Street would be closed temporarily, until Parramatta Road westbound is realigned. Residents would be able to access their houses, traffic flow would be maintained, detours would be clearly signposted and advance notification provided.
	Detail sought on the extent of M4−M5 Link connections to be built during the construction of the project	The design has provided for future stages of WestConnex. Tunnel ramps for the M4–M5 Link would be constructed as part of the project to minimise future community disruption. The ventilation outlet would provide ventilation for both the M4 East and future M4–M5 Link tunnels.
	Request for detailed plans around Wattle Street	Preferred design drawings are available on the WestConnex website.
	Request to move the tunnel exit further east to avoid an uphill exit	The design has combined the portals and moved them south-east, minimising the uphill exit.
	Suggested exit/entry ramps should be moved to Reg Coady Reserve at Haberfield. What is the acquisition requirement in Reg Coady Reserve?	The design did not move the ramps to Reg Coady Reserve, maintaining continued use of this facility by the community. A small portion of Reg Coady Reserve is currently owned by Roads and Maritime. The design proposes to temporarily resume a tract of land extending from 20 metres west of the corner of Martin Street, around the corner and 200 metres north along Wattle Street (the remaining section is within road reserve). The maximum width of this strip would be 30 metres. This would allow a temporary construction traffic lane to be built.

Issue	Concern/recommendation received from community and stakeholders	Response/mitigation in the preferred design announced June 2015
Property impacts	Concern about property acquisition on Walker Avenue	Some 14 properties would be acquired on Walker Avenue to allow for construction of the ventilation outlet. The design would also construct entry ramps for the future M4–M5 Link. By completing this work as part of the project, impacts on the community from future construction works would be lessened.
	Concern about the potential for additional land acquisition on Wattle Street	Following the selection of the preferred design, WDA has had certainty on acquisition requirements. WDA has been contacting owners whose properties have been identified for acquisition based on the preferred design.
	Concern about additional land acquisition on Parramatta Road between Bland Street and Chandos Street	The design proposes to construct a cut-and-cover tunnel between Chandos Street and Bland Street, on the southern side of Parramatta Road. The design has consolidated land acquisitions to the western side of Parramatta Road. It ensures that Ashfield Park and Yasmar are not affected.
	Concern about land acquisition for Northcote Street tunnel site	The design investigated numerous locations along the alignment for tunnelling sites that minimised community and environmental impacts. Locations to the north-west of this site were investigated but rejected due to previous land use as a service station and the need to acquire a greater number of residential properties. The Northcote Street site provides direct access to Parramatta Road for haulage.
Impact on green space	Concern about the impact on Reg Coady Reserve, including removal of trees	Approximately three trees would be removed for the construction of a temporary construction traffic lane. Pedestrian access through the park would be maintained during construction, with a small section of footpath relocated to provide access to the pedestrian bridge crossings at Dobroyd Canal (Iron Cove Creek) and the park to the north of the creek. Further, approximately 30 trees would be removed from the southern side of Wattle Street, to widen the street. Tree removals at this location have been minimised as far as possible.
Traffic and local road impacts	Question the width and number of lanes on Dobroyd Parade	Changes to Dobroyd Parade have been designed to meet predicted traffic demand and design requirements. Two westbound lanes are maintained on Dobroyd Parade. Travelling east on Dobroyd Parade, two lanes merge into one between Martin Street and Waratah Street to allow for the tunnel exit ramps, before re-forming two lanes. The width of Dobroyd Parade has been increased to allow for tunnel on- and off-ramps and a median at the intersection of Dobroyd Parade and Waratah Street.

Issue	Concern/recommendation received from community and stakeholders	Response/mitigation in the preferred design announced June 2015
	Request to remove right hand turn into Waratah Street or have a dedicated lane	The design removes the right hand turn lane from Wattle Street (heading eastbound), as traffic would need to cross the tunnel exit ramp lanes. Eastbound traffic on the tunnel exit ramp can turn right into Waratah Street using a dedicated turning lane. Access to Waratah would be via Ramsay Street.
	Concern about traffic congestion in the tunnel and along Wattle Street from traffic trying to access the City West Link	Traffic modelling demonstrates improved traffic flow on Wattle Street. As a result, lane numbers have been optimised and traffic lights sequenced to improve flow.

7.6 Future consultation

7.6.1 Subsurface acquisition consultation

As part of developing the tunnel corridor, Roads and Maritime would need to acquire some privately owned land (or interests in land such as easements) below the ground surface (*Fact sheet: acquisition of sub-surface lands*, RMS January 2015). Acquisition of such 'sub-surface property' would be carried out in a staged approach along the tunnel corridor.

As a first step, WDA would send a notification letter to property owners informing them of the need to acquire their sub-surface land.

This notification will be followed by a letter from Roads and Maritime that would include a sketch plan indicating the likely minimum depth of the sub-surface land to be acquired.

An acquisition officer from Roads and Maritime would be identified as a direct point of contact for any enquiries or concerns relating to the sub-surface acquisition process.

7.6.2 Consultation during the exhibition of the EIS

The EIS will be available for viewing at the following locations:

- Council offices: Auburn, Strathfield, Burwood, City of Canada Bay and Ashfield
- Local libraries: Auburn City Library, Strathfield Main Library, Strathfield High Street Community Library, Burwood Central Library, Concord Library, Five Dock Library, Haberfield Library and Ashfield Central Library
- Other locations: Roads and Maritime Services, WestConnex Information Kiosk at Westfield Burwood, Nature Conservation Council of NSW and Department of Planning and Environment
- Department of Planning and Environment and WestConnex websites.

A range of communication and consultation activities are planned for the public exhibition period including:

- A community update newsletter distributed to residents and businesses within the project corridor, outlining where to go for more information about the EIS, consultation activities planned during the exhibition period and how to make a submission
- Updates to the WestConnex project website including an interactive mapping tool highlighting the key features of the project and the potential impacts. An updated set of Frequently Asked Questions will also be uploaded to clarify aspects of the EIS
- A range of stakeholder meetings and briefings with local, State and Federal Members, councils, key interest and community groups
- Community information sessions and display materials at a number of locations in the project corridor, staffed by technical specialists to answer questions
- Project email and information phone line to manage enquiries and provide information on the EIS

- Advertisements in local and metropolitan English language and non-English language newspapers to promote the exhibition of the EIS and community consultation opportunities
- Fact sheets on key aspects of the EIS.

During the EIS exhibition, the community, government agencies and other interested parties may make written submissions on the project to the Secretary of DP&E.

Following the exhibition of the EIS, the Secretary of DP&E will provide copies of submissions to WDA. The Secretary of DP&E will then require WDA to prepare a submissions report to respond to the issues raised in submissions and a preferred infrastructure report to outline any proposed changes to the project. If the Secretary of DP&E considers that significant changes to the project are proposed, the Secretary of DP&E may make the preferred infrastructure report publicly available.

DP&E will prepare the Secretary's environmental assessment report and provide it to the Minister for Planning. The Minister for Planning will then decide whether to approve the project and, if approved, the conditions to be imposed.

7.6.3 Consultation during construction stages

Communication and consultation with stakeholders and the community during construction will focus on providing updates on construction activities and program, responding to enquiries and concerns in a timely manner and minimising potential impacts where possible. The following communication tools and activities would be used during the construction phase:

- Notification letters and phone calls to residents and businesses directly affected by construction works, changes to traffic arrangements and out of hours works
- Regular community updates on the progress of the construction program
- Face-to-face meetings with property owners as requested
- Regular website updates
- Advertising in local and metropolitan English language and non-English language newspapers to provide contact information for the project team
- Site signage around construction compounds
- 24-hour project information line, a dedicated email address and postal address.

A draft Community Consultation Framework can be found at **Appendix F**, which provides further details including a thorough stakeholder analysis, processes and procedures for complaint resolution, and management procedures for construction impacts including traffic management, landscaping and urban design, out of hours work and noise and vibration mitigation and management procedures.

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8 Traffic and transport

This chapter outlines the potential traffic and transport impacts associated with the M4 East project (the project). A detailed traffic and transport assessment has been undertaken for the project and is included in **Appendix G**.

The Secretary of the NSW Department of Planning and Environment has issued a set of environmental assessment requirements for the project; these are referred to as Secretary's Environmental Assessment Requirements (SEARs). **Table 8.1** sets out these requirements as they relate to traffic and transport, and identifies where they have been addressed in this environmental impact statement (EIS).

Table 8.1 Secretary's Environmental Assessment Requirements – traffic and transport

Secretary's Environmental Assessment Requirement	Where addressed in the EIS
Traffic and transport, including but not limited to:	
• Details of how the following meet the traffic and transport objectives of the project, taking into account adjacent sensitive land uses, future growth areas, approved and proposed infrastructure projects, and traffic (vehicular, cyclist and pedestrian) needs: – The preferred alignment and design – The proposed interchanges and connections to the surrounding road network – Associated road infrastructure facilities	**Section 8.4**
• An assessment and modelling of operational traffic and transport impacts on the local and regional road network (including Parramatta Road, Queens Road, Gipps Street, and other arterials), and the Sydney motorway network	**Section 8.4**
• Induced traffic and operational implications for public transport (particularly with respect to strategic bus corridors and bus routes) and consideration of opportunities to improve public transport patronage	**Sections 8.1** and **8.4.2**
• Impacts on cyclists and pedestrian access and safety and consideration of opportunities to integrate cycleway and pedestrian elements with surrounding networks	**Section 8.4.3**
• Construction traffic and transport impacts of the project (including ancillary facilities) and associated management measures, in particular:	
– Impacts to the road network (including safety and level of service, pedestrian and cyclist access, and disruption to public transport services and access to properties)	**Section 8.3**
– Route identification and scheduling of transport movements	**Section 8.3.1**
– The number, frequency and size of construction related vehicles (both passenger, commercial and heavy vehicles)	**Section 8.3.1**
– The nature of existing traffic on construction access routes (including consideration of peak traffic times)	**Section 8.2.2**
– The need to close, divert or otherwise reconfigure elements of the road network associated with construction of the project	**Section 8.3.4**
having reference to the cumulative construction impacts of other infrastructure preparing for or commencing construction	
• Details of how the project meets the objectives of the overall WestConnex Scheme.	**Section 8.4.4**

8.1 Assessment methodology

An integrated traffic modelling and forecasting approach was adopted for the traffic assessment for the project. This approach involved:

- Reviewing existing conditions along the Parramatta Road corridor
- Determining existing and future intersection and roadway traffic volumes
- Assessing potential construction impacts
- Assessing potential operational impacts of the project on the existing and future road network using LinSig, which is an intersection modelling platform that is capable of assessing the performance of isolated or coordinated networks of signalised intersections
- Recommending measures to mitigate and manage the traffic and transport impacts of the project during construction and operation.

A summary of the main tasks involved in the assessment is provided in **sections 8.1.1** to **8.1.4**. A detailed description of the methodology is provided in **Appendix G**.

8.1.1 Determine existing and future traffic volumes

Existing and future year intersection and roadway traffic volumes were calculated using outputs from the WestConnex Road Traffic Model (WRTM) Version 2.1, with a particular focus on the project area between Homebush Bay Drive at Homebush and Balmain Road at Leichhardt, and including the predicted transfer of principal and induced travel demand to the project from alternative transport corridors.

The following six key scenarios were modelled using the WRTM to provide morning (AM) peak and afternoon (PM) peak roadway and intersection turning volumes:

- Existing case (2012) – current road network with no new projects or upgrades
- Construction ‘do minimum’ (2017) – current road network with the inclusion of the completed M4 Widening project
- Operation ‘do minimum’ (2021) – assumes that the King Georges Road Interchange Upgrade and the M4 Widening projects are complete, but the remaining WestConnex projects, including the M4 East, are not built. It is called ‘do minimum’ rather than ‘do nothing’ as it assumes that projects currently incomplete but scheduled for opening prior to the assessment year are operational, thus the network conditions are different to the 'Existing case (2012)'
- Operation 'do something' (2021) – as per 'do minimum' with the M4 East complete and open to traffic, but without any other proposed future WestConnex projects, This scenario includes provision of kerbside bus lanes on Parramatta Road between Burwood Road at Burwood and Chandos Street at Haberfield/Ashfield (however, these bus lanes do not form part of the project)
- Operation ‘do minimum’ (2031) – a future network including the King Georges Road Interchange Upgrade and M4 Widening projects and some upgrades to the broader transport network, but does not include the project or any other proposed future WestConnex projects
- Operation 'do something' (2031) – all WestConnex projects are complete, and also includes the Sydney Gateway and the Southern Extension. Bus lanes were included in this scenario as per the 2021 ‘do something’ scenario, along with an eastbound bus lane from west of Hume Highway at Ashfield to east of Sloane Street at Haberfield/Summer Hill, and a westbound bus lane from west of Norton Street at Leichhardt to Hume Highway at Ashfield (however, these bus lanes do not form part of the project).

8.1.2 Assess construction impacts

The construction impact assessment involved an assessment of anticipated construction related vehicles travelling to, from, and within the project footprint on the existing M4, Parramatta Road and local roads that would provide access to construction ancillary facilities. Based on the construction program, the fourth quarter of 2017 has been used as the assessment year for construction impacts, as this is when peak construction traffic volumes are expected.

8.1.3 Assess operational impacts

LinSig traffic models were developed to determine the operational performance of the existing and future road network during the AM and PM peak periods. The modelling included interchanges with the project intersections along Parramatta Road and the surrounding road network in the vicinity of the project.

Following the calibration of AM peak and PM peak base LinSig models, future year networks and traffic demands were developed for the five key modelling scenarios to be assessed:

- 2017 future year construction model
- 2021 and 2031 future year 'do minimum' models
- 2021 and 2031 future year 'do something' models.

The objective of the 'do minimum' models was to provide a benchmark to compare the operational performance of the 'do something' scenarios against future network conditions without the project and subsequent WestConnex stages.

The operational traffic assessment also included crash analysis, travel speeds and travel time analysis, and opportunities to enhance public and active transport networks within the project area.

8.2 Existing environment

8.2.1 Route description

Figure 8.1 shows the road network in the vicinity of the project.

Parramatta Road

Parramatta Road is classified as a State Significant Road and forms a major east–west Sydney metropolitan road corridor. The road extends from the intersection of the M4 and Church Street at Granville in the west, to Broadway on the south-western outskirts of the Sydney CBD in the east. It connects to several other major east–west road corridors, including the M4.

The road varies between two and three lanes in each direction. In the eastbound direction, two lanes are provided from Homebush Bay Drive to Bedford Road at Homebush West, then three lanes to Knight Street at Homebush. Parramatta Road then narrows to two lanes to Concord Road at North Strathfield/Concord, and then widens to three lanes to Sloane Street at Haberfield. Continuing east, beyond the project area, two lanes remain after Sloane Street up until immediately after Flood Street at Leichhardt, where a bus lane is added.

In the westbound direction, two lanes are provided from Crystal Street at Petersham to Norton Street at Leichhardt, where it widens to three lanes. The road narrows to two lanes just after Liverpool Road (Hume Highway) at Ashfield, and then widens to three lanes after Dalhousie Street at Haberfield, where it continues as three lanes to the intersection with the existing M4. The approach to the M4 consists of one through lane and two right-turn lanes to the M4 westbound, which extend back to Phillip Street at Strathfield. Continuing west, the configuration increases to two lanes from Concord Road at North Strathfield/Concord to George Street at North Strathfield, followed by three lanes from George Street to Homebush Bay Drive.

Parramatta Road has a posted speed limit of 60 kilometres per hour in both directions. There are 22 signalised intersections along the 9.6 kilometre long section of the road between Centenary Drive/Homebush Bay Drive at Homebush and Orpington Street at Ashfield.

In the vicinity of the project, Parramatta Road is of local and regional importance. It provides the main route for road vehicles travelling to, from, or through the corridor. The main Parramatta Road transport corridor accommodates a mix of travel demand characteristics that range from short local trips to longer through vehicle movements. The diverse types of business along the Parramatta Road transport corridor service both the local and wider community, meaning that a number of medium distance, one way trips are generated along the corridor.

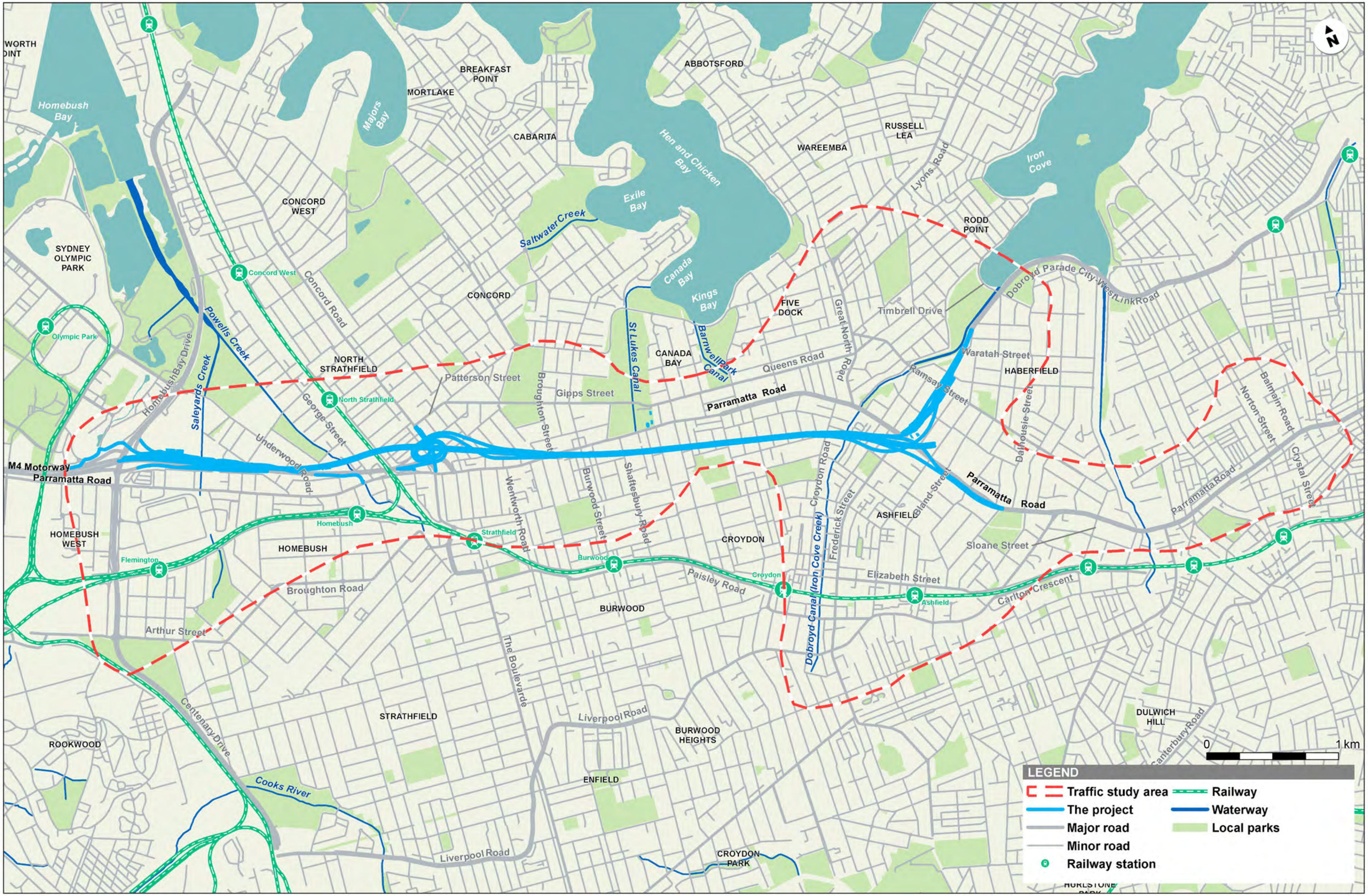

Figure 8.1 Existing road network within the study area

Adjacent transport corridors in the vicinity of the project, such as the Hume Highway, Wattle Street, Concord Road and the M4, connect Parramatta Road to major centres across the Sydney metropolitan area.

Parramatta Road currently accommodates high levels of demand to and from the M4, but functions as an arterial roadway, generally favouring through movements.

M4 Motorway

The M4 extends between the Blue Mountains at its western end and Parramatta Road at Concord at its eastern end. The M4 and Parramatta Road transport corridor is the main road freight, commercial and passenger route between the Sydney CBD, the inner-western suburbs, Parramatta, greater western Sydney and beyond to the Blue Mountains.

The M4 varies from two to four lanes in each direction, with on-ramps merging with the mainline carriageways in some locations resulting in operational constraints. East of Homebush Bay Drive, the posted speed limit varies between 60 and 90 kilometres per hour in each direction.

Work on the M4 Widening project began in March 2015. This project involves widening the M4 between Pitt Street at Parramatta and Homebush Bay Drive at Homebush, to include generally four lanes in each direction. The M4 Widening project also includes a new access from Hill Road to the M4 eastbound and a new on-ramp southbound from Homebush Bay Drive to the M4 westbound.

East–west routes

Alternative east–west arterial roads located in the vicinity of the project include:

- Frederick Street/Wattle Street/Dobroyd Parade/City West Link – this route, which is about 2.8 kilometres long, is a major connector between Sydney’s western and south-western suburbs and the Sydney CBD. It carries high volumes of traffic and provides an alternative route to Parramatta Road into Sydney CBD from inner-southern and inner-western Sydney
- Queens Road/Gipps Street/Patterson Street – this route extends about 3.4 kilometres from its intersection with Great North Road and Fairlight Street at Five Dock in the east, to Concord Road at Concord in the west. It provides an alternative route between Five Dock and Concord/M4 and serves a significant number of local businesses
- Hume Highway/Liverpool Road – this route, located to the south of Parramatta Road, is classified as a State Significant Road and provides an important metropolitan connection for both local and regional traffic. It extends from Liverpool in south-western Sydney, to join Parramatta Road near Summer Hill in the east, about 450 metres south-east of the project.

North–south routes

Key north–south arterial roads within the study area include:

- Homebush Bay Drive/Centenary Drive – this route extends about 6.5 kilometres between the northern Concord Road intersection at Rhodes and southern Hume Highway/Roberts Road intersection at Strathfield/Greenacre. It links the St George region, Sydney Olympic Park, Ryde, Sydney’s northern suburbs and the Northern Beaches. It includes east and west facing ramps to and from the M4. There are four signalised intersections along this corridor
- Concord Road/Leicester Avenue – this route extends about five kilometres between the intersection with Church Street at Meadowbank and the intersection with Everton Road at Strathfield. The Homebush Bay Drive/Centenary Drive route connects to Concord Road in Rhodes. Therefore, both routes share a similar north–south connectivity function in terms of linking the St George region with Sydney’s northern suburbs. However, Concord Road intersects with Parramatta Road further to the east and provides access to Strathfield rather than to Sydney Olympic Park. East facing ramps on the northern side of Parramatta Road provide direct access to and from the M4
- Great North Road and Lyons Road – extends about four kilometres through Five Dock and Drummoyne. It provides a north–east connection between Parramatta Road and Victoria Road.

8.2.2 Traffic volumes and patterns

To understand and analyse existing traffic volumes and patterns in the vicinity of the project, traffic surveys were undertaken between 2012 and 2014. The surveys recorded hourly traffic volumes at seven locations over a one week survey period. Survey locations are shown in **Figure 8.2**.

The following volumes are shown in **Table 8.2** for the seven survey sites:

- AM peak: morning single hour peak recorded between 6.00 am and 10.00 am
- PM peak: evening single hour peak recorded between 3.00 pm and 7.00 pm
- Average weekday traffic (AWT) volume: daily traffic volume – derived from 24 hour traffic counts recorded between Monday and Friday during the survey week
- Average daily traffic (ADT) volume: daily traffic volume – derived from 24 hour traffic counts recorded between Monday and Sunday during the survey week.

Table 8.2 Summary of traffic volumes

Site	AM peak hour	PM peak hour	Average weekday traffic (AWT)	Average daily traffic (ADT)
Site 1: Parramatta Road, Concord/Strathfield, east of the M4				
Eastbound	3,150	3,345	53,470	52,425
Westbound	3,053	2,691	49,735	48,950
Two-way	6,203	6,035	103,205	101,375
Site 2: Queens Road, Five Dock, between William Street and Coonardoo Close				
Eastbound	995	962	13,715	13,200
Westbound	941	987	13,610	13,245
Two-way	1,936	1,949	27,325	26,445
Site 3: Hume Highway, Ashfield, between Lion Street and Frederick Street				
Eastbound	1,068	913	14,585	14,000
Westbound	850	1313	15,715	15,235
Two-way	1,918	2,226	30,300	29,235
Site 4: Parramatta Road, Ashfield/Haberfield, west of Wattle Street				
Eastbound	2,535	2,370	43,370	43,190
Westbound	2,701	2,809	46,700	45,870
Two-way	5,236	5,179	90,070	89,060
Site 5: Ramsay Street, Five Dock/Haberfield, between Henley Marine Drive and Wolseley Street				
Eastbound	930	840	12,930	12,415
Westbound	829	990	13,170	12,740
Two-way	1,759	1,830	26,100	25,155
Site 6: Dobroyd Parade, Haberfield, east of Timbrell Drive				
Eastbound	1,993	2,117	32,285	32,175
Westbound	1,534	1,825	30,670	31,080
Two-way	3,527	3,942	62,955	63,255
Site 7: Parramatta Road, Haberfield/Lewisham/Leichhardt/Summer Hill, at the Hawthorne Canal				
Eastbound	2,384	1,883	32,925	32,140
Westbound	1,621	2,278	32,120	31,395
Two-way	4,005	4,161	65,045	63,535

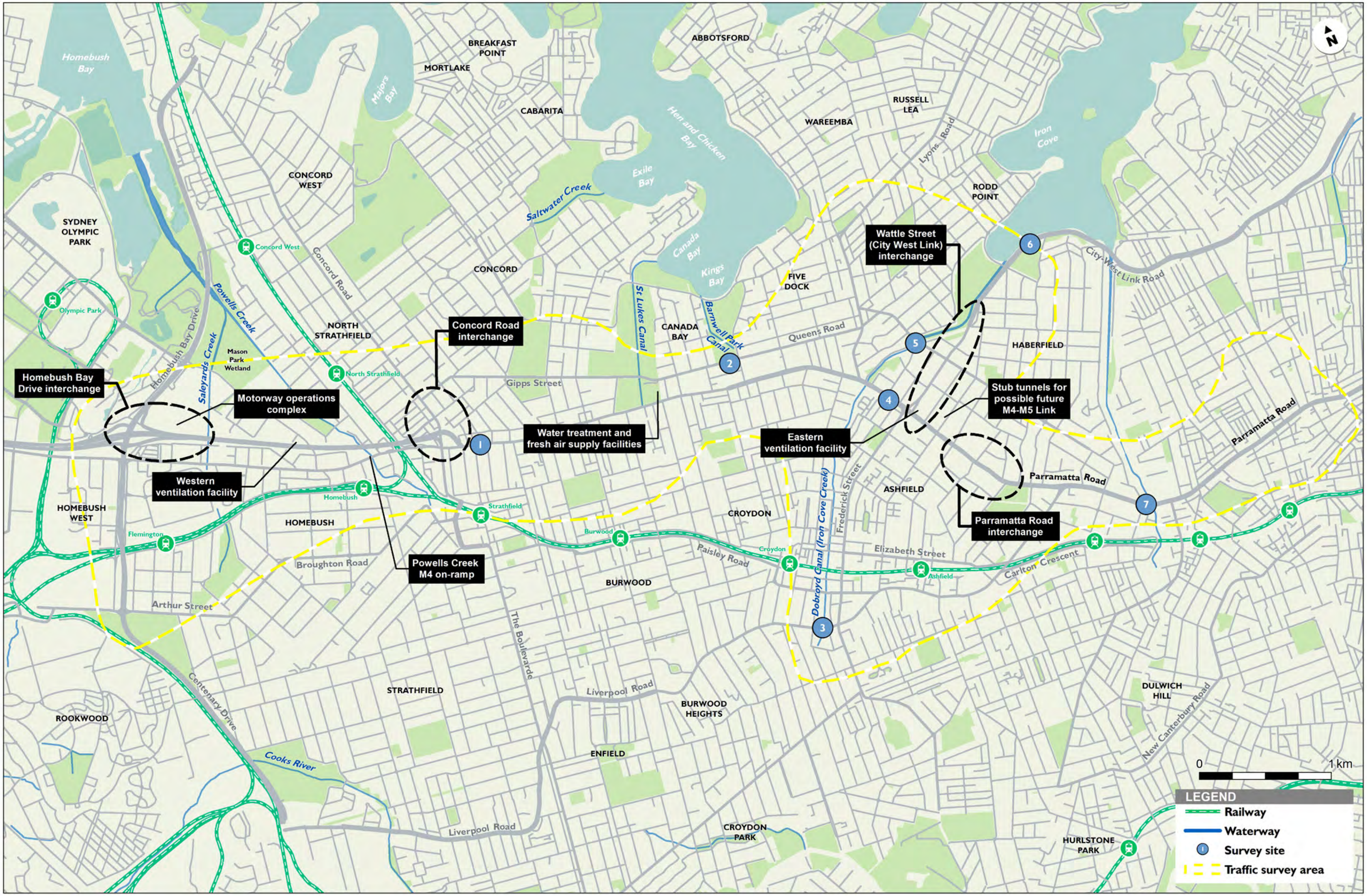

Figure 8.2 Traffic survey locations

The following key findings can be drawn from the traffic volumes shown in **Table 8.2**, and the figures in section 5.4 of the traffic and transport assessment in **Appendix G**:

- Parramatta Road:
  - Two-way AWT ranges from 101,375 east of the M4 to 89,060 west of Wattle Street, which equates to a 12 per cent reduction in daily traffic along Parramatta Road between these two locations. Moreover, AWT decreases to 63,535 vehicles per day on Parramatta Road at the Hawthorne Canal, which is a 37 per cent and 29 per cent reduction in comparison to the respective volumes east of the M4 and west of Wattle Street
  - AWT is generally around two per cent greater than ADT at all three locations on Parramatta Road, by direction and in combination. This indicates that average daily weekend traffic is generally at similar levels to ADT and hence the road corridor accommodates consistently high volumes of travel demand that are not biased towards weekday work-related trips
  - Peak period traffic volumes show similar trends to daily figures with the two-way AM peak and PM peak being 6,205 and 6,035 vehicles per hour respectively east of the M4. Importantly, the graphics show a fairly 'flat' profile of traffic throughout the day between the AM peak and PM peak periods at the three Parramatta Road locations. This confirms that traffic volumes on Parramatta Road are consistent throughout an average weekday, both during and between the more conventional morning and evening 'peak' periods
  - Traffic surveys recorded at three locations on Parramatta Road confirm that there is typically an even spread of directional volumes during the AM peak, PM peak and daily periods. The only location that shows a considerable deviation from this statistic is on Parramatta Road at the Hawthorne Canal during the AM peak, where eastbound volumes around 30 per cent higher than westbound traffic
- Dobroyd Parade:
  - Two-way AM peak and PM peak volumes recorded on Dobroyd Parade was 3,525 and 3,940 vehicles per hour respectively. Interestingly, the highest hourly volume was 2,115 vehicles in the eastbound direction during the PM peak period, which suggests that more vehicles are travelling towards the Sydney CBD in the evening
  - The two-way AWT volume on Dobroyd Parade is slightly less than the equivalent ADT figure, which suggests that traffic levels are fairly consistent across the seven day period, in line with patterns on the connecting Parramatta Road corridor
- Queens Road:
  - Directional peak period traffic volumes on Queens Road are at similar levels, ranging from 960 to 1045 vehicles per hour in the respective eastbound direction and westbound direction; during the average PM peak hour. This trend continues throughout the day with directional and two-way AWT and ADT volumes at similar levels, which peak to 27,325 vehicles during an average weekday. The profile of traffic across an average weekday on shows a more predictable pattern for two-way volumes, with more defined peaks during the morning and evening peak periods.
- Ramsay Street:
  - Peak hour volumes recorded on Ramsay Street are similar by direction and time-period, with the maximum flow around 1,000 vehicles per hour. Two-way AWT and ADT volumes were 26,100 and 25,155 vehicles per day, which equates to a four per cent increase in daily traffic during the five day period.
- Hume Highway:
  - Peak period counts on the Hume Highway show higher volumes of traffic in the eastbound and westbound direction during the respective AM peak and PM peak period. This suggests that the majority of vehicles are travelling towards the CBD in the morning and from the CBD in the evening.

8.2.3 Existing road network performance

Level of service

'Level of service' (LoS) is a measure to determine the operational conditions and efficiency of a roadway or intersection. The six levels of service range from A to F, with A representing the best operating conditions and F the worst. It is generally the practice of NSW Roads and Maritime Services (Roads and Maritime) to initiate investigations when the level of service of a roadway or intersection falls to D, and provide suitable remediation prior to the level of service decreasing further E or F. Further information on the definitions and calculation of level of service is provided in section 6.1 of the traffic and transport assessment (**Appendix G**).

Operational performance – roadways

Levels of service along the Parramatta Road and Wattle Street corridors under existing conditions are provided in **Table 8.3** for the AM and PM peak. The Parramatta Road corridor currently experiences high levels of mid-block traffic demand. West of Concord Road, the level of service generally exceeds D, with the mid-block volumes often exceeding the theoretical capacity of the road. The results indicate that, east of the M4, there are eastbound capacity issues during the AM peak. This reflects the relatively low traffic volumes on Parramatta Road west of Concord Road since the removal of tolls on the M4. An exception is east of Bland Street, where the traffic volumes on Parramatta Road are lower due to congestion at the Wattle Street intersection. High northbound volumes are also evident on Dobroyd Parade, reflecting city bound demand in the morning peak. The results for the PM peak are similar, although high traffic volumes are recorded in both directions. Low westbound traffic east of Bland Street can be explained by congestion at the Hume Highway intersection and the extra lane on Parramatta Road west of Dalhousie Street.

The Gipps Street and Queens Road corridor also experiences high traffic volumes and has a level of service of E/F in both peaks, with the exception of PM eastbound west of Great North Road. The midblock level of service for the existing M4 is generally D, but is somewhat distorted by queuing at the Parramatta Road intersection which artificially limits throughput.

Table 8.3 Base year midblock operational performance summary

Location and direction		No. lanes	AM peak hour LoS	PM peak hour LoS
Parramatta Road west of Bridge Road - Homebush	EB	3	B	C
	WB	3	C	C
Parramatta Road between Knight Street and Concord Road - Strathfield	EB	2	D	D
	WB	2	D	D
Parramatta Road between Mosely Street and Burwood Road - Strathfield	EB	3	F	F
	WB	3	F	E
Parramatta Road between Shaftesbury Road and Harris Street - Burwood	EB	3	E	E
	WB	3	D	E
Parramatta Road between Bland Street and Dalhousie Street - Haberfield	EB	3	D	D
	WB	3	D	C
Parramatta Road between Sloane Street and West Street - Haberfield	EB	2	F	F
	WB	3	D	E
Parramatta Road east of Crystal Street - Petersham	EB	2	F	E
	WB	2	D	F
Dobroyd Parade north of Timbrell Drive - Haberfield	NB	2	F	F
	SB	2	E	F
Queens Road west of Great North Road - Five Dock	EB	1	F	E
	WB	1	F	E
Queens Road west of Harris Street - Five Dock	EB	1	F	D
	WB	1	F	F
Gipps Street west of Burwood Road - Concord	EB	1	E	F
	WB	1	E	F
M4 Motorway west of Concord Road off-ramp – Strathfield	EB	2	D	D
	WB	2	D	C

Operational performance – intersections

Table 8.3 provides a summary of the level of service (average intersection delays) at key intersections along Parramatta Road corridor for the AM and PM peak. The intersections were grouped into nine clusters for assessment purposes (as shown in **Figure 8.3**).

Table 8.4 Base year intersection operational performance summary

Cluster	Intersection	AM peak hour LoS	PM peak hour LoS
1	Homebush Bay Drive | M4 eastbound on-ramp	A	A
	Homebush Bay Drive | M4 eastbound off-ramp	D	C
	Homebush Bay Drive | M4 westbound on-ramp & off-ramp	D	D
	Arthur Street | Centenary Drive	E	D
2	Underwood Road | Pomeroy Street	D	E
	Parramatta Road | Bridge Road	C	B
	Parramatta Road | Park Road	A	A
	Parramatta Road | Underwood Road	B	C
	Parramatta Road | Knight Street	A	A
3	Patterson Road | Concord Road	F	D
	Sydney Street | Concord Road	D	E
	Parramatta Road | Concord Road	E	F
	Parramatta Road | M4	E	E
4	Parramatta Road | Wentworth Road	F	D
	Parramatta Road | Broughton Street	D	B
	Parramatta Road | Burwood Road	F	B
	Gipps Street | Burwood Road	F	C
	Parramatta Road | Shaftesbury Road	E	D
5	Harris Street | Queens Road	D	D
	Great North Road | Queens Road	D	C
	Great North Road | Ramsay Road	D	E
	Ramsay Road | Fairlight Street	F	E
	Great North Road | Lyons Road	E	F
6	Parramatta Road | Harris Road	D	C
	Parramatta Road | Croydon Road	D	E
	Parramatta Road | Great North Road	E	D
	Parramatta Road | Frederick Street	F	F
	Parramatta Road | Bland Street	B	B
	Wattle Street | Ramsay Street	F	E
	Dobroyd Parade | Waratah Street	B	B
	Dobroyd Parade | Timbrell Drive	E	D
7	Hume Highway | Frederick Street	F	F
8	Parramatta Road | Dalhousie Street	C	B
	Parramatta Road | Hume Highway	F	F
	Parramatta Road | Sloane Street	D	C
9	Parramatta Road | Flood Street	D	D
	Parramatta Road | Norton Street	E	D
	Parramatta Road | Crystal Street	F	D

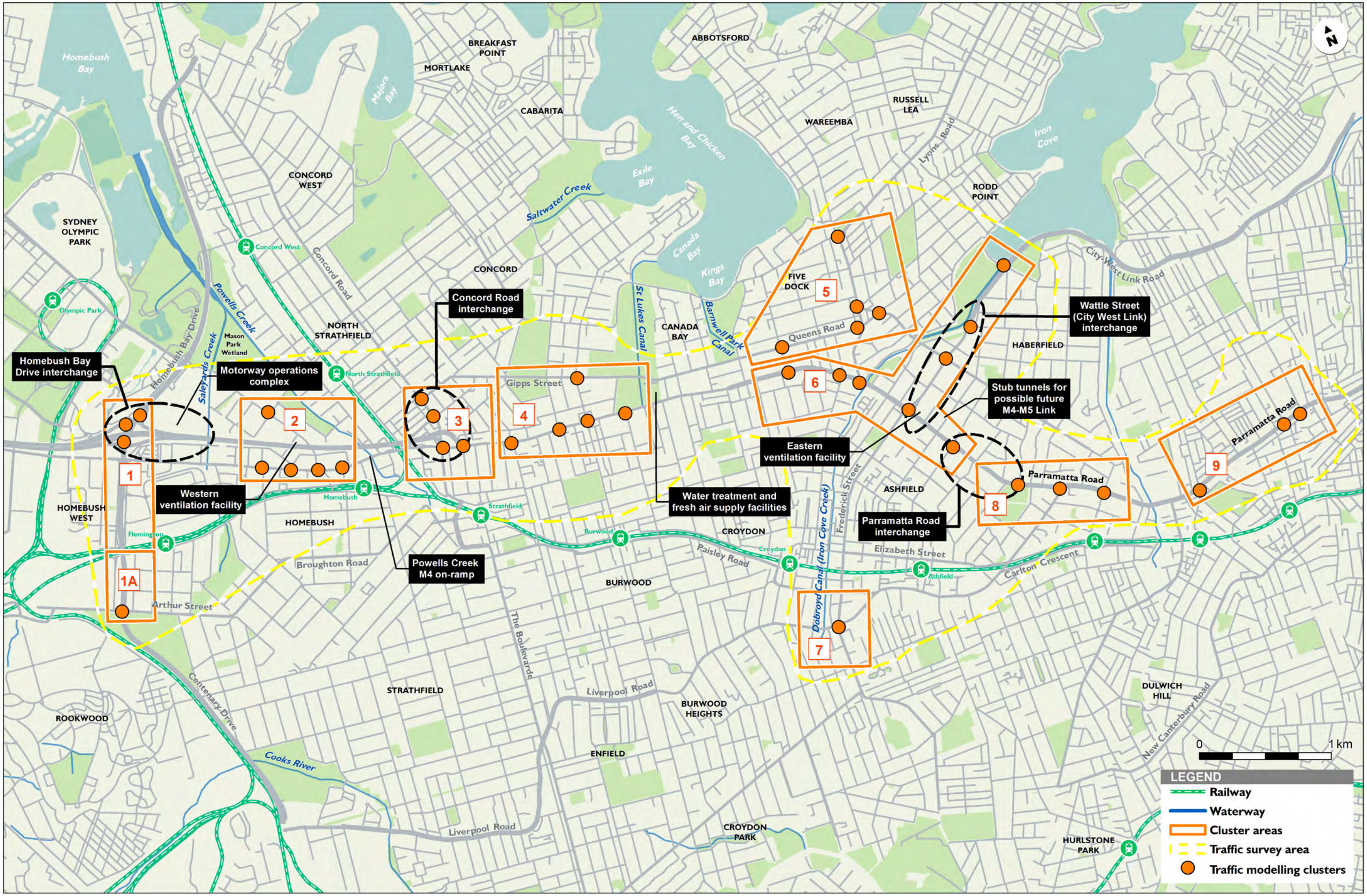

Figure 8.3 Traffic modelling clusters

The Parramatta Road and Wattle Street corridors experience significant congestion during the AM and PM peaks. The traffic signals are coordinated to provide priority along the corridor to reduce the average delays to the major through movements in the peak direction. The results shown in the table indicate that a number of the intersections operate at or close to capacity. Intersections with a number of conflicting movements experience higher average intersection delays.

Traffic crash history

Parramatta Road

Between July 2009 and June 2014, 919 crashes were recorded on Parramatta Road between Homebush Bay Drive and Balmain Road. Two were fatal crashes, 400 resulted in injury and 517 were non-casualty crashes. Of these crashes, 621 (68 per cent) occurred at intersections.

The crash breakdown indicates that about 43 per cent of crashes were rear end crashes. This is consistent with roadways that are approaching capacity and along which high levels of queuing occur on the approaches to intersections. About 15 per cent of crashes were between opposing vehicles, and about 10 per cent resulted from lane changes.

Corridor analysis

Crash severity indices provide an assessment of road safety based on the type and number of crashes occurring. All crash types carry different weightings with fatal crashes having the highest weighting. The crash severity index for Parramatta Road is 1.22 which is equal to the average for the Sydney Metropolitan Area. The M4 has a slightly lower rating of 1.18.

Existing tunnels in Sydney (eg Lane Cove, Eastern Distributor, Cross City Tunnel and Sydney Harbour Tunnel) have a crash severity index of 1.16 which is reflective of the more controlled conditions, lower speeds and greater drive care when travelling in tunnels.

Table 8.5 outlines the average crash rates for Parramatta Road, M4 and existing Sydney tunnels. Parramatta Road has a significantly higher crash rate compared to the M4 and existing Sydney Tunnels. Crash rates within Sydney's tunnels are substantially lower than on the M4 Motorway (ie three times lower) and Parramatta Road (ie about 12 times lower).

Table 8.5 Crash rates per 100 million vehicle kilometres travelled

Road	Crash rate per 100MVKT			
	Total	Fatal	Injury	Tow-away
Parramatta Road	136.0	0.3	54.8	70.9
M4 Motorway	33.9	0.1	11.7	22.1
Existing Sydney Tunnels (Lane Cove, Eastern Distributor, Cross City Tunnel and Sydney Harbour Tunnel)	11.6	0.0	4.2	7.4

Crashes on Parramatta Road between 1 July 2009 and 30 June 2014 cost an estimated total of $62,395,968, or $12,479,194 per annum. The analysis indicates an average crash cost per 100 million vehicle kilometres travelled of $14,670,060 for the four sections analysed.

8.2.4 Public and active transport

Bus network

The project falls within the Sydney Metropolitan Bus Region 6, which is operated by Sydney Buses. The bus network in the vicinity of the project includes buses servicing the Hurstville to Macquarie Park strategic north–south bus corridor (route M41) and the Burwood to the CBD strategic east–west bus route (route 461), which runs along Parramatta Road. There are several bus routes that operate within particular sections of the project area via train station hubs, such as Strathfield, Burwood and Ashfield.

There are a number of bus services that travel along sections of Parramatta Road between Homebush Bay Drive and Wattle Street (routes 525, 526, 461, 415, 490, 492 and 491). Six Sydney Metropolitan Bus Region 6 routes cross Parramatta Road during peak periods between Homebush Bay Drive and Wattle Street.

Sydney's Bus Future (Transport for NSW 2013) and the Parramatta Road Urban Transformation Program (being undertaken by Urban Growth NSW in conjunction with the project) will result in changes to the bus network using Parramatta Road and the wider project area.

Rail network

The project area is serviced by the North Shore, Northern and Western Rail Line (T1), and the Airport, Inner West and South Rail Line (T2). To the north of the project, North Strathfield Station is serviced by the Main Northern Rail Line which provides limited stops services to Sydney Central. To the south, up to 10 stations are serviced by the T1 and/or T2 Lines with some stations supporting limited stop express services. Strathfield and Burwood stations (to the south) accommodate the highest volume of passengers due to the large number of AM and PM peak services.

Pedestrian network

The nature of the pedestrian network in the vicinity of the project varies. Residential areas generally provide good local walking connections and footpaths, particularly in areas away from major roads. Sydney Markets, Sydney Olympic Park, Rhodes and Burwood are close to the study area and within walking distance to rail station and bus connections.

There are a limited number of signalised pedestrian crossings on Parramatta Road. The distance between signalised pedestrian crossings is up to 800 metres in some sections.

Cycling network

There are limited segregated cycling facilities along the Parramatta Road corridor. Dedicated cycleways or cycle lanes are generally aimed towards leisure rather than commuter trips. There are major gaps in north–south connections, due to the lack of permeability of Parramatta Road and the M4. In the project area, cyclists currently use the shoulders of the existing M4 to travel both eastbound and westbound. In the eastbound direction, cyclists are required to leave the M4 at Sydney Street due to the inadequate shoulder east of Sydney Street. In the westbound direction, cyclists access the M4 from the westbound on-ramp at Concord Road, due to the inadequate shoulder east of this location.

8.3 Assessment of construction impacts

Construction of the project has the potential to result in changes and disruptions to the existing road and transport network as a result of:

- The movement of construction vehicles, particularly heavy vehicles transporting spoil, to and from the construction footprint, including the 10 construction ancillary facilities
- Surface works requiring temporary traffic, cyclist and/or pedestrian diversions, road occupation, alterations to access, alterations to bus stops, temporary road closures, and alterations to speed limits.

A summary of the construction impact assessment is provided in the following sections.

8.3.1 Construction traffic volumes and routes

Type of traffic generated by construction

Construction would result in the generation of additional movements of both heavy and light vehicles on the road network. Construction traffic was divided into three categories for assessment purposes:

- Removal of spoil generated by construction activities
- Heavy vehicle deliveries and other heavy vehicles associated with construction activities
- Light vehicles travelling to and from ancillary construction facilities.

The impacts of the project during construction were assessed assuming that spoil would be hauled in a westerly direction along the M4.

The majority of the ancillary construction facilities proposed for the project would have some parking available, however parking would not be provided for the whole construction workforce. The management of construction workforce parking is discussed further in **section 6.6.5** of **Chapter 6** (Construction work). An upgraded car park on the northern side of Concord Oval would provide about 250 car parking spaces for employees of the main project office during weekdays (before 6.30 pm). During weekends and after 6.30 pm on weekdays, the following indicative allocation of car spaces would occur:

- 145 public parking spaces on Saturdays (leaving 100 for the construction workforce)
- 195 public parking spaces on Sundays (leaving 50 for the construction workforce)
- 145 public parking spaces on weeknights after 6.30 pm (leaving 100 for the construction workforce).

In addition, an existing car park at Railway Lane at North Strathfield containing about 50 car parking spaces would be used. This site is within walking distance of the Underwood Road civil and tunnel site (C3), Powells Creek civil site (C4), and the Concord Road civil and tunnel site (C5).

Construction traffic volumes

Table 6.20 in **Chapter 6** (Construction work) shows the predicted construction traffic volumes for each ancillary construction facility during a typical AM peak, PM peak and daily period. The table shows that the highest volumes of heavy vehicles are forecast to originate from the Concord Road civil and tunnel site (C5) and Northcote Street tunnel site (C7), with the highest volumes of light vehicles generated by the Cintra Park tunnel site (C6).

Table 8.6 provides indicative volumes on key roads during the AM and PM peak periods for construction heavy vehicles. The volumes shown are based on spoil haulage occurring between 7,00 am and 10.00 pm daily. However, 24 hour spoil haulage would be required during tunnelling activity.

Table 8.6 Indicative peak period distribution of heavy construction vehicles (two-way)

Road location	AM construction peak hour (7.30 am - 8.30 am)	PM construction peak hour (4.15 pm - 5.15 pm)
Wattle Street	80	60
Concord Road	34	21
Parramatta Road	172	161
M4 Motorway	240	203

Construction traffic routes

Table 6.19 in **Chapter 6** (Construction work) outlines the proposed access and egress points to and from the construction ancillary facilities. The spoil haulage routes from the tunnel sites are shown in **Figure 6.22** to **Figure 6.24** in **Chapter 6** (Construction work).

It has been assumed that concrete for tunnel construction would mainly originate from batching plants close to the project, although other sources may also be required. Other materials required for construction would, where as far as practicable, originate from within the Sydney region. Vehicles would generally use the arterial road network to access the various construction ancillary facilities.

8.3.2 Local road network impacts

Table 8.7 outlines the potential impacts of construction on the local road network in the vicinity of each of the construction ancillary facilities.

Table 8.7 Summary of local impacts of construction ancillary facilities

Ancillary construction facility	Potential impacts on local roads
Homebush Bay Drive civil site (C1)	Impacts would be minimal as vehicle access would be directly to and from the M4 or from the Homebush Bay Drive on-ramp. Temporary diversions at various stages and potential reduction in speed limit. There would be no reduction in the number of traffic lanes (except during night works) or impact on movements.
Pomeroy Street civil site (C2)	Impacts would be minimal as the majority of construction vehicles would access the site directly to and from the M4 via the Homebush Bay Drive civil site (C1) – this would include all heavy vehicle movements. Some light vehicles would use Pomeroy Street, however, the low daily vehicle numbers would result in only minor impacts. Parking along Pomeroy Street in the vicinity of the work zone would be impacted.
Underwood Road civil and tunnel site (C3)	Impacts would be limited to Underwood Road and Short Street East. Access to the site would be via a new traffic signal on Underwood Road. This new signal would potentially result in minor delays to traffic along Underwood Road. No impacts to Ismay Avenue or Allen Street are predicted, as all movements would be via the Underwood Road access. Parking along Underwood Road and Short Street East in the vicinity of the site would be impacted.
Powells Creek civil site (C4)	Powell Street would be used as a heavy vehicle access route. Construction vehicles would access Powell Street from the signalised intersection of Underwood Road and Parramatta Road. There could be minor delays for northbound vehicles on Underwood Road, and localised parking restrictions may be required to enable turning movements.
Concord Road civil and tunnel site (C5)	Impacts would be limited to Concord Road and Sydney Street. The existing signals at Concord Road and Sydney Street would be modified to allow vehicles to enter and exit the site. This may result in delays to road users on Concord Road. Light vehicle impacts on surrounding streets are expected to be minimal. It is predicted that Ada and Alexandra streets would experience some additional light vehicle traffic. Parking along Ada, Edward and Alexandra streets in the vicinity of the site would be potentially impacted.
Cintra Park tunnel site (C6)	Impacts from heavy vehicles would be minimal, as movements would be directly to and from Parramatta Road. Light vehicle movements would result in impacts along Gipps Street. The impact of these movements on the performance of nearby intersections is considered in **section 8.3.3**.
Northcote Street tunnel site (C7)	Impacts would be confined to Wattle Street, as movements would be directly to and from Parramatta Road via Wattle Street. A new movement, to permit heavy vehicles to turn around to access Parramatta Road, would be included at the existing signalised intersection at Waratah Street. This new movement would cause additional delays at this intersection (see **section 8.3.3**).
Eastern ventilation facility site (C8)	Impacts would be confined to Parramatta Road and Wattle Street, as movements would be directly to and from these arterial roads. Walker Avenue would experience some additional light vehicle movements; however, these impacts are expected to be minimal. The eastbound lanes of Walker Avenue would be closed and left-in from Parramatta Road permitted only for construction traffic. The southbound traffic lane would remain open to the public and would permit left turn onto Parramatta Road.

Ancillary construction facility	Potential impacts on local roads
Wattle Street and Walker Avenue civil site (C9)	Impacts would occur at Ramsay Street and Waratah Street due to the provision/modification of traffic signals and additional heavy vehicle movements. The impacts on these intersections are considered in **section 8.3.3**. Martin and Allum streets would be closed at Wattle Street during construction to allow for the construction of the project along Wattle Street. Martin Street would be reopened following construction (with changes to turning movements), while Allum Street would be closed permanently. Alternate access to Wattle Street would be available at Ramsay Street or Waratah Street.
Parramatta Road civil site (C10)	Impacts would be minimal as vehicles would access the site directly to and from Parramatta Road. Some delays for vehicles on Bland Street would be experienced due to heavy vehicles exiting the site via Bland Street to access Parramatta Road. One eastbound and one westbound lane of Parramatta Road would be closed as a result of the establishment of the civil site. This would result in two lanes in each direction during construction. Chandos Street would be closed at Parramatta Road during construction, and reopened during following construction.

8.3.3 Road and intersection performance

Road performance during construction

Table 8.8 shows the impact of construction on the operation of key roads. The table shows that several sections of Parramatta Road are forecast to exceed the roadway capacity with the increased background traffic and construction traffic in the 2017 AM and PM peak hours. The existing traffic volumes on these road sections are congested.

Table 8.8 Construction year (2017) midblock operational performance summary

Location and direction		No. lanes	AM peak hour (veh/hr)			PM peak hour (veh/hr)		
			Flow	V/C	LOS	Flow	V/C	LOS
Parramatta Road west of Bridge Road - Homebush	EB	3	1,332	0.49	C	1,678	0.62	D
	WB	3	1,804	0.67	D	1,694	0.63	D
Parramatta Road between Knight Street and Concord Road - Strathfield	EB	2	1,341	0.75	D	1,489	0.83	E
	WB	2	1,636	0.91	E	1,565	0.87	E
Parramatta Road between Mosely Street and Burwood Road - Strathfield	EB	3	2,768	1.03	F	2,823	1.05	F
	WB	3	2,830	1.05	F	2,490	0.92	E
Parramatta Road between Shaftesbury Road and Harris Street - Burwood	EB	3	2,376	0.88	E	2,457	0.91	E
	WB	3	2,078	0.77	D	2,358	0.87	E
Parramatta Road between Bland Street and Dalhousie Street - Haberfield	EB	3	2,099	0.78	D	2,185	0.81	D
	WB	3	1,840	0.68	D	1,668	0.62	D

Location and direction		No. lanes	AM peak hour (veh/hr) Flow	V/C	LOS	PM peak hour (veh/hr) Flow	V/C	LOS
Gipps Street west of Burwood Road - Concord	EB	1	872	0.97	E	994	1.10	F
	WB	1	861	0.96	E	1,067	1.19	F
M4 Motorway west of Concord Road off-ramp - Strathfield	EB	2	3,168*	0.70	D	3,135	0.70	C
	WB	2	3,290*	0.73	D	2,426	0.54	C

Notes: V/C = volume to capacity ratio

* Freeway level of service is evaluated in passenger car units

Intersection level of service

The performance of key intersections in the vicinity of the project was modelled for the intersections that would be likely to experience the highest traffic volumes of construction traffic. The detailed results of modelling are provided in section 7.4.3 of the Traffic and Transport Report in **Appendix G**. A summary of these results is provided below.

The results indicate that for the 2017 'do minimum' scenario, a number of key intersections on the Parramatta Road corridor would operate at or above capacity and experience high levels of delay during the AM and PM peak periods. The following intersections would operate at a level of service F for this scenario:

- Patterson Street/Concord Road (AM peak)
- Parramatta Road/Concord Road (PM peak)
- Parramatta Road/Wentworth Road (AM peak)
- Parramatta Road/Burwood Road (AM peak)
- Parramatta Road/Frederick Street (AM and PM peak)
- Wattle Street/Ramsay Street (AM peak).

As each of these intersections already operates at capacity without construction vehicles, the intersections are susceptible to large increases in average delay with only small increases in demand as a result of construction traffic. Background traffic growth accounts for part of the deterioration of the road network. In addition to those intersections already forecast to operate at or beyond capacity (without construction traffic), the modelling results indicate that the performance of the following intersections would deteriorate to a LoS F:

- Parramatta Road/George Street (PM peak)
- Sydney Street/Concord Road (PM peak)
- Parramatta Road/Concord Road (AM peak)
- Parramatta Road/M4 Motorway (AM peak)
- Parramatta Road/Broughton Street (AM peak)
- Parramatta Road/Croydon Road (AM and PM peak)
- Parramatta Road/Shaftsbury Road (AM peak).

The above results represent a worst case cumulative effect of construction traffic. This would not occur for the entire duration of the construction period.

It is noted that at some intersections, stable or minor improvements in performance (with the addition of construction traffic) would occur as a result of upstream intersections operating over capacity. Once capacity is reached, upstream intersections behave as bottlenecks, reducing traffic flow to downstream intersections. This explains why some intersections show slight improvements to performance with the addition of construction traffic.

8.3.4 Access changes

Table 6.16 in **Chapter 6** (Construction work) shows the temporary road closures and diversions on the existing road network required to facilitate construction. The majority of road and lane closures are anticipated to result in limited impacts to road users, as they would mainly affect local roads with low traffic volumes and/or streets where land acquisition is taking place. Alternative routes could therefore be used with minimal impacts.

Traffic lanes would be maintained on Sydney Street during peak hours. Impacts on the Sydney Street/Concord Road intersection as a result of construction traffic and changes to signal phasing are considered in **section 8.3.3**.

Existing lanes would generally be maintained on Ramsay Street although some short term detours, lane closures and temporary diversions may occur where approved under a Traffic Management and Safety Plan.

It is predicted that the inclusion of new signals at Parramatta Road and Orpington Street would only impact westbound vehicles. Potential impacts would be limited as a result of the low construction vehicle volumes, which would mean the turning signal would only be used infrequently. Impacts would also reduce if the signal phasing is offset with the Dalhousie Street intersection.

Parking restrictions would be put in place on Underwood Road (at the Underwood Road civil and tunnel site (C3)), and potentially at the Powell Street intersection to accommodate movements to the Powells Creek civil site (C4) via Powell Street.

8.3.5 Road safety

Construction traffic volumes are expected to be relatively low compared to existing traffic volumes on Parramatta Road and the M4. As a worst-case scenario, around 2,000 vehicles per day would be generated by construction, with heavy vehicles comprising slightly more than half this total. Compared to existing traffic volumes, construction traffic would be the equivalent of around two per cent of total daily traffic on Parramatta Road in the study area.

As the volume of traffic generated by construction is expected to be relatively low compared to existing traffic volumes, the impacts of this short-term increase in traffic on the existing road network is not expected to significantly impact road safety in the vicinity of the project. In addition, any foreseen impacts to road safety during construction would be mitigated through the provision of tailored traffic management plans and other measures.

8.3.6 Public transport

Bus network

An increase in heavy vehicles on the existing road network during the construction period would be likely to result in increased delays at intersections along the project corridor and in surrounding areas. It is likely that the volumes of heavy vehicles on Parramatta Road and surrounding major roads would increase. Construction would have the potential to result in the following impacts to public transport services:

- An increase in bus service travel times due to slower travel speeds and increased intersection delays
- Longer travel times to and from bus stops by supplementary travel modes (eg car passenger, walking to/from bus stop) due to an increase in traffic volumes, slower travel speeds and increased intersection delays
- Reduced amenity for bus users waiting at stops
- At least four bus-stops would need to be relocated to protect community safety during construction
- Connections between bus services and trains services may be affected.

Table 6.18 in **Chapter 6** (Construction work) outlines the indicative changes to bus stop locations during construction. These would be subject to consultation with Transport for NSW.

Rail network

No impacts to rail services in the project corridor and surrounding areas are expected as a result of construction. Bus service connections to railway stations may be affected due to a potential reduction in the reliability of bus services during construction.

8.3.7 Pedestrians and cyclists

Pedestrian and cyclist diversions required during construction are outlined in **Table 6.17** in **Chapter 6** (Construction work).

The increase in heavy vehicle volumes during construction would potentially impact walking and cycling as follows:

- Walking:
  - Increased walking distance as a result of diversions and road closures in some locations
  - Reduced pedestrian amenity
  - Potential adverse effect on pedestrian wait times at signalised intersections if adjustments are made to accommodate increased volumes
- Cycling:
  - Increased delays at intersections for on road cyclists due to an increase in traffic volumes
  - Increase in journey time and distance due to closed shoulders and detours
  - Reduced cyclist amenity.

A staging plan would be implemented to ensure connectivity is maintained for cyclists during construction. This would involve the provision of detour routes as the section of existing cycle route on the M4, around Homebush Bay Drive, would be unavailable during construction. A diversion route, to remove cyclists off the M4 has been implemented for the M4 Widening project, and this detour may be used during construction of the M4 East project. To avoid Concord Road, a further diversion would be provided (refer to **section 6.6.2** and **Figure 6.19** in **Chapter 6** (Construction work)). The route would be confirmed following appropriate consultation with Roads and Maritime, local councils and cycling groups.

8.4 Assessment of operation impacts

8.4.1 Road and intersection performance

Road performance during operation

The midblock level of service at key locations in the vicinity of the project was assessed for both the ‘do minimum’ and 'do something' scenarios. The results of modelling the 2021 and 2031 AM peak and PM peak operational performance of the project (the ‘do something’ scenarios) are summarised in **Table 8.9** to **Table 8.12**. The results for the ‘do minimum’ scenarios are provided for comparison.

There will be a reduction in traffic volumes on some sections of Parramatta Road as a result of the project which provides an opportunity to improve public transport along the corridor (not included as part of this project). The results of the 2021 AM peak and PM peak indicate that level of service along Parramatta Road improves significantly between the M4 and Dalhousie Street, with small deteriorations elsewhere. This reflects the extent of the project, and the fact that a larger number of vehicles can access Parramatta Road east of the project due to the increased capacity provided. It is noted that some of the higher traffic densities are observed downstream of the project on- and off-ramps on Parramatta Road and Wattle Street. This provides an indication of the extra capacity provided to take vehicles to those locations, and of potential exit and merge issues. A high level of service is provided within the section of the project carrying the most vehicles, east of Concord Road.

Table 8.9 2021 'do something' AM peak midblock operational performance

Location and direction		No. lanes	Do minimum (veh/hr) Flow	V/C	LoS	No. lanes	Do something (veh/hr) Flow	V/C	LoS
Parramatta Road west of Bridge Road - Homebush	EB	3	1,458	0.54	C	3	1,559	0.58	C
	WB	3	1,589	0.59	C	3	1,840	0.68	D
Parramatta Road between Knight Street and Concord Road - Strathfield	EB	2	1,376	0.76	D	2	1,769	0.98	E
	WB	3	1,632	0.60	D	3	2,202	0.82	F
Parramatta Road between Mosely Street and Burwood Road - Strathfield	EB	3	2,640	0.98	E	3	1,589	0.59	C
	WB	3	2,956	1.09	F	3	1,763	0.65	D
Parramatta Road between Shaftesbury Road and Harris Street - Burwood	EB	3	2,250	0.83	E	2	864	0.48	C
	WB	3	2,215	0.82	E	2	640	0.36	B
Parramatta Road between Bland Street and Dalhousie Street - Haberfield	EB	3	2,042	0.76	D	3	1,312	0.49	C
	WB	3	1,925	0.71	D	3	832	0.31	B
Parramatta Road between Sloane Street and West Street - Haberfield	EB	2	2,632	1.46	F	2	2,731	1.52	F
	WB	3	2,749	1.02	F	3	2,898	1.07	F
Parramatta Road east of Crystal Street - Petersham	EB	2	2,005	1.11	F	2	2,011	1.12	F
	WB	2	2,201	1.22	F	2	2,205	1.22	F
Dobroyd Parade north of Timbrell Drive - Haberfield	NB	2	1,987	1.10	F	2	1,989	1.11	F
	SB	2	1,882	1.05	F	2	1,916	1.06	F
M4 East east of Concord Road - Strathfield	EB	-	-	-	-	3	2,443*	0.36	B
	WB	-	-	-	-	3	3,045*	0.45	B
Queens Road west of Great North Road - Five Dock	EB	1	939	1.04	F	1	909	1.01	F
	WB	1	1,065	1.18	F	1	909	1.01	F
Queens Road west of Harris Street - Five Dock	EB	1	1,059	1.18	F	1	1,002	1.11	F
	WB	1	1,164	1.29	F	1	1,028	1.14	F
Gipps Street west of Burwood Road - Concord	EB	1	859	0.95	E	1	814	0.90	E
	WB	1	896	1.00	E	1	799	0.89	E
M4 Motorway west of Concord Road off-ramp - Strathfield	EB	2	2,883*	0.64	C	2	1,066*	0.24	A
	WB	2	3,509*	0.78	D	2	1,592*	0.35	B

Notes: V/C = volume to capacity ratio

* Freeway level of service is evaluated in passenger car units

Table 8.10 2021 'do something' PM peak midblock operational performance

Location and direction		No. lanes	Do minimum (veh/hr) Flow	V/C	LoS	No. lanes	Do something (veh/hr) Flow	V/C	LoS
Parramatta Road west of Bridge Road - Homebush	EB	3	1,839	0.68	D	3	1,948	0.72	D
	WB	3	1,594	0.59	D	3	1,882	0.70	D
Parramatta Road between Knight Street and Concord Road - Strathfield	EB	2	1,541	0.86	E	2	2,037	1.13	F
	WB	3	1,507	0.56	C	3	2,096	0.78	D
Parramatta Road between Mosely Street and Burwood Road - Strathfield	EB	3	2,912	1.08	F	3	1,272	0.47	C
	WB	3	2,420	0.90	E	3	1,744	0.65	D
Parramatta Road between Shaftesbury Road and Harris Street - Burwood	EB	3	2,582	0.96	E	2	847	0.47	C
	WB	3	2,290	0.85	E	2	1,052	0.58	C
Parramatta Road between Bland Street and Dalhousie Street - Haberfield	EB	3	2,246	0.83	E	3	1,132	0.42	C
	WB	3	1,582	0.59	C	3	833	0.31	B
Parramatta Road between Sloane Street and West Street - Haberfield	EB	2	2,320	1.29	F	2	2,448	1.36	F
	WB	3	2,373	0.88	E	3	2,495	0.92	E
Parramatta Road east of Crystal Street - Petersham	EB	2	1,987	1.10	F	2	2,053	1.14	F
	WB	2	2,154	1.20	F	2	2,255	1.25	F
Dobroyd Parade north of Timbrell Drive - Haberfield	NB	2	2,194	1.22	F	2	2,206	1.23	F
	SB	2	1,904	1.06	F	2	1,923	1.07	F
M4 East east of Concord Road - Strathfield	EB	-	-	-	-	3	2,854*	0.42	B
	WB	-	-	-	-	3	2,897*	0.43	B
Queens Road west of Great North Road - Five Dock	EB	1	774	0.86	E	1	735	0.82	E
	WB	1	913	1.01	F	1	863	0.96	E
Queens Road west of Harris Street - Five Dock	EB	1	756	0.84	E	1	642	0.71	D
	WB	1	1,000	1.11	F	1	958	1.06	F
Gipps Street west of Burwood Road - Concord	EB	1	1,010	1.12	F	1	906	1.01	F
	WB	1	1,045	1.16	F	1	1,011	1.12	F
M4 Motorway west of Concord Road off-ramp - Strathfield	EB	2	3,290*	0.73	D	2	1,030*	0.23	A
	WB	2	2,201*	0.49	C	2	783*	0.17	A

Notes: V/C = volume to capacity ratio

* Freeway level of service is evaluated in passenger car units

Table 8.11 2031 'do something' AM peak midblock operational performance

Location and direction		No. lanes	Do minimum (veh/hr) Flow	V/C	LoS	No. lanes	Do something (veh/hr) Flow	V/C	LoS
Parramatta Road west of Bridge Road - Homebush	EB	3	1,724	0.64	D	3	1,781	0.66	D
	WB	3	1,833	0.68	D	3	2,012	0.75	D
Parramatta Road between Knight Street and Concord Road - Strathfield	EB	2	1,551	0.86	E	2	1,948	1.08	F
	WB	3	1,908	0.71	D	3	2,412	0.89	E
Parramatta Road between Mosely Street and Burwood Road - Strathfield	EB	3	2,624	0.97	E	3	1,674	0.62	D
	WB	3	3,407	1.26	F	3	2,425	0.90	E
Parramatta Road between Shaftesbury Road and Harris Street - Burwood	EB	3	2,101	0.78	D	2	1,016	0.56	C
	WB	3	2,416	0.89	E	2	1,061	0.59	C
Parramatta Road between Bland Street and Dalhousie Street - Haberfield	EB	3	2,091	0.77	D	3	1,449	0.54	C
	WB	3	2,198	0.81	E	3	1,084	0.40	B
Parramatta Road between Sloane Street and West Street - Haberfield	EB	2	2,673	1.49	F	2	2,627	1.46	F
	WB	3	2,857	1.06	F	2	2,702	1.50	F
Parramatta Road east of Crystal Street - Petersham	EB	2	2,012	1.12	F	2	1,890	1.05	F
	WB	2	2,201	1.22	F	2	2,034	1.13	F
Dobroyd Parade north of Timbrell Drive - Haberfield	NB	2	1,957	1.09	F	2	1,917	1.07	F
	SB	2	2,100	1.17	F	2	1,958	1.09	F
M4 East east of Concord Road - Strathfield	EB	-	-	-	-	3	4,273*	0.63	C
	WB	-	-	-	-	3	6,668*	0.99	E
Queens Road west of Great North Road - Five Dock	EB	1	953	1.06	F	1	919	1.02	F
	WB	1	1,181	1.31	F	1	1,053	1.17	F
Queens Road west of Harris Street - Five Dock	EB	1	1,126	1.25	F	1	1,057	1.17	F
	WB	1	1,246	1.38	F	1	1,172	1.30	F
Gipps Street west of Burwood Road - Concord	EB	1	898	1.00	E	1	816	0.91	E
	WB	1	979	1.09	F	1	900	1.00	F
M4 Motorway west of Concord Road off-ramp - Strathfield	EB	2	2,879*	0.64	C	2	1,133*	0.25	A
	WB	2	4,159*	0.92	E	2	1,892*	0.42	B

Notes: V/C = volume to capacity ratio

* Freeway level of service is evaluated in passenger car units

Table 8.12 2031 'do something' PM peak midblock operational performance

Location and direction		No. lanes	Do minimum (veh/hr) Flow	V/C	LoS	No. lanes	Do something (veh/hr) Flow	V/C	LoS
Parramatta Road west of Bridge Road - Homebush	EB	3	2,003	0.74	D	3	2,060	0.76	D
	WB	3	1,720	0.64	D	3	2,020	0.75	D
Parramatta Road between Knight Street and Concord Road - Strathfield	EB	2	1,725	0.96	E	2	2,203	1.22	F
	WB	3	1,604	0.59	D	3	2,270	0.84	E
Parramatta Road between Mosely Street and Burwood Road - Strathfield	EB	3	3,132	1.16	F	3	1,756	0.65	D
	WB	3	2,530	0.94	E	3	1,890	0.70	D
Parramatta Road between Shaftesbury Road and Harris Street - Burwood	EB	3	2,817	1.04	F	2	1,644	0.91	E
	WB	3	2,264	0.84	E	2	1,514	0.84	D
Parramatta Road between Bland Street and Dalhousie Street - Haberfield	EB	3	2,570	0.95	E	3	923	0.34	B
	WB	3	1,602	0.59	D	3	552	0.20	A
Parramatta Road between Sloane Street and West Street - Haberfield	EB	2	2,642	1.47	F	2	2,562	1.42	F
	WB	3	2,779	1.03	F	2	2,404	1.32	F
Parramatta Road east of Crystal Street - Petersham	EB	2	2,499	1.39	F	2	2,374	1.32	F
	WB	2	2,596	1.44	F	2	2,280	1.27	F
Dobroyd Parade north of Timbrell Drive - Haberfield	NB	2	2,258	1.25	F	2	2,297	1.28	F
	SB	2	1,955	1.09	F	2	1,927	1.07	F
M4 East east of Concord Road - Strathfield	EB	-	-	-	-	3	5,948	0.88	D
	WB	-	-	-	-	3	5,749	0.85	D
Queens Road west of Great North Road - Five Dock	EB	1	802	0.89	E	1	756	0.84	E
	WB	1	958	1.06	F	1	915	1.02	F
Queens Road west of Harris Street - Five Dock	EB	1	842	0.94	E	1	710	0.79	D
	WB	1	1,037	1.15	F	1	995	1.11	F
Gipps Street west of Burwood Road - Concord	EB	1	1,057	1.17	F	1	1,008	1.12	F
	WB	1	1,073	1.19	F	1	1,056	1.17	F
M4 Motorway west of Concord Road off-ramp - Strathfield	EB	2	3,712*	0.82	D	2	1,539*	0.34	B
	WB	2	2,281*	0.51	C	2	814*	0.18	A

Notes: V/C = volume to capacity ratio

* Freeway level of service is evaluated in passenger car units

For the 2031 scenario, the opening of the possible future M4–M5 Link (which is subject to planning approval) (M4–M5 Link) provides scope for a limited extension of bus lanes east of Dalhousie Street, which is discussed further in **Appendix G**. This is accounted for in the assessment by a reduction in the number of westbound general traffic lanes between Sloane Street at Haberfield and West Street at Petersham.

In summary, the 2031 levels of service demonstrate the impact of the M4–M5 Link, as there is a small reduction in traffic density east of the Parramatta Road interchange (whereas there was an increase in 2021). However, the level of service would remain at F for all these midblocks. The exception is westbound to Sloane Street, where traffic increases substantially due to the provision of a bus lane in the 2031 'do something' scenario. There would be limited change on Dobroyd Parade east of Timbrell Drive, reflecting no significant fall in volumes due to the M4–M5 Link. However increases would be experienced west of Concord Road, with eastbound density approaching George Street of particular note. High traffic densities would be recorded on the project east of Concord Road, particularly westbound during the AM peak where capacity is reached.

Motorway performance

The midblock performance of the M4 East and M4 in 2021 and 2031 for the 'do minimum' and 'do something' scenarios are shown in **Table 8.13**.

In the 2021 AM and PM peaks, a high level of service is provided within the M4 East. There would also be improvements to the level of service for the M4 west of Concord Road as a result of the project.

In 2031, increased traffic densities are recorded within the M4 East tunnels, in particular during the westbound AM peak and the eastbound PM peak where capacity is reached.

High traffic densities are now recorded in the project's mainline tunnel east of Concord Road, particularly westbound during the AM peak and eastbound in the PM peak where capacity is reached.

Table 8.13 Midblock operational performance of motorways

Location and direction		No. lanes	Do minimum (veh/hr) Flow	V/C	LoS	No. lanes	Do something (veh/hr) Flow	V/C	LoS
AM peak - 2021									
M4 Motorway East east of Concord Road – Strathfield	EB	-	-	-	-	3	2443*	0.36	B
	WB	-	-	-	-	3	3315*	0.49	C
M4 Motorway west of Concord Road off-ramp – Strathfield	EB	2	2883*	0.64	C	2	1066*	0.24	A
	WB	2	3509*	0.78	D	2	1592*	0.35	B
PM peak - 2021									
M4 East east of Concord Road – Strathfield	EB	-	-	-	-	3	2864*	0.42	B
	WB	-	-	-	-	3	2446*	0.36	B
M4 Motorway west of Concord Road off-ramp – Strathfield	EB	2	3290*	0.73	D	2	1030*	0.23	A
	WB	2	2201*	0.49	C	2	783*	0.17	A
AM peak – 2031									
M4 Motorway East east of Concord Road – Strathfield	EB	-	-	-	-	3	4274*	0.63	C
	WB	-	-	-	-	3	6668*	0.99	E
M4 Motorway west of Concord Road off-ramp – Strathfield	EB	2	2879*	0.64	C	2	1133*	0.25	A
	WB	2	4159*	0.92	E	2	1892*	0.42	B

Location and direction		No. lanes	Do minimum (veh/hr) Flow	V/C	LoS	No. lanes	Do something (veh/hr) Flow	V/C	LoS
PM peak - 2031									
M4 East east of Concord Road – Strathfield	EB	-	-	-	-	3	6399	0.95	E
	WB	-	-	-	-	3	5749	0.85	D
M4 Motorway west of Concord Road off-ramp – Strathfield	EB	2	3712*	0.82	D	2	1539*	0.34	B
	WB	2	2281*	0.51	C	2	814*	0.18	A

Notes: * *Freeway LoS is evaluated in passenger car units.*

*** Additional reduction in traffic lanes due to assumed provision of bus lanes*

Intersection performance

Modelling of intersection performance involved grouping the key intersections into nine clusters (as shown in **Figure 8.3**). The intersection performance results are summarised in **Table 8.14**.

In summary, the results of the intersection analysis show significant reductions in delay during all operational scenarios as a result of the project. However, a number of intersections have been assessed as presenting challenging conditions for the 'do something' scenarios. These issues are summarised as follows:

- The intersection of Parramatta Road and George Street experiences significant delay in all ‘do minimum’ and ‘do something’ scenarios. Proposed intersection amendments, such as reinstating the north approach double right turn, mean that the delay only increases in the 2031 AM peak. Delays at this intersection may combine with the operation of the Powells Creek on-ramp to increase the risk of queuing impacting the performance of other intersections. The modelled delays indicate a risk of queued vehicles reaching the Concord Road intersection
- Concord Road would continue to experience a high level of delays due to a significant increase in volumes. By 2031, northbound delays through Patterson Street could lead to lengthy delays and the formation of significant queues on the northbound off-ramp, and potentially through the congested Parramatta Road intersection
- Substantially higher right turn volumes between Parramatta Road and Shaftesbury Road lead to a significant increase in delays in the 2031 PM peak
- Capacity restrictions at the Dobroyd Parade/Timbrell Drive and Parramatta Road/Hume Highway intersections are likely to block through adjacent intersections and lead to significant queuing on the project off-ramps in 2021. Particular issues result from higher right turn volumes from Timbrell Drive to Dobroyd Parade, and from Parramatta Road to Hume Highway
- The opening of the M4–M5 Link and the provision of ramps on Wattle Street significantly reduces congestion east of Bland Street, but re-introduces significant delays at the Parramatta Road and Wattle Street intersection. A large left turn movement from Parramatta Road is a key issue which could impact bus travel times in the kerbside lane.

Table 8.14 Summary of intersection performance modelling results

Cluster	2021 'do something' AM peak	PM peak	2031 'do something' AM peak	PM peak
1	Limited impacts with small reductions in delay at Arthur Street/Centenary Drive failing to significantly reduce congestion.	Limited impacts at most intersections. Similar to the AM peak, existing congestion at George Street is retained which could combine with the introduction of the Powells Creek ramp to create queuing issues at Knight Street. An increase in delay is also forecast at the congested (level of service F) Underwood Road/Pomeroy Street intersection primarily due to an increase in right turn movements.	Limited changes to performance with only the Arthur Street/Centenary Drive intersection experiencing significant delays.	Minor performance improvements on Homebush Bay Drive although the Arthur Street and Centenary Drive intersection would continue to experience heavy delays.
2	Limited impacts on Parramatta Road west of Concord Road (despite the large increase in volume and introduction of Powells Creek ramp). The introduction of the ramp combined with long existing delays at George Street may however increase the risk of queuing impacting the operation of Knight Street and Underwood Road intersections as eastbound vehicles get held at the stopline west of the ramp. A very large reduction in delay at the existing Parramatta Road and M4 intersection due to the substantial reduction in demand on the existing M4. This is forecast to provide a high quality level of service A rather than the pre-existing F.		A significant increase in the existing substantial delays at George Street. Queues from this intersection have the potential to interfere with operations at Concord Road, Knight Street and Underwood Road. The Parramatta Road and Underwood Road intersection also begins to experience higher delays due to a large volume increase.	Congested conditions (level of service F) are retained at Underwood Road/Pomeroy Street, and Parramatta Road/George Street. Performance at the latter intersection may lead to queuing extending through other intersections such as the critical Concord Road junction.

Cluster	2021 'do something' AM peak	PM peak	2031 'do something' AM peak	PM peak
3	Conditions on Concord Road remain highly congested but proposed intersection improvements at Patterson Street and Parramatta Road provide additional right turn capacity and help to maintain similar levels of delay despite significant increases in traffic volumes.	Overall delays are similar with increases at Concord/Parramatta and Concord/Patterson balanced by sizable reductions in delay at Sydney Street/Concord Road and the Parramatta/M4 intersection. Northbound queuing from the Patterson Street intersection may however block through the Sydney Street intersection and lead to queues extending onto the northbound off ramp and back to the highly congested Concord and Parramatta intersection	Limited impacts due to increased capacity generally matching the increased volumes attracted by the scheme. While overall delays remain similar, the effect of significant congestion could be to create long queues on the project off ramps creating a risk of extending into the tunnel. The exception is the Parramatta Road/M4 intersection which performs strongly with the scheme in place and experiences significant delays without.	Traffic volume increases on Concord Road would lead to significant increases in delay at the already congested Concord/Parramatta and Concord/Patterson intersections. This would result in lengthy queuing and to access and egress issues at the M4 East ramps on Concord Road.
4	Conditions on Parramatta Road east of Concord undergo substantial reductions in levels of delay and are forecast to provide a level of service B/C from the pre-existing F despite the reduction of through capacity due to bus lane provision. This is achieved through the transfer of traffic to the project. A large reduction in delay is also experienced at the Gipps Street intersection with Burwood Road although it would remain relatively congested.	Overall conditions on Parramatta Road east of Concord remain similar as the reduction in traffic is balanced by the reduction in capacity due to the provision of bus lanes	Conditions east of Concord continue to provide greatly improved performance with the project in place; however, level of service F would continue to be experienced at Parramatta Road/Wentworth Road due to high turning volumes, and also at Gipps Street/Burwood Road	Benefits continue to be provided at intersections east of Concord with the exception of Parramatta Road/Shaftesbury Road where large increases in right turn demand combined with reductions in through capacity due to the bus lane provision, lead to additional delay and deterioration in level of service from D to F. Limited changes are observed on Gipps Street due to a modest reduction in volumes.
5	Reductions in delay in Five Dock although conditions would remain congested (level of service E/F) due to high background traffic volumes.	Impacts in Five Dock would be experienced due to changing traffic conditions resulting in a large increase in delay at the already congested intersection of Great North Road/Lyons Road. Conversely, there is significant relief at the Great North Road/Queens Road due to a reduction in volumes.	Lengthy delays and level of service F are experienced at all intersections in the Five Dock area continue to exist in the ‘do something’ scenario.	Performance changes are variable within the Five Dock area with extremely lengthy delays experienced with both the 'do minimum' and 'do something' scenarios.

Cluster	2021 'do something' AM peak	PM peak	2031 'do something' AM peak	PM peak
6	There would be substantial reductions in delay at the key intersections of Parramatta Road with Great North Road, Parramatta Road with Wattle Street, and Wattle Street with Ramsay Street. These intersections go from highly congested level of service F conditions to B/D There is a substantial increase in delay at the Dobroyd Parade and Timbrell Drive intersection (from level of service D to F) due primarily to vehicles using the M4 East tunnel. Queuing at this intersection would extend all the way through Waratah Street and onto the M4 East exit ramp.	Changes are similar to the AM peak with substantial improvement in performance at key intersections such as Parramatta Road and Wattle Street, balanced by significant additional delays at Timbrell Drive/Dobroyd Parade. While queuing at Timbrell Drive/Dobroyd Parade intersection is not as severe as the morning peak, congestion remains likely to impact operations at Waratah Street and lead to delays on the M4 East off-ramp	The 2021 pattern of performance improvements continues with the exception of the Parramatta Road and Great North Road intersection where increases in turning movements combine with the loss of through capacity due to the provision of bus lanes to increase delays. While conditions continue to improve at the critical Parramatta Road and Wattle Street intersection, demand for movements to/from the M4-M5 Link ramps maintains a level of congestion (level of service F) although significantly lower than in the 'do minimum' scenario. The Dobroyd Parade/Timbrell Drive intersection also continues to experience increased delays and level of service F despite having a lower demand following the introduction of the M4-M5 Link. This is caused by changes in travel patterns such as the increased demand for the right turn from Timbrell Drive, and the reduction in delay elsewhere allowing more of the vehicle demand to actually reach the intersection. Delays are however significantly less than in 2021 before the introduction of the M4-M5 Link.	Performance changes are variable with substantial reductions in delay at Arlington Street, Great North Road, Parramatta Road/Wattle Street and Ramsey Street being balanced by a significant increase in delay at Dobroyd Parade/Timbrell Drive. While there is a substantial improvement in performance at Parramatta Road/Wattle Street, it remains level of service F partly due to re-introduction of a high left turn demand to Wattle Street because of the opening of the M4-M5 Link ramps.

Clu ster	2021 'do something' AM peak	PM peak	2031 'do something' AM peak	PM peak
7	Conditions would remain highly congested at Hume Highway and Frederick Street (level of service F).	The Hume Highway/Frederick Street intersection would experience a significant reduction in delay but remain congested at level of service F due to the heavy future demand on this corridor.	Delays reduce along with volumes at the Hume Highway and Frederick Street intersection but remain at very high levels and level of service F.	There are small reductions in delays at the Hume Highway and Frederick Street intersection; however, the intersection continues to fail at level of service F with very lengthy average delays.
8 and 9	Traffic volume increases east of the Parramatta Road M4 ramps would result in higher levels of delay at all intersections, particularly Sloane Street, Norton Street and Crystal Street which are all level of service F. These delays are likely to result in blocking through upstream intersections and ultimately lead to significant congestion at Dalhousie Street close to the merge. Resultant delays would lead to lengthy eastbound queues impacting the tunnel and potentially upstream intersections on Parramatta Road such as Bland Street.	East of the Parramatta Road ramps, there would be a substantial increase in delay at the Hume Highway intersection with Parramatta Road, mainly due to a significant increase in right turn demand. Queuing at this intersection would impede operations at adjacent intersections such as Dalhousie Street and Sloane Street, and is expected to lead to lengthy queuing on the M4 East off ramp and into the tunnel. Notwithstanding impacts from the Hume Highway intersection, other Parramatta Road intersections such as Sloane Street, Norton Street and Crystal Street also experience a significant deterioration in performance	The introduction of the M4-M5 Link has a significant beneficial impact on all Parramatta Road intersections east of the M4 East ramps, particularly at Crystal Street and Norton Street which go from level of service F to C/D. While experiencing a significant reduction in average delay of more than 40 seconds, the Hume Highway and Parramatta Road intersection would however remain congested (level of service F) with potential for queuing to reach the merge point and tunnel ramps.	The introduction of the M4-M5 Link generates significant benefits at the Parramatta Road intersections east of the M4 East ramps, particularly at the Hume Highway, and Norton Street and Crystal Street intersections which while remaining level of service F reduce in average delay by more than 100 seconds each.

Travel times

Indicative AM peak travel time savings on strategic routes (taken from the WRTM) are illustrated in **Figure 8.4**. The travel time savings discussed below do not include any savings resulting from the M4 Widening project. The analysis suggests that travel time savings of between six and eight minutes are provided by the project in 2021 on most strategic routes assessed. Travel time savings in 2031 take account of the M4–M5 Link and result in more substantial time savings of 10 to 18 minutes.

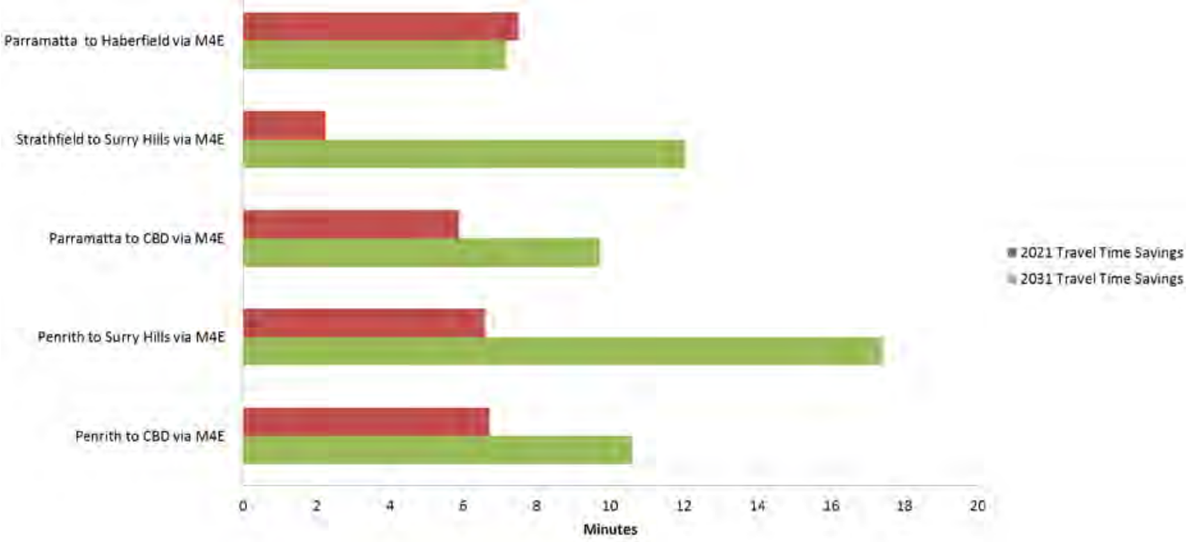

Figure 8.4 Travel time savings – AM peak

PM peak travel time savings are illustrated in **Figure 8.5** and demonstrate similar time savings in 2021, with an increase in 2031 to savings of 13 to 20 minutes.

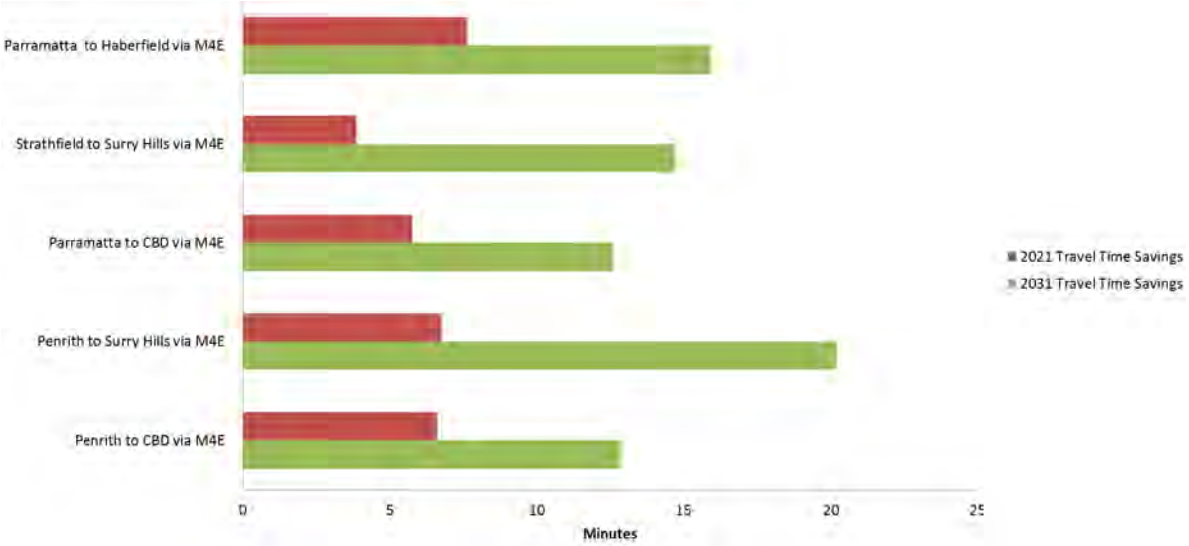

Figure 8.5 Travel time savings – PM peak

The analysis demonstrates travel time savings on strategic corridors resulting from the project, augmented in 2031 by the completion of WestConnex. It is noted that the WTRM is a strategic model which may not fully account for intersection delays at a detailed level and therefore provides a conservative assessment. Analysis from the LinSig intersection models suggests substantial time savings at intersections, delivering further benefits to local, regional and strategic trips.

Safety

The WRTM has been used to estimate the number of crashes in the study area (using the M4 and Parramatta Road corridors) with and without the project, using the assumption that the number of crashes per vehicle kilometre travelled is similar to the existing situation.

This assessment was confined to the existing M4 and Parramatta Road corridors where existing data can be used to estimate future behaviour.

Crashes during the do minimum scenario are predicted to rise slowly over time on the M4 and Parramatta Road corridor. This reflects the forecast increases in traffic volumes. Annual costs of $14.95 million are anticipated in 2021 with these expected to rise to $16.31 million per annum by 2031.

With the construction of the project (do something scenario), there is a clear overall road safety benefit on the corridor with a 32 per cent reduction in crash costs in 2021 from $14.95 million to $10.2 million annually. This reduction in crash costs is less pronounced in 2031 due to the large volume increases on the project but nevertheless a reduction of approximately 25 per cent is observed with costs falling from $16.31 million to $12.22 million per annum.

The project design and construction would incorporate design reviews and road safety audits in compliance with Roads and Maritime guidance to follow best practice in reducing crash risks.

8.4.2 Public transport

Bus network

Transport for NSW intends to operate a new high frequency bus route between Burwood and the CBD, via Parramatta Road. Bus frequency has yet to be confirmed; however, a guide of 15 to 20 buses per hour in 2021, and 20 to 30 buses per hour in 2031 has been provided.

The operational modelling has assumed that bus lanes would be provided between Burwood Road and east of Bland Street to coincide with the opening of the project. Further provision of bus lanes to the east is also assumed to coincide with the opening of the M4–M5 Link.

A high level analysis has been undertaken to understand the potential level of bus delays at signalised intersections with and without the project. The results are provided in **Table 8.15** and **Table 8.16**.

Table 8.15 2021 Bus delays at signalised intersections between Burwood Road and Bland Street

Direction	Do minimum (min:sec)		Do something (min:sec)		Time saving (min:sec)	
	AM peak	PM peak	AM peak	PM peak	AM peak	PM peak
Eastbound	4:40	7:59	1:50	1:54	2:50	6:05
Westbound	15:52	6:39	1:55	1:50	13:57	4:49

Table 8.16 2031 bus delays at signalised intersections between Burwood Road and Bland Street

Direction	Do minimum (min:sec)		Do something (min:sec)		Time saving (min:sec)	
	AM peak	PM peak	AM peak	PM peak	AM peak	PM peak
Eastbound	7:54	16:08	2:29	3:39	5:03	10:53
Westbound	18:02	8:04	2:00	2:40	15:50	5:37

The results indicated that, in 2021, time savings for buses of up to 14 minutes in the westbound direction are achievable. Other time savings vary between three and six minutes. In 2031, AM time savings increase to five to 15 minutes and the PM peak is five to 11 minutes. Bus delays in 2031 'do something' scenarios rise only marginally with the exception of eastbound during the PM peak. This is mainly a result of delays at the Wattle Street intersection due to a high left turn demand to the M4–M5 Link ramps and the absence of a dedicated left turn provision.

The project amends the priority for buses serving the Olympic Park via the underpass at Homebush Bay Drive. Bus would be required to give way to vehicles on the M4 eastbound on-ramp. The operation of this ramp would be subject to further discussions between WDA, Roads and Maritime and Sydney Olympic Park Authority (SOPA).

The *NSW Long Term Transport Master Plan* (Transport for NSW 2012a) provides the overarching strategy for Sydney's transport future. The Plan recognises the importance of the Parramatta Road corridor as the main connection between the Sydney CBD and Western Sydney. Potential improvements for the corridor come from the long term Master Plan through the Parramatta Road Urban Transformation Program.

A re-design of the Parramatta Road corridor is not being delivered at part of the project. However, the project will create the opportunity to investigate how existing road space and transport operations could be reconfigured/rebalanced (eg improved east-west and north-south movements) to improve public transport access/services/patronage along and across the Parramatta Road corridor.

Opportunities to improve public transport patronage

As a result of the predicted reductions in traffic volumes provided by the project in 2021 peak periods on Parramatta Road, the project presents the opportunity to provide bus lanes on Parramatta Road east of Burwood Road (as part of a separate project. The assessment also indicates that peak period bus intersection delays would reduce by five to 15 minutes in the 2031 operational scenario.

Provision of bus lanes, as part of a separate project, could lead to an increase in the number of services. Combined with the reduction in bus travel times, this would have the potential to improve public transport patronage along the corridor.

8.4.3 Pedestrian and cyclist facilities

As the majority of road network changes associated with the project would occur underground and at existing intersections, there would be limited change to pedestrian facilities on surface roads. Improvements to pedestrian facilities may, however, occur as part of potential future changes to the Parramatta Road environment to be considered as part of the *New Parramatta Rd: Draft Parramatta Road Urban Renewal Strategy* (UrbanGrowth NSW 2015).

Potential benefits include:

- Realigned pedestrian footpaths at locations such as the Wattle Street and Ramsay Street intersection
- Additional crossing locations such as the southbound off-ramp location on Concord Road and the Powell's Creek westbound on-ramp
- Amendments to signal timings due to changes in traffic volume and distribution. As the majority of intersections within the study area would carry fewer vehicles, this would be generally positive and provide scope for additional pedestrian crossing time and/or signal phases.

Cyclists can also expect to benefit from reduced traffic volumes through the study area, and the ability to use the bus lanes on Parramatta Road which would be facilitated by the project.

The existing eastbound cycleway on the northern side of the M4 would be re-routed from east of Homebush Bay Drive to near Pomeroy Street. Part of the re-routed cycleway would be off-road, improving cyclist safety and amenity. In addition, as a result of the removal of the existing Concord Road northbound on-ramp connecting to the existing M4 westbound, a new cycleway ramp would be provided near Queen Street at North Strathfield. These changes would not significantly adversely affect cyclist travel times and amenity.

8.4.4 Fulfilment of project objectives

The objectives of the project are identified in **Chapter 3** (Strategic context and project need). The performance of the project measured against the traffic and transport-related project objectives is discussed below.

Support Sydney's long-term economic growth through improved motorway access and connections linking Sydney's international gateways (Sydney Airport and Port Botany), Western Sydney and places of business across the city

The assessment in this chapter and **Appendix G** has identified large reductions in vehicle delay along the corridor between Homebush Bay Drive in the west, and City West Link and Haberfield/Leichardt in the east. This is evident both within the new project tunnel which would ultimately provide connectivity to the M4–M5 Link, and also on the existing Parramatta Road, despite the reduction in capacity due to the provision of kerbside bus lanes. As a result, connectivity between the major centres identified in this objective would be improved as a result of the project.

Relieve road congestion so as to improve the speed, reliability and safety of travel in the M4 corridor, including parallel arterial roads

As discussed above, large reductions in vehicle delay are forecast as a result of the project on the overall corridor, and specifically on Parramatta Road. The assessment has also identified benefits on the parallel route along Queens Road and Gipps Street. The project would also provide additional route options along the corridor and therefore increase network resilience in the event of incidents.

Cater for the diverse travel demands along these corridors that are best met by road infrastructure

The project provides the opportunity for the provision of bus lanes on Parramatta Road east of Burwood Road due to the substantial reductions in traffic volumes during peak periods. This has been assessed as reducing peak period bus intersection delays by five to 15 minutes in the 2031 operational scenario. The traffic reductions and bus lanes also provide greater opportunities for cyclist use of Parramatta Road and parallel corridors sharing in the overall volume reduction. Finally, greater priority for pedestrians at signalised crossings would be possible in tandem with the reductions in traffic volume.

Create opportunities for urban revitalisation, improved liveability, and public and active transport improvements along and around Parramatta Road

The reduction in traffic volumes and congestion on Parramatta Road provides opportunities for reprioritisation of capacity for public transport and pedestrian movements. This would be further explored in the Parramatta Road Urban Transformation Program being undertaken in parallel with the WestConnex project.

Enhance the productivity of commercial and freight generating land uses strategically located near transport infrastructure

The improvement in connectivity and journey times across the corridor, together with the associated opportunities for regeneration being explored in the Parramatta Road Urban Transformation Program, improve the capacity of the transport network for the increased productivity of land uses.

Enhance movements across the Parramatta Road corridor which are currently restricted

Reductions in eastbound and westbound traffic volumes provide opportunities for increased cross movements along the corridor. Delays are forecast to substantially reduce at the majority of intersections assessed.

Integrate with the preceding and proposed future stages of WestConnex, without creating significant impacts on the surrounding environment or duplicating any potential issues across the construction periods

In its initial stages of construction, the project would overlap with the M4 Widening and the King Georges Road Interchange Upgrade projects, and substantially overlaps with construction of the New M5. Only the M4 Widening project uses similar access routes to the construction ancillary facilities, and the staggering of construction periods results in completion of a significant proportion of the M4 Widening works before construction intensifies on the M4 East project. Minimal cumulative impacts would therefore be likely, relative to the full construction peak of the project itself.

The project provides the connection between the M4 Widening and M4–M5 Link projects through the mainline tunnel connection. The design accommodates the ultimate construction of the M4–M5 Link through the construction of stub tunnels and the interim layout on Wattle Street. No significant impact or overlap has therefore been identified relating to the future WestConnex stages.

8.5 Assessment of cumulative impacts

8.5.1 Construction

Based on current information, elements of the construction program would occur simultaneously with three other WestConnex projects:

- King Georges Road Interchange Upgrade
- M4 Widening
- New M5 (subject to planning approval).

The King Georges Road Interchange Upgrade is scheduled for completion by the second quarter of 2017. While there is a small time overlap with the beginning of project construction, heavy vehicle and other access routes are not expected to converge, so there would be minimal potential for cumulative impacts.

M4 Widening construction works are scheduled for completion by the end of December 2016. Construction haul routes and vehicle access routes are expected to be similar to the project given the location and nature of construction. This would result in a small overlap between the commencement of construction of the project and the completion of construction on the M4 Widening. The workforce demand profile for the project suggests that vehicle movements would increase from about 20 per cent of peak construction in the first quarter of 2016, to 80 per cent in the third quarter. During this period, construction vehicle movements related to the M4 Widening would reduce, as the majority of work sites would be completed by the end of the second quarter. As a result, the combined impact during this period is expected to be less than during the peak construction period for the project alone.

Subject to planning approval, the New M5 currently has a projected construction timetable extending from the third quarter of 2016 to the third quarter of 2019. This is a delay of about six months behind the project. There is therefore a large overlap between the construction periods for the two projects. Preliminary information indicates that the majority of heavy vehicle and other routes associated with the New M5 would use the existing M5 corridor and therefore have a limited potential for cumulative impact with the project.

A discussion of the cumulative impacts resulting from other projects is included in **section 26.5.1** (Cumulative impacts). In summary, there are currently no other major projects whose construction would significantly increase traffic volumes and patterns along the Parramatta Road corridor (within the project area) during the construction period.

Construction volumes associated with minor works are anticipated to have a negligible impact similar to that of daily or seasonal variations in traffic volumes and patterns.

8.5.2 Operation

The operational traffic modelling for the 2031 'do something' scenario assumes the completion of all WestConnex projects. This therefore represents a cumulative traffic impact assessment for WestConnex.

8.6 Management of impacts

8.6.1 Project design features that manage impacts

Layout changes to the existing road network have been proposed to complement and/or mitigate the impacts of the project within the project design. These include:

- Provision of a northbound right turn bay on Concord Road approaching the Patterson Street intersection, to reduce northbound queuing downstream of the M4 East northbound off-ramp

- Removal of the existing Concord Road northbound on-ramp connecting to the existing M4 westbound and provision of the Powells Creek on-ramp to access the M4 westbound, to reduce the volume of westbound Parramatta Road traffic turning right into Concord Road
- Removal of the left turn to the existing M4 westbound for eastbound Parramatta Road traffic and provision of a new Concord Road southbound on-ramp connecting to the existing M4 westbound. This will reduce the volume of southbound Concord Road traffic turning left into Parramatta Road
- Lane utilisation changes on the southbound approach of Concord Road to Parramatta Road resulting in the creation of a double right turn bay and a shared through and left lane. This helps accommodate additional right turn demand created by the southbound off-ramp
- Provision of an additional right turn bay on the westbound approach of Parramatta Road to Concord Road to cater for additional right turn demand to the eastbound on-ramp
- Westbound lane utilisation changes on Parramatta Road approaching the existing M4 and Concord Road. Two continuing lanes will be provided with a single right turn lane to the existing M4, reflecting a change in the balance of demand for westbound traffic
- New right turn provision from Wattle Street to Ramsay Street (eastbound) for Wattle Street surface traffic that will not be able to use the existing right turn at Waratah Avenue.

8.6.2 Road network optimisation

Management of road network assets is a key function of Roads and Maritime which uses network and corridor planning strategies to best manage and enhance these assets to maximise community benefits. Network and corridor planning is a process aimed at enhancing the capacity to manage and enhance the road network to meet community expectations. Integrated network and corridor planning processes are a critical input to working towards the vision of “a safe sustainable and efficient road transport system”. The process involves a few key elements including:

- Setting network and corridor objectives in line with NSW and Australian Government strategies and community expectations
- Analysing anticipated performance against appropriate safety, traffic and asset measures
- Identifying strategic priorities to achieve appropriate safety, traffic and asset performance over the longer term within the context of limited funding.

As a key part of network management, network and/or corridor optimisation is a key tool in the management of project impacts. Together with the ongoing development of the Roads and Maritime Pinch Point Program targeting peak hour traffic hotspots, and other infrastructure measures, it facilitates the management of impacts identified in **section 8.4** to ensure that travel time savings are maintained to the greatest extent possible by minimising intersection and midblock delays.

In addition to an optimisation strategy and potential infrastructure provision, the maintenance of the existing traffic control system is a key ingredient in providing Roads and Maritime with the tools to appropriately manage congestion on the network. A review of existing SCATS infrastructure at key intersections in the study area, including detectors, will be undertaken and upgrades will be implemented where appropriate.

To manage impacts identified in **section 8.4**, a number of network optimisation techniques have been identified, along with upgrades requiring civil works, funding and further investigation. These are identified in **Table 8.17** (measures OpTT2 and OpTT4). These techniques and upgrades do not form part of the project but are recommended as measures considered appropriate to mitigate the impacts identified in this assessment. Additional changes may be proposed and implemented by Roads and Maritime following the operational traffic review identified in **Table 8.17** (measure OpTT1).

8.6.3 Environmental management measures

Environmental management measures relating to traffic and transport are outlined in **Table 8.17**.

Table 8.17 Environmental management measures – traffic and transport

Impact	No.	Environmental management measure	Responsibility	Timing
Construction				
General	TT1	A Traffic Management and Safety Plan (TMSP) will be prepared as part of the construction environmental management plan (CEMP), in consultation with the relevant road authority, local councils, emergency services, road user groups and pedestrian and bicycle groups. The TMSP will include the guidelines, general requirements and principles of traffic management to be implemented during construction. It will be prepared in accordance with Austroads *Guide to Road Design* (with appropriate Roads and Maritime supplements), the RTA *Traffic Control at Work Sites* manual and AS1742.3: *Manual of uniform traffic control devices – Part 3:Traffic control for works on roads*, and any other relevant standard, guide or manual. It will seek to minimise delays and disruptions, and identify and respond to any changes in road safety as a result of highway construction works.	Construction Contractor	Pre-construction
	TT2	The TMSP will include: • A traffic route and haulage management plan • Site traffic and access management plans • An incident response plan • A detailed travel management plan for construction staff at the various worksites, in consultation with local councils and stakeholders associated with the sporting facilities adjacent to the project site. This will include the promotion of public transport and car-pooling to reduce work site-related vehicle movements, and also investigate feasible options for the provision of off-site car parking to reduce parking on local roads.	Construction Contractor	Construction
Impacts to road network performance (delays) and safety	TT3	Construction and temporary works will be staged to avoid conflicts with the existing road network and maximise spatial separation between work areas and travel lanes.	Construction Contractor	Construction

Impact	No.	Environmental management measure	Responsibility	Timing
	TT4	Analyse traffic volume data to identify capacity requirements, assess the potential impact of lane occupancies on traffic flows, plan lane occupancies to minimise the work area, and identify the best time to minimise inconvenience to road users. Restrictions and obstructions will be limited, road capacities maximised and peak traffic periods avoided where possible.	Construction Contractor	Construction
	TT5	Temporary closed-circuit television (CCTV) and variable message signs (VMS) will be provided to link with the existing TMC network to facilitate monitoring and management of impacts	Construction Contractor	Construction
	TT6	Throughout construction, consultation with the Transport Management Centre will be undertaken to ensure impacts to traffic flows are minimised.	Construction Contractor/ Roads and Maritime	Construction
	TT7	Road occupancy licences will be obtained for work that impacts traffic on existing roads in accordance with the requirements of council or Roads and Maritime.	Construction Contractor	Construction
Impacts on pedestrians and cyclists	TT8	Pedestrian and cyclist access will be maintained where possible throughout construction. Where not feasible, alternate routes will be provided and communicated to the community.	Construction Contractor	Prior to construction commencing
Impacts to public transport	TT9	Changes in bus stops will be undertaken in consultation with Transport for NSW and bus operators, with the community informed of any potential changes in advance.	Construction Contractor	Construction
Impacts to access	TT10	Local road closures will be managed and adequate property access will be maintained. Where road closures are required, reasonable and practical alternate traffic routes will be provided and communicated to the community. This will be undertaken in consultation with Roads and Maritime, local councils and property owners likely to be affected.	Construction Contractor	Construction
Impacts on existing road surfaces	TT11	A Road Dilapidation Report will be prepared and will include identification of the existing conditions of local roads and mechanisms to repair any damage caused by the project.	Construction Contractor	Pre-construction and post-construction
Impacts to emergency services	TT12	The TMSP will be developed in consultation with local emergency services and procedures will be implemented to maintain priority access and a safe environment will be maintained for emergency vehicles to travel through construction areas.	Construction Contractor	Construction

Impact	No.	Environmental management measure	Responsibility	Timing
	TT13	Local emergency services will be frequently updated on the staging and progress of construction works.	Construction Contractor	Construction
Operation				
Confirmation of assessed impacts	OpTT1	An operational traffic review will be undertaken 12 months after the opening of the project to confirm the operational impacts of the project on surrounding arterial roads and major intersections. This review will be undertaken by a suitably qualified traffic consultant that is independent of the design and studies undertaken as part of the EIS.	Roads and Maritime	12 months from start of operation
Network and corridor optimisation	OpTT2	A network and corridor optimisation approach will be adopted to manage delay and queuing impacts with optimisation works occurring at the following locations: • Parramatta Road/George Street intersection in Homebush/North Strathfield • Concord Road corridor between Patterson Street and Parramatta Road in Concord • Parramatta Road/Shaftesbury Road intersection in Burwood/Concord (post M4-M5 Link opening) • Dobroyd Parade/Timbrell Drive intersection in Haberfield • Parramatta Road/Great North Road intersection in Croydon/Five Dock (post M4–M5 Link opening) • Parramatta Road/Wattle Street intersection in Ashfield/Haberfield (post M4–M5 Link opening) • Parramatta Road (east of Bland Street) • Parramatta Road/Crystal Street/Balmain Road in Leichhardt/Petersham • Sydney Olympic Park access. Further detail of the proposed optimisation is outlined in Section 10.2.3 of the Traffic and Transport Assessment in **Appendix G**.	Roads and Maritime	Operation
Maintenance of existing network	OpTT3	A review of existing SCATS infrastructure at key intersections in the study area, including detectors, will be undertaken and upgrades will be implemented where appropriate to improve any impacts resulting from the project.	Roads and Maritime	Operation

Impact	No.	Environmental management measure	Responsibility	Timing
Network upgrades	OpTT4	The following network upgrades will be investigated in consultation with relevant local councils, Roads and Maritime and affected communities: • Conversion of Mortley Avenue to entry only (except buses) at the Timbrell Drive / Dobroyd Parade intersection, with an additional entry lane to facilitate amended lane utilisation on the Timbrell Drive approach. Layout amendments could be required on Mortley Avenue which will need to consider impacts on existing parking provision, the location of the bus stop and some existing mature trees • Extension of left turn bay from Dobroyd Parade to Timbrell Avenue providing additional capacity for traffic reassigned from Mortley Avenue via Waratah Avenue and Dobroyd Parade • Provision of additional short lane on the Timbrell Drive approach to Dobroyd Parade potentially facilitated by using the old footpath area which is currently being replaced by the construction of a footbridge (subject to bridge assessment). The additional capacity will allow a greater share of green time for Dobroyd Parade movements • Provision of a new signalised left turn slip lane from Parramatta Road to Wattle Street to accommodate the high number of movements to the M4-M5 tunnel in the PM peak • Increase in parking restrictions on the southbound side of Great North Road to provide increased capacity. Further detail of the identified network upgrades is outlined in Section 10.2.3 of the Traffic and Transport Assessment in **Appendix G**.	Roads and Maritime	Operation

Impact	No.	Environmental management measure	Responsibility	Timing
	OpTT5	The following network upgrades will be investigated in consultation with relevant local councils, Roads and Maritime and affected communities, and implemented as and when required based on traffic growth and changing traffic patterns: • Enabling right turn movements from the kerbside lane from George Street southbound to Parramatta Road • Extension of parking restrictions on the southern (westbound) side of Ramsay Street between Wattle Street and Walker Avenue • Reassignment of the second right turn lane on the Wattle Street westbound approach to Parramatta Road post opening of the M4–M5 Link, to provide an additional right turn bay for traffic exiting the M4–M5 Link and leaving a single right turn lane from Wattle Street • Creation of a double right turn on the Wattle Street westbound approach to Ramsay Street post opening of the M4–M5 Link. This could be achieved by reallocating the right hand through lane, leaving a single through/left lane.	Roads and Maritime	Operation
Smart motorways	OpTT6	Smart motorway management will be considered for implementation within the project tunnel and associated ramps and approaches.	Roads and Maritime/Motorway operator	Operation

9 Air quality

9.1 Introduction

This chapter describes the methodology used to assess the impacts of the M4 East project (the project) on regional, local and in-tunnel air quality, and the results of that assessment in summary. **Appendix H** provides greater detail of the monitoring and modelling methodologies and results.

The Secretary of the NSW Department of Planning and Environment (DP&E) has issued a set of environmental assessment requirements for the project; these are referred to as Secretary's Environmental Assessment Requirements (SEARs). **Table 9.1** sets out these requirements, and identifies where they have been addressed in this environmental impact statement (EIS).

Table 9.1 Secretary's Environmental Assessment Requirements – air quality

Secretary's Environmental Assessment Requirement	Where addressed in EIS
Air quality – including but not limited to:	
• An assessment of construction and operational activities that have the potential to impact on in-tunnel, local and regional air quality. The air quality impact assessment should provide an assessment of the risk associated with potential discharges of fugitive and point source emissions on sensitive receivers, and include:	Operational and construction air quality impacts, including construction activities likely to impact with the potential to impact on air quality are identified and addressed in **Sections 9.6** and **9.7** and **Appendix H**.
– the identification of all sources of air pollution and assess potential emissions of PM_{10}, $PM_{2.5}$, CO, NO2 and other nitrogen oxides and volatile organic compounds (eg BTEX) and consider the impacts from the dispersal of these air pollutants on the ambient air quality along the proposal route, proposed ventilation outlets and portals, surface roads and ramps, the alternative surface road network, and in-tunnel air quality,	The sources of air quality pollutants are described in **Sections 9.7**and **9.8** and **Appendix H**. The impacts of these pollutants are described in this **Chapter 9** (Air Quality) and in **Appendix H**.
– assessment of worst case scenarios for in-tunnel and ambient air quality, including assessment of a range of traffic scenarios, including worst case design maximum traffic flow scenario (variable speed) and worst case breakdown scenario, and discussion of the likely occurrence of each,	**Section 9.7.2** and Appendix L of the Air Quality Assessment Report **Appendix H**.
– details of the proposed tunnel design and mitigation measures to address in-tunnel air quality and the air quality in the vicinity of portals and any mechanical ventilation systems (ie ventilation stacks and air inlets) including details of proposed air quality monitoring (including criteria),	The design and operation of the ventilation system is described in **section 5.6** in **Chapter 5** (Project description). The mitigation measures are described in **section 9.9**.

Secretary's Environmental Assessment Requirement	Where addressed in EIS
– demonstrate how the project and ventilation design ensures that concentrations of air emissions meet NSW, national and international best practice for in-tunnel and ambient air quality, and taking into consideration the approved criteria for the NorthConnex project;	**Sections 9.7** and **9.8** and **Appendix H.**
– consideration of any advice from the Advisory Committee on Tunnel Air Quality on the project;	Reference has been made to the technical papers published by the NSW Chief Scientist and Engineer's Office on behalf of the Advisory Committee on Tunnel Air Quality, in particular the *Initial Report on Tunnel Air Quality*, July 2014 and the Advisory Committee on Tunnel Air Quality Final Report On the NorthConnex M1-M2 Project Revised Submissions and Preferred Infrastructure Report at; http://majorprojects.planning.nsw.gov.au/index.pl?action=view_job&job_id=6136
– details of any emergency ventilation systems, such as air intake/exhaust stacks, including protocols for the operation of these systems in emergency situations, potential emission of air pollutants and their dispersal, and safety procedures, and	The ventilation facilities, including emergency systems and their operation, are described in **Sections 5.6** and **5.**7 in **Chapter 5** (Project description),
– details of in-tunnel air quality control measures considered, including air filtration. Justification must be provided to support the proposed measures;	The in-tunnel air quality control measures are described in **Chapter 5** (Project description). **Section 5.6** describes the justification of the air quality management measures that have been considered, including a consideration of air filtration are described in **section 9.10**.
• details of the proposed mitigation measures to prevent the generation and emission of dust (particulate matter and TSP) and air pollutants (including odours) during the construction of the proposal, particularly in relation to ancillary facilities (such as concrete batching plants), the use of mobile plant, stockpiles and the processing and movement of spoil; and	The proposed mitigation measures to reduce the impact of dust from construction activities are described in **Sections 9.2** and **9.4**.
• cumulative assessment of the local and regional air quality due to the operation of Stage 3 – M4 South (Haberfield to St Peters) and surface road operations.	**Section 9.8** and **Appendix H** present an analysis of the potential cumulative impacts on local and regional air quality from the operation of the M4 East and the possible future M4–M5 Link.

Secretary's Environmental Assessment Requirement	Where addressed in EIS
• The air quality assessment, including the setting of air quality criteria, must be done in consultation with NSW Health and the Environment Protection Authority and with the consideration of any applicable advice provided by the Advisory Committee on Tunnel Air Quality; and	A summary of consultation with NSW Health, the NSW Environment Protection Authority (EPA) and other NSW Government agencies is provided in **Chapter 7** (Consultation).
• modelling (including dispersion modelling) must be conducted in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (EPA, 2005) or a suitably justified and verified alternative method based on current scientific understanding of atmospheric dispersion. Particular attention must be given to the verification of the method of predicting local air quality or meteorological conditions based on non-local or modelled data.	**Sections 9.2**, **9.4.2** and **Appendix H** provide descriptions of the model selection and validation for including the verification of the method for predicting local air quality**.**

9.2 Assessment approach

9.2.1 Overview

This assessment considers the impacts of the project on regional and local air quality, and the cumulative impacts of this project and the M4−M5 Link. The assessment also includes detailed analysis of the predicted quality of air inside the tunnel.

A number of recent air quality assessments for surface roads and tunnels in Australia and New Zealand were reviewed to identify methodologies, tools and findings that could inform the project assessment. These previous assessments are summarised in Appendix D of the air quality assessment report in **Appendix H**. The summary includes details of the pollutants considered, the sources of emissions, the dispersion models used, and the approaches used to assess impacts on air quality during construction and operation.

9.2.2 Terminology

The concentration of a pollutant at a given location comprises contributions from various sources. Several terms have been used to describe these contributions.

The following terms have been used in this chapter to describe the concentration of a pollutant at a specific location (receptor) over a specific averaging period:

- **Background concentration** describes all contributing sources of a pollutant concentration other than road traffic. It includes, for example, contributions from natural sources, industry and domestic activity
- **Surface road concentration** describes the contribution of pollutants from the surface road network. It includes not only the contribution of the nearest road at the receptor, but also the net contribution of the modelled road network at the receptor
- **Ventilation outlet concentration** describes the contribution of pollutants from tunnel ventilation outlets
- **Total concentration** is the sum of the sources defined above: background, surface road and ventilation outlet concentrations. It may relate to conditions with or without the project under assessment

- **The change in concentration due to the project** is the difference between the total concentration with the project and the total concentration without the project, and may be either an increase or a decrease, depending on factors including the redistribution of traffic on the network as a result of the project.

9.2.3 Air quality criteria

Air quality was assessed in relation to the criteria listed in **Table 9.2**.

Table 9.2 Air quality criteria applicable to the project assessment

Pollutant/metric	Concentration	Averaging period	Source
Criteria pollutants			
Carbon monoxide (CO)	30 mg/m^3	1 hour	NSW Department of Environment and Conservation (NSW DEC) (2005b)
	10 mg/m^3	8 hours (rolling)	NSW DEC (2005b)
Nitrogen dioxide (NO_2)	246 µg/m^3	1 hour	NSW DEC (2005b)
	62 µg/m^3	1 year	NSW DEC (2005b)
Particulate matter of up to 10 micrometres in size (PM_{10})	50 µg/m^3	24 hours	NSW DEC (2005b)
	30 µg/m^3	1 year	NSW DEC (2005b)
	25 µg/m^3	1 year	NSW proposed standard
	20 µg/m^3	1 year	NSW proposed target
Particulate matter of up to 2.5 micrometres in size ($PM_{2.5}$)	25 µg/m^3	24 hours	National Environment Protection Measure (NEPM) Advisory Standard
	20 µg/m^3	24 hours	NSW proposed target
	8 µg/m^3	1 year	NEPM Advisory Standard
	7 µg/m^3	1 year	NSW proposed target
Air toxics			
Benzene	0.029 mg/m^3	1 hour	NSW DEC (2005b)
Polycyclic aromatic hydrocarbons (PAHs) (as Benzo[a]pyrene)	0.0004 mg/m^3	1 hour	NSW DEC (2005b)
Formaldehyde	0.02 mg/m^3	1 hour	NSW DEC (2005b)
1,3-butadiene	0.04 mg/m^3	1 hour	NSW DEC (2005b)

Note: µg is a microgram equal to one millionth of a gram and mg is a milligram or one thousandth of a gram

In-tunnel air quality

Carbon monoxide

Carbon monoxide (CO) has historically been an indicator of the level of motor vehicle emissions in tunnels, and has therefore been used as the basis of in-tunnel air quality criteria. Advances in vehicle technology have been effective in reducing the levels of CO emissions, so that other emissions are now more relevant indicators of in-tunnel air quality. Chief among these is nitrogen dioxide.

Nitrogen dioxide

Nitrogen dioxide (NO_2) is a respiratory irritant with identified health effects at levels that may be encountered in road tunnels (**section 10.4.1**). DP&E considers that NO_2 is the key pollutant of concern for in-tunnel air quality, and applied new criteria to the NorthConnex tunnel in its approval conditions (NSW Department of Planning and Environment 2015). The new criterion for NO_2 is a tunnel average of 0.5 parts per million (ppm), measured as a rolling average throughout the tunnel, with a limit at any point in the tunnel of 1.0 ppm. This criterion is equivalent to the most stringent international workplace health and safety criteria and compares favourably to international design guidelines for in-tunnel NO_2 levels, which range between 0.4 ppm and 1.0 ppm. Detailed design of the project tunnel would address this criterion under all operating conditions, in addition to the CO and visibility (particulate) limits noted in **Table 9.3** and **Table 9.4**. These are the same operational criteria applied to the recently approved NorthConnex tunnel.

Table 9.3 In-tunnel operational criteria for CO and NO_2

Parameter	Averaging period	Concentration limit (ppm)
In-tunnel average limit along tunnel length		
CO	Rolling 15-minute	87
	Rolling 30-minute	50
NO_2	Rolling 15-minute	0.5
In-tunnel single point exposure limit		
CO	Rolling 3-minute	200

Visibility and particulate matter

Visibility is an important consideration in the design of the tunnel ventilation system; the visibility is required to be greater than the minimum vehicle stopping distance at the design speed (Permanent International Association of Road Congresses (PIARC) 2012). Visibility is reduced by the scattering and absorption of light by particles suspended in the air. The measurement of visibility in a tunnel (using an opacity meter) is based on the concept that a light beam ‘decays’ (reduces in intensity) as it passes through air. The level of decay can thus be used to determine the opacity of the air. For tunnel ventilation, visibility is expressed by the extinction coefficient K.

The amount of light scattering or absorption is dependent upon the composition, diameter and density of the particles in the air. Particles that affect visibility are generally in a size range of 0.4 to 1.0 micrometres.

Table 9.4 In-tunnel operational criteria for visibility

Parameter	Averaging period	Average extinction coefficient limit (m^{-1})
In-tunnel average limit along tunnel length		
Visibility	Rolling 15-minute	0.005

The operational extinction coefficient limit of 0.005 m^{-1} may result in tunnel emissions being visible under congested conditions, but not at sufficient levels to produce hazy conditions (PIARC 2012).

Air quality at tunnel ventilation outlets

The tunnel would be designed and operated to avoid emissions from the tunnel portals as far as practicable. Elevated ventilation outlets, one at each end of the tunnel, would be designed and constructed as described in **Chapter 5** (Project description) and **Chapter 6** (Construction works). Tall tunnel ventilation outlets are effective in dispersing emissions from tunnels using the momentum and buoyancy of the plume. A combination of the design height of the outlet and the amount of fresh air mixed with the contaminated air from a tunnel can be used to ensure appropriate dilution and compliance with local air quality standards. The project ventilation outlet heights and locations are shown in **Table 9.19**.

Ambient air quality standards and goals

An ambient air quality standard defines a metric relating to the concentration of an air pollutant in the ambient air. The term 'standard' is used here to refer to the numerical value of the concentration for a given pollutant in legislation. The *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (NSW DEC 2005b) (Approved Methods) refer to 'impact assessment criteria', and this terminology is also used here.

An air quality standard is typically expressed as a concentration limit for a given averaging period (eg annual mean or 24-hour mean), which may either be stated as a 'not-to-be-exceeded' value or permit some exceedances. Several averaging periods may be used for the same pollutant to address long-term and short-term exposure.

In 1998 Australia adopted a National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM), with the goal of ensuring compliance with air quality standards within 10 years of commencement, in order to attain 'ambient air quality that allows for the adequate protection of human health and wellbeing'. The AAQ NEPM established national standards for six 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 of less than 10 µm (PM_{10}).

The AAQ NEPM was extended in 2003 to include advisory reporting standards for PM with an aerodynamic diameter of less than 2.5 µm ($PM_{2.5}$). The impact assessment criteria for these pollutants are shown in **Table 9.5**.

Table 9.5 Advisory reporting standards for $PM_{2.5}$ in AAQ NEPM

Pollutant or metric	Criterion		Averaging method	Source
	Concentration	Averaging period		
Particulate matter less than 2.5 µm ($PM_{2.5}$)	25 µg/m^3	24 hours	Calendar day	AAQ NEPM 2003
	8 µg/m^3	1 year	Calendar year	AAQ NEPM 2003

Air toxics

Air toxics are gaseous or particulate organic pollutants that are present in the air in low concentrations, but are defined on the basis that they are, for example, highly toxic, carcinogenic or highly persistent in the environment, so as to be a hazard to humans, plants or animal life. Sources of air toxics include motor vehicles, solid fuel combustion, industry, and materials such as paints and adhesives in new buildings.

In recognition of the potential health effects of exposure to air toxics, the National Environment Protection (Air Toxics) Measure (Air Toxics NEPM) identifies 'investigation levels' for five priority pollutants: benzene, formaldehyde, toluene, xylenes and benzo(a)pyrene (as a marker for polycyclic aromatic hydrocarbons). These are not compliance standards, but are used to assess the significance of monitored levels of air toxics with respect to protection of human health.

9.2.4 NSW assessment criteria

The Australian states and territories manage emissions and air quality. In NSW the statutory methods used for assessing air pollution from stationary sources are listed in the NSW Approved Methods (NSW DEC 2005b).

The metrics, criteria and goals set out for criteria pollutants in the NSW Approved Methods are listed in **Table 9.6**. The $PM_{2.5}$ advisory standards are designed for the evaluation of overall population exposure rather than the impacts of a specific facility, and there is no requirement to evaluate $PM_{2.5}$ in the NSW Approved Methods. However, they are often considered to be applicable.

Table 9.6 Impact assessment criteria for 'criteria pollutants' in NSW Approved Methods (NSW DEC, 2005)

Pollutant or metric	Criterion: Concentration	Criterion: Averaging period	Calculation	Source
Carbon monoxide (CO)	87 ppm or 100 mg/m^3	15 minutes	-	World Health Organization (WHO) (2000)
	25 ppm or 30 mg/m^3	1 hour	One hour clock mean	
	9 ppm or 10 mg/m^3	8 hours	Rolling mean of one-hour clock means	AAQ NEPM 1998
Nitrogen dioxide (NO_2)	120 ppb or 246 µg/m^3	1 hour	One hour clock mean	AAQ NEPM 1998
	30 ppb or 62 µg/m^3	1 year	Calendar year mean	
Particulate matter less than 10 µm (PM_{10})	50 µg/m^3	24 hours[(a)]	Calendar day mean	AAQ NEPM 1998
	30 µg/m^3	1 year	Calendar year mean	EPA (1998)[(b)]
Sulfur dioxide (SO_2)	250 ppb or 712 µg/m^3	10 minutes	-	National Health and Medical Research Council (NHMRC 1996)
	200 ppb or 570 µg/m^3	1 hour	One hour clock mean	AAQ NEPM 1998
	80 ppb or 228 µg/m^3	1 day	Calendar day mean	
	20 ppb or 60 µg/m^3	1 year	Calendar year mean	
Lead (Pb)	0.5 µg/m^3	1 year	Calendar year mean	AAQ NEPM 1998
Total suspended particulate matter (TSP)	90 µg/m^3	1 year	Calendar year mean	NHMRC (1996)
Photochemical oxidants (as ozone (O_3))	100 ppb or 214 µg/m^3	1 hour	One hour clock mean	AAQ NEPM 1998
	80 ppb or 171 µg/m^3	4 hours	Rolling mean of one-hour clock means	
Hydrogen fluoride (HF)[(c)]	0.50/0.25 µg/m^3	90 days	-	Australian and New Zealand Environment and Conservation Council (ANZECC 1990)
	0.84/0.40 µg/m^3	30 days	-	
	1.70/0.40 µg/m^3	7 days	-	
	2.90/1.50 µg/m^3	24 hours	-	

(a) Up to five exceedances per year are allowed in the AAQ NEPM, but not in the NSW Approved Methods.

(b) The AAQ NEPM does not specify an annual mean standard for PM_{10}.

(c) The first value is for general land use, which includes all areas other than specialised land use. The second value is for specialised land use, which includes all areas with vegetation that is sensitive to fluoride, such as grape vines and stone fruits.

The Approved Methods document specifies air quality criteria for many other substances (mostly hydrocarbons), including air toxics. The SEARs for the project require an evaluation of BTEX compounds: benzene, toluene, ethylbenzene, and xylenes. The impact assessment criteria in the Approved Methods priority air toxics and BTEX compounds are given in **Table 9.7**. From a health perspective the annual average is the most relevant metric for air toxics, as the main effects are chronic in nature.

Table 9.7 Impact assessment criteria for air toxics

Substance	Concentration	Averaging period	Source
Benzene	0.009 ppm or 0.029 mg/m^3	1 hour	NSW Approved Methods (impact assessment criteria)
Toluene[(a)]	0.09 ppm or 0.36 mg/m^3	1 hour	
Ethylbenzene	1.8 ppm or 8 mg/m^3	1 hour	
Xylenes[(a)]	0.04 ppm or 0.19 mg/m^3	1 hour	
PAHs (as b(a)p)	0.0004 mg/m^3	1 hour	
1,3-butadiene	0.018 ppm or 0.04 mg/m^3	1 hour	
Acetaldehyde[(a)]	0.023 ppm or 0.042 mg/m^3	1 hour	
Formaldehyde	0.018 ppm or 0.02 mg/m^3	1 hour	

(a) Odour criterion

Pollutants and metrics excluded from the project assessment

The following pollutants and metrics were not considered to be relevant to the ambient air quality assessment of the project (nor to road transport projects in general):

- Sulfur dioxide (SO_2). Although SO_2 is emitted from road vehicles, SO_2 emissions are directly proportional to the sulfur content of the fuel, and given that petrol and diesel in NSW now contain less than 50 ppm and 10 ppm of sulfur respectively, the emissions of SO_2 are very low. Sulfur dioxide is therefore not a major concern in terms of transport related air quality
- Lead. The removal of lead from petrol means that it is no longer considered to be an air quality problem other than in relation to specific industrial activities, such as smelting
- Total suspended particulate (TSP). For road transport, TSP can be broadly assumed to be equivalent to PM_{10}, and therefore within the controlling standard. While this is certainly the case for exhaust particles, it is possible that some non-exhaust particles are greater than 10 µm in diameter
- Ozone (O_3). Because of its secondary and regional nature, ozone cannot practicably be considered in a local air quality assessment. In addition, the changes in emissions associated with the project were well below the thresholds that trigger an ozone assessment (see **section 9.7.2**)
- Hydrogen fluoride (HF). The standards for HF relate to sensitive vegetation rather than human health, and HF is not a pollutant that is relevant to road vehicle operation.

There are currently no standards for assessment of ‘ultrafine’ particles. These are particles with a diameter of less than 0.1 µm. While there is some evidence that particles in this size range are associated with adverse health effects, it is not currently practical to incorporate them into an environmental impact assessment. There are several reasons for this, including the rapid transformation of such particles in the atmosphere, the need to treat ultrafine’ particles in terms of number rather than mass, the lack of robust emission factors, the lack of robust concentration response functions, the lack of ambient background measurements, and the absence of air quality standards.

In relation to concentration response functions, the WHO Regional Office for Europe (2013) has stated the following:

> '… the richest set of studies provides quantitative information for $PM_{2.5}$. For ultrafine particle numbers, no general risk functions have been published yet, and there are far fewer studies available. Therefore, at this time, a health impact assessment for ultrafine particles is not recommended.'

For the purpose of the project assessment it has therefore been assumed that the effects of ultrafine' particles on health are adequately represented by those of $PM_{2.5}$.

9.2.5 Modelling scenarios

Overview

Two types of scenario were considered for ambient air quality:

- Expected traffic scenarios
- Regulatory worst case scenarios.

For the expected traffic scenarios the following were determined:

- The total concentration for comparison against NSW impact assessment criteria and international air quality standards
- The contributions of the different sources (background, surface roads and ventilation outlets)
- The change in the total concentration associated with the project.

The results are presented as:

- Pollutant concentrations at discrete receptors (in charts and tables)
- Pollutant concentrations across the modelling domain (as contour plots).

Expected traffic scenarios

The expected traffic scenarios included in the operational ambient air quality assessment are summarised in **Table 9.8**. The scenarios took into account changes over time in the composition and performance of the vehicle fleet, as well as predicted traffic volumes and the distribution of traffic on the road network. The results from the modelling of these scenarios were also used in the health risk assessment for the project (described in **Chapter 11**).

Future year land use projections and infrastructure were included in the traffic modelling to understand the level of traffic demand and associated travel patterns, including induced demand. The air quality scenarios modelled used the expected traffic conditions in the corresponding years in terms of volume, composition and speed, as represented in the WestConnex Road Traffic Model (WRTM).

The traffic demand scenarios used for the assessment of the project are shown in **Table 9.8**.

Table 9.8 Expected traffic scenarios for the operational assessment

Scenario code	Scenario description	WestConnex projects included
2014-BY	2014 − Base year (existing conditions)	No WestConnex projects
2021-DM	2021 – Do minimum (no M4 East)	King Georges Road Interchange Upgrade and M4 Widening
2021-DS	2021 – Do something (with M4 East)	King Georges Road Interchange Upgrade, M4 Widening and M4 East
2031-DM	2031 – Do minimum (no M4 East)	King Georges Road Interchange Upgrade and M4 Widening

Scenario code	Scenario description	WestConnex projects included
2031-DS	2031 – Do something (with M4 East)	King Georges Road Interchange Upgrade, M4 Widening and M4 East
2031-DSC	2031 – Do something (cumulative) (with M4 East and M4-M5 Link projects)	King Georges Road Interchange Upgrade, M4 Widening, M4 East and other WestConnex stages including New M5, M4−M5 Link, Sydney Gateway and Southern Extension

2014 base year

For the purpose of the air quality assessment, a 2014 base year was used. This was used to establish existing conditions. The inclusion of a base year enables the dispersion modelling methodology to be verified against real-world air pollution monitoring data. The base year also provided a current baseline that helped to define underlying trends in projected emissions and air quality, and provided a sense of scale and context for the project impacts.

2021 'do minimum'

2021 was adopted as the primary year for forecasting impacts of the project. The primary 'do minimum' case assumes that the King Georges Road Interchange Upgrade and M4 Widening projects are complete, but that the remainder of the WestConnex projects are not built. It is called 'do minimum' rather than 'do nothing' as it assumes that infrastructure schemes currently incomplete but scheduled for opening prior to the assessment year are operational.

2021 'do something'

As per the primary 'do minimum' scenario, this represents conditions with the project complete and open to traffic, but without any other subsequent WestConnex projects. .It is considered that traffic patterns would be more stable by 2021 than immediately after opening in 2019.

2031 'do minimum'

2031 was adopted as the case for 10 years after the primary year, and was considered to allow for full ramp-up of traffic demand as travellers respond to the provision of the fully completed WestConnex and the associated tolls The 'do minimum' scenario assumes a future network, including the King Georges Road Interchange Upgrade and M4 Widening projects, and some upgrades to the broader transport network over time to improve capacity and cater for traffic growth, but does not include the other subsequent WestConnex projects.

2031 'do something'

This scenario assumes all WestConnex projects are complete, and also includes the Sydney Gateway and the Southern Extension.

2031 'do something (cumulative)'

This is an additional 'do something' scenario with the M4 East, New M5 and M4–M5 Link projects in place. This excludes contributions from the New M5 ventilation outlets (including the shared outlet with the M4–M5 Link), because of their geographical distance from the project. In other words, it was assumed that there would be no 'overlap' in the areas affected by the emissions from the M4 East and New M5 ventilation outlets (approximately six to eight kilometres away).

Regulatory worst case scenarios

The objective of these scenarios was to demonstrate that compliance with the emission limits for the tunnel ventilation outlets would guarantee acceptable ambient air quality.

The scenarios were:

- RWC-A. This scenario applied to the project only. The same ventilation outlets and assumptions were applicable in 2021 and 2031

- RWC-B. This scenario applied to the project and the M4-M5 Link, taking into account the additional ventilation outlets.

These scenarios assessed constant ventilation outlet concentrations (at maximum allowable limits) over a 24-hour period, to provide a representation of the theoretical maximum changes in air quality across all potential operational modes, including unconstrained and worst case traffic conditions (from an emissions perspective) as well as vehicle breakdown situations. The concentration limits for the ventilation outlets are shown in **Table 9.9** and were taken from the NorthConnex Instrument of Approval. These limits were converted to mass emission rates (in kilograms per hour, or kg/h) based on assumed ventilation settings. A 'medium' level air flow of 400 cubic metres per second (m^3/s) was assumed for each outlet, with the corresponding number of fans in operation, effective outlet diameters and exit velocities. Sensitivity tests were also conducted using alternative 'high' (800 m^3/s) and 'low' (200 m^3/s) air flows with corresponding outlet conditions and emission rates, but these gave results that were very similar to those for the medium air flow case and have therefore not been reported here.

Table 9.9 Concentration limits for ventilation outlets

Pollutant	Limit concentration (mg/m^3)
PM_{10}	1.1[(a)]
$PM_{2.5}$	1.1
NO_X	20.0
NO_2	2.0
CO	40.0
Volatile organic hydrocarbons/total hydrocarbons (VOC/THC)	1.0

The ventilation outlet assumptions for the regulatory worst case scenarios are shown in **Appendix H** (Table 8.19) and the results are presented in **section 9.7.3**.

The analysis was undertaken to assist regulatory authorities in assessing and determining potential ventilation outlet concentration limits that could be applied through conditions of approval. Assuming that concentration limits are applied to the ventilation outlets, the results of the analysis will demonstrate the air quality performance of the project if it operates continuously at the limits. In reality, ventilation outlet concentrations would vary over a daily cycle due to changing traffic volumes and tunnel fan operation.

The assumptions underpinning the worst case scenarios were very conservative, and resulted in contributions from project ventilation outlets that were much higher than could realistically occur under any operational conditions in the tunnel.

9.2.6 Accuracy and conservatism

There is generally a desire for a small amount of conservatism in air quality assessments. The reasons for this include the following:

- Allowing for uncertainty. An assessment on the scale undertaken for this project is a complex, multi-step process that involves a range of assumptions, inputs, models and post-processing procedures. There is an inherent uncertainty in each of the methods used to estimate emissions and concentrations, and there are clearly limits to how accurately any impacts in future years can be predicted. Conservatism is built into predictions to ensure that a margin of safety is applied (ie to minimise the risk that any potential impacts are underestimated)
- Providing flexibility. It is not desirable to define the potential environmental impacts of a project too narrowly in the early stages of the development process. A conservative approach provides flexibility, allowing for ongoing design refinements within an approved environmental envelope (AECOM 2014).

Conversely, excessive conservatism in an assessment risks overstating potential air quality impacts and associated human health risks. This, in turn, may lead to some undesirable outcomes that need to be mitigated and managed. An overly conservative approach may create, or contribute to, concerns within the local community and among other stakeholders about the impacts of the project. It may lead to additional, or more stringent, conditions of approval than necessary, including requirements for the mitigation, monitoring and management of air quality. Overstatement of vehicle contributions to local air quality may also lead to overstating the benefit where vehicle emissions are reduced by the project (AECOM 2014).

Air quality assessments therefore need to strike a balance between these potentially conflicting requirements.

The operational air quality assessment for the project has been conducted, as far as possible, with the intention of providing 'accurate' or 'realistic' estimates of pollutant emissions and concentrations. The general approach has been to use inputs, models and procedures that are as accurate as possible, except where the context dictates that a degree of conservatism is sensible. An example of this is the estimation of the maximum one-hour NO_2 concentration during a given year. Any method that provides a 'typical' or 'average' one-hour NO_2 concentration will tend to result in an underestimate of the likely maximum concentration, and therefore a more conservative approach is required.

However, the scale of the conservatism can be difficult to define, and this can sometimes result in assumptions being overly conservative. Skill and experience is required to estimate impacts that err on the side of caution but are not unreasonably exaggerated or otherwise skewed. By demonstrating that a deliberate overestimate of impacts is acceptable, it can be confidently predicted that the actual impacts that are likely to be experienced in reality would also lie within acceptable limits (AECOM 2014b).

9.2.7 Model selection and validation

Both the emissions and dispersion models were validated for use in the assessment of this project. The Graz Lagangrian (GRAL) dispersion model (version 14.11) was selected for this study, and was validated by comparing predicted and measured concentrations in the 2014 base year.

GRAL was chosen because it is:

- Suitable for regulatory applications and can utilise a full year of meteorological data
- Able to predict low wind speed conditions (less than one metre per second) better than most other models
- Specifically designed for the simultaneous modelling of road transport networks, including line sources (surface roads), point sources (tunnel ventilation outlets) and other sources
- Able to take into account vehicle wake effects
- Able to characterise pollution dispersion in complex local terrain and topography, including the presence of buildings in urban areas
- Validated in a wide range of studies featuring complex and flat terrain and with varying meteorological conditions (high/low wind speeds, stable/unstable atmospheric conditions etc.

While the GRAL system has not been used extensively in Australia, it was used in the assessment of the Waterview Connection tunnels near Auckland, New Zealand. The model set up for this project has been tailored to suit the needs of both the study at hand and the regulatory requirements in NSW in relation to air quality.

The GRAL model is described in more detail in **Appendix H**. The method and results of the evaluation are given in Appendix I of the air quality assessment report provided in **Appendix H**, and are summarised below.

GRAL was configured to provide concentration predictions for each main pollutant (CO, NO_X, NO_2 and PM_{10}) at each of nine air quality monitoring sites (seven background and two roadside) in the WestConnex GRAL domain and for the full 2014 base year. The WestConnex and M4 East model domains are described in **section 9.4.2**. $PM_{2.5}$ was not included as no independent testing of the model performance for $PM_{2.5}$ was possible.

The GRAL predictions were for the combined surface road network and the existing M5 East tunnel ventilation outlet. For each monitoring site the GRAL predictions were extracted for an hourly time series of concentrations for 2014. These were combined with an estimated background contribution for each monitoring site.

The performance of GRAL was also investigated for the project-specific air quality monitoring stations. Given that only partial monitoring data for 2014 were available at each site, the comparisons between the model and the measurements were made for the monitoring period covered at each site.

The vehicle emission models used in the in-tunnel and ambient air quality assessments were validated by comparison with the EPA measured emissions from the Lane Cove Tunnel (see Appendix E of the air quality assessment in **Appendix H**).

9.2.8 Sensitivity tests

A number of sensitivity tests were conducted to investigate the effects of varying the key assumptions in the ambient air quality assessment (**Appendix H**). These included:

- The influence of ventilation outlet temperature
- The influence of ventilation outlet height
- The inclusion of buildings near tunnel ventilation outlets.

These tests were based on a sub-area of the M4 East GRAL domain of approximately two kilometres by two kilometres around the project's eastern ventilation outlet. Only the ventilation outlet contribution, and only annual mean $PM_{2.5}$ and maximum 24-hour $PM_{2.5}$, were included in the tests. A sub-set of 14 sensitive receptors was evaluated. The predicted concentrations were indicative, as the aim of the sensitivity tests was to assess the proportional sensitivity of the model to specific input parameters.

9.3 Construction air quality assessment methodology

Activities on construction ancillary facilities can be categorised into four types (as noted in **Figure 9.1**) to reflect their potential impacts. The potential for dust emissions is then assessed for each likely activity in each category:

- **Demolition** is any activity that involves the removal of existing structures
- **Earthworks** covers the processes of soil stripping, ground levelling, excavation and landscaping. Earthworks primarily involves excavating material, haulage, tipping and stockpiling
- **Construction** is any activity that involves the provision of new structures, or modification or refurbishment of existing structures. 'Structures' include buildings, ventilation outlets and roads
- **Track-out** involves the transport of dust and dirt from the construction/demolition site onto the public road network on construction vehicles. These materials may then be deposited and re-suspended by vehicles using the network.

It is very difficult to *quantify* dust emissions from construction activities, since it is not possible to predict the weather conditions that will prevail during specific construction activities. In any case, the effects of construction on airborne particle concentrations would generally be temporary and relatively short-lived, and mitigation should be straightforward, since dust suppression measures are routinely employed as 'good practice' on most construction ancillary facilities. It is therefore more usual to provide a *qualitative* assessment of potential construction dust impacts. This approach follows the guidance published by the UK Institute of Air Quality Management (IAQM) (2014), the aim of which is to identify risks and recommend appropriate mitigation measures.

Construction activities would occur at several sites within the project area, as described in Chapter 6 (Construction work). Many of these activities would be transitory. The majority of the construction footprint would be underground; however, surface works would be required to support tunnelling activities and to construct surface infrastructure such as interchanges, tunnel portals, ventilation facilities, ancillary operations buildings and facilities, and the eastbound cycleway near the Homebush Bay Drive interchange.

The guidance published by the IAQM (2014) was used for the assessment of air quality during construction (see **Appendix H**). The IAQM guidance has been adapted for use in NSW, taking into account factors such as the assessment criteria for ambient PM_{10} concentrations. The potential construction air quality impacts have been assessed based on the proposed works, plant and equipment, and the potential emission sources and levels.

The IAQM procedure for assessing construction dust impacts is shown in **Figure 9.1**.

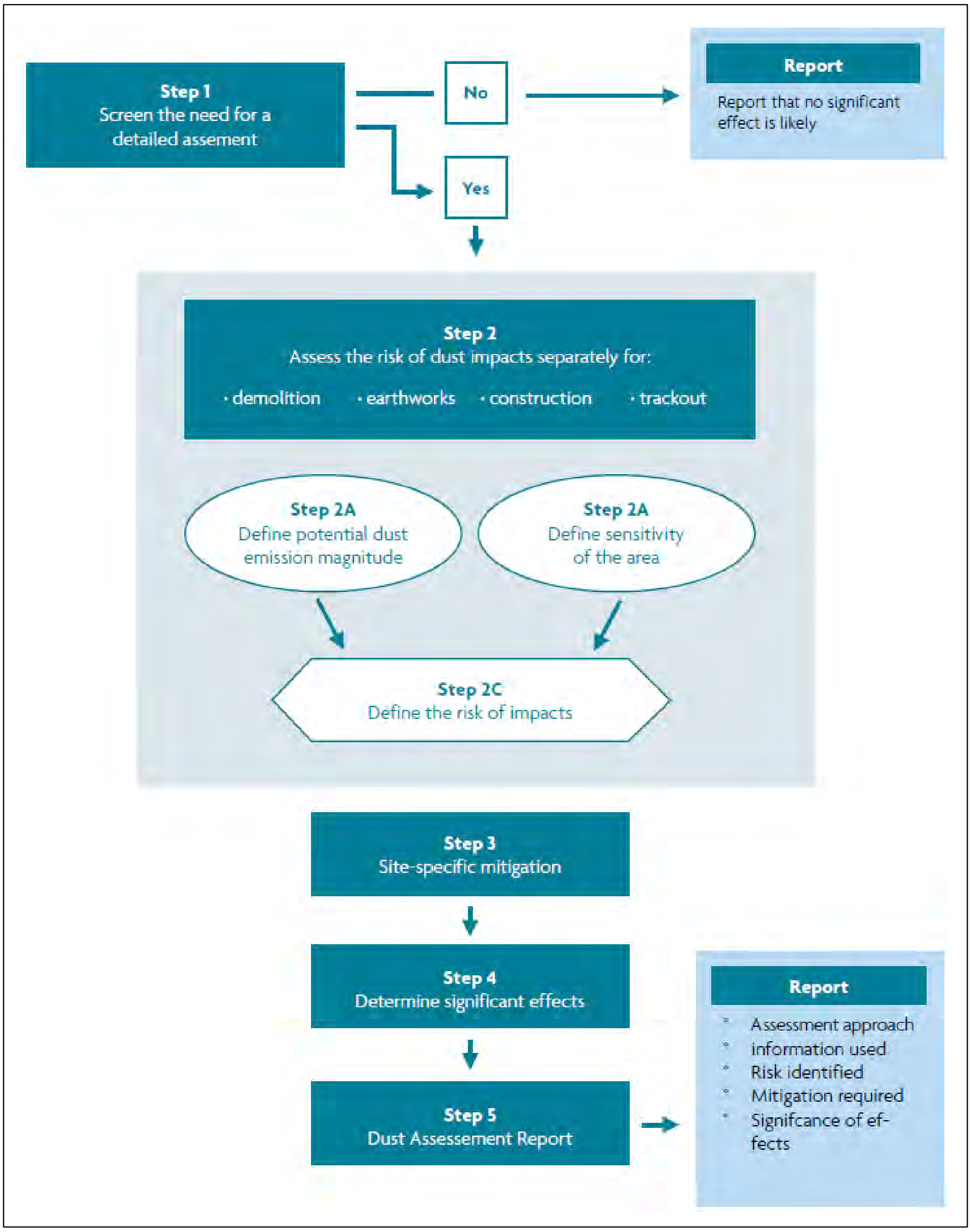

Figure 9.1 Steps in an assessment of construction dust (IAQM 2014)

The main air pollution and amenity issues at construction ancillary facilities are:

- Dust deposition (soiling of surfaces) and visible dust plumes
- Elevated PM_{10} concentrations due to dust-generating activities
- Exhaust emissions from diesel-powered construction equipment.

The assessment methodology considers three dust impacts:

- Annoyance due to dust deposition (soiling of surfaces)
- The risk of health effects from increased exposure to PM_{10}
- Harm to ecological receptors.

The risk of dust impacts from a demolition/construction ancillary facility causing loss of amenity and/or health or ecological impacts is related to the following (IAQM 2014):

- The nature of the activities being undertaken
- The duration of the activities
- The size of the site
- The meteorological conditions (wind speed, direction and rainfall). Adverse impacts are more likely to occur downwind of the site and during drier periods
- The proximity of receptors to the activities
- The sensitivity of the receptors to dust
- The adequacy of the mitigation measures applied to reduce or eliminate dust.

9.4 Operational assessment methodology

Details of the various components of the operational assessment methodology are provided in **Appendix H** and a summary of the in-tunnel and external air quality assessment is provided below.

9.4.1 In-tunnel assessment methodology

The in-tunnel traffic, airflow, pollution level and temperature have been modelled using the EQUA AB software IDA Tunnel, which models air flows and pollutant concentrations. A traffic model within the simulation applies traffic continuity and realistic rules on traffic flow versus speed, to predict the traffic density and speed throughout the tunnel. The resulting airflows, in combination with the vehicle emissions, determine the pollutant levels in the tunnel.

This software was used to model tunnel ventilation and pollution concentrations under varying traffic flows, from free-flowing to congested conditions, for the years 2021 and 2031, over a 24-hour period on a summer and a winter day.

Congested traffic (maximum traffic flow) scenario

Multi-lane tunnels have an advantage in mitigating congestion, in that slow vehicles can occupy the left lane, allowing the remaining lanes to accommodate faster moving traffic. The notion of uniformly slow moving traffic throughout a tunnel in the absence of an accident or other incident is unrealistic. Since ventilation simulation software and other calculation methods do not consider this speed difference between lanes, they underestimate the aerodynamic effect of vehicles and produce lower estimates of tunnel air flow and higher estimates of in-tunnel pollution, especially for congested cases where the speed difference between lanes is significant.

When congestion does occur in the model simulations, it is associated with high traffic demand at entry portals and occurs locally where traffic merges, or at steep exit ramps where congestion may extend back into the mainline tunnel. Since traffic flow is compressible, especially in a long tunnel, some sections can flow freely while others are congested.

Two real life congestion scenarios have been simulated:

- A single lane closure in the three-lane mainline tunnel
- Congestion at the exit portals.

Traffic simulation within the IDA Tunnel model shows that these events do not produce severe drops in traffic speed throughout the mainline tunnel. In order to generate severe congestion along the mainline, it was necessary to apply a traffic speed limit; this is a somewhat artificial method of producing the severe congestion scenarios required for ventilation design.

Emissions from the total vehicle 'fleet' in Sydney were calculated based on:

- Australia-specific emission factors (PIARC 2012 and the air quality assessment contained in **Appendix H**
- Traffic volumes taken from the WRTM, as discussed in **Chapter 8** (Traffic and Transport)
- Traffic mix (existing M4 traffic data, weigh-in-motion studies), as discussed in **Chapter 8**
- Tunnel alignment and geometry.

In-tunnel vehicle emissions were modelled following PIARC (2012) methods, with the Australian fleet specifications extrapolated to 2020 and used for both the 20121 and 2031 scenarios (Appendix L of the air quality assessment in **Appendix H**).

9.4.2 External air quality assessment methodology

The operational ambient air quality assessment was based on the GRAMM/GRAL modelling system. This system consists of two main modules: a prognostic wind field model (the Graz Mesoscale Model, or GRAMM) and a dispersion model (GRAL). The elements of the system are shown in **Figure 9.2** and summarised below. Full details of the methodology are presented in the air quality assessment report in **Appendix H**.

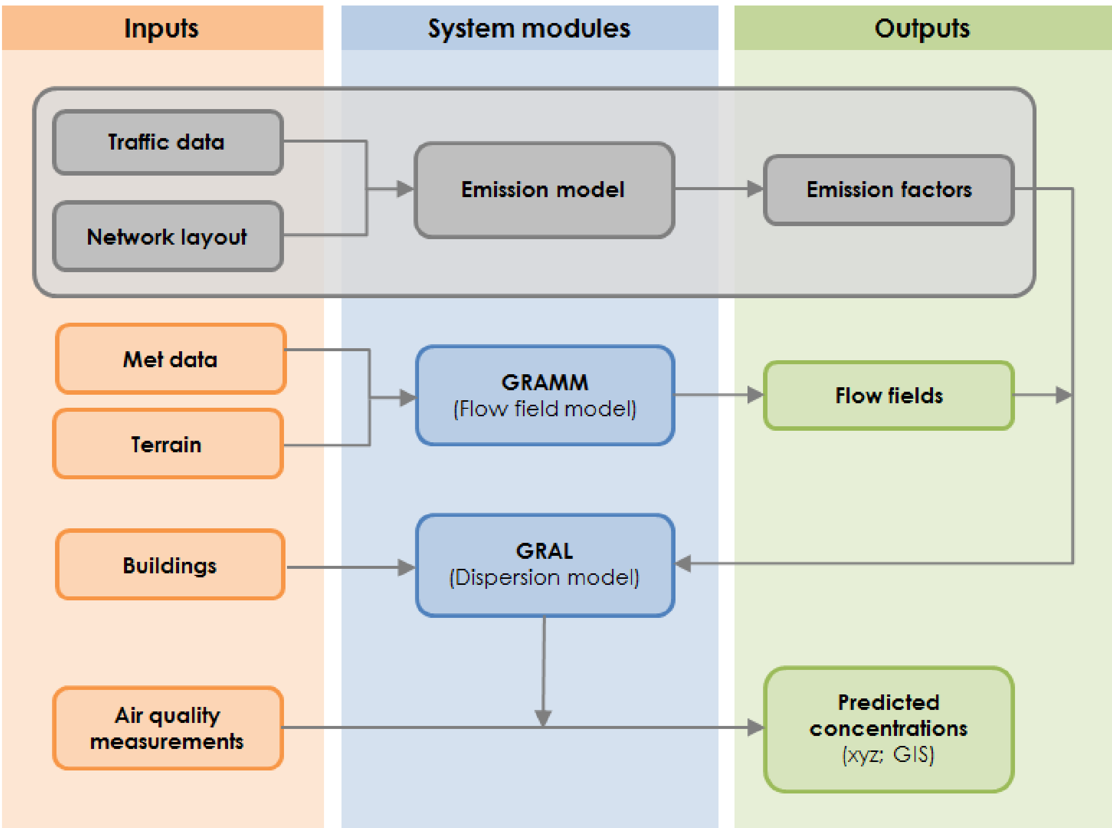

Figure 9.2 Overview of the GRAMM/GRAL modelling system

The GRAL dispersion model is a three-dimensional model used to predict pollutant concentrations. It is suitable for regulatory applications and can use a full year of meteorological data. It predicts pollutant concentrations under low wind speed conditions less than one metre per second) more accurately than Gaussian models (eg CALINE). It is specifically designed for the simultaneous modelling of surface roads, point sources (tunnel ventilation outlets) and tunnel portals, and takes into account vehicle wake effects.

GRAL characterises pollution dispersion in complex local terrain and topography, including the presence of buildings in urban areas. It has been validated in a wide range of studies featuring complex and flat terrain, and with different meteorological conditions such as high and low wind velocities, and stable or unstable atmospheric conditions (Appendix I of the Air Quality Assessment Report in **Appendix H**) and is not inherently conservative (see discussion of conservatism in **section 9.2.6**).

Definition of modelling domains

The modelling domains for the project are shown in **Figure 9.3**. The following terms are used in this report to describe the different geographical areas of the assessment:

- The GRAMM domain (also referred to as the 'study area') is shown by the red boundary in **Figure 9.3**. This was used for the modelling of meteorology, and was the largest area included in the assessment. The GRAMM domain covers a substantial part of Sydney, extending 25 kilometres in the east−west (x) alignment and 20 kilometres in the north−south (y) alignment.
- The WestConnex GRAL domain for dispersion modelling is shown by the black boundary in **Figure 9.3**. This extended 15 kilometres in the east−west alignment and 14 kilometres in the north−south alignment. Every dispersion model was run undertaken for the WestConnex GRAL domain, which includes all WestConnex projects (a section of the M4 Widening, M4 East, King Georges Road Interchange Upgrade, New M5 and M4−M5 Link). The large size of the WestConnex GRAL domain was defined for a number of reasons:
  - It facilitated a 'whole of project' modelling approach, whereby the specific information for each WestConnex project could be extracted and presented in more detail for the separate EISs (in this case, for the M4 East project). This improved both the efficiency and consistency of the air quality assessments for the various WestConnex projects
  - It provided the cumulative impacts of all relevant projects, such as the combined ventilation outlet for the M4 East and M4−M5 Link
  - It maximised the flexibility of the assessment process, and is capable of accommodating any future changes in the requirements of any project
  - It maximised the number of meteorological and air quality monitoring stations that could be included for model evaluation purposes.
- The M4 East GRAL domain is shown by the blue boundary in **Figure 9.3**. This extended 8.5 kilometres in the east−west alignment and 6.2 kilometres in the north−south alignment. No separate modelling was undertaken for this domain; rather, the model results for this area were extracted from the model results for the WestConnex GRAL domain.

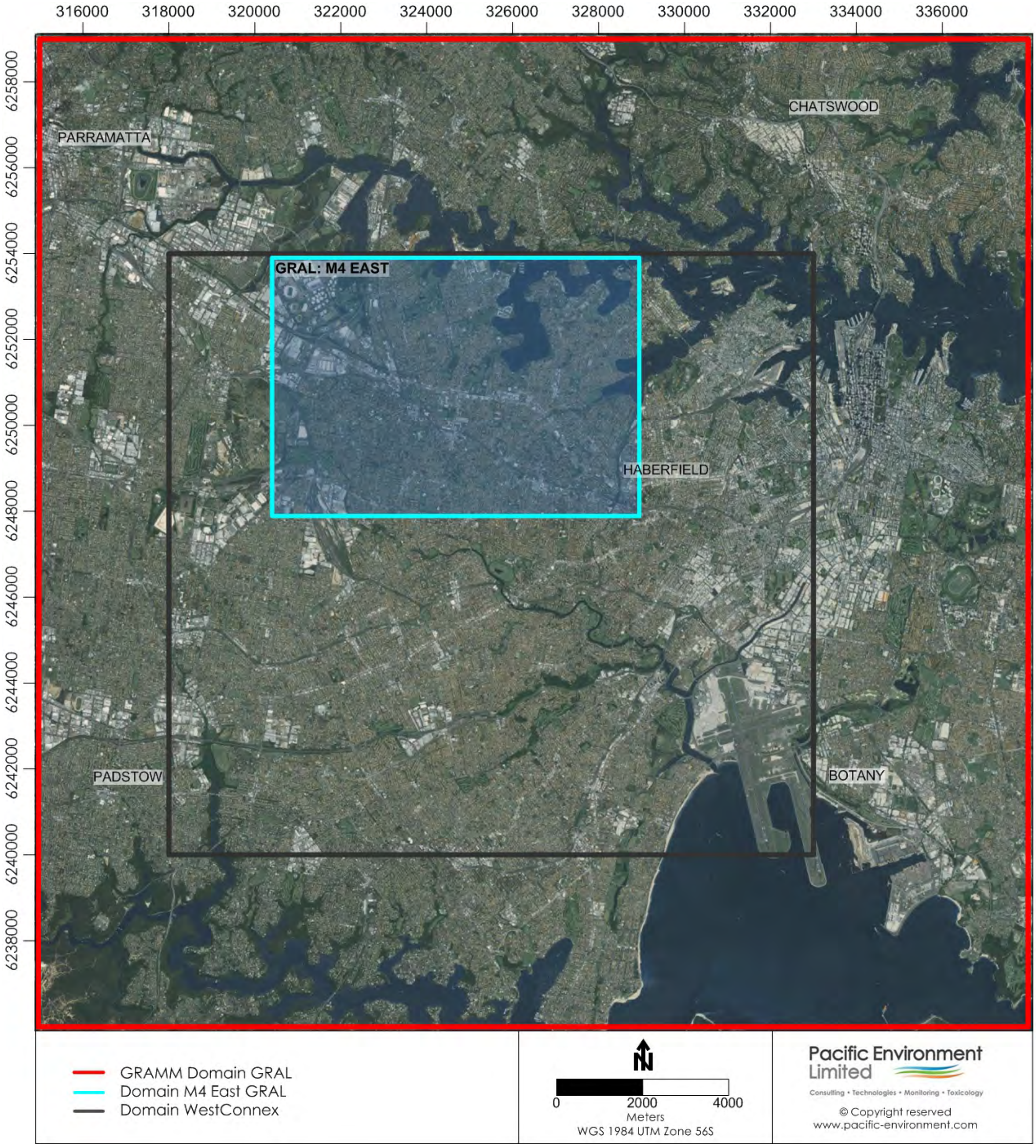

Figure 9.3 Modelling domains for GRAMM and GRAL

Determination of components of assessment

The various pollutant concentrations were determined as follows:

- Background concentrations were based on measurements from air quality monitoring stations at urban background locations in the study area, but well away from roads (as defined in Australian Standard AS/NZS 3580.1.1:2007). The approaches used to determine long-term and short-term background concentrations are explained in Appendix F of the air quality assessment in **Appendix H**. Background concentrations were assumed to remain unchanged in future years
- Surface road concentrations and ventilation outlet concentrations were estimated (separately) using the GRAL dispersion model
- For all pollutants except NO_2, as the background concentration was the same with and without the project, the project increment was equal to the difference between the road concentration (surface roads and ventilation outlets) with and without the project. A different method was required for NO_2

to account for the atmospheric chemistry in the roadside environment (see Appendix G of the air quality assessment in **Appendix H**).

Receptors

Appendix H presents contour maps showing concentrations, and changes in concentration, across the entire M4 East GRAL domain. The concentrations are based on a Cartesian grid of points with an equal spacing of 10 metres in the x and y directions. This results in 527,000 grid locations across the M4 East GRAL domain.

This report also presents distributions of changes in concentration at over 10,000 discrete receptor locations along the project corridor where people are likely to be present for some period of the day. Two types of discrete receptor locations were defined for use in the assessment:

- 'Community receptors'. These were taken to be representative of particularly sensitive locations within a zone (600 metres either side) along the project corridor, such as schools, child care centres and hospitals. For these receptors a detailed approach was used to calculate the total concentration of each pollutant. This involved the combination of the contemporaneous road/outlet time series of concentrations from GRAL and the background time series of concentrations, stated as a one-hour mean for each hour of the year in each case. The number of such receptors that could be treated in this was dictated by the limit on the number of time series that could be extracted from GRAL. In total, 31 community receptors were included in the assessment
- 'Residential, workplace and recreational (RWR) receptors'. These were all discrete receptor locations along the project corridor, and mainly covered residential and commercial land uses. The 31 community receptors were also included. For these receptors a simpler statistical approach was used to combine a concentration statistic for the modelled roads and outlets (eg maximum 24-hour mean PM_{10}, annual mean NO_X) with an appropriate background statistic. Around 10,000 RWR receptors were included in the assessment.

The RWR receptors are discrete points in space, classified according to the land use identified at that location. The RWR receptors do not identify the number of residential (or other) properties at the location. The residential land use at an RWR receptor location may range from a single-storey dwelling to a multi-storey, multi-dwelling building. The RWR receptors are therefore not designed for the assessment of changes in total population exposure. The human health risk assessment (**Appendix J**) combines the air quality information with the highest available resolution population data from the Australian Bureau of Statistics to calculate key health indicators that reflect population-weighted change in concentrations across the study area.

Although not all particularly sensitive receptors along the project corridor were included in the first type, they were included in the second type. This included, for example, aged care facilities and some additional schools. This approach was considered to be appropriate, in that it allowed all relevant receptors to be included in the assessment whilst recognising model limitations

Community receptors are listed in **Table 9.10**. RWR receptor types are listed in **Table 9.11**. The locations of both types of receptor are shown in **Figure 9.4**.

Table 9.10 Community receptors

Receptor code	Receptor name	Receptor location	
		x	y
SR01	Peek-A-Boo Early Learning	327364	6249386
SR02	Aiya Medical Centre	323074	6251114
SR03	St John of God Burwood Hospital	324279	6250670
SR04	MLC School Sydney	324373	6250528
SR05	Southern Cross Catholic Vocational College	324552	6250486
SR06	Burwood ENT Surgery	324764	6250661
SR07	Burwood Chest Clinic	324772	6250684
SR08	Homebush Boys High School	322126	6251117
SR09	Homebush Public School	322791	6250986

Receptor code	Receptor name	Receptor location	
		x	y
SR10	Homebush Medical Centre	322985	6250902
SR11	Pre-University New College	323209	6250772
SR12	McDonald College	323089	6251759
SR13	Light House Child Care	323095	6251629
SR14	MLC School Sydney	324268	6250516
SR15	Strathfield Private Hospital	324039	6250416
SR16	St Mary's Catholic Primary School	324437	6250834
SR17	Rosebank College	326234	6250636
SR18	Little VIPs	326895	6250197
SR19	Ella Community Child Care Centre	327793	6249519
SR20	Ramsay Street Medical Centre	327755	6249680
SR21	St. John of Arc Catholic School	327895	6249716
SR22	Saint Joan of Arc's Catholic Church Haberfield	327948	6249729
SR23	Dobroyd Point Public School	328040	6250175
SR24	Domremy College	327401	6250774
SR25	The Infants Home	326973	6249712
SR26	Lucas Gardens School	325624	6250771
SR27	Educare Playschool	326366	6249880
SR28	Goodstart Early Learning	327638	6249350
SR29	Haberfield Public School	327384	6249525
SR30	Happy Little Campers	326584	6250974
SR31	Burwood Girls High School	325448	6250134

Table 9.11 RWR receptor types and numbers

Receptor type	Number
Residential	7,251
Garage	1,493
Commercial property	465
Industrial property	38
Educational establishment	97
Child care centre	9
Medical centre / hospital	16
Place of worship	17
Hotel	9
Café/Bar	9
Outdoor 'active'	549
Outdoor 'passive'	210
Total	**10,154**

Figure 9.4 Community and residential, workplace and recreational receptors for air quality modelling

9.5 Existing environment

This section describes the existing environment and conditions in the study area, including:

- A description of the terrain and land use in the study area
- The meteorology (weather patterns) in the study area
- Consideration of historical trends in road traffic emissions
- The historical and current air quality environment in the study area
- The meteorological inputs for the operational air quality assessment
- The background concentrations for the operational air quality assessment.

9.5.1 Terrain and land use

The topography of the land in an area plays an important role in the dispersion of air pollutants. It steers winds, generates turbulence and large scale eddies, and generates drainage flows at night (when air cools and flows downslope) and upslope flows during the day (as a result of surface heating).

Terrain data for Sydney were obtained from the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) website. The terrain within the WestConnex study area is predominantly flat, but increases in elevation to the north of the Five Dock Bay area towards the Hills District and to the south towards the Sutherland Shire and adjoining parkland.

The terrain along the project corridor rises from an elevation of around 15 metres Australian Height Datum (AHD) at the western end to an elevation of around 22 metres AHD at the eastern end. Land use within the M4 East GRAL domain consists primarily of urban areas, with pockets of small recreational reserves and waterbodies around Five Dock Bay and towards the east coast. The uniformity of the terrain, and the lack of major obstacles to wind flow, should support good dispersion and air flow throughout the study area.

9.5.2 Climate

Table 9.12 and **Table 9.13** present the 20-year temperature and rainfall data for the two closest Bureau of Meteorology (BoM) sites, located at Sydney Olympic Park (Archery Centre) (site number 066195) and the Canterbury Racecourse (site number 066194). Monthly averages of maximum and minimum temperatures are presented, as well as rainfall data consisting of mean monthly rainfall and the average number of rain days per month.

Table 9.12 Climate averages for Sydney Olympic Park

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean daily maximum temperature (ºC)												
28.4	28.1	26.6	23.9	20.8	18.3	17.6	19.5	22.5	24.3	25.3	27.4	23.6
Mean daily minimum temperature (ºC)												
19.3	19.4	17.8	14.3	11.2	8.9	7.8	8.7	11.6	13.7	15.8	17.9	13.9
Mean monthly rainfall (mm)												
84.4	109.8	66.0	89.2	88.2	75.8	63.5	56.7	52.7	64.9	76.2	58.0	884.0
Mean rain days per month (number)												
7.6	7.7	7.6	6.9	7.7	6.9	6.3	4.4	5.5	7.1	7.8	6.8	82.3

Source: BoM (2015b) Climate averages for Station: 066195; Commenced: 1995 – last record 2015; Latitude: 33.85°S; Longitude: 151.06 °E

Table 9.13 Climate averages for Canterbury Racecourse

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean daily maximum temperature (ºC)												
27.6	27.2	25.9	23.3	20.5	18.1	17.5	19.0	22.1	23.4	24.6	26.3	23.0
Mean daily minimum temperature (ºC)												
18.3	18.3	16.4	12.7	9.3	7.1	5.8	6.5	9.5	12.0	14.8	16.8	12.3
Mean monthly rainfall (mm)												
76.0	103.6	73.3	113.4	84.9	98.8	57.8	63.3	45.7	62.4	81.4	64.7	927.8
Mean rain days per month (number)												
7.6	7.8	7.5	7.8	7.1	8.9	6.7	5.1	4.7	6.2	8.3	6.8	84.5

Source: BoM (2015c) Climate averages for Station: 066194; Commenced: 1995 – last record 2015; Latitude: 33.91°S; Longitude: 151.11 °E

The annual average maximum and minimum temperatures recorded at the Sydney Olympic Park station are 23.6°C and 13.9°C, respectively. At Canterbury Racecourse these are 23.2°C and 12.3°C, respectively. On average, January is the hottest month, with average maximum temperatures of 28.4°C and 27.6°C at Olympic Park and Canterbury, respectively. July is the coldest month at both stations, with average minimum temperatures of 7.8°C and 5.8°C, respectively.

Rainfall data collected at the Sydney Olympic Park station shows that February is the wettest month, with an average rainfall of 110 millimetres over an average of eight rain days. The average annual rainfall is 884 millimetres over an average of 82 rain days per year. Rainfall data from the Canterbury site shows the wettest month on average occurring in April, with 113 millimetres falling over eight rain days. The average annual rainfall is slightly higher, at 928 millimetres over an average of 85 rain days per year.

9.5.3 Meteorology

Several meteorological stations in the study area were considered, and their locations are shown in **Figure 9.5**. Data relevant to the dispersion modelling such as wind speed, wind direction, temperature and cloud cover was obtained for the following locations (shown in **Figure 9.5**):

- NSW Office of Environment and Heritage (OEH) meteorological stations:
  - Chullora
  - Earlwood
  - Rozelle
- BoM meteorological stations:
  - Canterbury Racecourse Automatic Weather Station (AWS) (site number 066194)
  - Fort Denison (site number 066022)
  - Sydney Airport Allied Meteorological Office (AMO) (site number 066037)
  - Sydney Olympic Park AWS (site number 066195)
  - Sydney Olympic Park AWS (Archery Centre) (site number 066212).

An analysis of the data required as input for GRAMM was conducted to examine the availability and validity of the data from these meteorological stations. Data recovery, wind speed, wind direction, temperature and relative humidity information for years 2009 to 2014 was analysed, where available, for each of the sites. A minimum of five years of data was chosen for analysis, in line with the requirements of determining site-representative data outlined in the Approved Methods.

It is noted that the OEH Randwick site is also located within the model domain. However, as it would be less than 500 metres away from the western edge of the domain, it was not considered for inclusion in the model due to potential model boundary effects, which could skew the wind fields at this location.

Appendix H (Meteorological Data and Evaluation) of the air quality assessment report in **Appendix H** of this EIS provides a summary of the annual data recovery, average wind speed and percentage of calms (wind speeds less than 0.5 metres per second) for each of the selected meteorological stations from 2009 to 2014. The table shows a generally high percentage of data recovery at each site over the last six years consistent with the data requirements in the Approved Methods. There was a high level of consistency in the annual average wind speed and annual percentage of calms across the years within each meteorological station database. Wind speed conditions, including episodes of calm conditions, have remained relatively consistent over the period.

Annual and seasonal wind roses for all six years and for all sites were used to analyse the general wind patterns across the modelling domain. These are presented in **Appendix H**. The wind roses showed very similar wind patterns for all six years at each individual site. The dominant wind patterns are predominantly from the northwest and southeast directions. The seasonal patterns are also very similar between each site.

Based on the analysis of the available meteorological data within the GRAMM modelling domain (**Figure 9.5**) presented in **Appendix H**, data from the BoM Canterbury Racecourse AWS meteorological station were chosen as the input to GRAMM for modelling. The site was considered to be representative of the meteorology in the domain.

Analysis of the Canterbury Racecourse data showed that the wind speed and direction patterns for the past six years (2009 to 2014) were consistent from year to year Appendix H (Meteorological Data and Evaluation) of the Air Quality Assessment Report in **Appendix H** of this EIS**.** Other sites also showed consistencies, but the Canterbury Racecourse AWS site was the most centrally located with respect to WestConnex. The analysis of six years of data also showed that 2014, the most recent year available, was representative of longer term weather conditions. The selection of the 2014 meteorological data was consistent with the use of 2014 measured ambient air quality data to define background concentrations for the assessment.

Figure 9.6 to **Figure 9.9** show annual and diurnal plots of wind speed and temperature from the Canterbury Racecourse site for 2014. The annual plots show a typical distribution of wind speed and temperature over the course of a year. The diurnal plots also show typical patterns, with higher wind speeds and temperatures during the day, decreasing at night and in the early morning.

Having determined that 2014 was a representative year, these data were then used to run the meteorological model (GRAMM) to determine three-dimensional wind fields across the modelling domain. This process is described further in **Appendix H**. Wind speed and direction values were extracted at each of the meteorological stations shown in **Figure 9.5** and some statistical analysis was carried out to compare these extracted (predicted) data with the observations at each of those sites. This process is discussed further in section **Appendix H**.

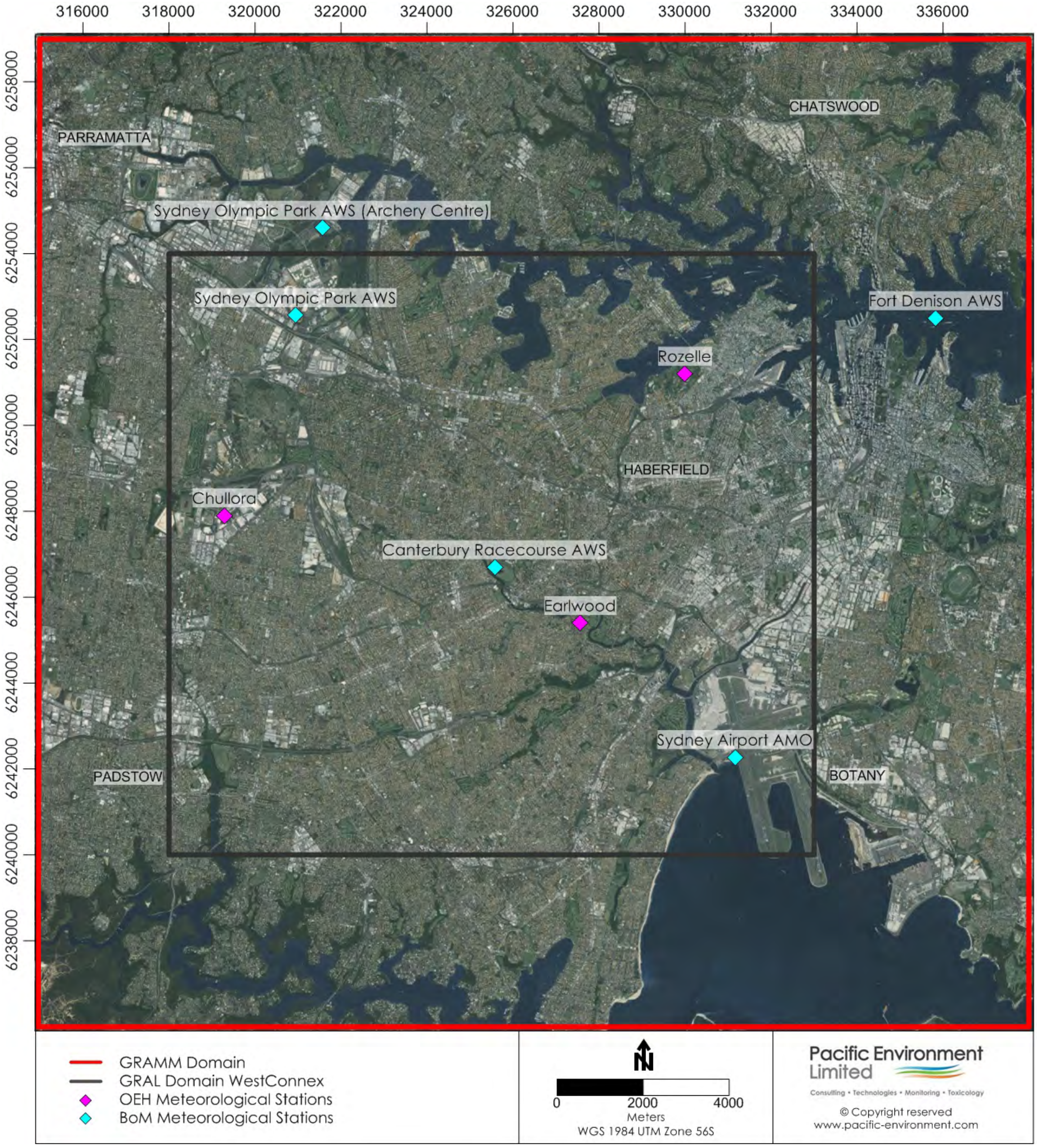

Figure 9.5 **Meteorological stations in the GRAMM model domain**

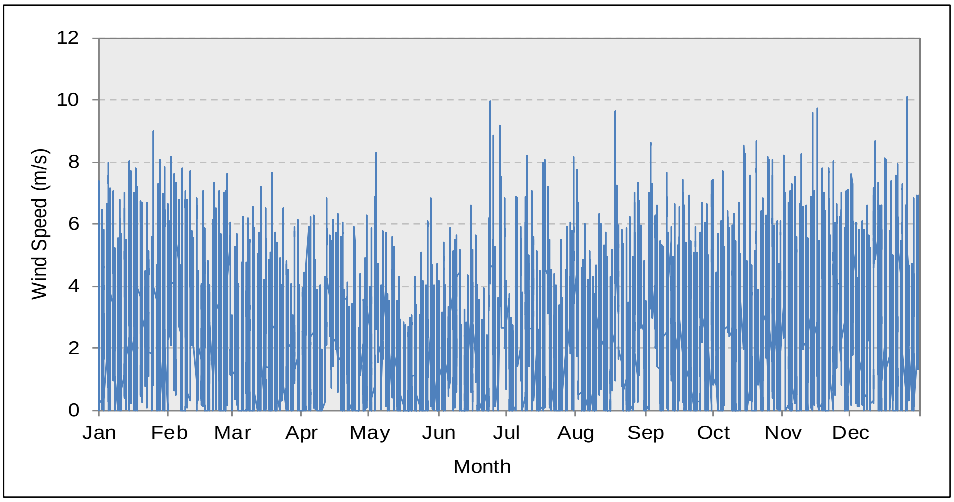

Figure 9.6 **Hourly average wind speeds at Canterbury Racecourse – 2014**

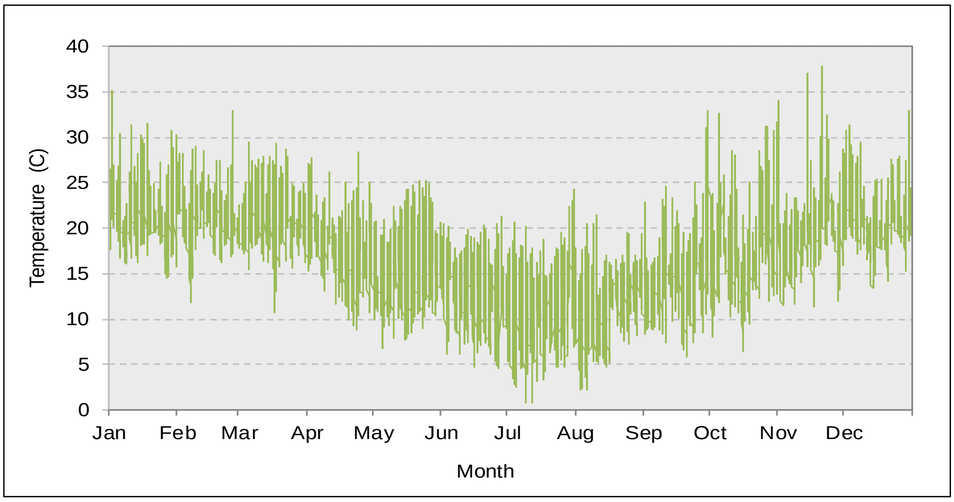

Figure 9.7 **Hourly average temperatures at Canterbury Racecourse – 2014**

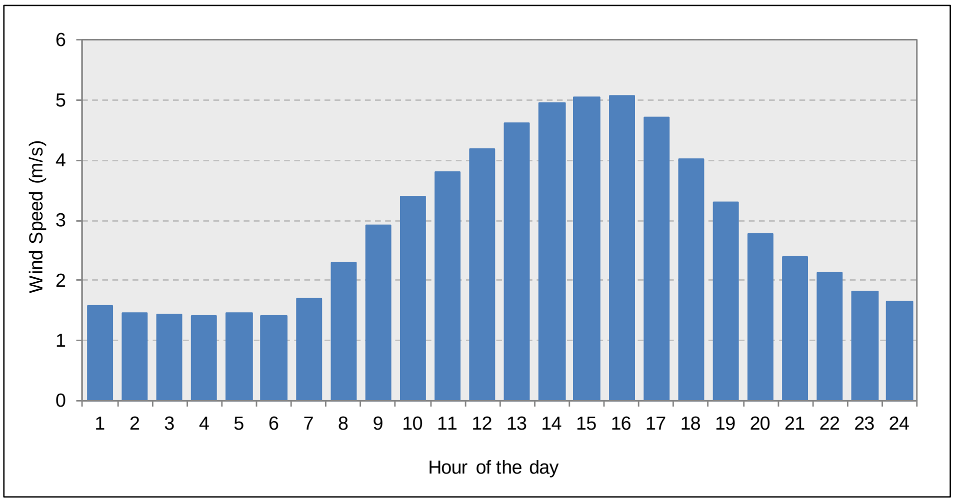

Figure 9.8 **Average wind speeds by hour of day at Canterbury Racecourse – 2014**

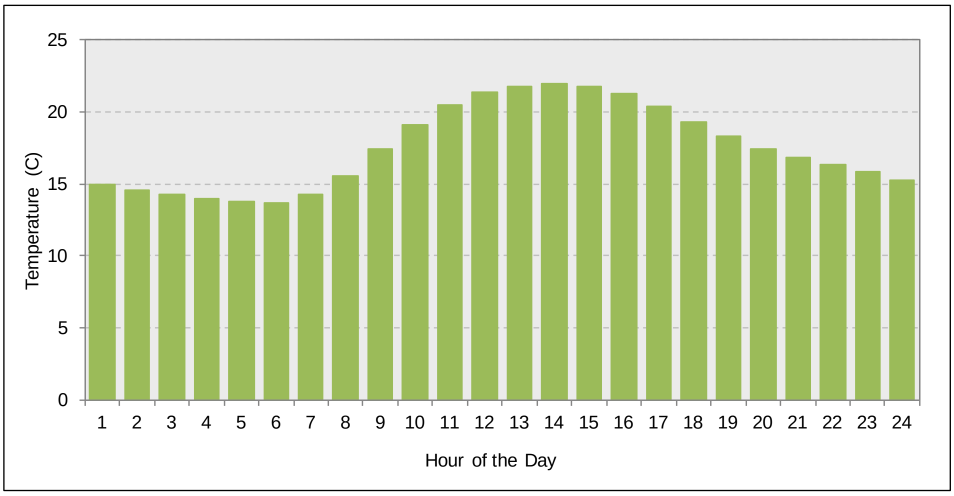

Figure 9.9 **Average temperatures by hour of day at Canterbury Racecourse – 2014**

9.5.4 Emissions

Calculations have established that exhaust emissions of some pollutants from road transport have decreased as vehicle emissions legislation has tightened, and they are predicted to decrease further in the future (Bureau of Infrastructure, Transport and Regional Economics (BITRE) 2010).

However, over the longer term, it is anticipated that emission levels will start to rise again, as increases in annual vehicle activity (associated with the projected population growth in Sydney) begin to offset the reductions achieved by the current emission standards and vehicle technologies (Department of Infrastructure and Transport (DIT) 2012).

The most detailed and comprehensive source of information on current and future emissions in the Sydney area is the emissions inventory compiled by EPA. An emissions inventory defines the amount, in tonnes per year, of each pollutant that is emitted from each source in a given area. The base year of the latest published EPA inventory is 2008 (NSW EPA 2012), and projections are available for 2011, 2016, 2021, 2026, 2031 and 2036. The importance of road transport as a source of pollution in Sydney can be illustrated by reference to sectoral emissions. The data for anthropogenic (caused by humans) and biogenic (caused by plants and animals) emissions in Sydney, and also for road transport in Sydney, have been extracted from the latest EPA inventory and are presented here. Emissions were considered for the most recent historical year (2011) and for the future years.

Sectoral emissions

Figure 9.10 shows that in 2011 road transport in Sydney was the single largest sectoral contributor to emissions of CO (44 per cent) and NO_X (57 per cent). It was also responsible for a significant proportion of emissions of volatile organic compounds (VOCs) (17 per cent), PM_{10} (10 per cent) and $PM_{2.5}$ (12 per cent). The main contributors to VOCs were domestic and commercial activity and biogenic sources such as volatile oils from vegetation. The most important sources of PM_{10} and $PM_{2.5}$ emissions were the domestic and commercial sector, and industry. The contribution to PM from the domestic sector in Sydney was due largely to wood burning for heating in winter. Emissions from natural sources, such as bushfires, dust storms and marine aerosol, also contributed significantly to PM concentrations. Road transport contributed only two per cent of total SO_2 emissions in Sydney, reflecting the reduction in sulphur in road transport fuels in recent years. SO_2 emissions in Sydney were dominated by the off-road mobile sector and industry.

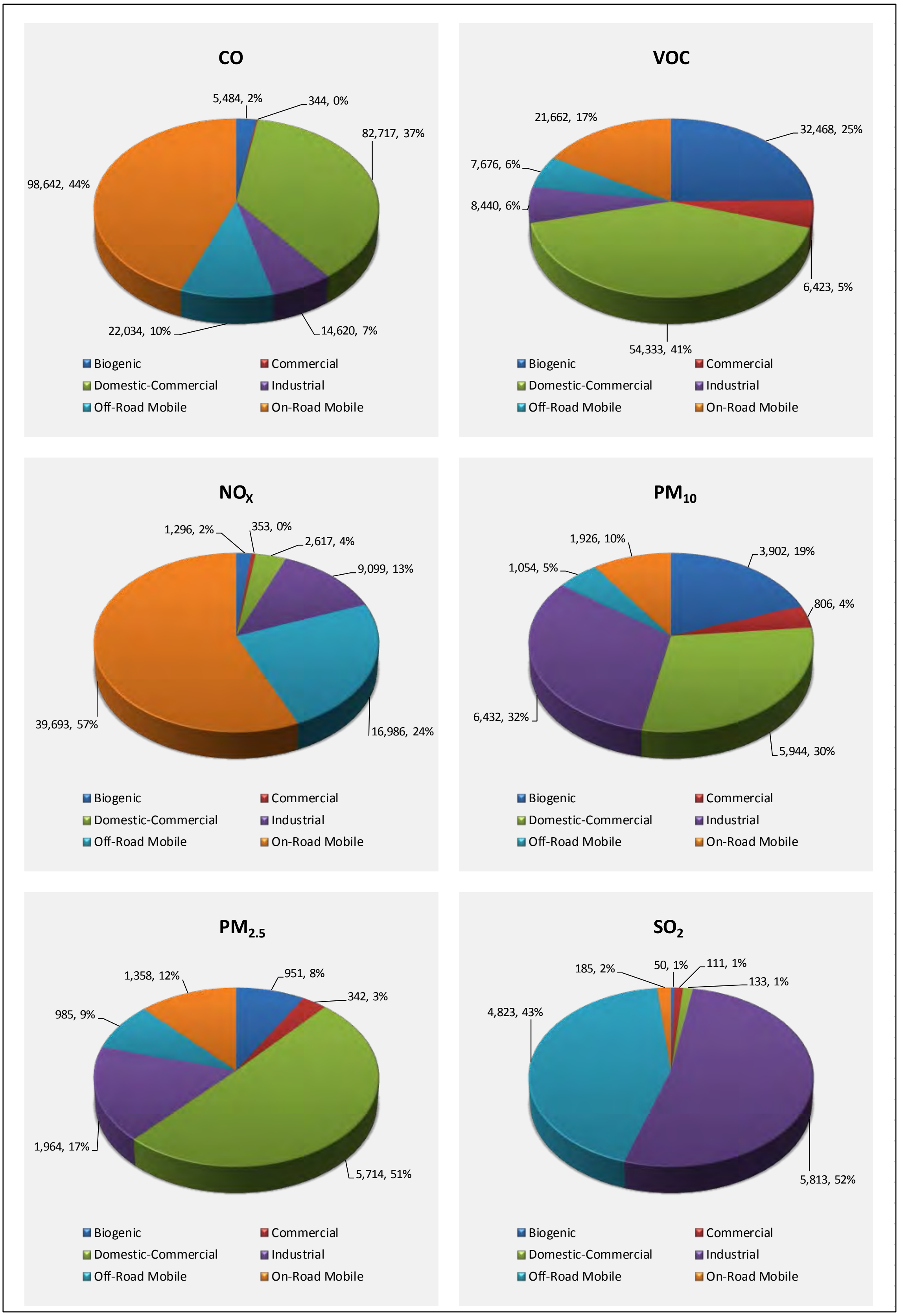

Figure 9.10 Sectoral emissions in Sydney, 2011 (values in tonnes per year and percentage of total)

Road transport sector emissions

The breakdown of emissions in 2011 from the road transport sector by process and vehicle type is presented in **Figure 9.11**. Petrol passenger vehicles (mainly cars) accounted for a large proportion of the vehicle kilometres travelled (VKT) in Sydney. Diesel passenger vehicles have represented only a very small proportion of the total passenger vehicle fleet. However, the improved performance of light-duty diesel vehicles over the last 10 years, together with superior fuel economy, has boosted sales and the market share is increasing (NSW EPA 2012). Exhaust emissions from these vehicles were responsible for 62 per cent of CO from road transport in Sydney in 2011, 45 per cent of NOx and 76 per cent of SO_2. They were a minor source of PM_{10} (4 per cent) and $PM_{2.5}$ (9 per cent). Non-exhaust processes were the largest source of road transport PM_{10} (60 per cent) and $PM_{2.5}$ (46 per cent). This is a larger proportion than in most European countries, as there are relatively few diesel cars in Australia. Heavy-duty diesel vehicles are disproportionate contributors of NOx and PM emissions due to their inherent combustion characteristics, high operating mass (and hence high fuel usage) and level of emission control technology (NSW EPA 2012).

Projected emissions for sectoral and road transport emissions in Sydney from 2011 to 2036 are shown in **Figure 9.12** and **Figure 9.13**.

The projections of sectoral emissions in **Figure 9.12** show that the road transport contribution to CO, VOCs and NO_X emissions will decrease substantially between 2011 and 2036, due to improvements in emission control technology. For PM_{10}, $PM_{2.5}$ and SO_2 the road transport contributions will also decrease, but their smaller contributions mean that these reductions will have only a minor impact on total emissions.

The projections of road transport emissions are broken down by process and vehicle group in **Figure 9.13**. Substantial reductions in emissions of CO, VOCs, and NO_X are projected between 2011 and 2036. There will be smaller changes in emissions of PM_{10} and $PM_{2.5}$. SO_2 emissions are proportional to fuel sulfur content, and this is assumed to remain constant in the inventory.

The inventory also records emissions of specific organic compounds, based on speciation profiles of petrol and diesel fuels.

9.5.5 General characteristics of Sydney air quality

Air quality in the Sydney region has improved over the last few decades. The improvements have been attributed to initiatives to reduce emissions from industry, motor vehicles, businesses and residences.

Historically, elevated levels of CO were generally only encountered near busy roads, but concentrations have fallen as a result of improvements in motor vehicle technology. Since the introduction of unleaded petrol and catalytic converters in 1985, peak CO concentrations in central Sydney have plummeted, and the last exceedance of the air quality standard for CO in NSW was recorded in 1998 (NSW Department of Environment, Climate Change and Water (DECCW) 2009 and 2010).

While levels of NO_2, SO_2 and CO continue to be below national standards, levels of ozone and particles (PM_{10} and $PM_{2.5}$) sometimes exceed the standards.

Ozone and PM levels are affected by:

- The annual variability in the weather
- Natural events such as bushfires and dust storms, as well as hazard-reduction burns
- The location and intensity of local emission sources, such as wood heaters, transport and industry (OEH 2015).

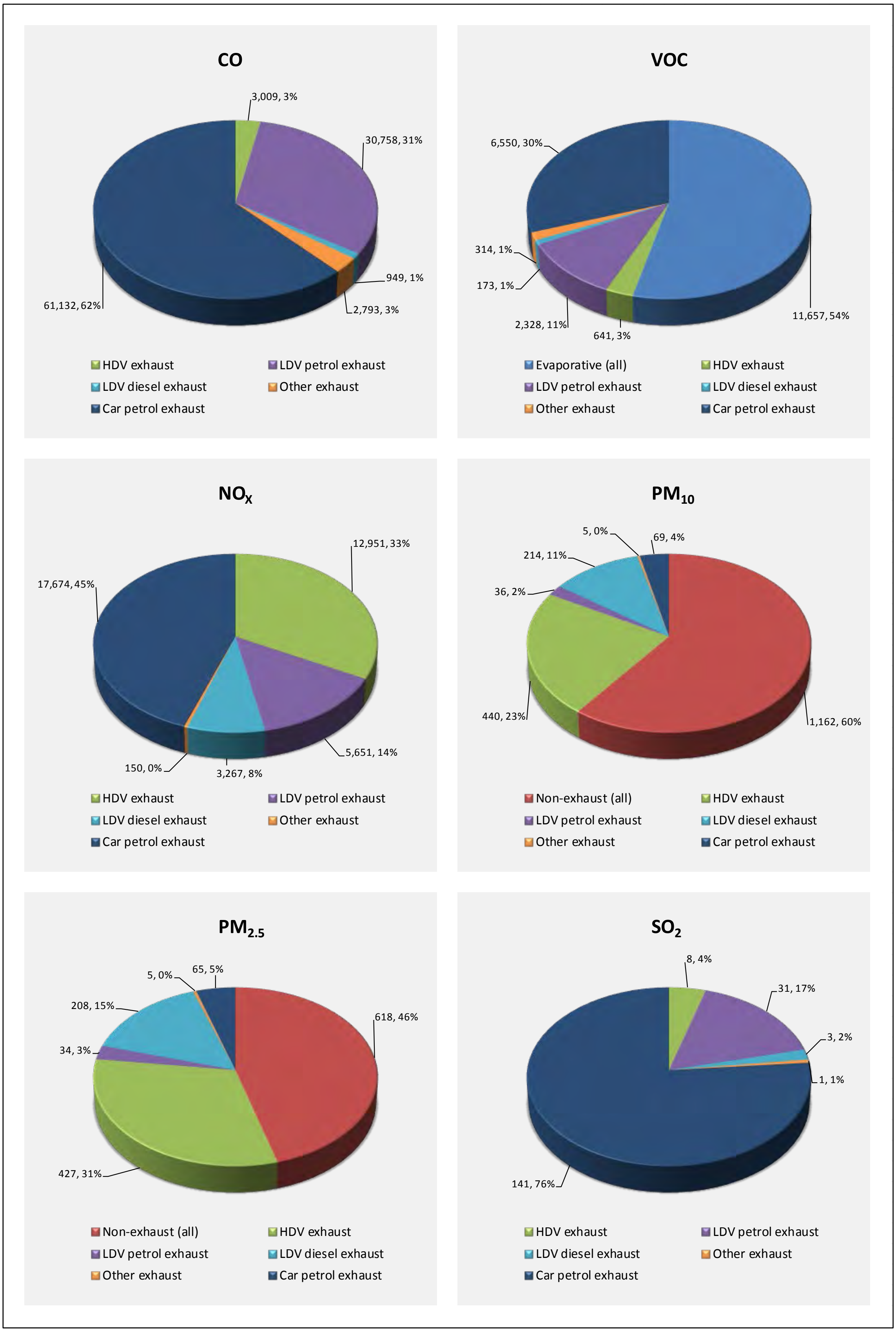

Figure 9.11 Breakdown of road transport emissions – Sydney, 2011 (values in tonnes per year and percentage of total)

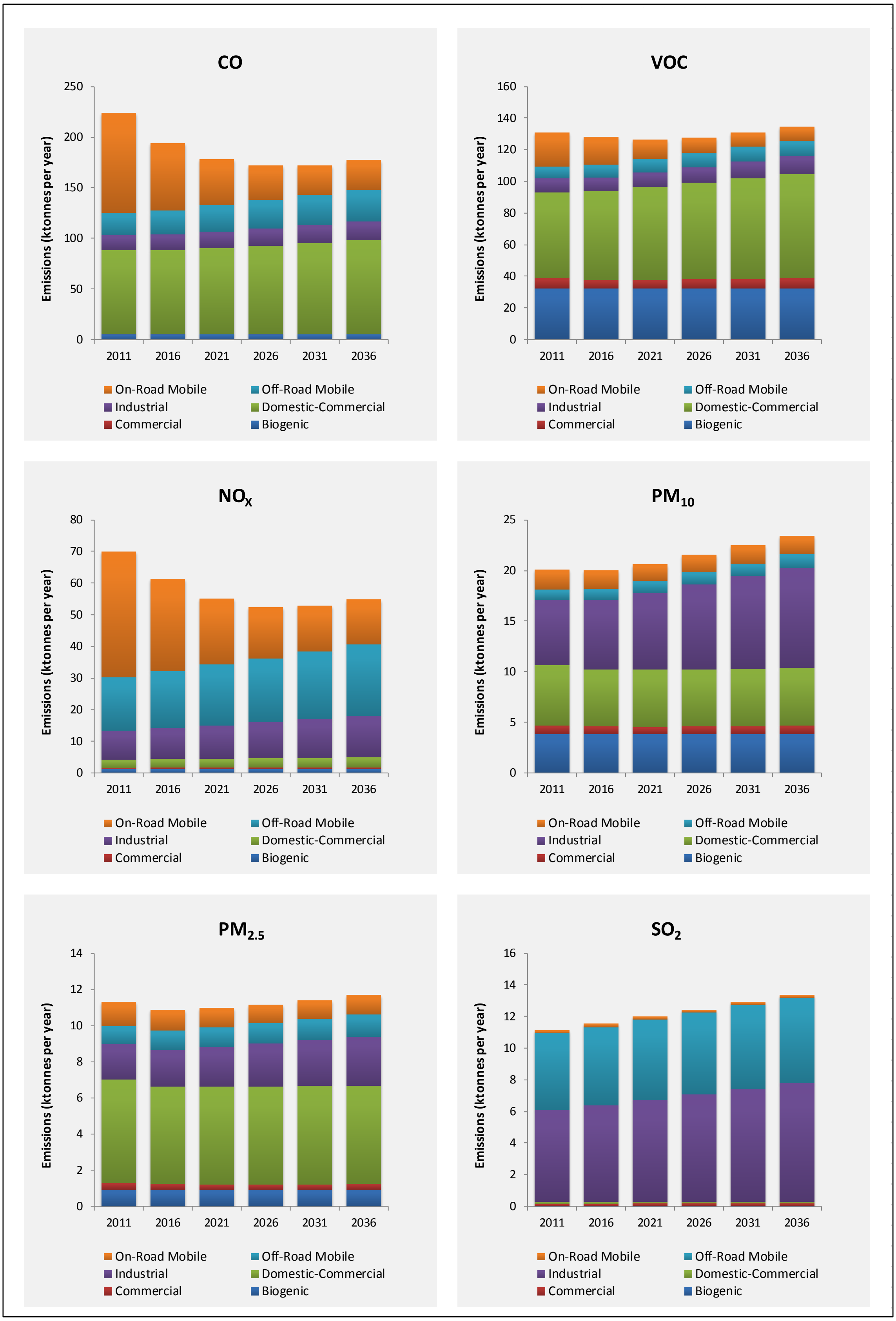

Figure 9.12 **Projections of sectoral emissions – Sydney, 2011–2036**

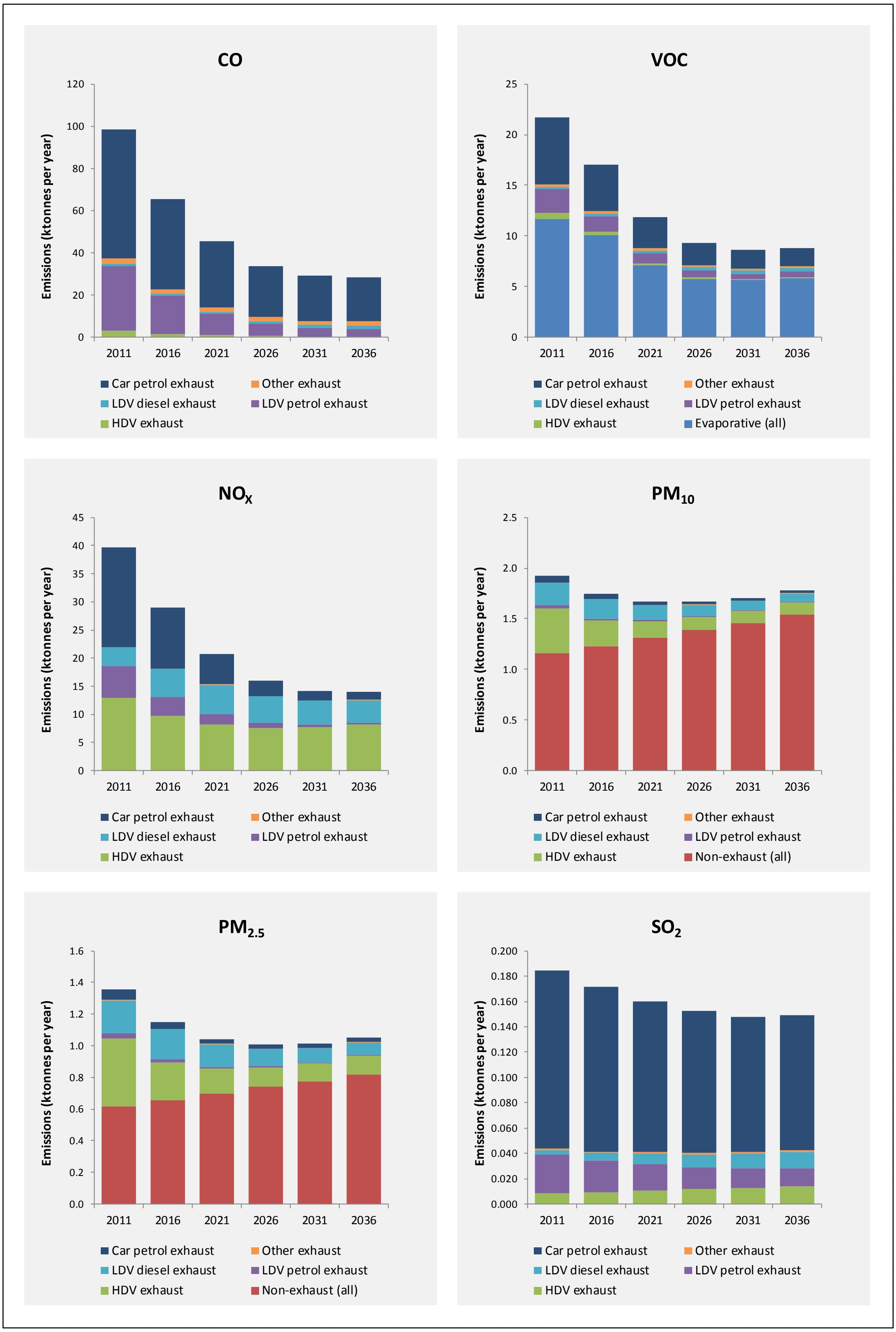

Figure 9.13 Projections of road transport emissions – Sydney, 2011–2036

9.5.6 Data from existing monitoring sites in the study area

A detailed analysis of historical trends (2004−14) and the current state of Sydney's air quality is provided in Appendix F of the Air Quality Assessment Report in **Appendix H**. The analysis was based upon data from multiple long-term monitoring stations operated by OEH and NSW Roads and Maritime Services (Roads and Maritime), as well as from monitoring stations established more recently and specifically for the project. The data from the monitoring sites were also used to define appropriate background concentrations of pollutants for the project assessment.

The data for specific air quality metrics during the period 2004−14 can be summarised as follows:

- Maximum one-hour and rolling eight-hour mean CO concentrations
  - All maximum values were well below the air quality criteria of 30 mg/m^3 (one-hour) and 10 mg/m^3 (eight-hour)
  - There was a general downward trend in concentration, but it was not statistically significant at any site
- Annual mean NO_2 concentrations
  - Concentrations at all sites were well below the NSW air quality criterion of 62 µg/m3. Values at the OEH sites exhibited a systematic, and generally significant, downward trend. However, in recent years the concentrations at some sites appear to have stabilised. At the Roads and Maritime background sites there was no significant downward trend
  - The average NO_2 concentrations at the roadside sites were 34-37 µg/m3, and therefore around 10-15 µg/m3 higher than those at the background sites. Even so, the NO_2 concentrations at roadside were also well below the assessment criterion
- Maximum one-hour NO_2 concentrations
  - Although variable, maximum NO_2 concentrations have remained largely stable over time, and the values at all sites continue to be below the NSW air quality criterion of 246 µg/m3
  - The maximum one-hour mean NO_2 concentrations at the Roads and Maritime roadside sites in 2014 were 115 and 122 µg/m3 respectively. These values are on a par with the higher maximum values for the background sites
- Annual mean PM_{10} concentrations
  - Concentrations at the OEH sites showed a downward trend between 2004 and 2014, but this was only statistically significant at two sites. In recent years the annual mean concentration at the OEH sites has been between 17 µg/m^3 and 20 µg/m^3, except at Lindfield, where the concentration is substantially lower (around 14 µg/m3). The concentration at the Roads and Maritime background sites appears to have stabilised at around 15 µg/m3. These values can be compared with air quality criterion of 30 µg/m3
- Maximum 24-hour PM_{10} concentrations
  - Maximum 24-hour PM_{10} concentrations exhibited a slight downward trend, but there was a large amount of variation from year to year. In 2014 the concentrations at the various sites were clustered around 40 µg/m^3, but the historical patterns suggest that this would be unlikely to continue into the future
- Annual mean $PM_{2.5}$ concentrations
  - $PM_{2.5}$ is only measured at three OEH sites in the study area. Concentrations at the two OEH sites closest to the project – Chullora and Earlwood − showed a broadly similar pattern, with a systematic reduction between 2004 and 2012 being followed by a substantial increase between 2012 and 2014. The main reason for the increase was a change in the measurement method, which indicated that background $PM_{2.5}$ concentrations in the study area during 2014 were already very close to, or above, the advisory reporting standard in the AAQ NEPM of eight µg/m^3

- Maximum 24-hour $PM_{2.5}$ concentrations
  - There has been no systematic trend in the maximum 24-hour $PM_{2.5}$ concentration. As with the annual mean $PM_{2.5}$ concentration, the maximum one-hour concentrations are very close to, or above, the advisory reporting standard in the PMAAQ NEPM of 25 µg/m^3.

9.5.7 Project-specific monitoring

The WestConnex Delivery Authority (WDA) has established five monitoring stations in the M4 East GRAL domain to support the development and assessment of the project. The WDA monitoring stations were designed to supplement the existing OEH and Roads and Maritime stations, to establish the representativeness of the data from these sites, and to provide long-term air quality data in the vicinity of the project. The locations of the monitoring stations were determined with consideration being given to a number of criteria; one station is located at an urban background site and four stations are located near busy roads to characterise population exposure in these areas.

All monitoring stations are listed in **Table 9.14**; further details are provided in Appendix F of the air quality assessment in **Appendix H**.

Table 9.14 Air quality monitoring stations

Authority	Project	Location	Site type	Period covered
OEH	N/A	Southern Sydney TAFE, Chullora WChullor Street	Urban background	2004-2014
		Beaman Park, Earlwood	Urban	2004-2014
		Bradfield Road, Lindfield	Urban	2004-2014
		Rose Street, Liverpool	Urban	2004-2014
		William Lawson Park, Prospect	Urban	2004-2014
		Randwick Barracks, Randwick	Urban	2004-2014
		Rozelle Hospital, Rozelle	Urban	2004-2014
Roads and Maritime	M5 East tunnel	Gipps Street, Bardwell Valley	Urban	2008-2013
		Thompson Street, Turrella	Urban	2008-2013
		Jackson Place, Undercliffe	Urban	2008-2013
		Wavell Parade, Earlwood	Urban	2008-2013
		Flat Rock Rd, Kingsgrove (M5	Peak	2008-2013
		M5 East tunnel portal	Peak	2008-2013
	NorthConnex	Headen Sports Park	Urban	Dec 2013 to Jan
		Rainbow Farm Reserve	Urban	Dec 2013 to Jan
		James Park	Urban	Dec 2013 to Jan
		Observatory Park	Peak (roadside)	Dec 2013 to Jan
		Brickpit Park	Peak (roadside)	Dec 2013 to Jan
	Lane Cove Tunnel	Longueville Road/ Epping Road	Peak (roadside)	Oct 2008 to Nov 2009
WDA	WestConnex M4 East	Wattle Street, Haberfield	Peak (roadside)	Aug 2014 to Apr
		Edward Street, Concord	Peak (near-	Sep 2014 to Apr
		Bill Boyce Reserve, Homebush	Peak (near-	Sep 2014 to Apr
		Concord Oval, Concord	Peak (roadside)	Nov 2014 to Apr
		St Lukes Park, Concord	Urban	Nov 2014 to Apr

9.6 Assessment of air quality impacts during construction

An assessment of construction impacts on air quality was undertaken in accordance with the procedure described in **Figure 9.1**. A detailed assessment is provided in the air quality assessment report in **Appendix H**. The following sections discuss the potential impacts on air quality during construction that were identified through this assessment.

9.6.1 Significance of risks

For almost all construction activity, the aim should be to prevent significant effects on receptors through the use of effective mitigation. Experience shows that this is normally possible. Hence the residual impacts will normally be 'not significant' (IAQM 2014).

However, even with a rigorous Construction Air Quality Management Plan in place, it is not possible to guarantee that the dust mitigation measures will be effective all the time. There is the risk that nearby residences, commercial buildings, hotel, cafés and schools in the immediate vicinity of the construction zone, might experience some occasional dust soiling impacts. This does not imply that impacts are likely, or that if they did occur, that they would be frequent or persistent. Overall construction dust is unlikely to represent a serious ongoing problem. Any effects would be temporary and relatively short-lived, and would only arise during dry weather with the wind blowing towards a receptor, at a time when dust is being generated and mitigation measures are not being fully effective. The likely scale of this would not normally be considered sufficient to change the conclusion that with mitigation the effects will be 'not significant'.

In the western and central areas of the project, the nearest sensitive receptors are located along Parramatta Road north and south of the designated construction area. At the eastern end of the project as Parramatta Road turns towards the southeast, receptors are towards the east and west of Parramatta Road and along Wattle Street to the northeast.

A review of the annual and seasonal wind roses (**Appendix H**) indicates the winds that could be capable of transporting emissions towards receptors. Given the transitional nature of the prevailing winds with respect to the receptors, this could occur at any time of year.

There are unlikely to be any construction projects of this magnitude occurring concurrently with this project in the immediate vicinity, except the M4 Widening project to the west of the M4 East. This may affect a limited area. As such, cumulative impacts due to dust from construction are unlikely.

9.7 Assessment of air quality impacts during operation

9.7.1 In-tunnel air quality

Air quality is monitored continuously in all Sydney's major road tunnels, with monitors installed along the length of each tunnel. These typically measure CO and visibility, and are specially designed for use in road tunnels where access for routine essential maintenance is restricted by the need to minimise traffic disruption. While these instruments typically only have a coarse resolution, more precise instrumentation has been installed in the ventilation outlets of some tunnels, with measurements including PM_{10}, $PM_{2.5}$, NO_X and NO_2. Some of the data from these instruments are available on the web sites of the tunnel operators of the Lane Cove and Cross City Tunnels. Measurements from those tunnels have been used to inform the air quality assessment for this project.

In-tunnel traffic, airflow, pollution levels and temperature for the project and for the future M4–M5 Link were modelled using the IDA Tunnel software (http://www.equa.se/en/tunnel/ida-tunnel/road-tunnels). The data used in the tunnel ventilation simulation, and the results of the simulation, are provided in full in Appendix L of the air quality assessment in **Appendix H**.

The three pollutants assessed for in-tunnel air quality were NO_2, CO and $PM_{2.5}$ (exhaust only, as visibility). For the operating years of the project, NO_2 will be the pollutant that determines the required airflow and drives the design of ventilation for in-tunnel pollution.

Design traffic scenarios

The tunnel ventilation system would operate in, and be responsive to, a range of traffic modes which are described in **Chapter 5** (Project description) and Appendix L of the air quality assessment in **Appendix H**. As an example, **Figure 9.16** illustrates the modelled air flows at the eastern ventilation outlet that would be required to maintain the in-tunnel air quality below the criteria with varying expected traffic volumes for each hour of the day.

The daily traffic volumes by hour for the project in 2031 are shown in **Figure 9.14** and **Figure 9.15**.

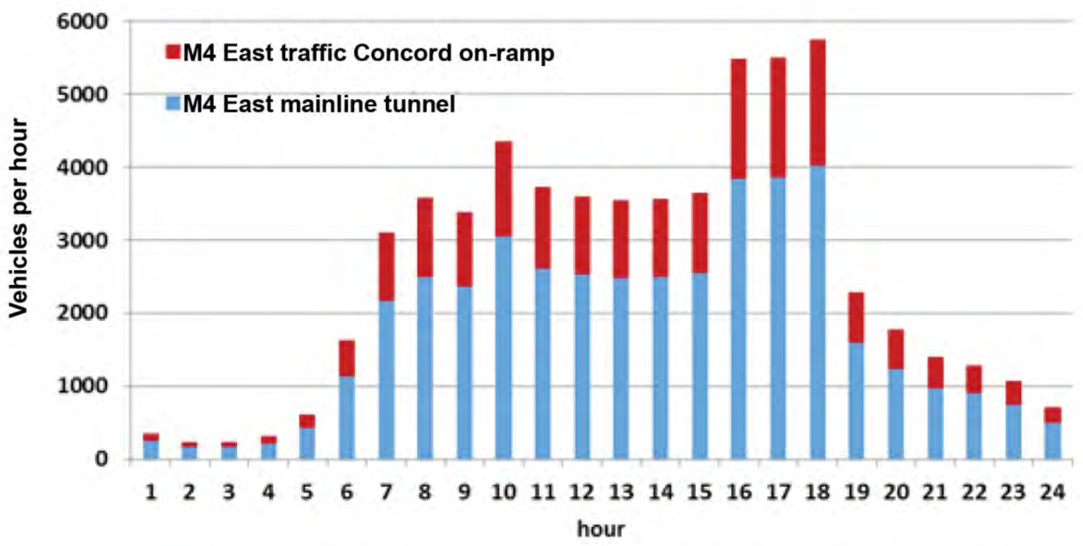

Figure 9.14 Modelled daily traffic demand for M4 East eastbound

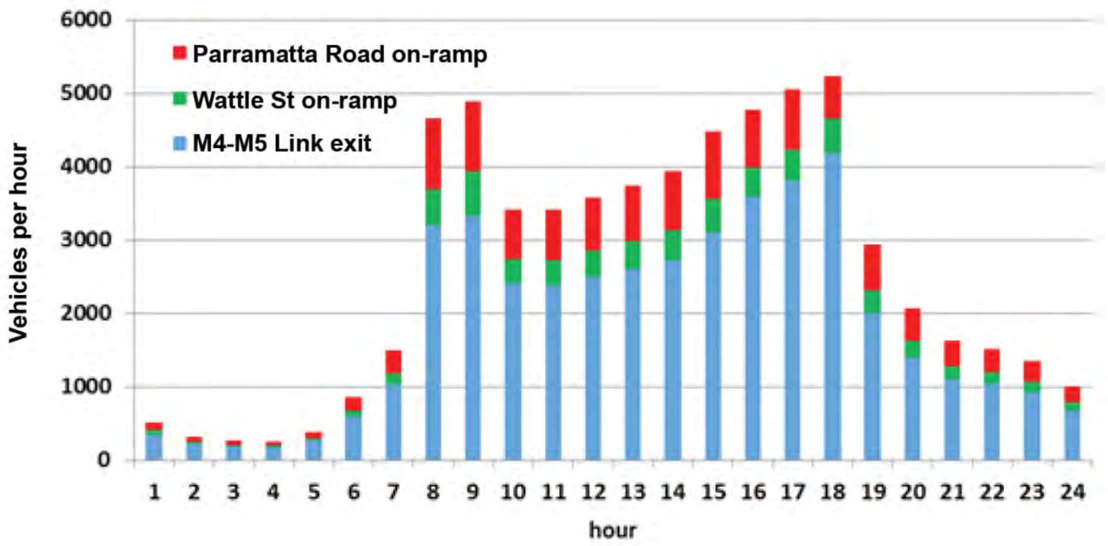

Figure 9.15 Modelled daily traffic demand for M4 East westbound

The hourly traffic demand in the tunnel was used as input to the modelling of air flow requirements and the resulting pollutant levels in the tunnel, shown in **Figure 9.16**.

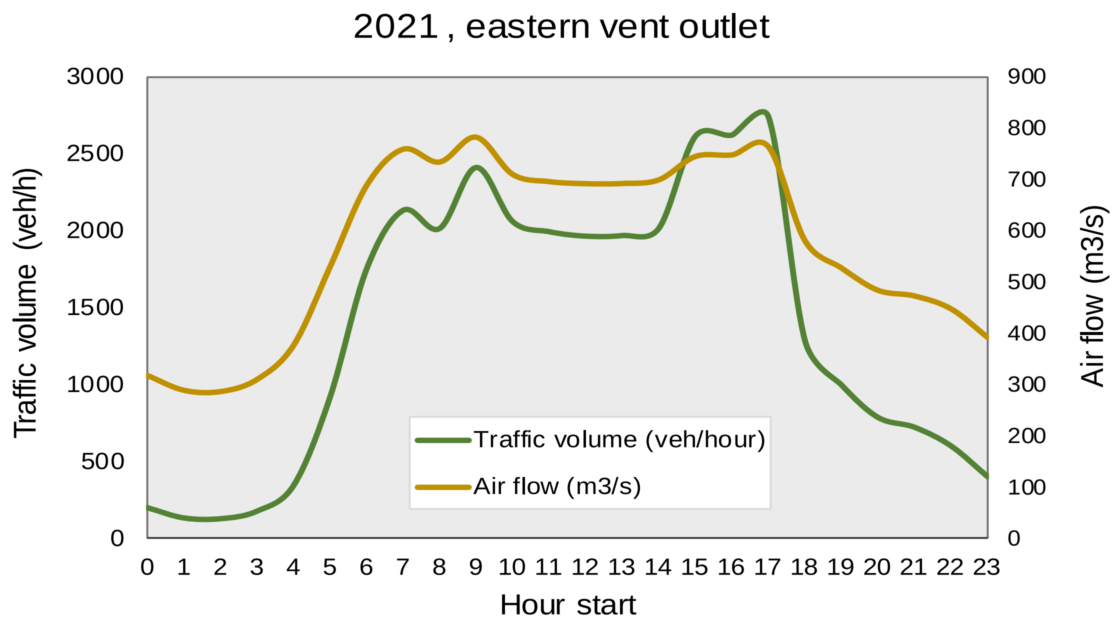

Figure 9.16 Relationship between air flow and traffic volumes in 2021

Free flowing or normal traffic

'Normal' traffic conditions refer to the conditions that occur the majority of the time, when the predicted weekday traffic volumes are high and traffic is flowing freely. Normal traffic conditions are assessed but are not considered to represent the worst case or maximum pollutant generation scenario.

Under normal traffic conditions the tunnel ventilation system would use vehicle aerodynamic drag (commonly referred to as the 'piston effect') to draw air in through the entrance portals, and to move the air along the tunnel in sufficient volumes to satisfy the fresh air demand of the traffic.

In-tunnel air containing vehicle emissions would be extracted from the tunnels before it reaches the exit portals. Air would be exhausted through a ventilation off-take inside the tunnels and transferred to the ventilation facility via a shaft. The air would then be discharged from the ventilation outlet to the atmosphere to achieve effective dispersion.

For the tunnel off-ramps, air would be drawn back down the ramp for extraction via the ventilation facility. This would require jet fans to maintain the air flow against the direction of traffic flow. A similar approach would be applied to sections of the mainline tunnels close to the exit portals.

Under low traffic, the vehicle generated piston effect would be lessened. In these situations the airflow would need to be assisted by the jet fans located throughout the tunnels. Under low traffic conditions, emission levels would also be low, consistent with the number of vehicles in the tunnel. Additional fresh air supply is unlikely to be required.

Predicted criteria pollutant levels for the normal traffic scenario

This model simulation uses the traffic demand shown in **Figure 9.14** and **Figure 9.15**.

The results for 2021-DS, 2031-DS and 2031-DSC are presented in **Figure 9.17**, **Figure 9.20** and **Figure 9.19**. These plots, which show the diurnal change in the peak in-tunnel value, confirm that the tunnel ventilation system would be designed to maintain in-tunnel air quality well within operational limits.

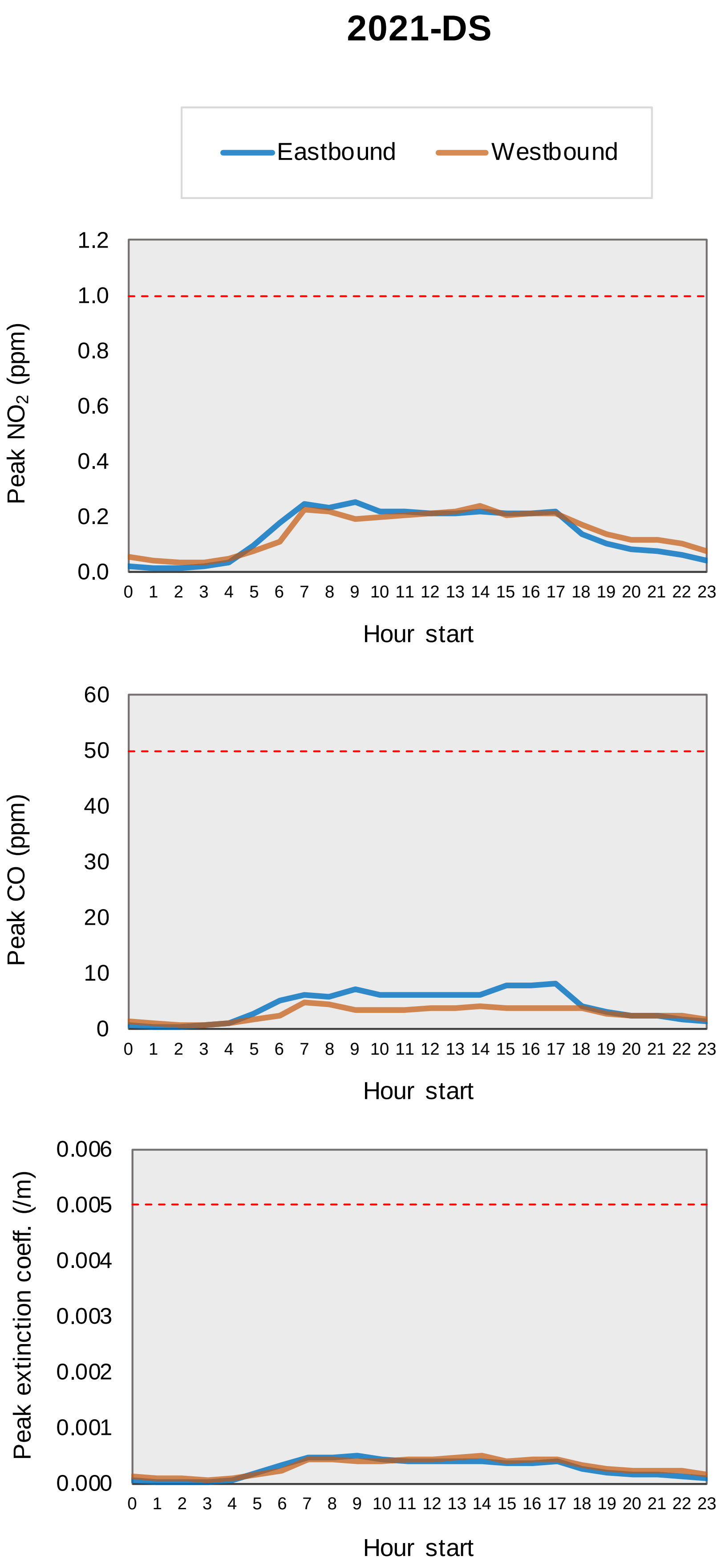

Figure 9.17 **Peak in-tunnel NO_2, CO and extinction coefficient – 2021-DS**

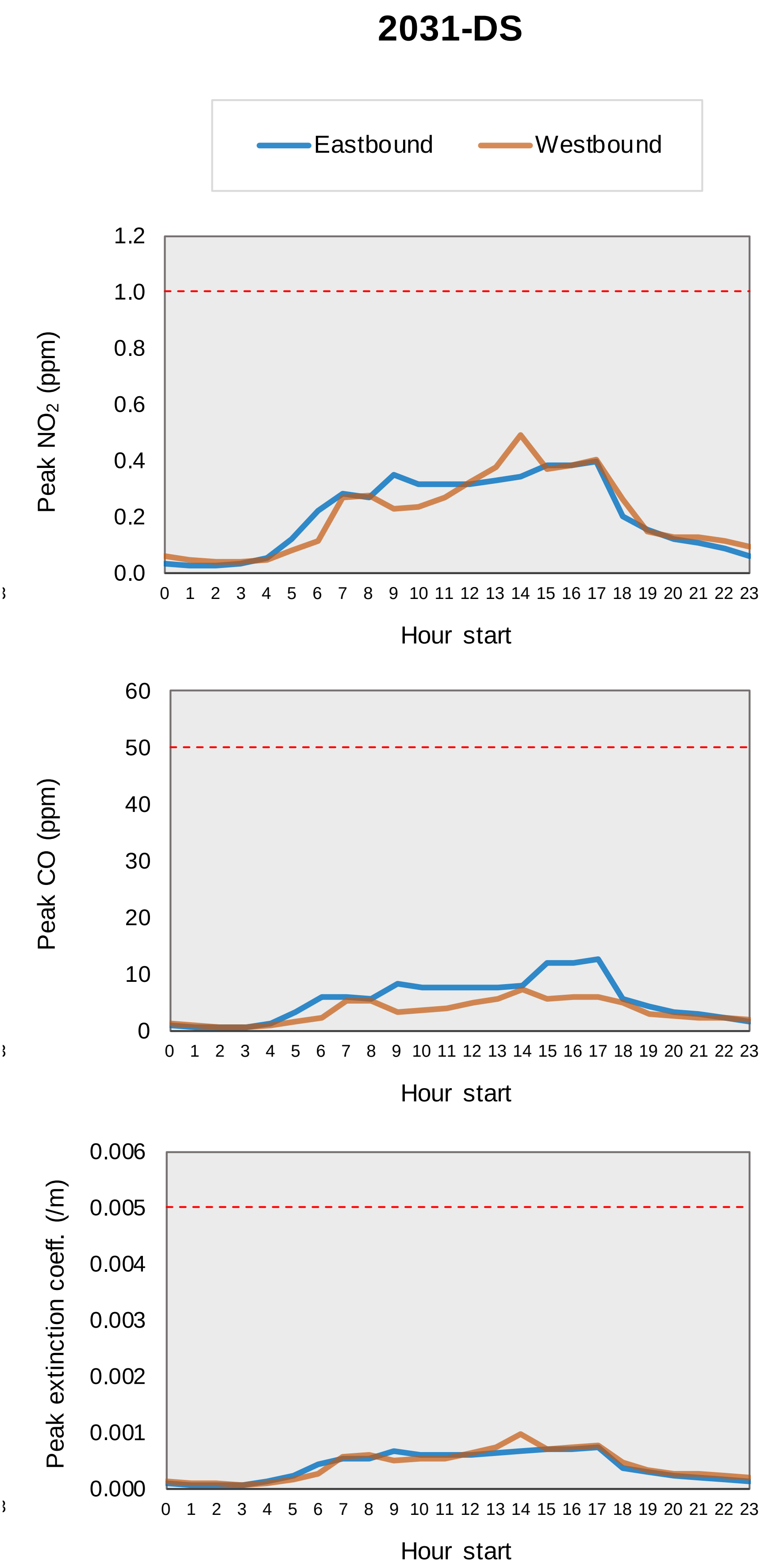

Figure 9.18 Peak in-tunnel NO_2, CO and extinction coefficient – 2031-DS

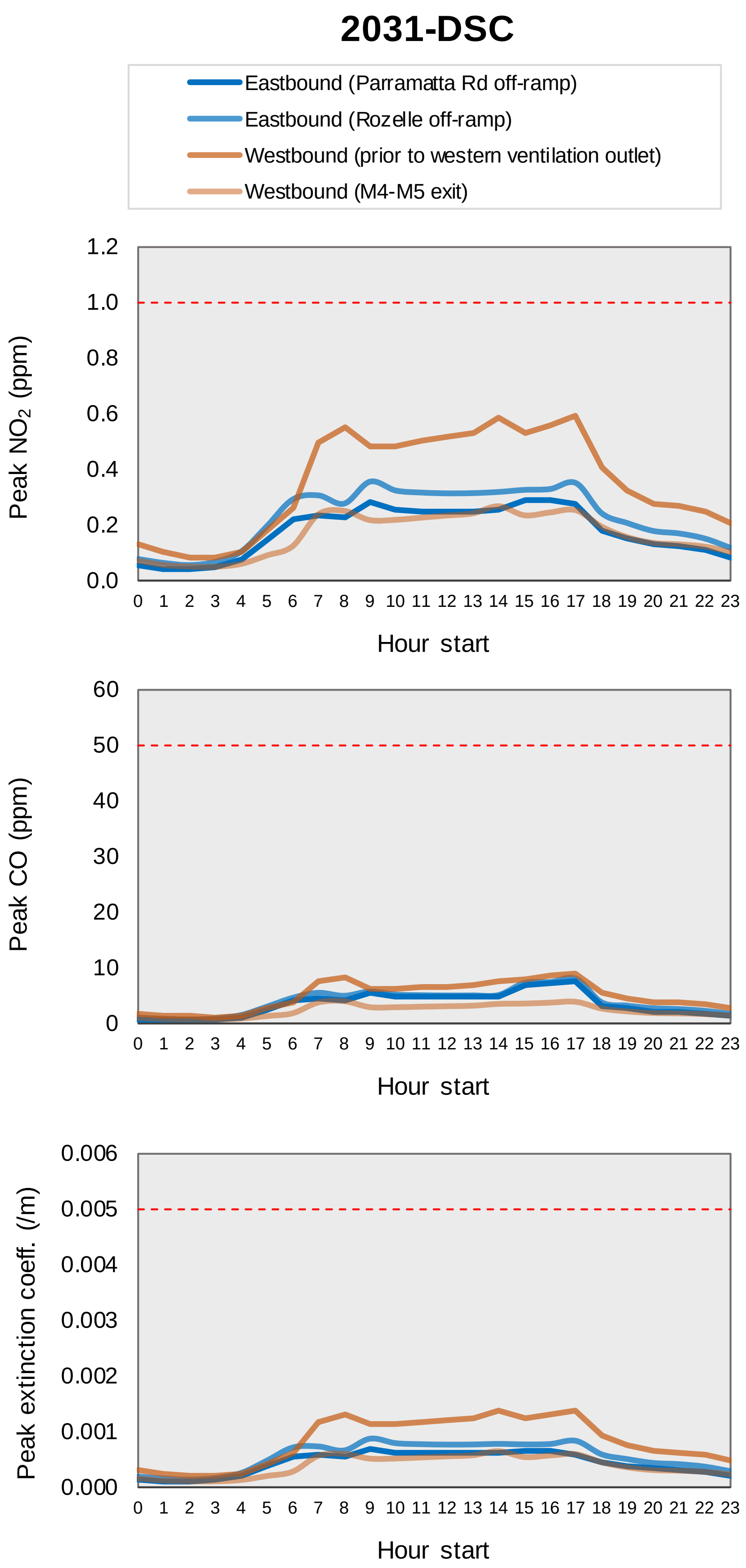

Figure 9.19 **Peak in-tunnel NO_2, CO and extinction coefficient – 2031-DSC**

Congested traffic (maximum traffic flow – variable speeds)

Multi-lane tunnels have an advantage in mitigating congestion in that slow vehicles can occupy the left lane, allowing the remaining lanes to accommodate faster moving traffic Ventilation simulation results for 2031 congested traffic are tabulated in Appendix L of the air quality assessment in **Appendix H.** The traffic flow cases are for steady state traffic demand, with the mainline traffic speeds at nominal limits of 20 kilometres per hour, 40 kilometres per hour, 60 kilometres per hour and 80 kilometres per hour.

Congested cases have been generated by applying speed limits in the model near the end of critical sections. The traffic then backs up behind that forced speed limit as determined by the throughput and the modelled traffic behaviour. Traffic flows from 1,000 vehicles per hour to 5000 vehicles per hour were modelled, ensuring that traffic saturation (maximum traffic) was reached. With the ramp inflows and outflows held in the same proportions as the normal peak hour traffic, some parts of the tunnel network would become saturated before others.

This approach of applying artificial constraints has been necessary because of the difficulty in generating realistic congested scenarios. The M4 East and M4−M5 Link eastbound tunnels would have several exit ramps from the Concord Road interchange to Rozelle. Tunnel operators would not allow traffic to bank back into the tunnel at speeds below 20 kilometres per hour, but even if external network congestion reduced the speed on all seven exit lanes to 20 kilometres per hour, the exit capacity would remain relatively high, and the three lanes of the mainline from Concord Road would continue to run relatively freely. Congestion on the external road network is therefore unlikely to cause congestion within the tunnel. In particular, it would not create sufficiently heavy congestion eastbound to generate a cumulative scenario reflecting M4 East and M4−M5 Link.

The most realistic cause of traffic congestion in the mainline tunnels would be the use of the variable speed limit signs to slow traffic near the end of the mainline tunnels, for instance in response to an incident such as oil on the roadway or other hazard. However, such incidents would not occur with the same frequency as external network congestion, and they would be short-lived because of the implementation of incident traffic management procedures.

Predicted criteria pollutant levels for the breakdown traffic scenario

In the case of a vehicle breakdown in the tunnel, the tunnel operator may close one lane upstream of the disabled vehicle to clear a path for the incident management vehicle. With one lane closed, the number of vehicles in the tunnel would decrease and the average speed in the other lanes would be reduced. If the breakdown occurred near the tunnel exit, and the operators were to take no action, the traffic would bank up and over time might resemble the congested scenario. However, when the tunnel is appropriately controlled, the foreseeable breakdown scenario is less onerous than the congested case. The congested case results may therefore be applied to the breakdown scenario, with some conservatism. Given the low frequency of these occurrences, the added conservatism in breakdown cases is not significant.

Major incident conditions, including major accident and fire scenarios, require significant traffic control measures to be put in place including tunnel closure. The ventilation system would be operated to provide a safe environment for tunnel occupants, eg smoke may be ventilated from the tunnel portals in the case of a fire (**Appendix H**).

The predicted pollutant levels from the congested traffic scenarios need to be considered in this context.

Predicted criteria pollutant levels for the congested traffic scenario

These congested case results are compared with the 80 kilometres per hour (free flowing) case. The important conclusion from these results, as shown in **Figure 9.20** and **Figure 9.21** is that in-tunnel pollution levels can be maintained at levels below the criteria under all traffic conditions.

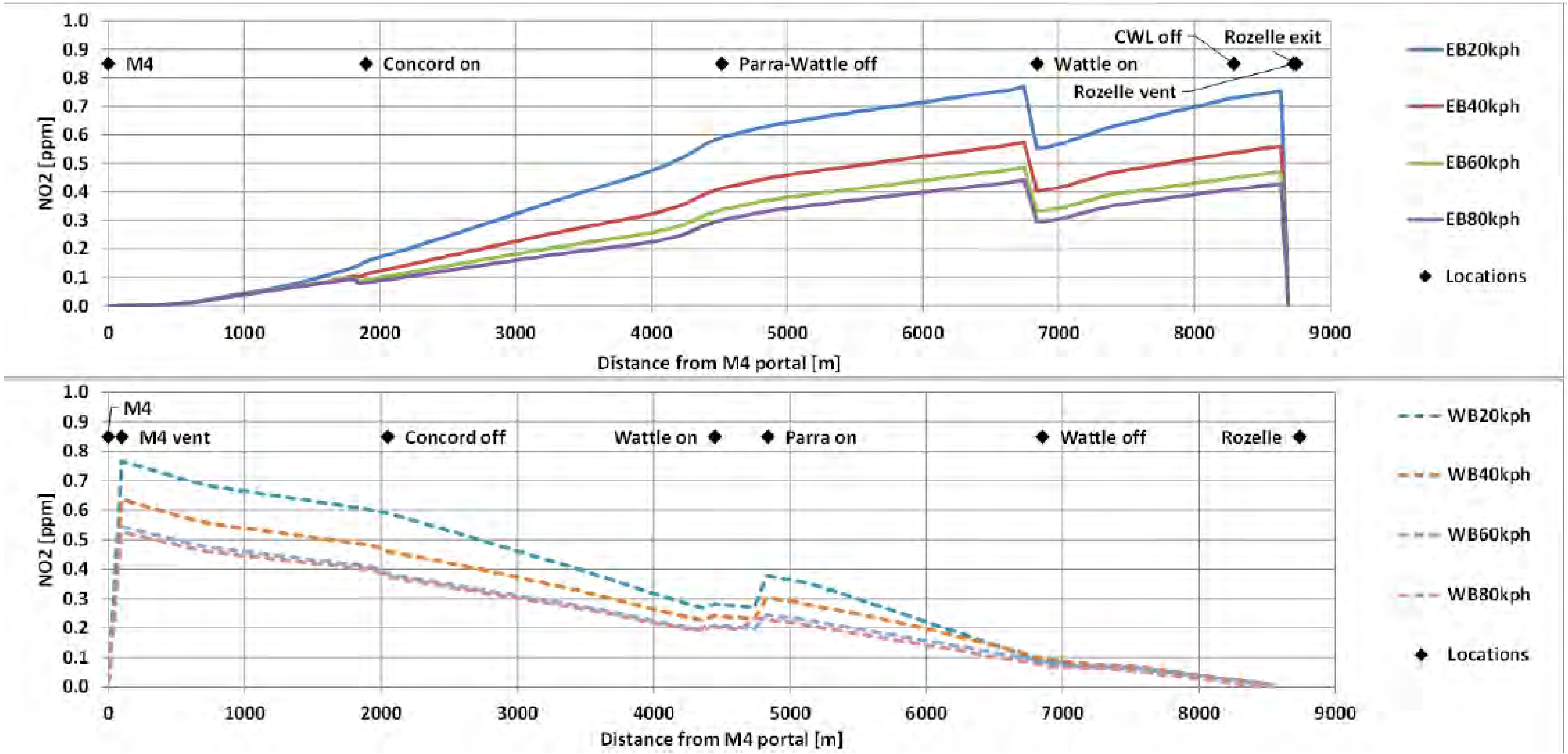

Figure 9.20 **Profiles of NO_2 levels in 2031 for maximum traffic flows at various speeds between 20 and 80 kilometres per hour from the western entry of M4 East to M4-M5 Link at Rozelle**

Notes:

(a) 'Concord on' is the Concord Road on-ramp

(b) 'Parra Wattle off' means the Parramatta Road and Wattle Street off-ramps

(c) 'Wattle on' is the Wattle Street on-ramp

(d) 'CWL off' is the City West Link off-ramp

(e) 'Rozelle vent' is a possible future ventilation outlet

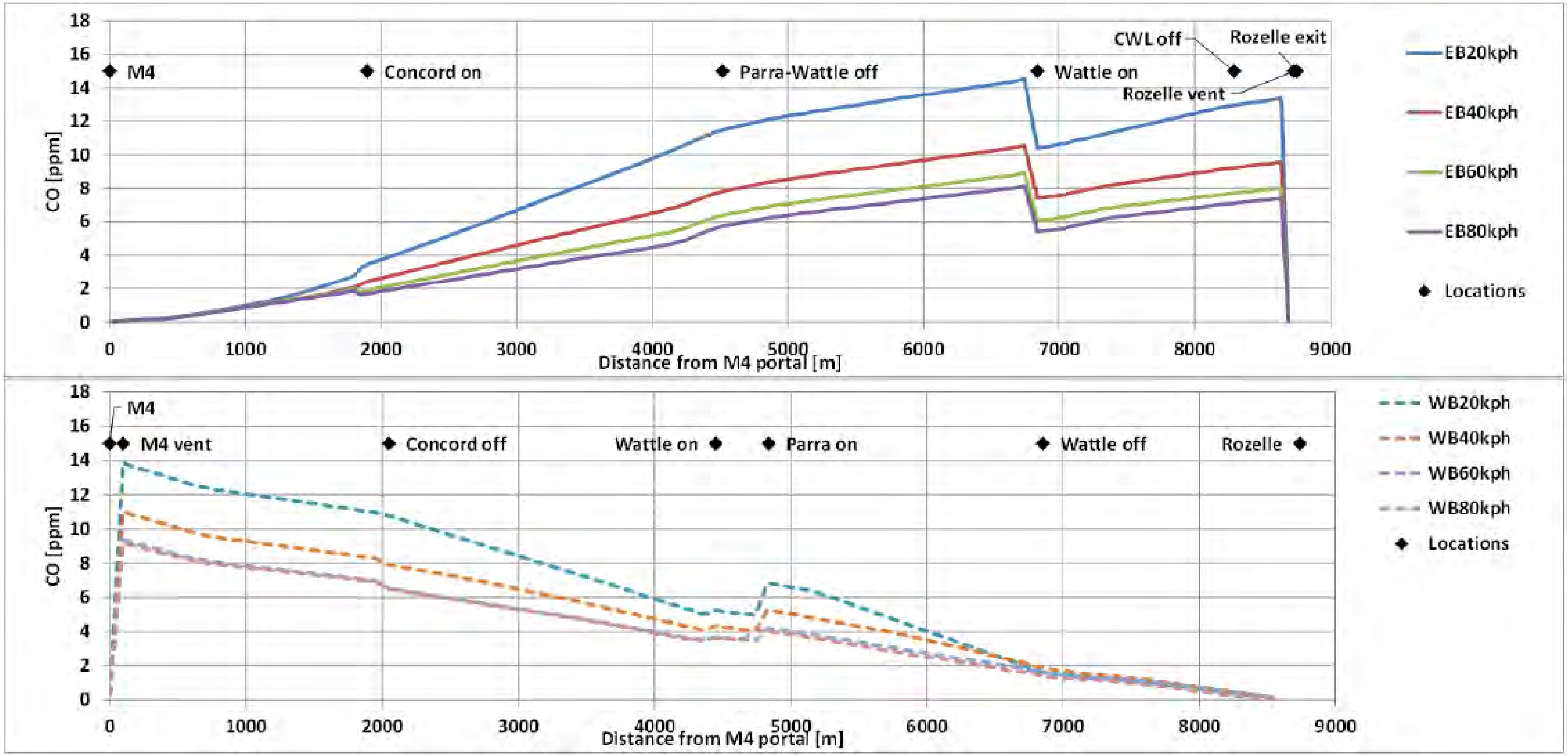

Figure 9.21 **Profiles of CO levels in 2031 for maximum traffic flows at various speeds between 20 and 80 kilometres per hour from Rozelle to the western portal of the M4 East**

Notes:

(f) 'Concord on' is the Concord Road on-ramp

(g) 'Parra Wattle off' means the Parramatta Road and Wattle Street off-ramps

(h) 'Wattle on' is the Wattle Street on-ramp

(i) 'CWL off' is the City West Link off-ramp

(j) 'Rozelle vent' is a possible future ventilation outlet

The tunnel average values for NO_2 for the varying traffic speeds are shown in **Table 9.15.**

Table 9.15 Relationship between travel speed and average NO_2 concentrations

Average vehicle speed	Eastbound 20 km/h	40 km/h	60 km/h	80 km/h	Westbound 20 km/h	40 km/h	60 km/h	80 km/h
NO_2 average	0.44	0.32	0.27	0.24	0.36	0.30	0.25	0.24
NO_2 peak 1	0.77	0.58	0.49	0.44	0.38	0.3	0.23	0.23
NO_2 peak 2	0.75	0.56	0.47	0.43	0.77	0.64	0.55	0.53

The maximum peak concentrations of pollutants in the tunnel for all traffic scenarios are shown in **Table 9.16**. The maximum in-tunnel concentrations of CO and NO_2, as well as the peak extinction coefficient, were calculated using the methods described in Appendix L of the air quality assessment report (**Appendix H**). The maximum concentrations for all traffic scenarios, including worst-case conditions, were within the concentrations associated with the regulatory worst case.

Table 9.16 Maximum in-tunnel concentrations for all scenarios

Scenario		Maximum in-tunnel concentrations					
		NO_2 (ppm)		CO (ppm)		$PM_{2.5}$ (mg/m^3)	
		EB	WB	EB	WB	EB	WB
Expected traffic	2021-DS	0.45	0.35	12	11	0.44	0.38
	2031-DS	0.40	0.51	13	12	0.41	0.52
	2031-DSC	0.47	0.81	9.1	17	0.62	0.96
Capacity traffic	2021-DS	0.62	0.88	12	16	0.79	1.05
	2031-DS	0.62	0.88	12	16	0.79	1.05
	2031-DSC	0.62	0.88	12	16	0.79	1.05
Regulatory worst case (a)		1.07	1.07	35.0	35.0	1.1	1.1

(a) CO and NO_2 volume concentrations estimated for a temperature of 25^{o}C.

9.7.2 Assessment of ambient air quality impacts

Surface roads

The changes in the total emissions resulting from the project can be viewed as a proxy for its regional air quality impacts. Total emissions were calculated for all surface roads included in the WRTM for the WestConnex GRAL domain. The emissions, in tonnes per year, are shown in **Table 9.17** and the changes in emissions are shown in **Table 9.18**. For the pollutants NO_X and PM, the net effects of the project on total emissions in 2021 and 2031 were very small (less than 0.2 per cent). In the cumulative case for 2031 there would be an increase in emissions of NO_X and PM of around 1.5 to two per cent. The effects of the project on emissions were much smaller than the projected reductions in emissions over time. For example, between 2014 and 2031, NO_X emissions (without the project) are projected to decrease by 55 per cent.

The increase in NO_x emissions for the assessed road network in 2021 is estimated to be eight tonnes per year. This value equates to a tiny proportion of anthropogenic NO_x emissions in the Sydney airshed in 2016 (around 53,700 tonnes). It was therefore concluded that the regional impacts of the project would be negligible, and undetectable in ambient air quality measurements at background locations.

Table 9.17 Total emissions in the WestConnex model domain

Scenario code	Scenario description	Total VKT[a] per day (million vehicle-km)	Total emissions (tonnes/year) CO	NOx	PM_{10}	$PM_{2.5}$	THC
2014-BY	2014 - Base Year (existing conditions)	14.5	15,240	6,581	322	234	1,542
2021-DM	2021 - Do Minimum (no M4 East)	15.7	9,025	4,068	278	182	934
2021-DS	2021 - Do Something (with M4 East)	15.8	9,039	4,076	278	182	926
2031-DM	2031 - Do Minimum (no M4 East)	17.6	6,102	2,963	288	179	598
2031-DS	2031 - Do Something (with M4 East)	17.7	6,139	2,968	288	179	593
2031-DSC	2031 - Do Something Cumulative (with M4 East and M4-M5 Link)	19.1	6,585	3,011	294	182	585

(a) VKT – vehicle kilometres travelled

Table 9.18 Changes in total emissions in the WestConnex model domain

Scenario comparison	Change in total emissions (%) CO	NOx	PM_{10}	$PM_{2.5}$	THC
Do Minimum scenarios					
2021-DM vs 2014-BY	-40.8%	-38.2%	-13.7%	-22.4%	-39.4%
2031-DM vs 2014-BY	-60.0%	-55.0%	-10.4%	-23.6%	-61.2%
Project scenarios					
2021-DS vs 2021-DM	0.2%	0.2%	0.0%	0.0%	-0.8%
2031-DS vs 2031-DM	0.6%	0.2%	0.0%	0.0%	-0.8%
2031-DSC vs 2031-DM	7.9%	1.6%	2.0%	1.9%	-2.2%

Tunnel ventilation outlets

The M4 East ventilation outlet heights and locations are shown in **Table 9.19** and in **Chapter 5** (Project description).The western ventilation outlet for the M4–M5 Link would be adjacent to the M4 East eastern ventilation outlet.

Table 9.19 Ventilation outlet locations and heights

Tunnel project	Ventilation outlet	Traffic direction	Outlet location (MGA) X	Y	Ground elevation (m) Z	Outlet height (m) above ground floor level*
M4 East	A (Eastern ventilation facility, M4 East outlet)	EB	327101	6249870	15.3	25.0
	B (Western ventilation facility)	WB	322708	6251442	7.5	30.5

Tunnel project	Ventilation outlet	Traffic direction	Outlet location (MGA) X	Y	Ground elevation (m) Z	Outlet height (m) above ground floor level*
M4 East and M4-M5 Link	A (Eastern ventilation facility, M4 East outlet)	EB	327101	6249870	15.3	25.0
	C (Eastern ventilation facility, City West Link/Rozelle)	EB	330523	6250293	5.1	25.0
	B (Western ventilation facility)	WB	322708	6251442	7.5	30.5
	D (Eastern ventilation facility, M4-M5 Link outlet)	WB	327107	6249871	15.3	25.0

*Ground floor level of the ventilation building.

Regulatory worst case scenario

A summary of the results for the regulatory worst case scenario for the 10,154 RWR receptors is presented in **Table 9.20**.

Table 9.20 Results of regulatory worst case assessment (RWR receptors)

		Maximum ventilation outlet contribution at any receptor				
		Regulatory worst case scenario		Expected traffic scenario		
Pollutant and period	Units	2021-DS, 2031-DS	2031-DSC	2021-DS	2031-DS	2031-DSC
CO (one hour)	(mg/m^3)	0.12	0.23	N/A[(a)]	N/A[(a)]	N/A[(a)]
NO_X (annual)	($\mu g/m^3$)	3.49	6.98	0.47	0.56	1.11
NO_X (1 hour)	($\mu g/m^3$)	59.36	114.82	13.67	15.55	28.06
NO_2 (annual)	($\mu g/m^3$)	0.56[(b)]	1.12[(b)]	0.10	0.13	0.28
NO_2 (1 hour)	($\mu g/m^3$)	N/A	N/A	N/A	N/A	N/A
PM_{10} (annual)	($\mu g/m^3$)	0.19	0.38	0.03	0.04	0.09
PM_{10} (24 hour)	($\mu g/m^3$)	1.40	2.79	0.21	0.27	0.53
$PM_{2.5}$ (annual)[(c)]	($\mu g/m^3$)	0.19	0.38	0.02	0.03	0.06
$PM_{2.5}$ (24 hour)[(c)]	($\mu g/m^3$)	1.40	2.79	0.15	0.18	0.36
THC (one hour)	($\mu g/m^3$)	11.88	22.96	N/A[(a)]	N/A[(a)]	N/A[(a)]

(a) Not determined.
(b) Estimated as 16% of NO_X.
(c) The same emission rates were used for PM_{10} and $PM_{2.5}$.

The regulatory worst case scenario is a theoretical analysis and the actual impacts of the tunnel operation for all traffic scenarios are expected to be much lower. However, Roads and Maritime would monitor ambient air quality after project opening to demonstrate that the ventilation outlets have no detectable impact on local air quality.

Expected traffic scenarios

The ventilation outlet airflows, exit velocities and emission rates for NO_2, $PM_{2.5}$ (vehicle exhaust only) and CO under the expected traffic scenarios are provided in **Appendix H**.

Further details of the modelling procedures are provided in **Appendix H**.

Predicted pollutant levels with and without the project

For each pollutant and metric the following concentrations were determined:

- The total pollutant concentration from all contributions (background, surface roads and ventilation outlets), focusing on the 2021-DS and 2031-DS scenarios
- The change in the total pollutant concentration was calculated as the difference between the 2021-DS and 2021-DM scenario, and between the 2031-DS and 2031-DM scenario
- The pollutant contribution from ventilation outlets alone in the 2021-DS and 2031-DS scenarios. The predicted concentrations at the 31 community and 10,154 RWR receptors are presented in three ways:
  - In bar charts for absolute concentration and changes in concentration for the 31 community receptors
  - As ranked bar charts for absolute concentration and changes in concentration at the 10,154 RWR receptors
- Pollutant concentrations across the modelling domain (as contour plots). These have only been provided for the most important pollutants: NO_2, PM_{10} and $PM_{2.5}$.

The results show that the criteria pollutants are well below the relevant criteria at all receptors for 2021 and 2031; the results for these criteria pollutants are shown in **Section 9.7.4**.

The longer averaging times for each pollutant are presented here as they are generally more important in the consideration of potential health impacts than the shorter averaging periods. Additional results, including tabulated concentrations and contour plots, are provided in Appendix J of the Air Quality Assessment Report in **Appendix H**.

9.7.3 Carbon monoxide (maximum rolling eight-hour mean)

Results for community receptors

Figure 9.22 shows the maximum rolling eight-hour mean CO concentrations at the community receptors for the project in 2021 and 2031. Because no model predictions were available for the period with the highest background concentration, the maximum background value was combined with the maximum model prediction at each receptor. The background was therefore taken to be the same at all locations. As with the one-hour mean, at all the receptors the concentration was well below the NSW impact assessment criterion, which in this case is 10 µg/m^3. No lower criteria appear to be in force internationally.

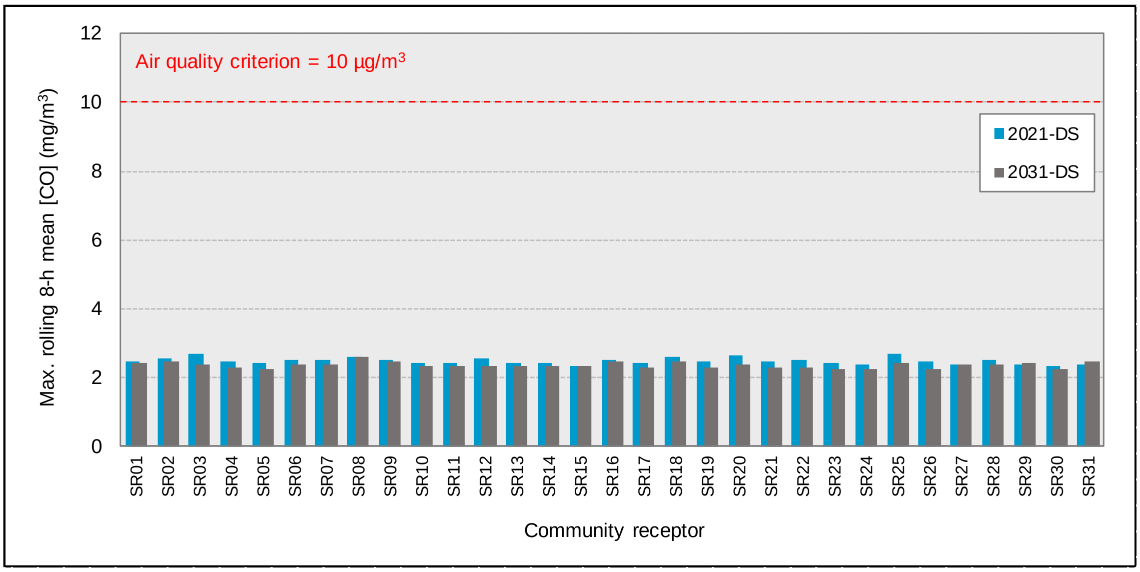

Figure 9.22 **Maximum rolling eight-hour mean CO at community receptors with the project in 2021 and 2031 (2021-DS and 2031-DS)**

The main contributor at these receptors in the 2021-DS scenario was the background concentration (**Figure 9.23**). The surface road contribution ranged from nine per cent to 22 percent, whereas the tunnel ventilation outlet contribution was less than 0.3 per cent.

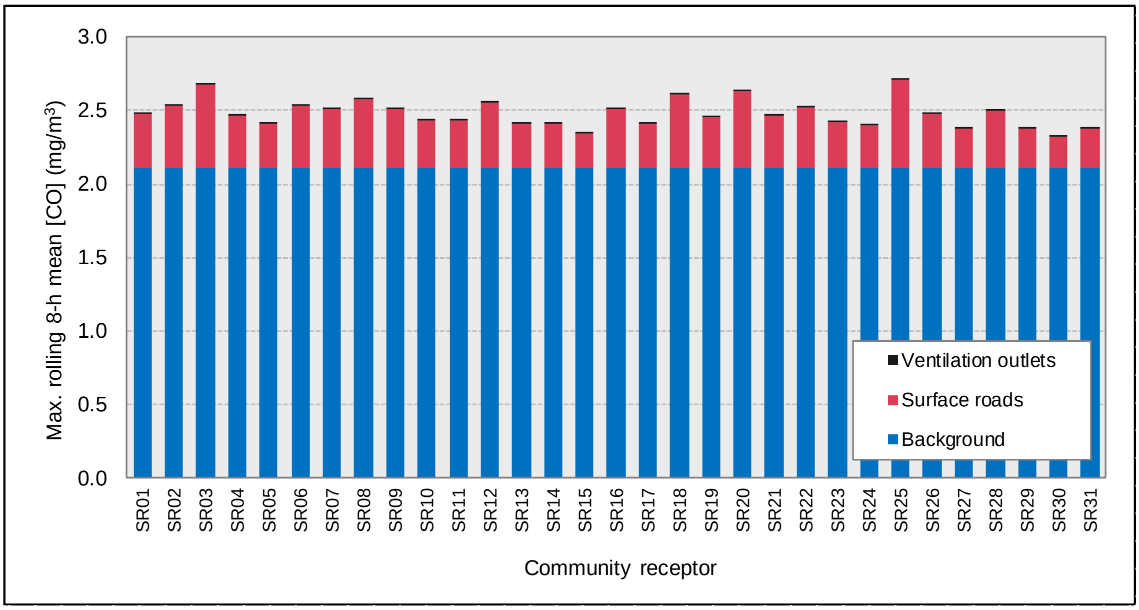

Figure 9.23 **Source contributions to maximum rolling eight-hour mean CO at community receptors with the project in 2021 (2021-DS)**

Figure 9.24 shows that the change in the maximum rolling 8-hour CO concentration at most of the community receptors was less than 0.3 mg/m^3.

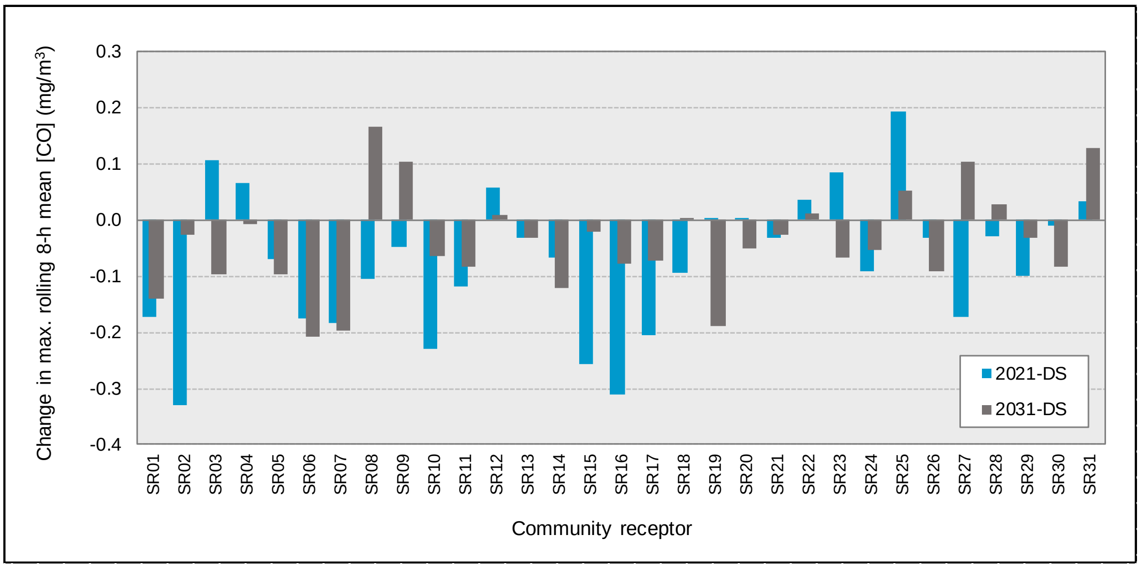

Figure 9.24 **Maximum rolling eight-hour mean CO at community receptors with the project in 2021 and 2031 (2021-DS and 2031-DS)**

Results for RWR receptors

The rolling eight-hour mean CO concentrations were not extracted from GRAL. However, these would be broadly similar to those obtained for maximum one-hour concentrations.

9.7.4 Nitrogen dioxide (annual mean)

Results for community receptors

Figure 9.25 shows the annual mean NO_2 concentrations at the 31 community receptors with the project in 2021 and 2031. At all these receptor locations the concentration was below 27 µg/m^3, and therefore less than 45 per cent of the NSW impact assessment criterion of 62 µg/m^3. It should be noted that a lower air quality standard has been adopted elsewhere (eg 40 µg/m^3 in the EU). The concentrations at the community receptors were also below this value.

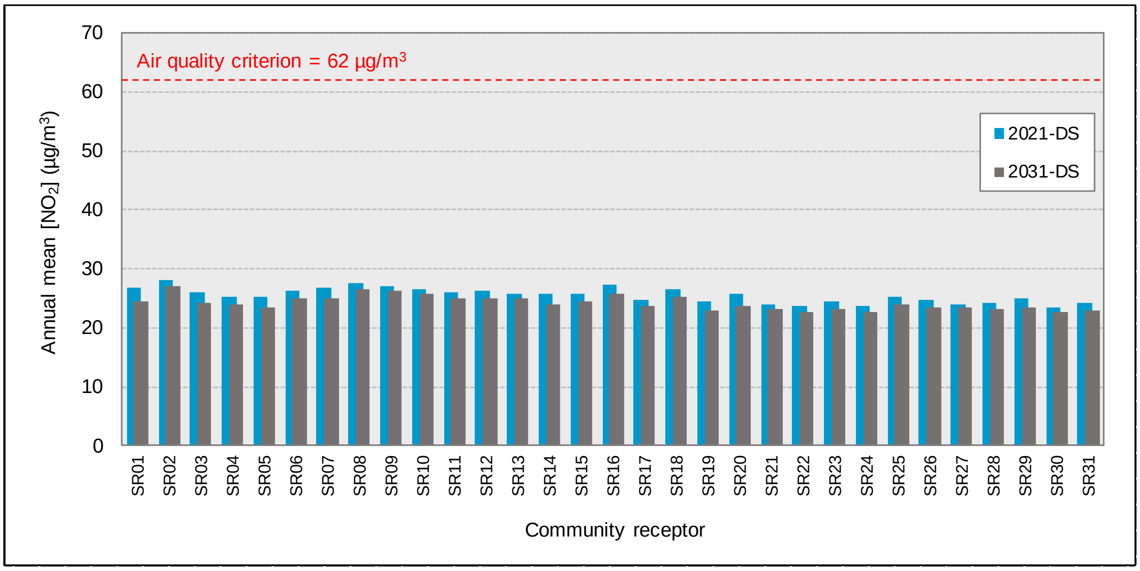

Figure 9.25 **Annual mean NO_2 at community receptors with the project in 2021 and 2031 (2021-DS and 2031-DS)**

Figure 9.26 presents the source contributions to total annual mean NO_2 concentrations in the 2021-DS scenario.

The source contributions were estimated using a 'cumulative' approach involving the following steps:

A. The background NO_X concentration alone was converted to NO_2

B. The sum of the background and road NO_X concentrations was converted to NO_2

C. The sum of the background, road and outlet NO_X concentrations was converted to NO_2.

The road and outlet contributions were then obtained as the differences in NO_2, where road NO_2 was determined as NO_2 from Step B minus NO_2 from Step A, and outlet NO_2 was determined from Step C minus Step B. This allowed for the reduced oxidising capacity of the near-road atmosphere at higher total NO_X concentrations (**Appendix H**).

The results indicate that the background at these receptors is likely to be responsible for, on average, around 80 per cent of the predicted annual mean NO_2, with most of the remainder being due to surface roads. Surface roads were responsible for between 13 per cent and 25 per cent of the total, depending on the receptor. The contribution of tunnel ventilation outlets was less than 0.4 per cent.

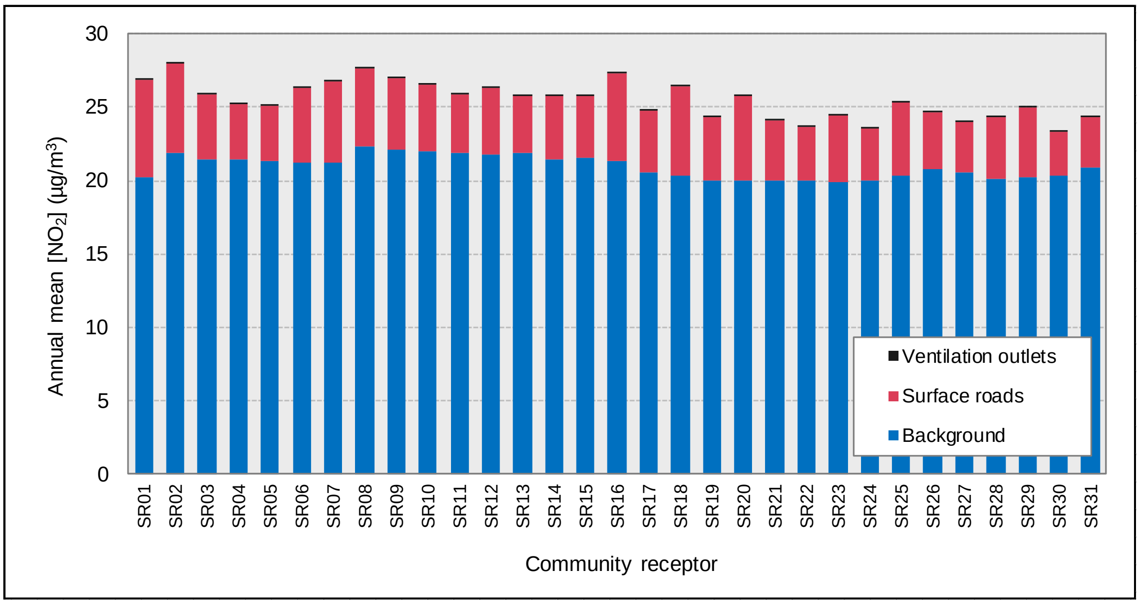

Figure 9.26 **Source contributions to annual mean NO_2 at community receptors with the project in 2021 (2021-DS)**

Figure 9.32 shows the changes in concentration in the 'Do Something' scenarios relative to the 'Do Minimum' scenarios for the community receptors. Although there was a small increase in the NO_2 concentration at some receptors (less than 0.54 $\mu g/m^3$), at most locations there was a reduction. The largest reduction for these community receptors – around 3.54 $\mu g/m^3$ in 2021 – was predicted to occur at receptor SR16 (St Mary's Catholic Primary School), and effectively represented the removal of a large proportion of the surface road contribution at this location.

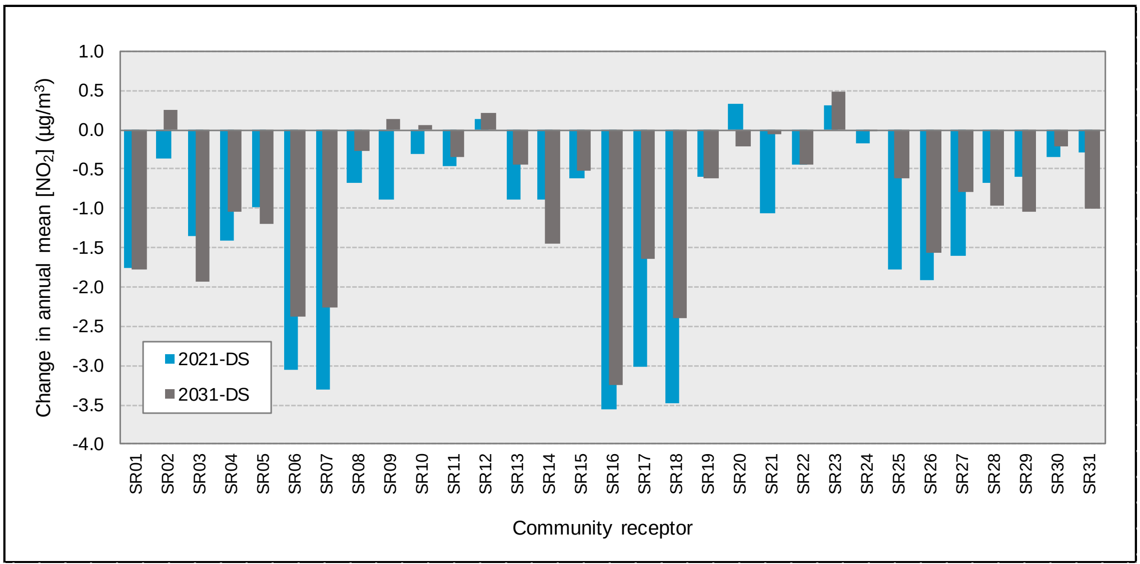

Figure 9.27 **Change in annual mean NO_2 at community receptors with the project in 2021 and 2031 (2021-DS and 2031-DS)**

Results for RWR receptors

The annual mean NO_2 criterion for NSW was not exceeded at any of the 10,154 RWR receptors in any scenario. In 2021 and 2031 the highest concentrations associated with the project were predicted to be 34.4 µg/m^3 and 31.04 µg/m^3, and in both cases these concentrations represented a decrease relative to the corresponding 'Do Minimum' scenarios. The higher maximum annual mean NO_2 concentration in the cumulative case (2031-DSC) was 31.6 µg/m^3.

The annual mean NO_2 concentrations at the RWR receptors in the 2021-DS scenario are shown, with a ranking by total concentration, in **Figure 9.28**. Concentrations at the vast majority of receptors were between around 23 µg/m^3 and 30 µg/m^3. As noted above, all concentrations were well below the assessment criterion of 62 µg/m^3, as well as being below the EU limit value of 40 µg/m^3. The maximum contribution of tunnel ventilation outlets at any location in 2021 was 0.1 µg/m^3, whereas the surface road contribution ranged between 2.4 µg/m^3 and 14.2 µg/m^3. The corresponding values for 2031 were 0.13 µg/m^3, 1.8 µg/m^3 and 10.8 µg/m^3.

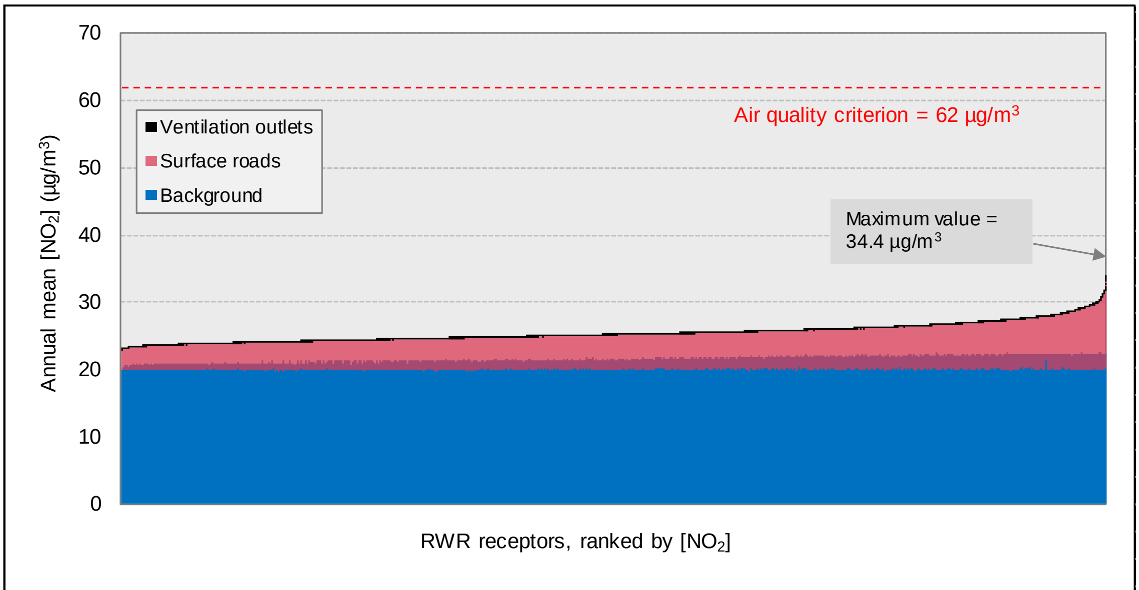

Figure 9.28 **Source contributions to annual mean NO_2 at RWR receptors with the project in 2021 (2021-DS)**

The change in the annual mean NO_2 concentration at the RWR receptors in the 2021-DS scenario (relative to the 2021-DM scenario) are shown, ranked by change in concentration, in **Figure 9.29**. There was clearly a general downward shift in the predicted annual mean concentration across the M4 East GRAL domain as a result of the project, with substantial reductions at a large number of locations. There was an increase in NO_2 at 15 per cent of the receptors, although the increase was greater than1 $\mu g/m^3$ for only 0.54 per cent of receptors.

The annual mean NO_2 concentrations, and the changes in the annual mean, in the 2031-DS scenario are given in Appendix J of the air quality assessment in **Appendix H**. These closely resemble the results for 2021.

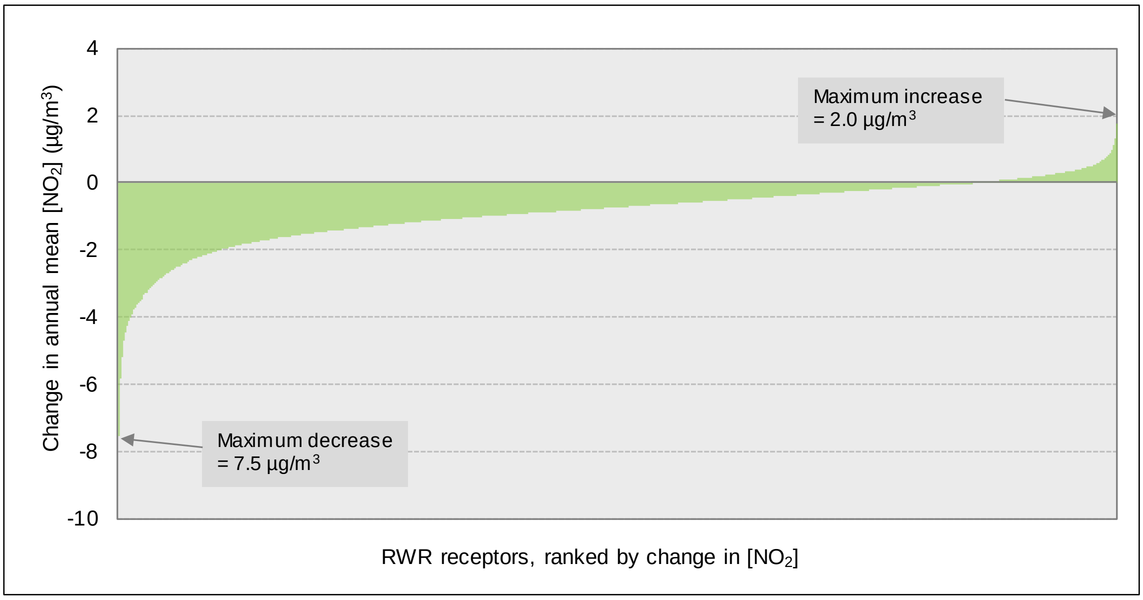

Figure 9.29 **Changes in annual mean NO_2 at RWR receptors with the project in 2021 (2021-DS)**

Contour plots

Contour plots showing the spatial distribution of annual mean NO_2 concentrations across the M4 East GRAL domain in 2021 are provided for the Do Minimum case (ie without the project) in **Figure 9.30**, and for the Do Something case (ie with the project) in **Figure 9.31**. These plots are based on 527,000 data points, spaced at 10 metre intervals across the domain. Many of the points therefore fall along the axes of roads, and are therefore not necessarily representative of population exposure. The maps also show main surface roads and the locations of the project ventilation facilities.

Annual mean concentrations are clearly the highest along major roads, notably the M4 and Centenary Drive to the south of Sydney Olympic Park, and to a lesser extent Parramatta Road. The concentrations are also influenced slightly by the background NO_2 concentration gradient, which increases from east to west (see Appendix F, Figure F-38 of the air quality assessment in **Appendix H**).

An equivalent contour plot for the change in the annual mean NO_2 concentration with the project in 2021 is given in **Figure 9.32**. This shows the general reductions in NO_2 across the domain, and in particular along Parramatta Road. Some sections of Parramatta Road have larger reductions in concentration than other sections.

The equivalent plots for 2031 are presented in Appendix J of the air quality assessment in **Appendix H**.

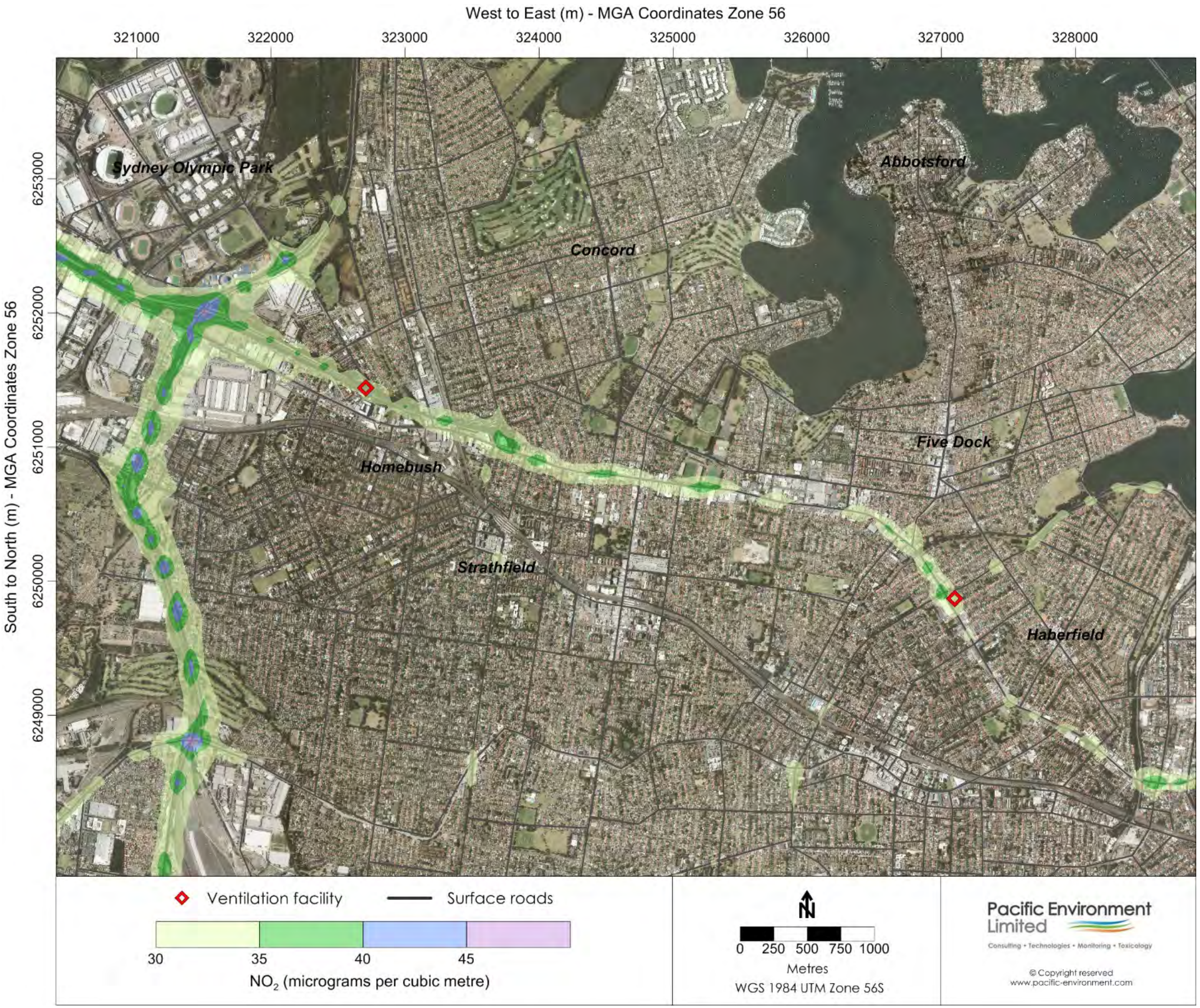

Figure 9.30 **Contour plot showing annual mean NO_2 without the project in 2021 (2021-DM)**

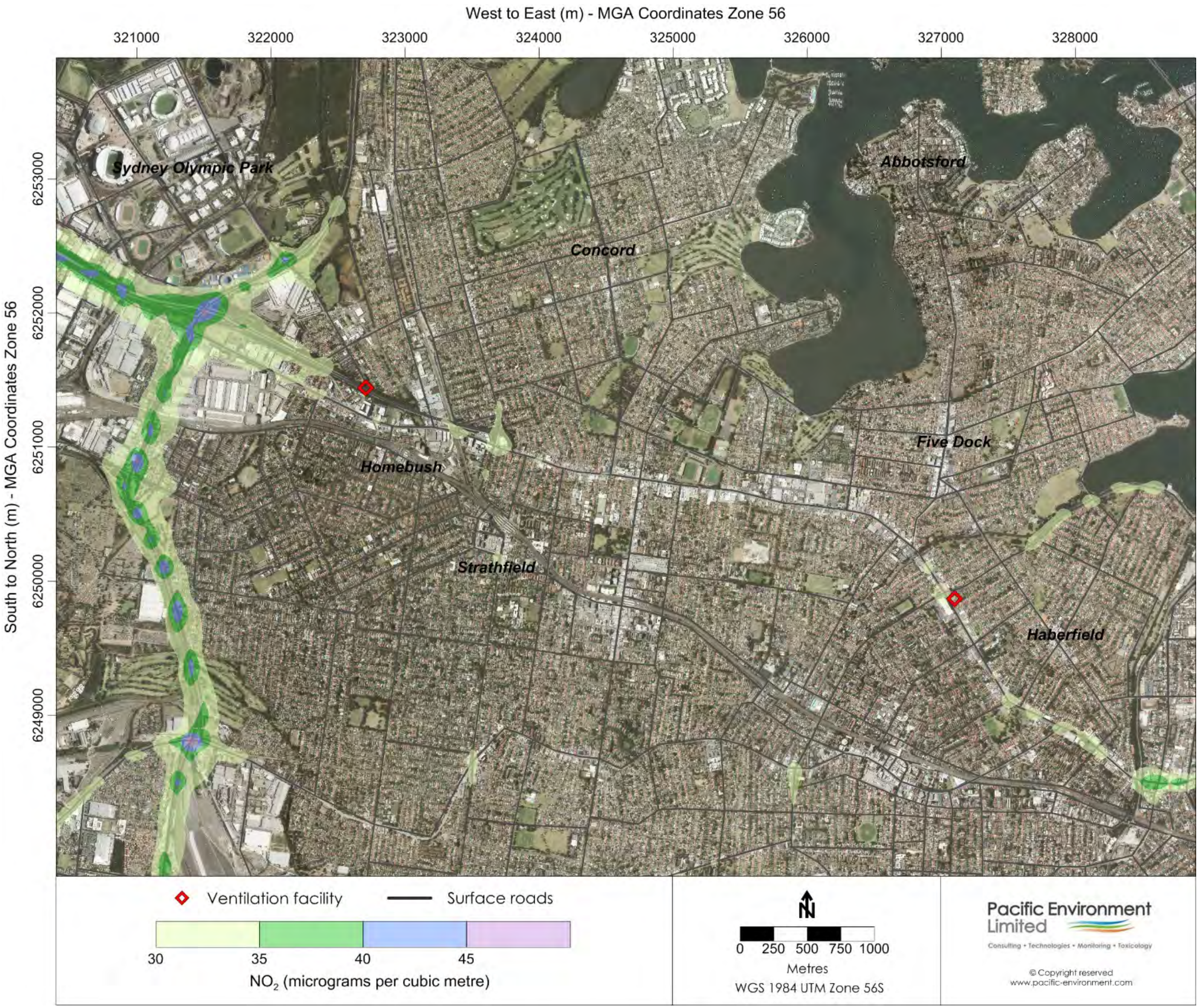

Figure 9.31 Contour plot showing annual mean NO_2 with the project in 2021 (2021-DS)

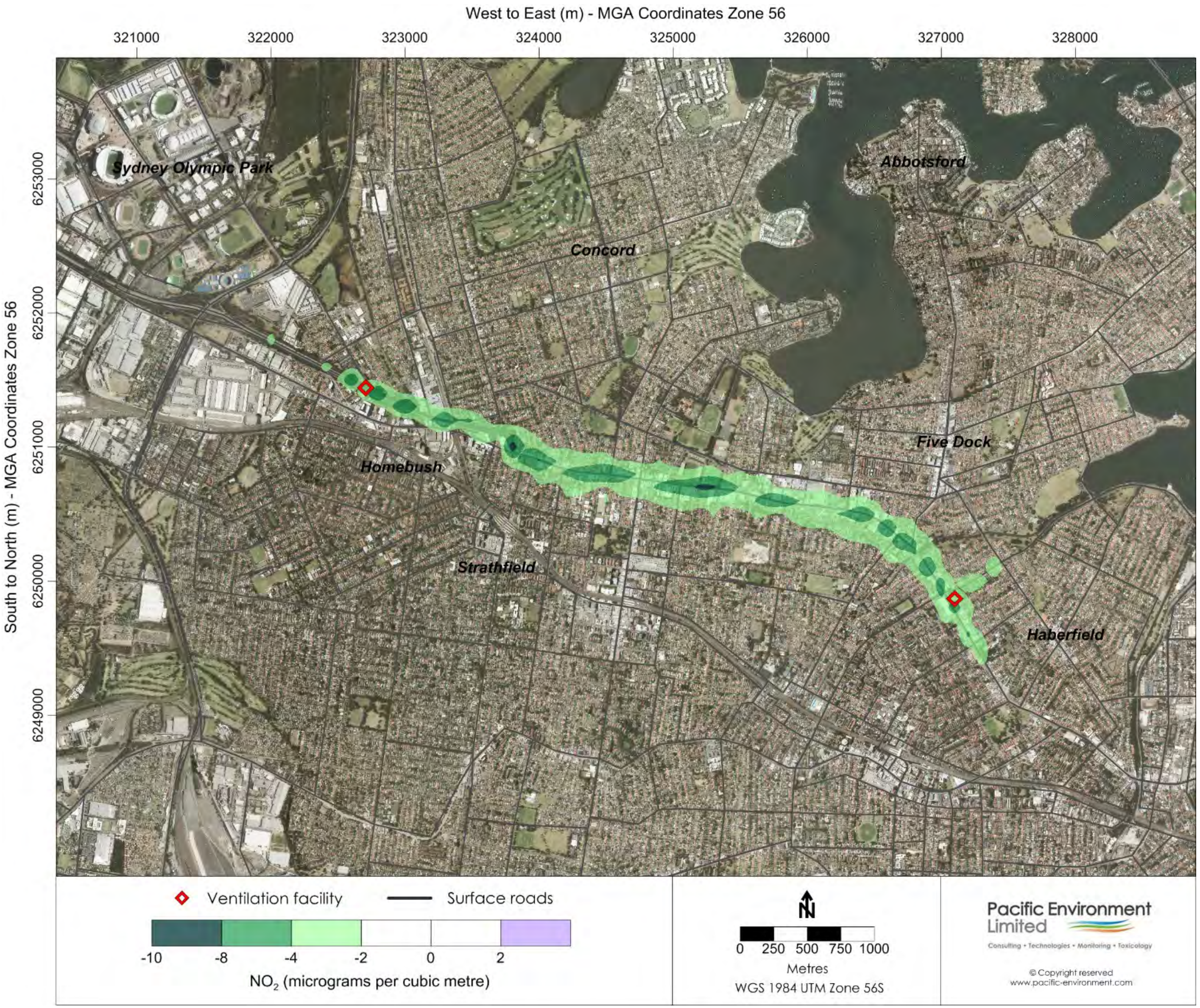

Figure 9.32 Contour plot showing change in annual mean NO_2 with the project in 2021 (2021-DS)

9.7.5 PM_{10} (annual mean)

Results for community receptors

The annual mean PM_{10} concentrations at the 31 community receptors with the project in 2021 and 2031 are shown in **Figure 9.33**. As with NO_2, there was little variation in concentration between the receptors. At all the community receptors the concentration would be below 20 µg/m^3, and therefore well below the NSW impact assessment criterion of 30 µg/m^3. PM_{10} concentrations at these receptors – which are close to busy roads in Sydney – were only slightly higher than the lowest PM_{10} standard in the literature (18 µg/m^3 in Scotland) (**Appendix H**).

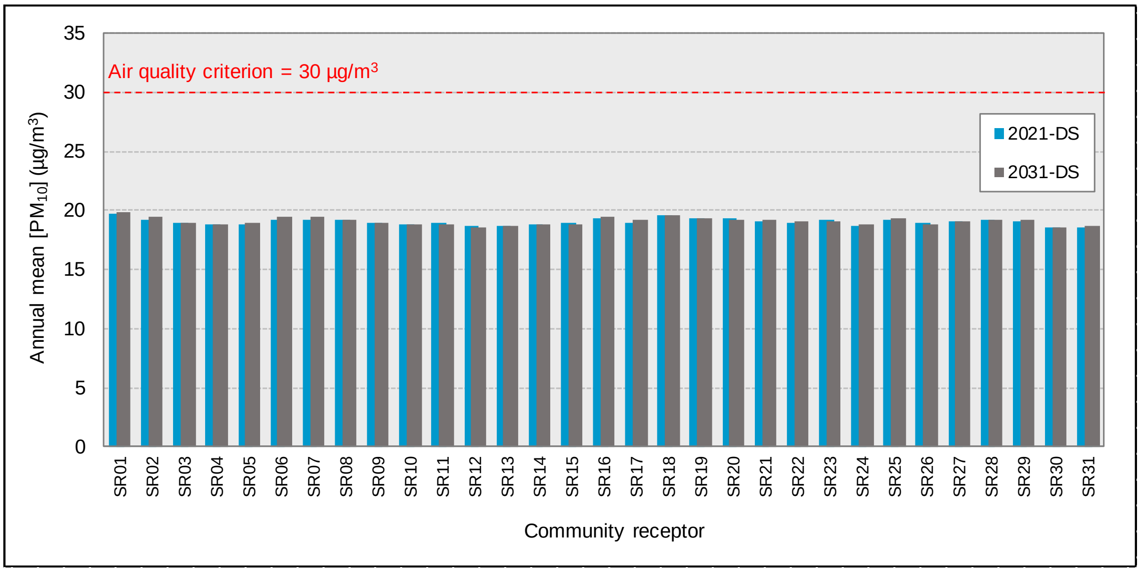

Figure 9.33 Annual mean PM_{10} at community receptors with the project in 2021 and 2031 (2021-DS and 2031-DS)

The concentrations in the 2021-DS scenario were again dominated by the background (**Figure 9.34**), with a small contribution from roads (0.7-1.7 µg/m^3) and a negligible contribution from ventilation outlets.

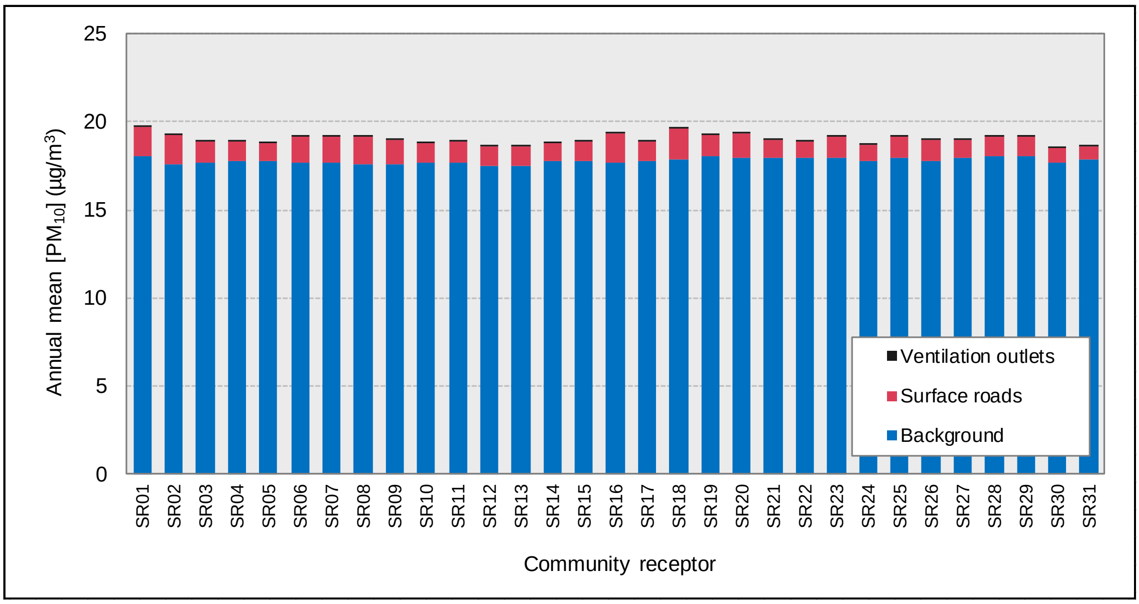

Figure 9.34 Source contributions to annual mean PM_{10} at community receptors with the project in 2021 (2021-DS)

Figure 9.35 shows the changes in concentration in the Do Something scenarios relative to the Do Minimum scenarios for the community receptors. Small increases in concentration were predicted for some receptors, but decreases were predicted for most.

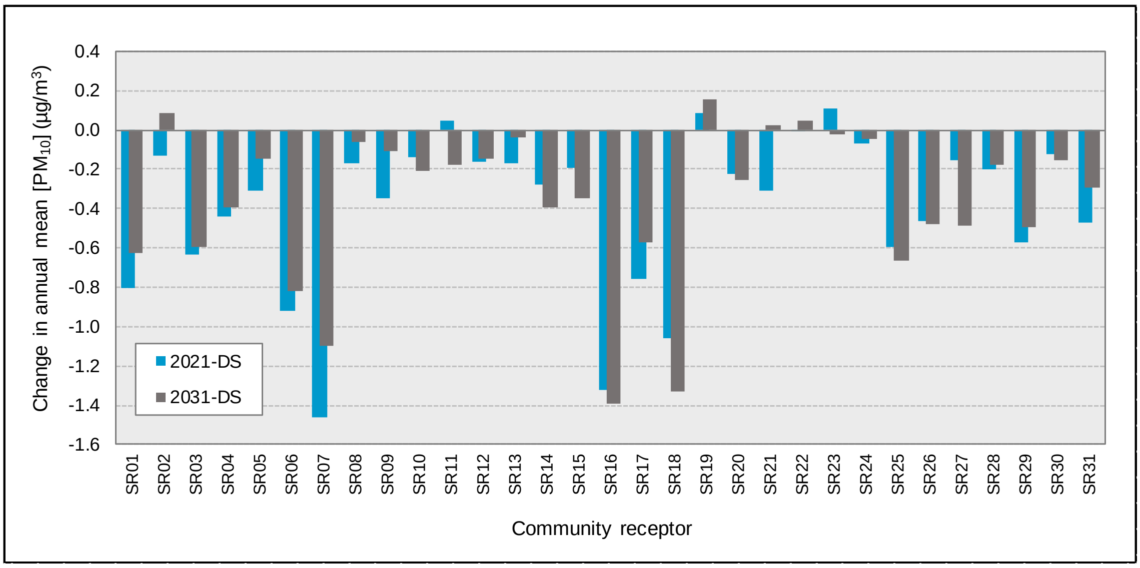

Figure 9.35 Change in annual mean PM_{10} at community receptors with the project in 2021 and 2031 (2021-DS and 2031-DS)

Results for RWR receptors

The ranked annual mean PM_{10} concentrations at the RWR receptors in the 2021-DS scenario are shown in **Figure 9.36**. The concentration at the majority of receptors was below 20 µg/m^3, and concentrations at all receptors were well below the NSW assessment criterion of 30 µg/m^3. The highest predicted concentration at any receptor in this scenario was 22.3 µg/m^3, but as with other pollutants and metrics the highest values were only predicted for a small proportion of receptors. The surface road contribution was between 0.6 µg/m^3 and 4.2 µg/m^3. The largest contribution from tunnel ventilation outlets was just 0.06 µg/m^3 in 2021-DS (0.07 µg/m^3 in 2031-DS).

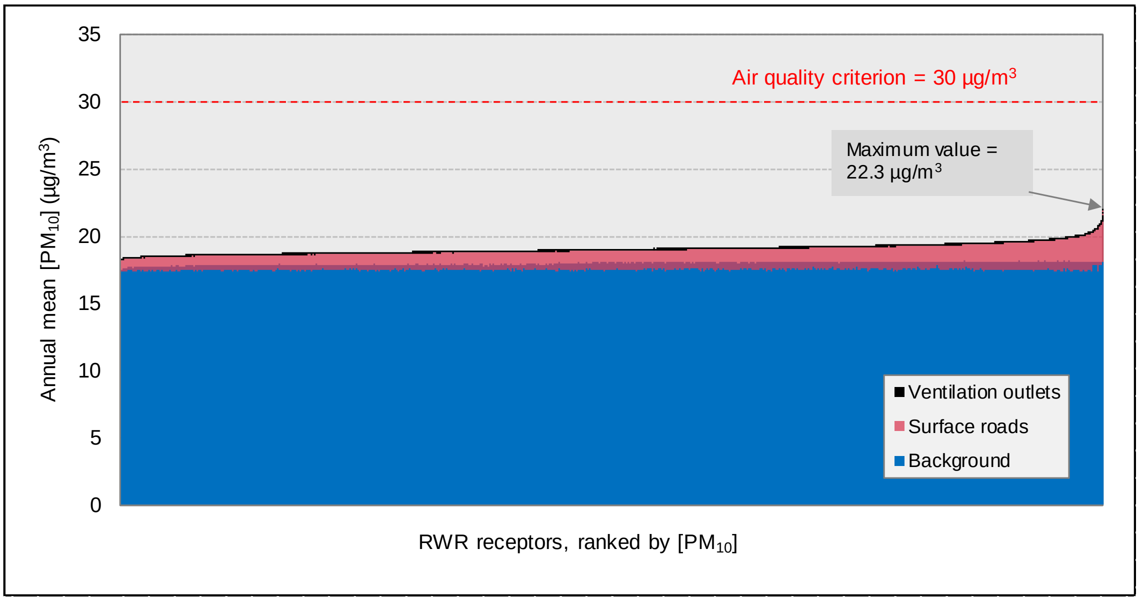

Figure 9.36 Source contributions to annual mean PM_{10} at RWR receptors with the project in 2021 (2021-DS)

The change in the annual mean PM_{10} concentration at the RWR receptors in the 2021-Do Something scenario (relative to the 2021-Do Minimum scenario) is shown, ranked by change in concentration, in **Figure 9.37**. Once again, there was a marked downward shift in the predicted annual mean concentration along the project corridor as a result of the project, with substantial reductions at a large number of locations. There was an increase in PM_{10} at 16 per cent of the receptors, although the increase was greater than 0.5 µg/m^3 for only five per cent of the 10,154 receptors. The largest predicted increase in concentration at any receptor as a result of the project in 2021 was 0.7 µg/m^3, and the largest predicted decrease was 2.8 µg/m^3.

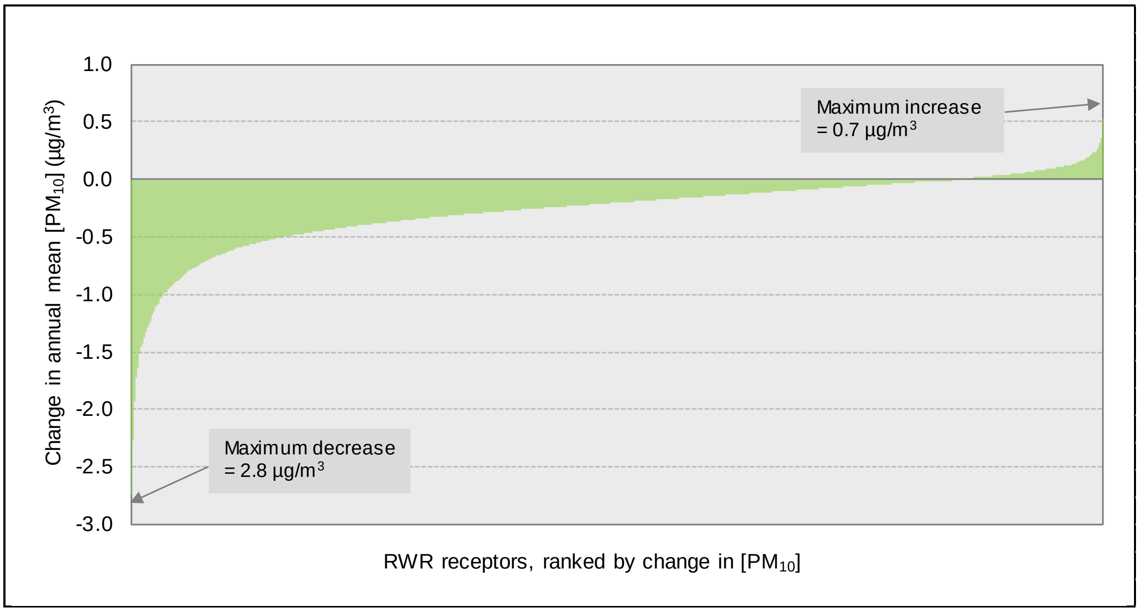

Figure 9.37 Changes in annual mean PM_{10} at RWR receptors with the project in 2021 (2021-DS)

The corresponding plots for the 2031-DS scenario are given in Appendix J of the air quality assessment in **Appendix H**.

Contour plots

The contour plots for annual mean PM_{10} in 2021 are given in Figure 9.39 and **Figure 9.40**. These show a fairly even distribution across the domain, reflecting the homogenous nature of background concentrations (see Appendix F of the air quality assessment in **Appendix H**) and the relatively small contribution from road traffic. Slightly elevated concentrations are evident along the major road corridors. The contour plot for the change in concentration with the project in 2021 (**Figure 9.40**) shows small reductions in annual mean PM_{10} along Parramatta Road.

The equivalent plots for 2031 are presented in Appendix J of the air quality assessment in **Appendix H**.

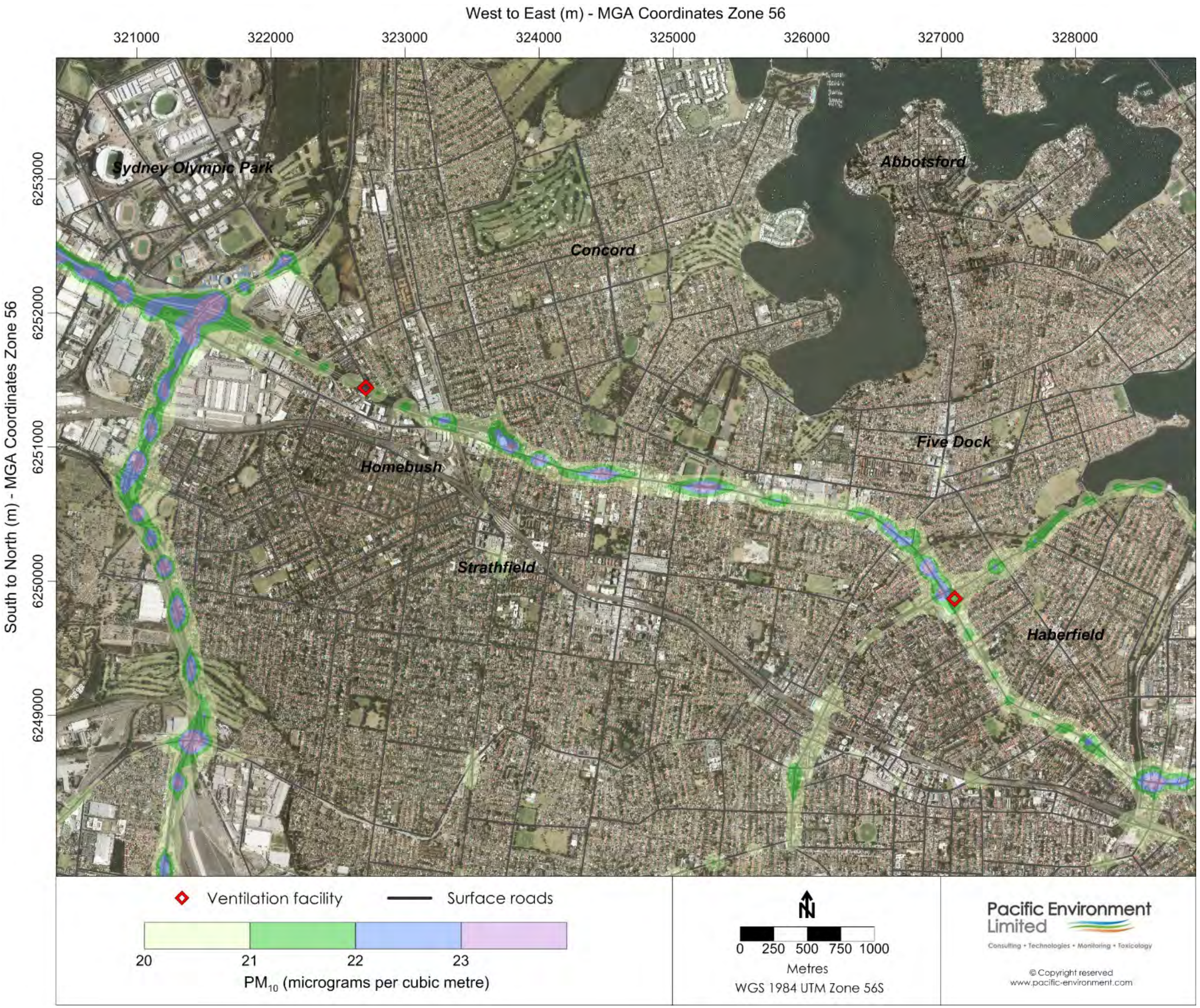

Figure 9.38 Contour plot showing annual mean PM_{10} in 2021 without the project (2021-DM)

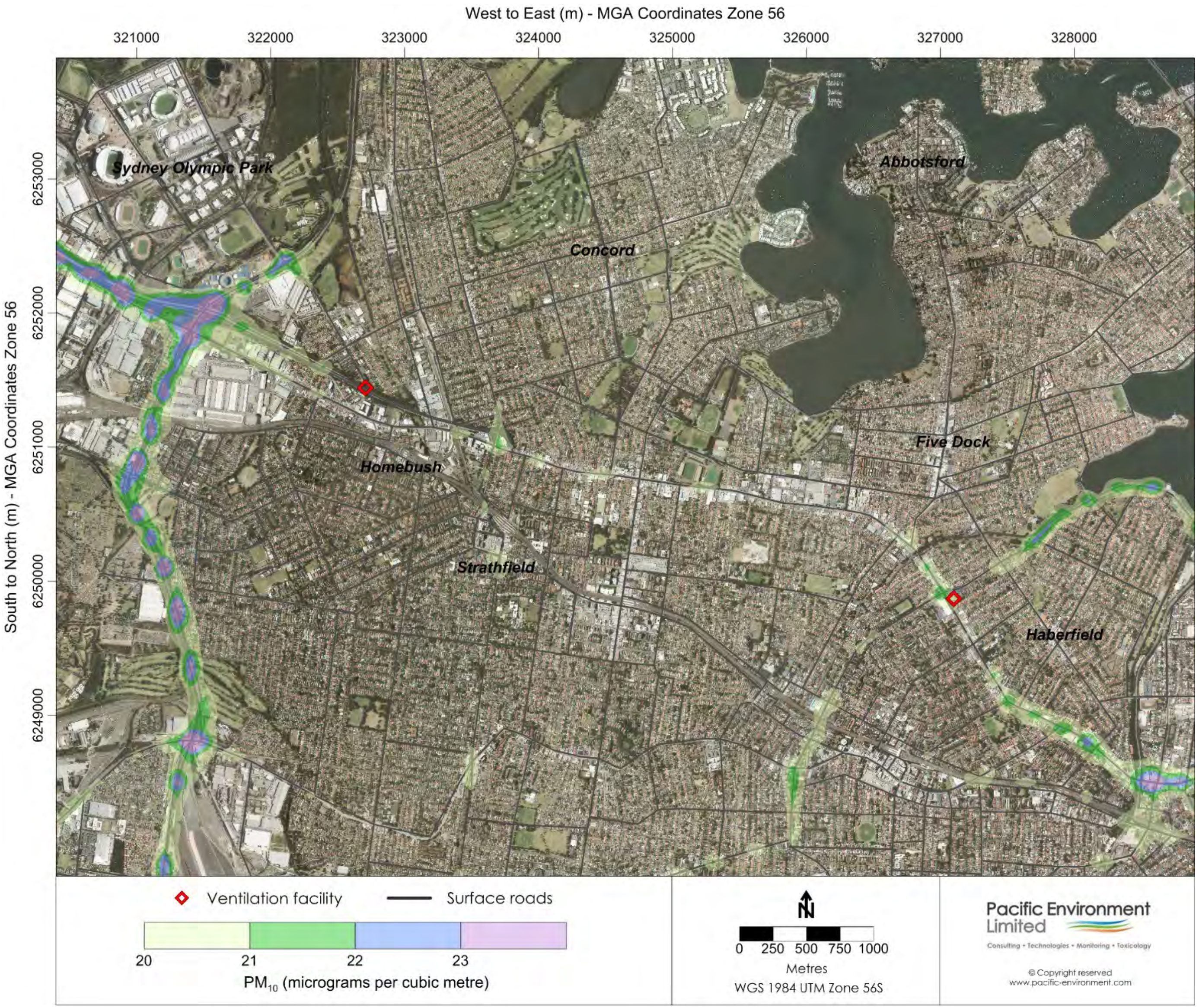

Figure 9.39 Contour plot showing annual mean PM10 in 2021 with the project (2021-DS)

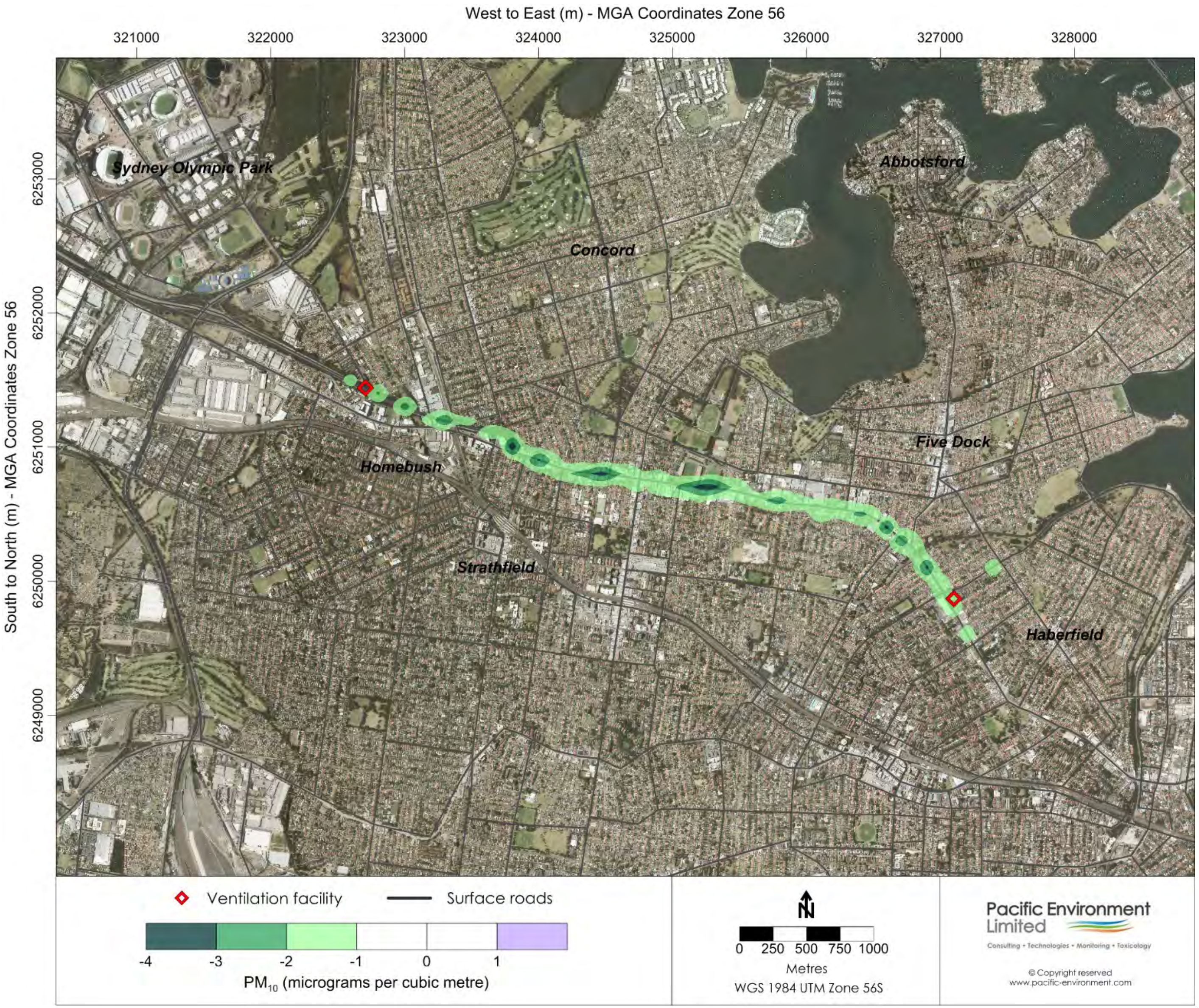

Figure 9.40 Contour plot showing change in annual mean PM_{10} with the project in 2021 (2021-DS)

9.7.6 PM_{10} (maximum 24-hour mean)

Results for community receptors

The maximum 24-hour mean PM_{10} concentrations at the 31 community receptors with the project in 2021 and 2031 are shown in **Figure 9.41**. At all receptor locations the maximum concentration was below – but close to – the NSW impact assessment criterion of 50 µg/m^3, which is the most stringent standard in force internationally. At all receptors, the maximum total 24-hour concentration occurred on one of only two days of the year (10 February or 31 October), and coincided with the two highest 24-hour background concentrations in the synthetic PM_{10} profile (44.5 and 45.2 µg/m^3). This provided support for the use of a maximum or high percentile value as the background for the RWR receptors across the M4 East GRAL domain (see **Appendix H**).

The surface road contributions to the maximum 24-hour PM_{10} concentration at each receptor was small (generally <2 µg/m^3), as shown in **Figure 9.42**. The tunnel ventilation outlet contributions alone were negligible (<0.2 µg/m^3).

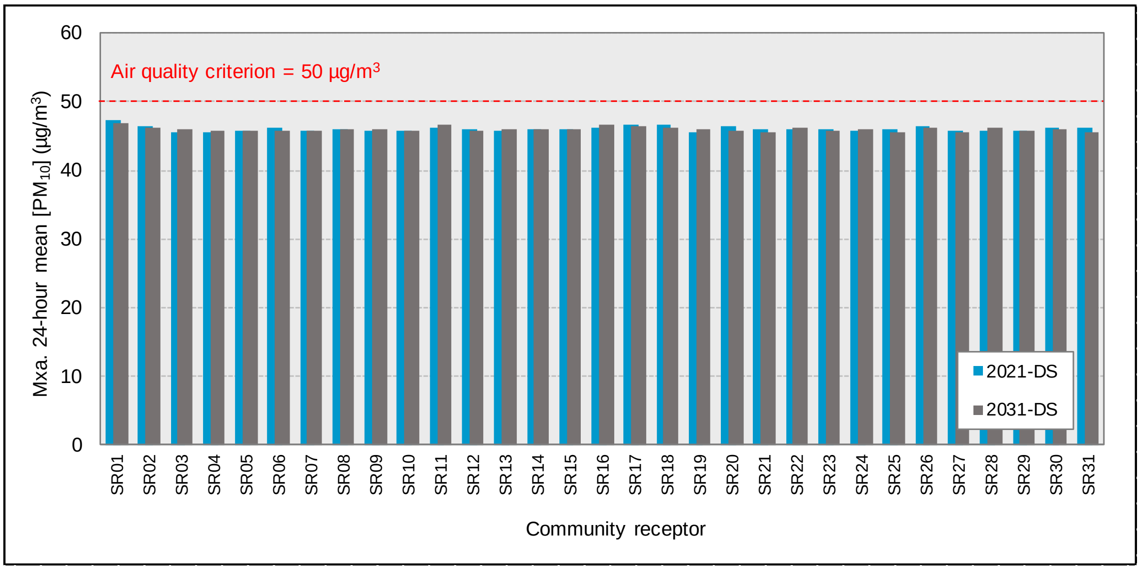

Figure 9.41 Maximum 24-hour PM_{10} at community receptors in 2021 and 2031with the project (2021-DS and 2031-DS)

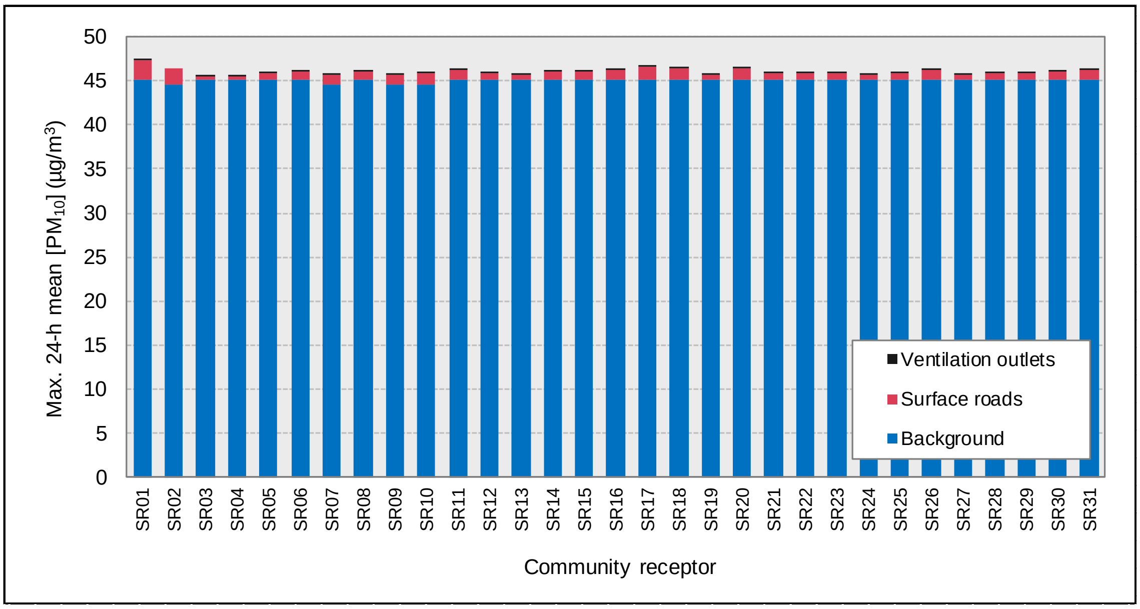

Figure 9.42 Source contributions to maximum 24-hour PM_{10} at community receptors in 2021 with the project (2021-DS)

Figure 9.43 shows the changes in concentration in the Do Something scenarios relative to the Do Minimum scenarios for the community receptors. The changes were generally small (<1 µg/m^3). Small increases in concentration were predicted with the project for some receptors in 2021 and 2031.

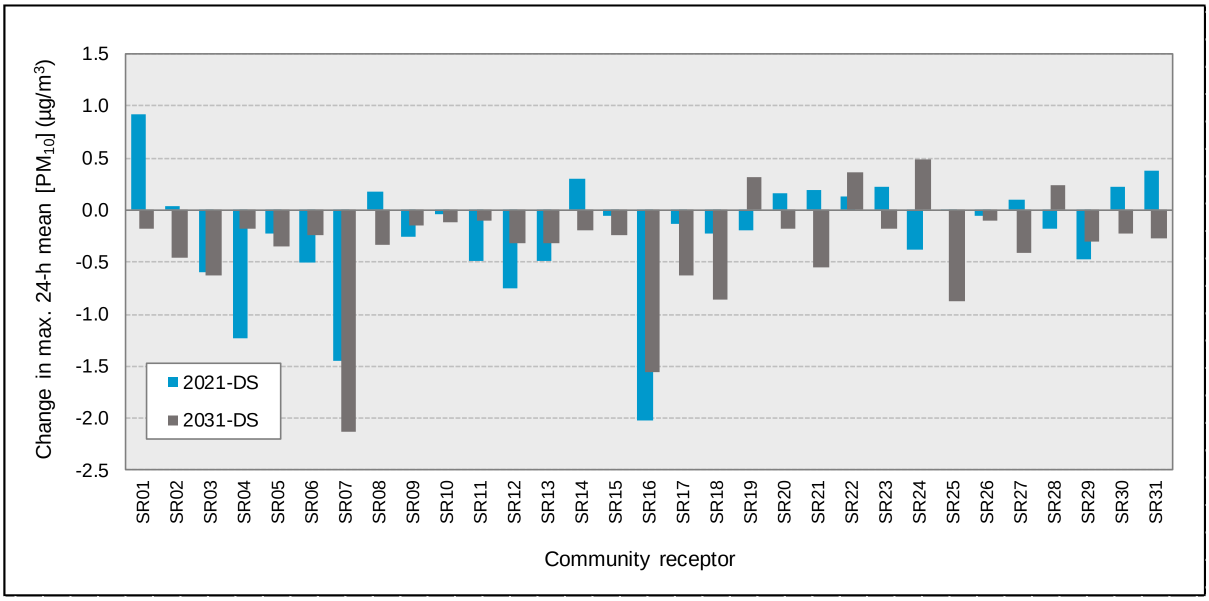

Figure 9.43 **Change in maximum 24-hour PM_{10} at community receptors in 2021 with the project (2021-DS and 2031-DS)**

Results for RWR receptors

The ranked maximum 24-hour mean PM_{10} concentrations at the RWR receptors in the 2021-DS scenario are shown in **Figure 9.44**. Results for RWR receptors were highly dependent on assumptions for the background. The concentration at the majority of receptors was below the NSW impact assessment criterion of 50 µg/m^3. The proportion of receptors with a concentration above the criterion decreased from 0.9 per cent in the 2021 Do Minimum scenario to 0.1 per cent with the project. The contributions of surface roads and ventilation outlets were not additive. The maximum contribution of tunnel outlets at any receptor was only 0.37 µg/m^3 in 2021 (0.42 µg/m^3 in 2031).

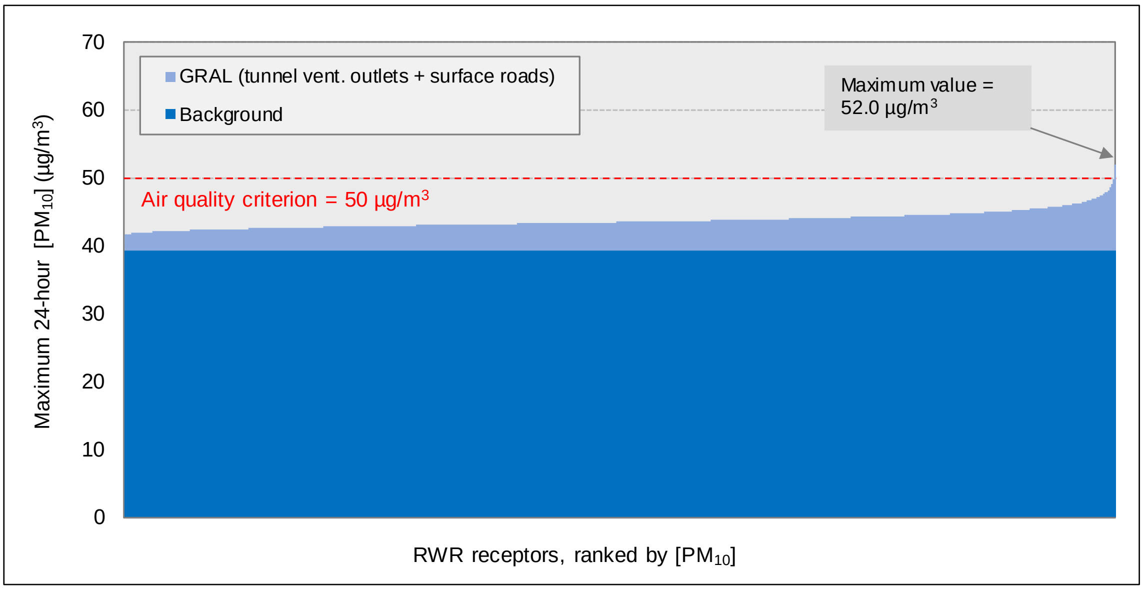

Figure 9.44 **Source contributions to maximum 24-hour PM_{10} at RWR receptors (2021-DS)**

The changes in the maximum 24-hour mean PM_{10} concentration with the project in 2021 are ranked, by change in concentration, in **Figure 9.45**. The same downward shift in predicted concentrations along the corridor is apparent. There was an increase in the maximum 24-hour PM_{10} at 21 per cent of the receptors, although the increase was greater than 2 µg/m^3 for only 0.3 per cent of receptors. The largest predicted increase in concentration at any receptor as a result of the project was 4.84 µg/m^3, and the largest predicted decrease was 10.6 µg/m^3.

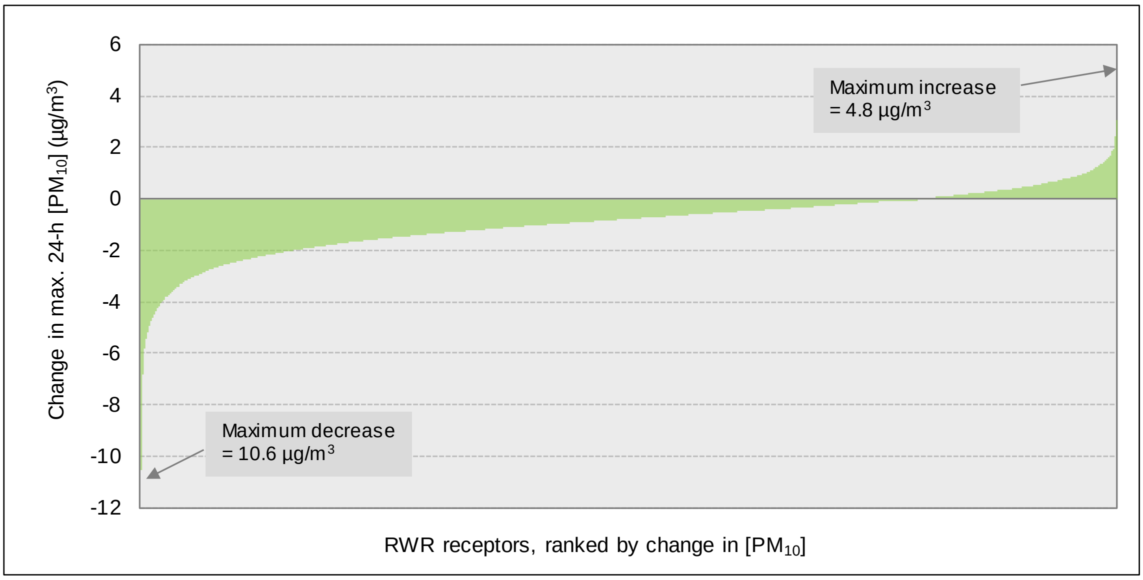

Figure 9.45 Changes in maximum 24-hour PM_{10} at RWR receptors (2021-DS)

Contour plots

The contour plots for maximum 24-hour average PM_{10} in 2021 are given in **Figure 9.46**, **Figure 9.47** and **Figure 9.48**. These show a fairly even distribution across the domain, reflecting the homogenous nature of background concentrations (see Figure F-4 in Appendix F of the air quality assessment report in **Appendix H**) and the relatively small contribution from road traffic. Slightly elevated concentrations are evident along the major road corridors.

Figure 9.48 shows the contour plot for the change in maximum 24-hour PM_{10} concentration with the project in 2021. There were reductions of up to 20 per cent of the NSW criterion along some sections of Parramatta Road.

The equivalent plots for 2031 are presented in Appendix J of the air quality assessment in **Appendix H**.

Figure 9.46 Contour plot showing maximum 24-hour average PM10 without the project in 2021(2021-DM)

Figure 9.47 Contour plot showing maximum 24-hour average PM_{10} with the project (2021-DS)

Figure 9.48 **Contour plot showing change in maximum 24-hour PM_{10} with the project (2021-DS)**

9.7.7 $PM_{2.5}$ (annual mean)

Results for community receptors

The annual mean $PM_{2.5}$ concentrations at the 31 community receptors with the project in 2021 and 2031 are presented in **Figure 9.49**. The results are based on an assumed background concentration of eight µg/m^3 (the AAQ NEPM advisory reporting standard), and therefore the figure shows exceedances at all receptors. Clearly there would also be exceedances of the proposed NSW target of seven µg/m^3. Internationally, there are no standards lower than eight µg/m^3 for annual mean $PM_{2.5}$. The next lowest is 12 µg/m^3 (California, Scotland).

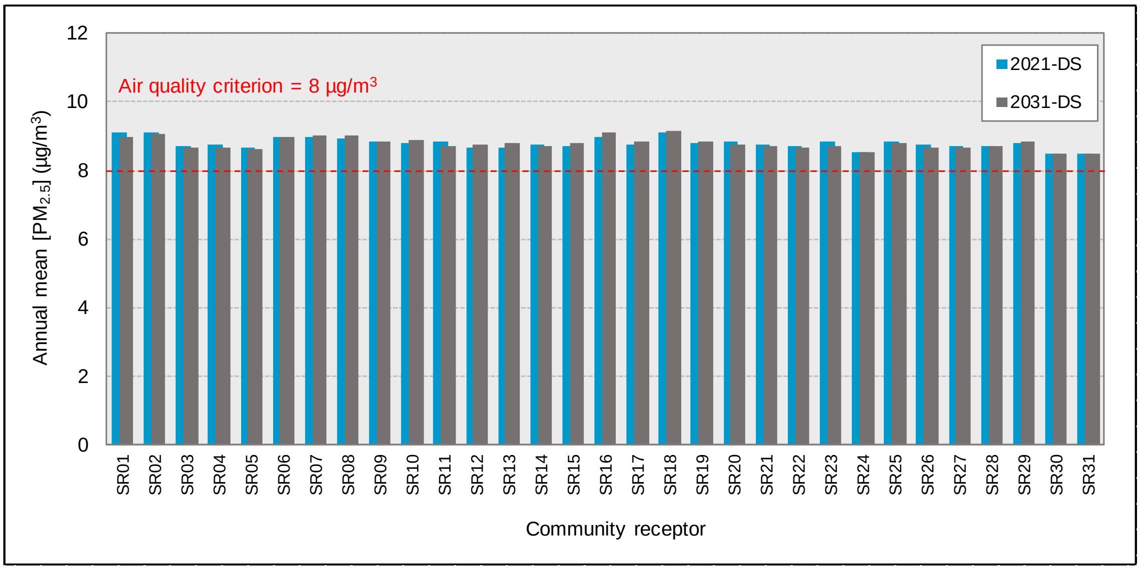

Figure 9.49 Annual mean $PM_{2.5}$ at community receptors (2021-DS and 2031-DS)

Figure 9.54 shows that concentrations were again dominated by the background. The surface road contribution was between 0.5 µg/m^3 and 1.1 µg/m^3. The largest contribution from tunnel ventilation outlets was just 0.03 µg/m^3.

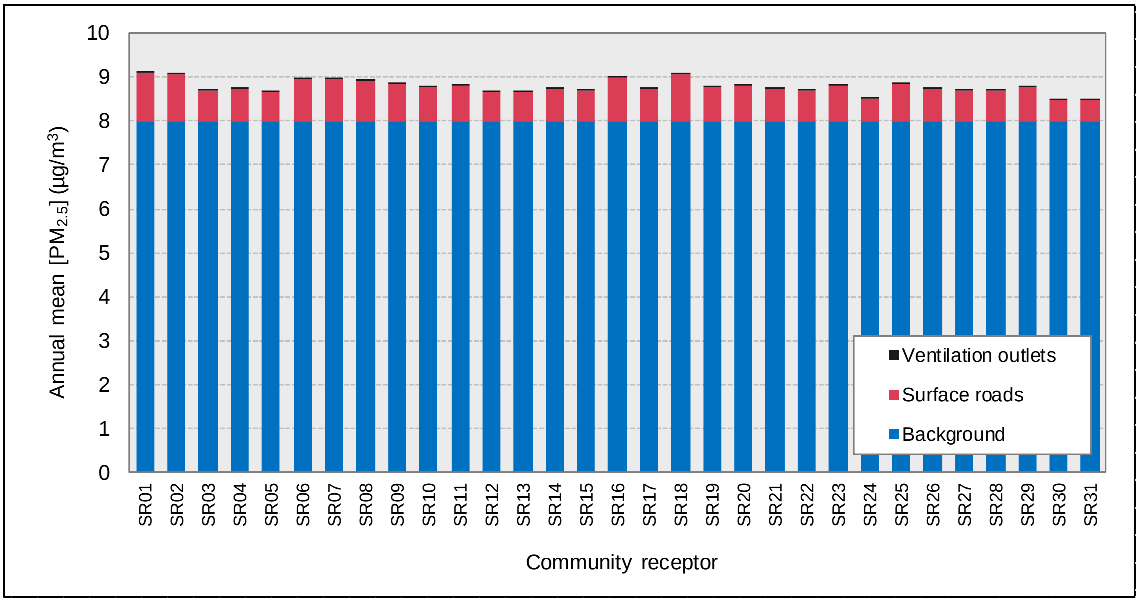

Figure 9.50 Source contributions to annual mean $PM_{2.5}$ at community receptors (2021-DS)

Figure 9.55 shows the changes in concentration in the Do Something scenarios relative to the Do Minimum scenarios for the community receptors. Some notable reductions in $PM_{2.5}$ concentrations were predicted at some receptors (up to around 0.9 µg/m^3). Small increases in concentration with the project were predicted for some receptors.

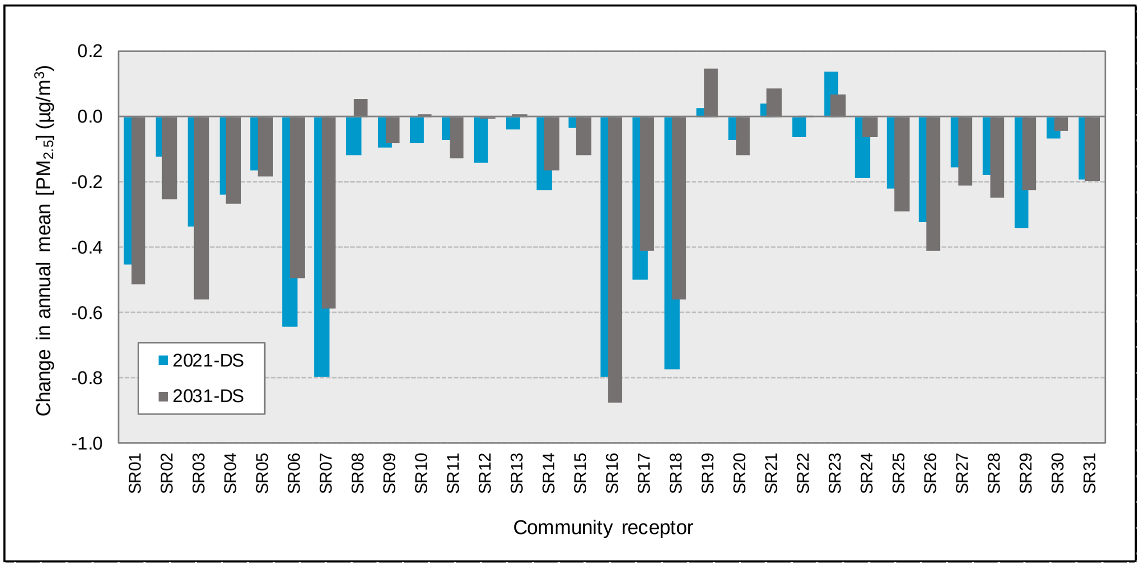

Figure 9.51 Change in annual mean $PM_{2.5}$ at community receptors (2021-DS and 2031-DS)

Results for RWR receptors

The ranked annual mean $PM_{2.5}$ concentrations at the RWR receptors in the 2021-DS scenario are shown in **Figure 9.56**, including the contributions of surface roads and ventilation outlets. As the background concentration was taken to be the same as the NSW criterion of eight µg/m^3, the concentration at all receptors was above this value. The highest concentration at any receptor in this scenario was 10.8 µg/m^3, but as with other pollutants and metrics the highest values were only predicted for a small proportion of receptors. The surface road contribution was between 0.4 µg/m^3 and 2.8 µg/m^3. The largest contribution from tunnel ventilation outlets in 2021 was 0.04 µg/m^3 (0.05 µg/m^3 in 2031).

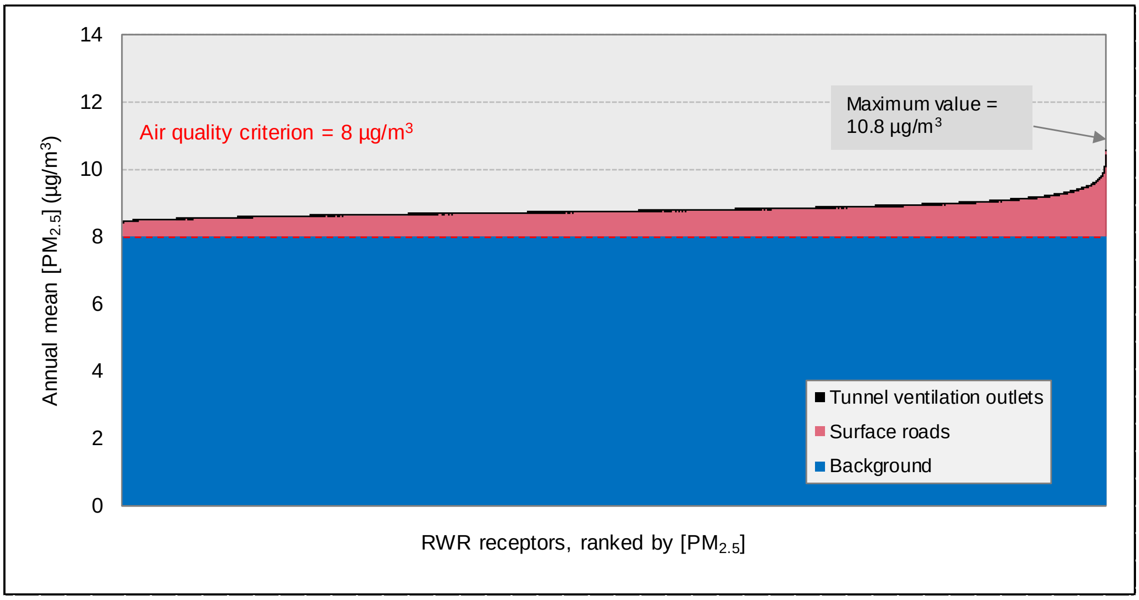

Figure 9.52 Source contributions to annual mean $PM_{2.5}$ at RWR receptors (2021-DS)

The change in the annual mean $PM_{2.5}$ concentration at the RWR receptors in the 2021-DS scenario are ranked in **Figure 9.57**. The pattern here was very similar to that for PM_{10}, with substantial reductions in concentration at a large number of locations. There was an increase in $PM_{2.5}$ at 15 per cent of the receptors, although the increase was greater than 0.2 µg/m^3 for only 0.4 per cent of receptors. The largest predicted increase in concentration at any receptor as a result of the project in 2021 was 0.5 µg/m^3, and the largest predicted decrease was 1.9 µg/m^3.

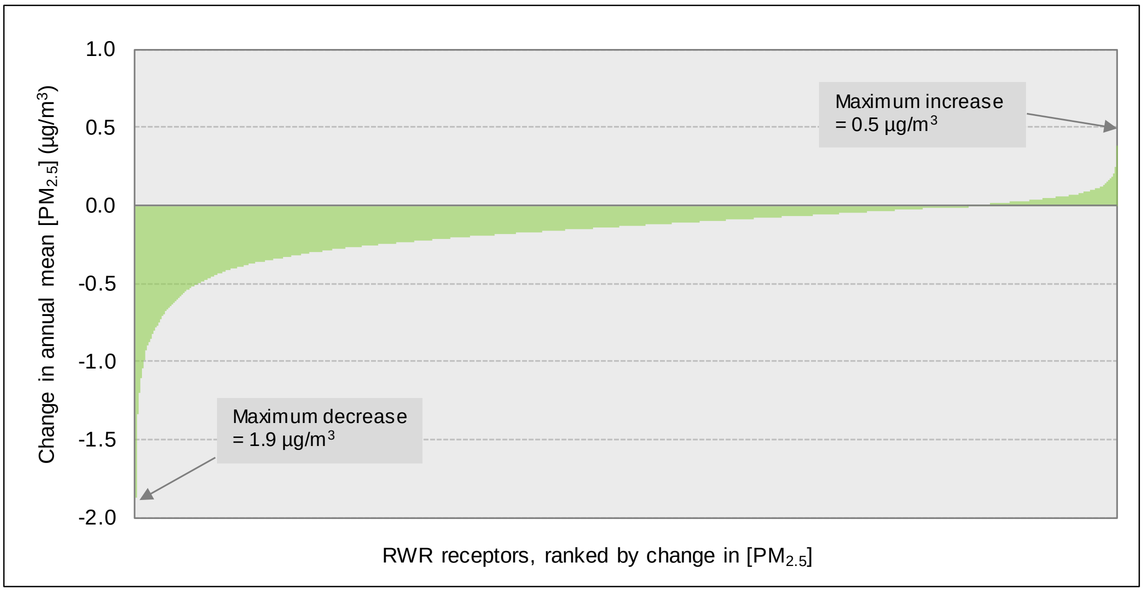

Figure 9.53 Changes in annual mean $PM_{2.5}$ at RWR receptors (2021-DS)

The equivalent plots for 2031 are presented in Appendix K of the air quality assessment in **Appendix H**.

9.7.8 Air toxics

Four air toxics – benzene, polycyclic aromatic hydrocarbons (PAHs) (as benzo(a)pyrene), formaldehyde and 1,3-butadiene – were considered in the assessment. These compounds were taken to be representative of the much wider range of air toxics associated with motor vehicles, and they have commonly been assessed for road projects.

The changes in the maximum one-hour benzene concentration at the community receptors as a result in the project in 2021 and 2031 are show in **Figure 9.54**, where they are compared with the NSW impact assessment criterion from the Approved Methods. These changes took into account emissions from both surface roads and tunnel ventilation outlets, although the contribution of the latter was, at most, around 25 per cent and generally less than 10 per cent. It can be seen from **Figure 9.54** that there was a decrease in the predicted benzene concentration at most of these receptors. Where there was an increase in the concentration, this was well below the assessment criterion. The changes in the maximum one-hour benzo(a)pyrene, formaldehyde and 1,3-butadiene concentration are presented in **Figure 9.55**, **Figure 9.56**,and **Figure 9.57** respectively. For each compound, where there was an increase in the concentration, this was well below the NSW impact assessment criterion. The largest increases for the community receptors were also representative of the largest increases for the RWR receptors.

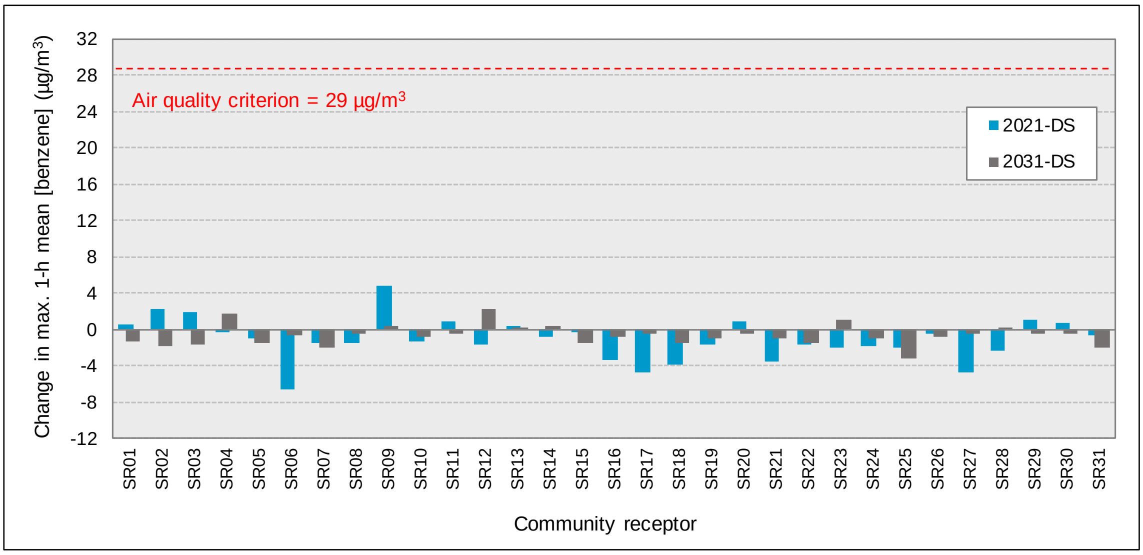

Figure 9.54 **Change in maximum one-hour mean benzene at community receptors with the project in 2021 and 2031 (2021-DS and 2031-DS)**

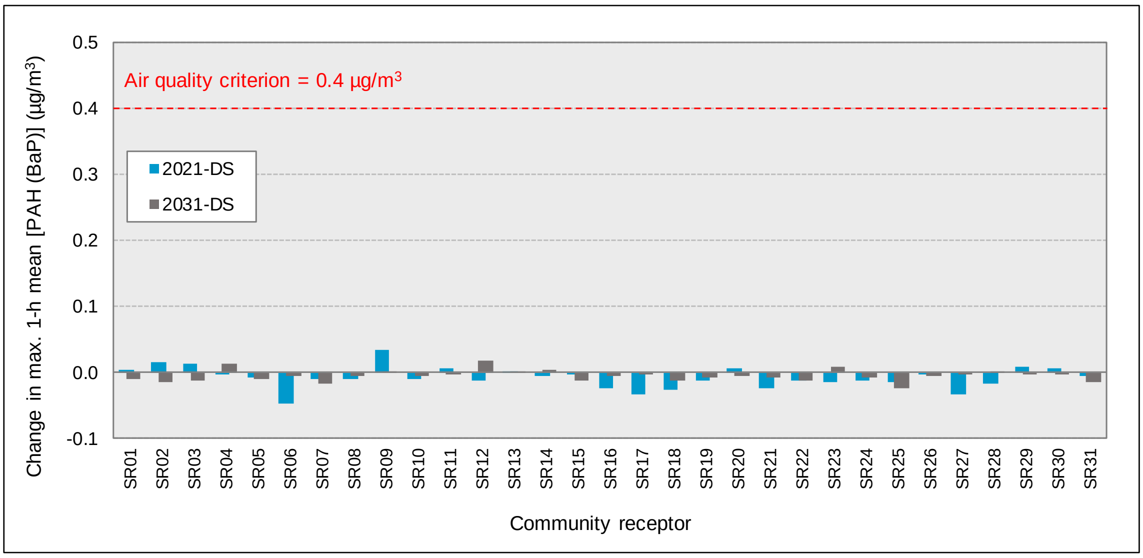

Figure 9.55 **Change in maximum one-hour mean benzo(a)pyrene at community receptors with the project (2021-DS and 2031-DS)**

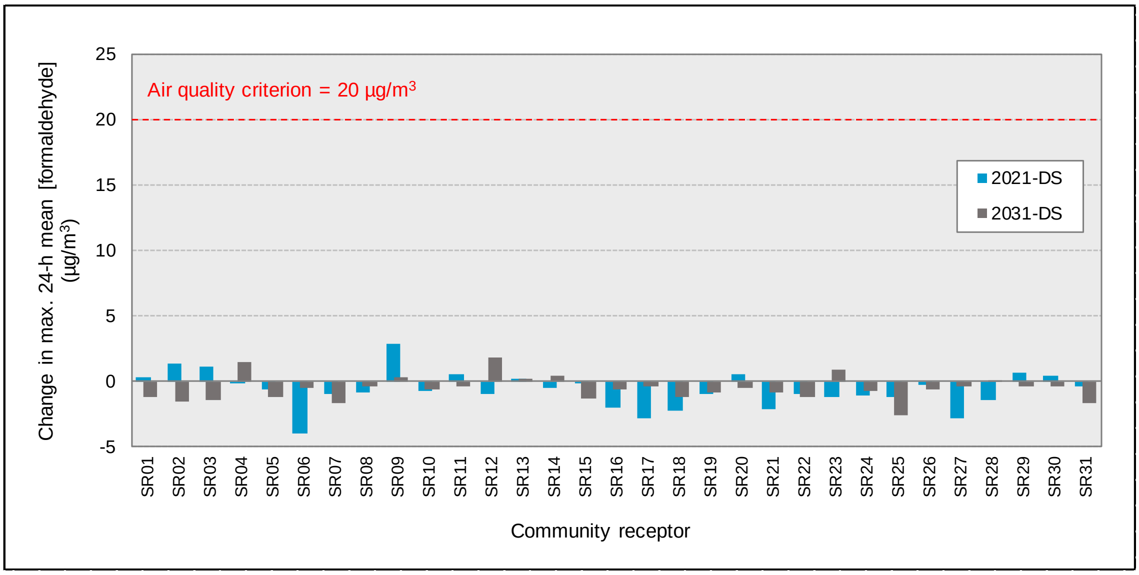

Figure 9.56 **Change in maximum one-hour mean formaldehyde at community receptors with the project in 2021 and 2031 (2021-DS and 2031-DS)**

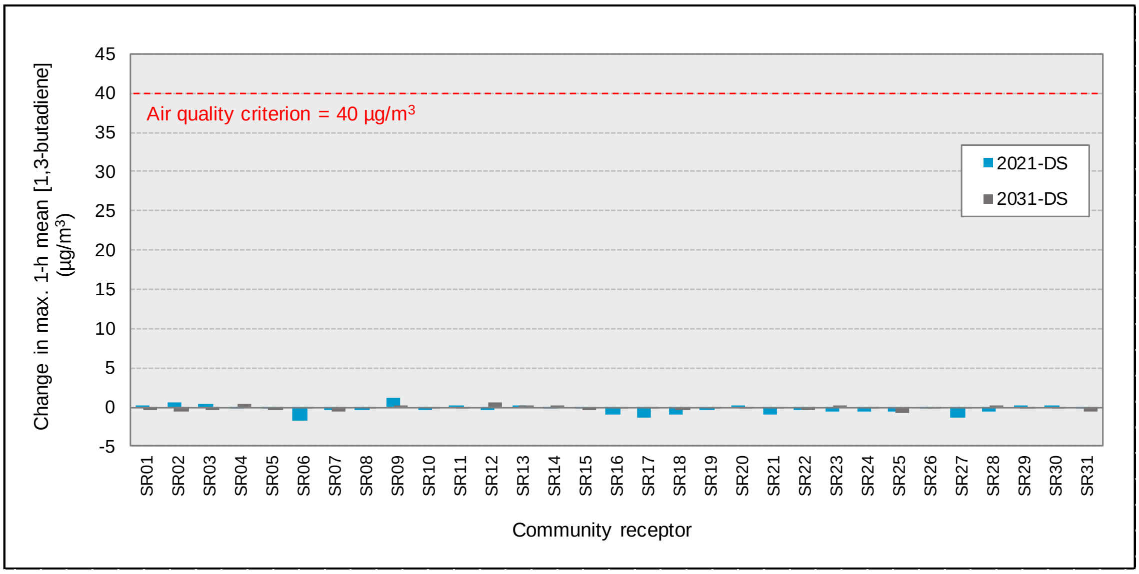

Figure 9.57 **Change in maximum one-hour mean 1,3-butadiene at community receptors (2021-DS and 2031-DS)**

9.8 Assessment of cumulative impacts

This assessment considers the potential cumulative impacts of the project with the possible future stages of WestConnex. All results are shown in Appendix J of the air quality assessment report in **Appendix H** and are illustrated in **Figure 9.58** to **Figure 9.66**.

9.8.1 Results for expected traffic scenarios

The results for the expected traffic scenarios and all pollutants are presented in Appendix K of the air quality assessment in **Appendix H**.

In the majority of cases the results for the community receptors in the 2031-DSC scenario were very similar to those in the 2031-DS scenario, and an example of this is provided (for annual mean NO_2) in **Figure 9.27**. The results are therefore not discussed further here. The one exception to this was 24-hour mean $PM_{2.5}$, for which an exceedance of the criterion was predicted at one receptor (SR07) in the 2031-DSC scenario (**Figure 9.62**).

As shown in **Figure 9.58**, there is minimal change in the maximum rolling eight-hour mean CO at community receptors when the M4–M5 Link is in operation.

Carbon monoxide (maximum rolling eight-hour mean)

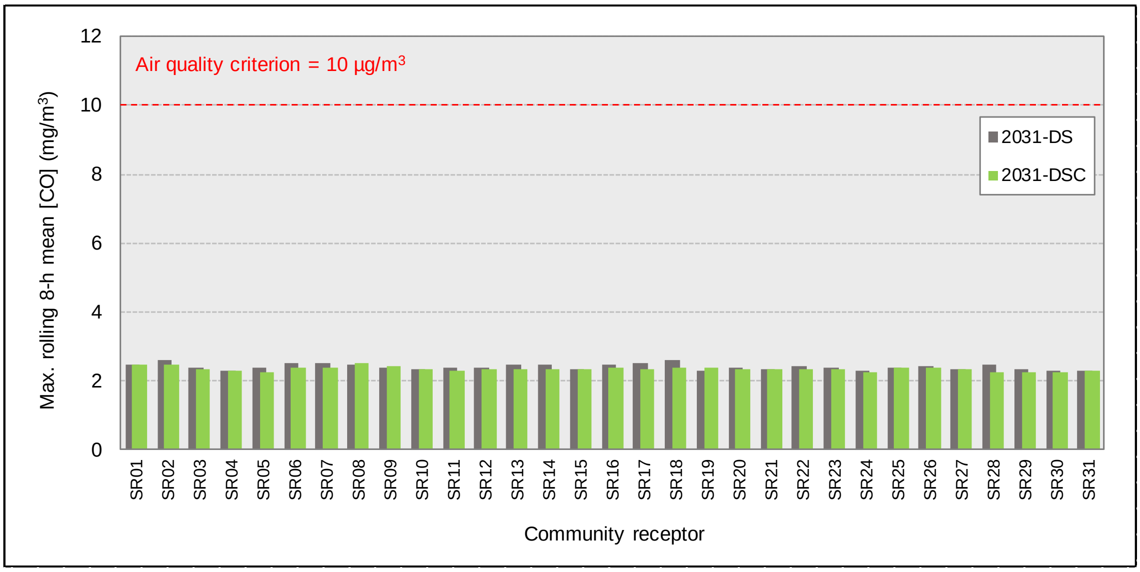

Figure 9.58 Maximum rolling eight-hour mean CO at community receptors (2021-DS and 2031-DSC)

Nitrogen dioxide (annual mean)

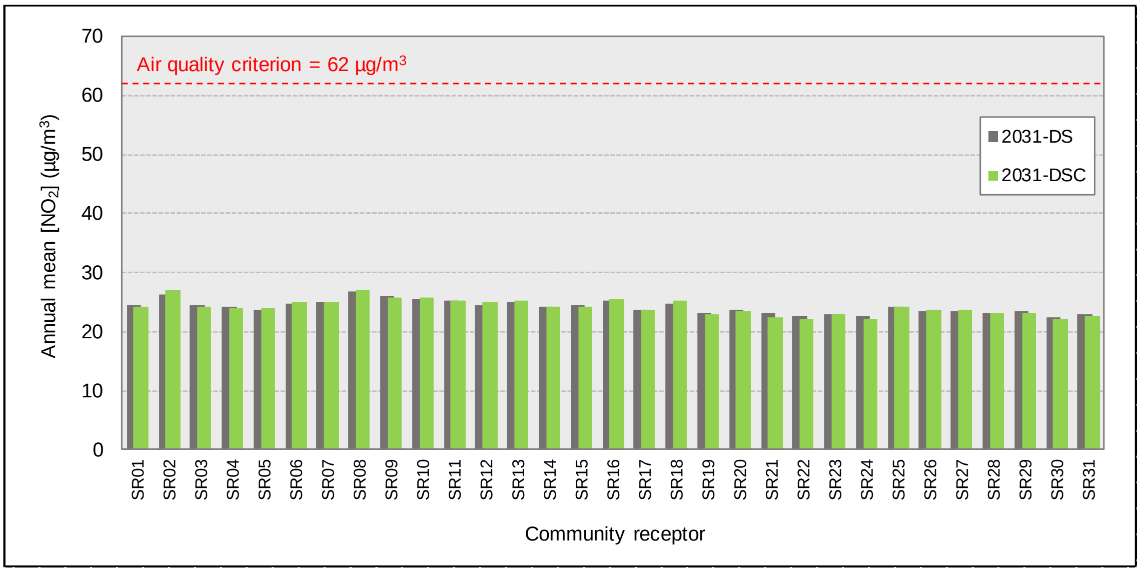

Figure 9.59 Annual mean NO_2 at community receptors with the project and the M4-M5 Link (2021-DS and 2031-DSC)

PM_{10} (annual mean)

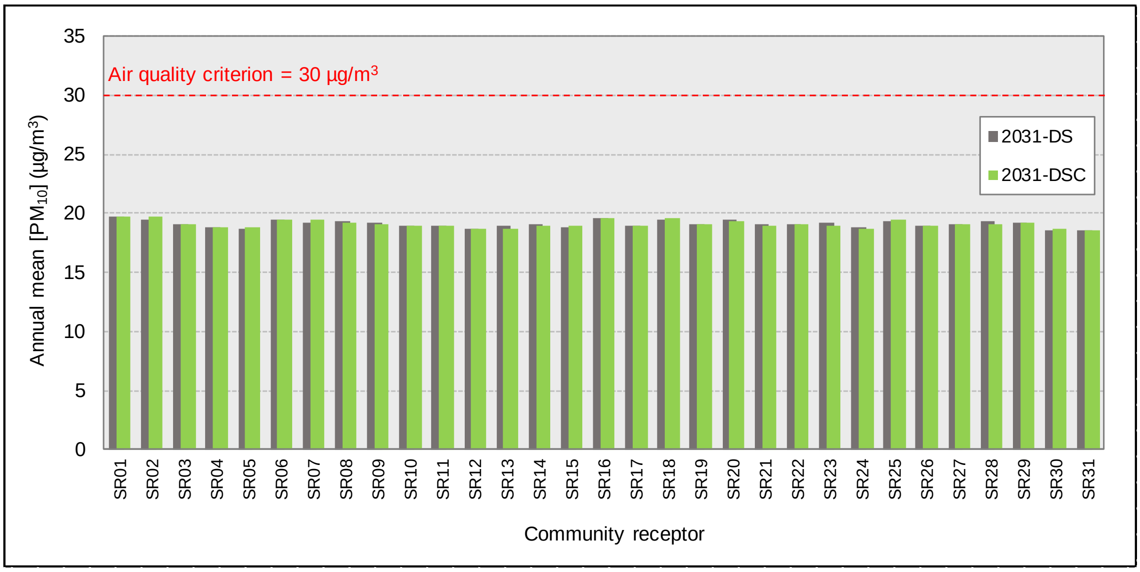

Figure 9.60 **Maximum 24-hour mean PM_{10} at community receptors with the project in 2021 and with the M4-M5 Link in 2031 (2021-DS and 2031-DSC)**

$PM_{2.5}$ (annual mean)

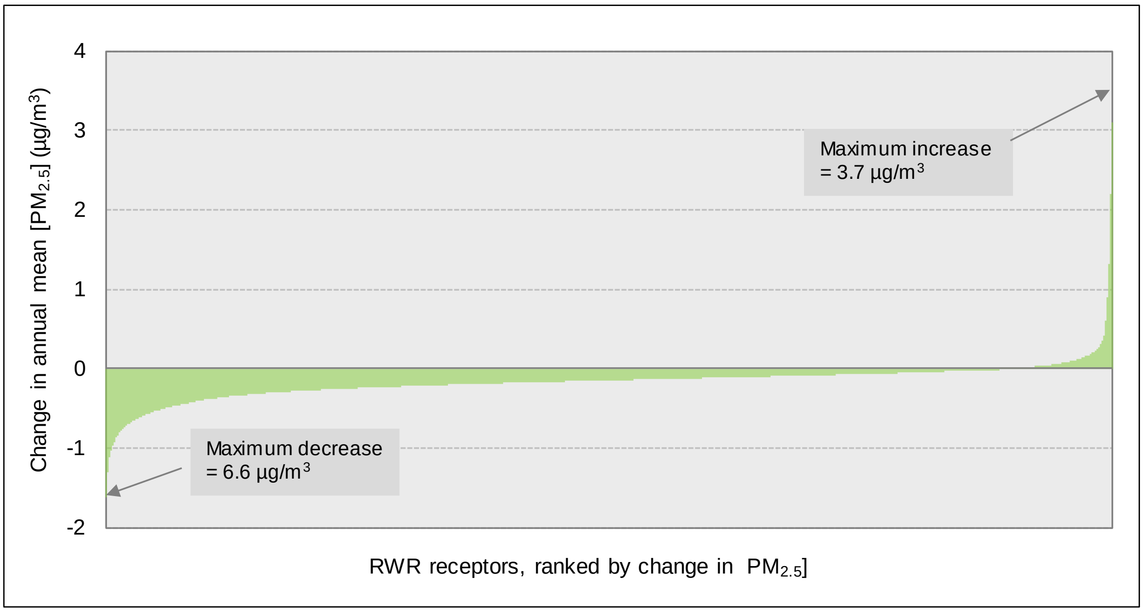

Figure 9.61 **Changes in annual mean $PM_{2.5}$ at RWR receptors with the project and the M4-M5 Link in 2031 (2031-DSC)**

$PM_{2.5}$ (maximum 24-hour mean)

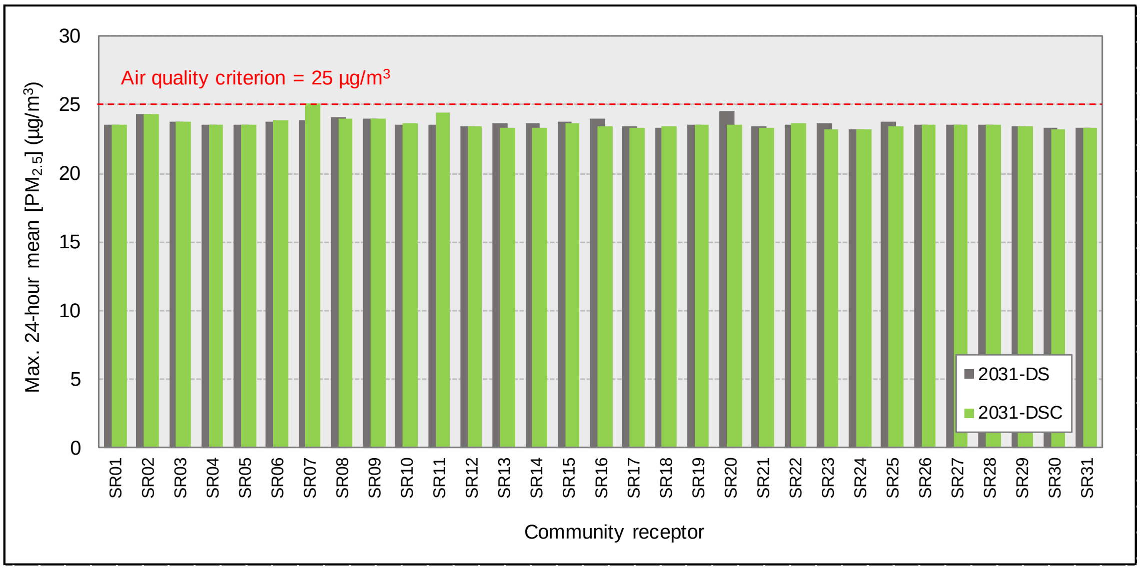

Figure 9.62 Maximum 24-hour mean $PM_{2.5}$ at community receptors with the project in 2021 and with the M4-M5 Link (2021-DS and 2031-DSC)

The results for the 2031-DSC scenario at the RWR receptors were also broadly similar to those for the 2031-DS scenario. However, there are predicted to be some increases in concentration for a very small number of receptors, as shown in Appendix K of the air quality assessment in **Appendix H**. These include, for example, an increase in annual mean $PM_{2.5}$ of 3.7 ug/m^3.

Air toxics

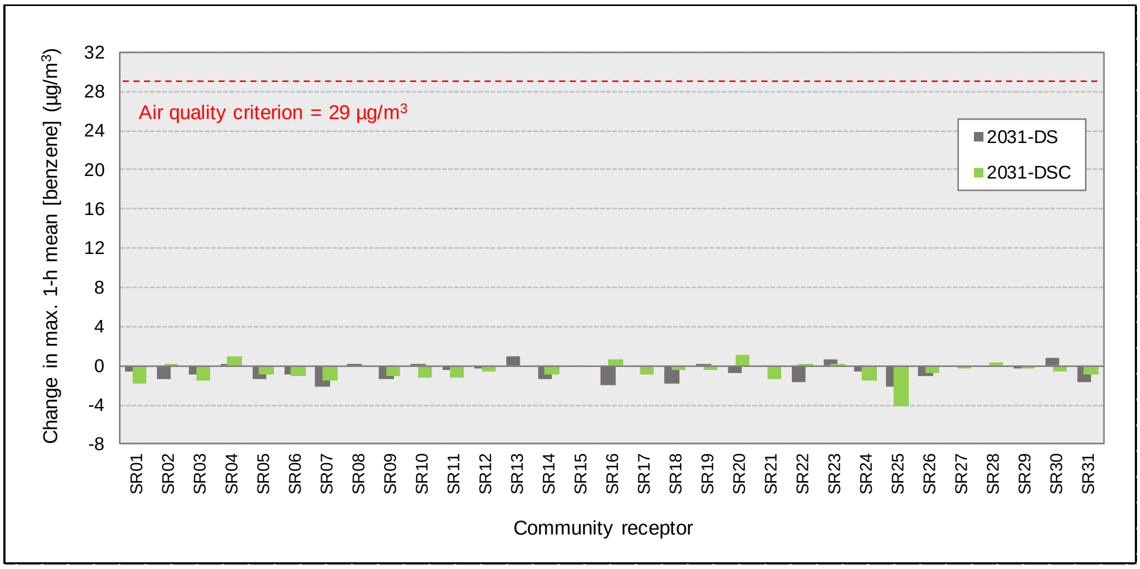

Figure 9.63 Change in maximum one hour mean benzene at community receptors with the project in 2021 and with the M4-M5 Link in 2031 (2021-DS and 2031-DSC)

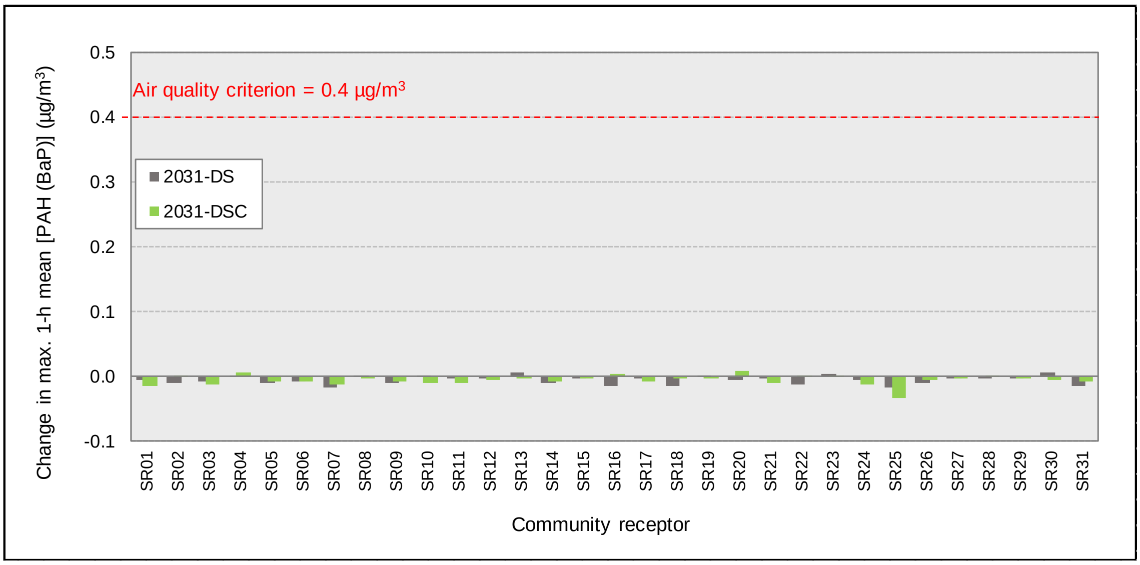

Figure 9.64 **Change in maximum one hour benzo(a)pyrene at community receptors with the project in 2021 and with the M4-M5 Link in 2031 (2021-DS and 2031-DSC)**

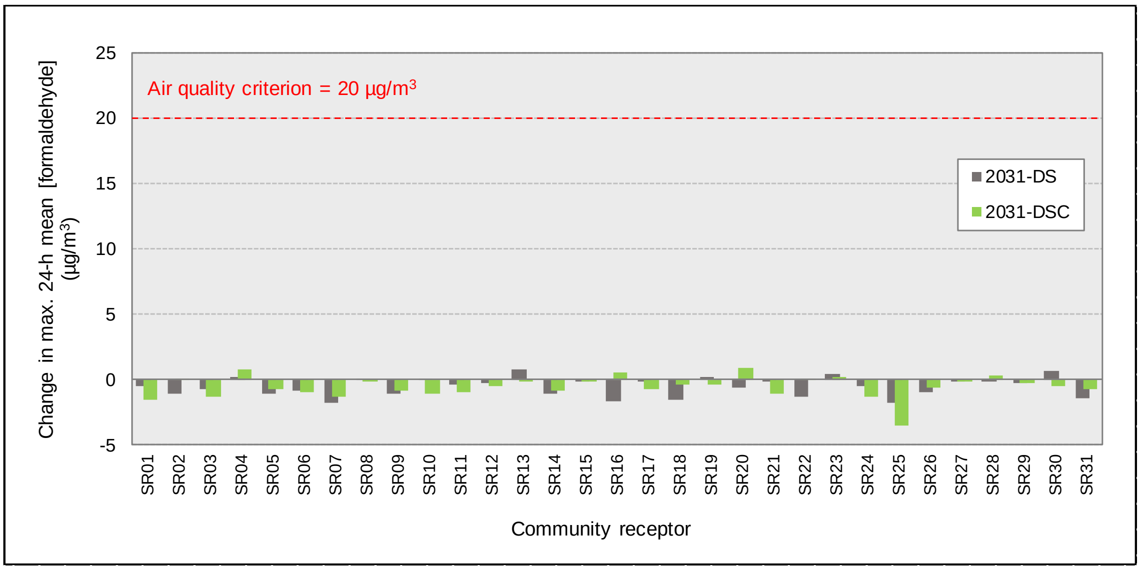

Figure 9.65 **Change in maximum 24 hours mean formaldehyde at community receptors with the project in 2021 and with the M4-M5 Link in 2031 (2021-DS and 2031-DSC)**

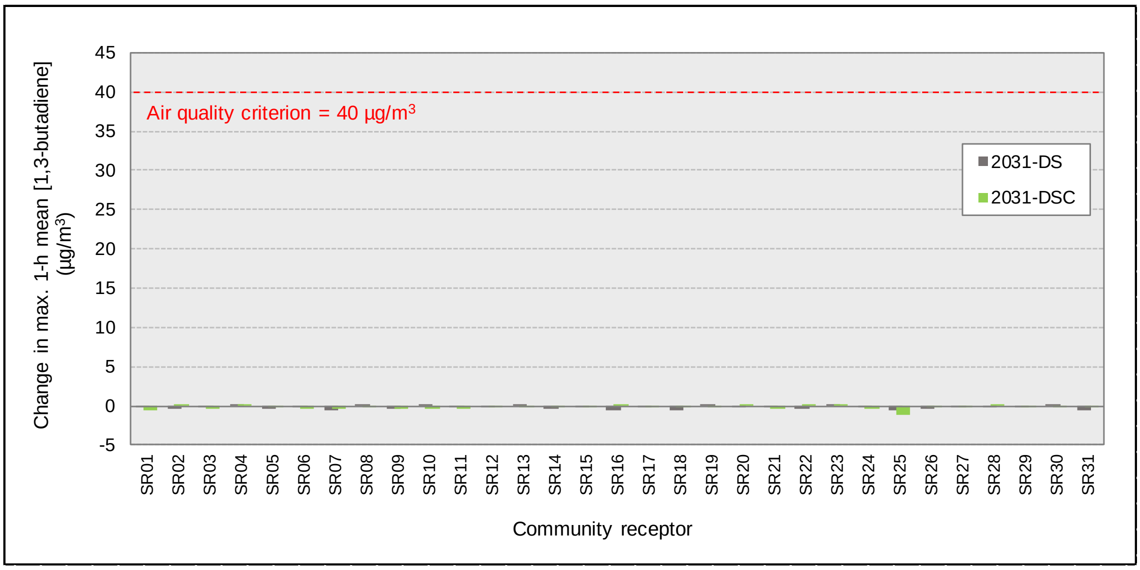

Figure 9.66 **Change in maximum one hour mean 1.3-butadiene at community receptors with the project in 2021 and with the M4-M5 Link in 2031 (2021-DS and 2031-DSC)**

9.9 Management of impacts

9.9.1 Construction impacts

Step 3 of the construction assessment involved determining mitigation measures for each of the four potential activities in Step 2. This was based on the risk of dust impacts identified in Step 2C. For each activity, the highest risk category was used. These measures are provided in **Table 9.21**. Most of the recommended measures are routinely employed as 'good practice' on construction ancillary facilities.

A Construction Air Quality Management Plan would be produced to cover all construction phases of the project. This Plan should contain details of the site-specific mitigation measures to be applied. Additional guidance on the control of dust at construction ancillary facilities in NSW is provided as part of the NSW EPA Local Government Air Quality Toolkit.

Table 9.21 **Environmental management measures – air quality**

Impact	No.	Environmental management measure	Responsibility	Timing
Construction				
General	AQ1	Develop and implement a Construction Air Quality Management Plan which requires consultation with NSW EPA. Any measures that are required will differ depending on the activities occurring, and so will need to be tailored for each individual site.	Construction contractor	Pre-construction
	AQ2	Carry out regular site inspections to monitor compliance with the Construction Air Quality Management Plan, record inspection results.	Construction contractor	Construction
	AQ3	Develop and implement a stakeholder communications plan that includes community engagement before work commences on site.	Construction contractor	Pre-construction

Impact	No.	Environmental management measure	Responsibility	Timing
	AQ4	Display the name and contact details of person(s) accountable for air quality and dust issues at the boundaries of each construction area. This may be the environment manager/engineer or the site manager. Display the head or regional office contact information	Construction contractor	Construction
Dust management	AQ5	Plan site layout so that machinery and dust causing activities are located away from receptors, as far as is possible.	Construction contractor	Construction
	AQ6	Erect solid screens or barriers around dusty activities or the site boundary that are at least as high as any stockpiles on site.	Construction contractor	Construction
	AQ7	Ensure where reasonable and feasible appropriate control methods are implemented to minimise dust emissions from the project site.	Construction contractor	Construction
	AQ8	Remove materials that have a potential to produce dust from site as soon as possible, unless being re-used on site. If they are being re-used on-site, cover as soon as practicable.	Construction contractor	Construction
	AQ9	Impose and signpost a maximum-speed-limit of 20 km/h on surfaced and unsurfaced haul roads and in work areas.	Construction contractor	Construction
	AQ10	Where practicable, only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, (e.g. suitable local exhaust ventilation systems).	Construction contractor	Construction
	AQ11	Ensure an adequate water supply on the site for effective dust/particulate matter suppression/mitigation, using non-potable water where possible and appropriate.	Construction contractor	Construction
	AQ12	Where possible, use enclosed chutes and conveyors and covered skips.	Construction contractor	Construction
	AQ13	Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate.	Construction contractor	Construction
	AQ14	Ensure equipment is readily available on site to clean any dry spillages, and clean up spillages as soon as reasonably practicable after the event using appropriate cleaning methods.	Construction contractor	Construction
	AQ15	Avoid scabbling (roughening of concrete surfaces) if possible.	Construction contractor	Construction

Impact	No.	Environmental management measure	Responsibility	Timing
Stockpile management	AQ16	Stockpiles would be located outside overland flowpaths, and where left exposed and undisturbed for longer than 28 days, would be finished and contoured to minimise loss of material in flood or rainfall events. Materials which require stockpiling for longer than 28 days would be stabilised by compaction, covering with anchored fabrics, or seeded with sterile grass where appropriate.	Construction contractor	Construction
	AQ17	Where a stockpile, eg sand or fine aggregate, has the potential to generate dust, control measures would be implemented. These would include wetting the stockpile, covering the stockpile or contouring the stockpile.	Construction contractor	Construction
	AQ18	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.	Construction contractor	Construction
	AQ19	For smaller supplies of fine powder materials ensure bags are sealed after use and stored appropriately to prevent dust.	Construction contractor	Construction
Tracking of material on roads	AQ20	Use water-assisted dust sweeper(s) on the access and local roads, to remove, as necessary, any material tracked out of the site.	Construction contractor	Construction
	AQ21	Avoid dry sweeping of large areas.	Construction contractor	Construction
	AQ22	Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport.	Construction contractor	Construction
	AQ23	Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable.	Construction contractor	Construction
	AQ24	Record all inspections of haul routes and any subsequent action in a site log book.	Construction contractor	Construction
	AQ25	Where reasonable and feasible, haul roads will be maintained with water carts and graders, and the condition of the roads will be monitored.	Construction contractor	Construction
	AQ26	Implement site exit controls (eg wheel washing system and rumble grids) to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable.	Construction contractor	Construction
	AQ27	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.	Construction contractor	Construction

Impact	No.	Environmental management measure	Responsibility	Timing
	AQ28	Access gates to be located at least 10 metres from receptors where possible.	Construction contractor	Construction
Emissions management	AQ29	Ensure all construction vehicles comply with their relevant emission standards.	Construction contractor	Construction
	AQ30	Ensure that, where practicable engines idling is minimised when stationary.	Construction contractor	Construction
	AQ31	Avoid the use of diesel or petrol powered generators and use mains electricity or battery powered equipment where practicable.	Construction contractor	Construction
	AQ32	Promote and encourage sustainable travel (public transport, cycling, walking, and car-sharing).	Construction contractor	Construction
	AQ33	No bonfires and burning of waste materials	Construction contractor	Construction
Demolition	AQ34	Soft strip inside buildings before demolition (retaining walls and windows in the rest of the building where possible, to provide a screen against dust).	Construction contractor	Construction
	AQ35	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 and may be more useful for covering larger areas.	Construction contractor	Construction
	AQ36	Minimise explosive blasting where possible during demolition, using appropriate manual or mechanical alternatives.	Construction contractor	Construction
	AQ37	Bag and remove any biological debris or other hazardous materials such as asbestos, damp down such material before demolition.	Construction contractor	Construction
Earthworks	AQ38	Re-vegetate earthworks and exposed areas/soil stockpiles to stabilise surfaces as soon as practicable.	Construction contractor	Construction
	AQ39	Use hessian, mulches or tackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable.	Construction contractor	Construction
	AQ40	Where possible, only remove any cover for exposed areas in small areas during work and not all at once.	Construction contractor	Construction

Impact	No.	Environmental management measure	Responsibility	Timing
Cumulative impacts	AQ41	Regular communication with other high risk construction ancillary facilities 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 network routes.	Construction contractor	Construction
	AQ42	Undertake regular on-site and off-site inspection, where receptors are nearby, to monitor dust, record inspection results	Construction contractor	Construction
Complaints management	AQ43	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.	Construction contractor	Construction
	AQ44	Make complaints available to the Secretary upon request.	Construction contractor	Construction
	AQ45	Record any exceptional incidents that cause dust and/or air emissions, either on- or offsite, and the action taken to resolve the situation in the log book.	Construction contractor	Construction

9.9.2 Operational impacts

The SEARs for the project require details of, and justification for, the air quality management measures that have been considered. This section of the report reviews the measures that are available for improving tunnel-related air quality, and then describes their potential application in the context of the project. The measures have been categorised as follows:

- Tunnel design
- Ventilation design and control
- Air treatment systems
- Emission controls and other measures
- Monitoring.

Tunnel design

It is important that the tunnel infrastructure is designed in such a way that the generation of pollutant emissions by the traffic using the tunnel is minimised. The main considerations include avoiding large gradients and congested traffic conditions, including the management of traffic on the roads leading in and out of the tunnel. In addition, the risk of incidents leading to congestion needs to be addressed, including accidents involving oversized vehicles.

Ventilation design and control

There are several reasons why a tunnel needs to be ventilated. The main reasons are:

- Control of the internal environment. It must be safe and comfortable to drive through the tunnel. Vehicle emissions must be sufficiently diluted so as not to be hazardous during normal operation, or when traffic is moving slowly

- Protection of the external environment. It is unacceptable for polluted air from tunnel portals or ventilation stacks to present a health or nuisance hazard to the community. Ventilation, and the dispersion of pollutants, is overwhelmingly the most effective and accepted method for minimising the impacts of tunnels on ambient air quality. Collecting emissions and venting them via ventilation stacks is a very efficient way of dispersing pollutants. Studies show that the process of removing surface traffic from heavily trafficked roads and dispersion of emissions from an elevated location results in substantially lower concentrations at sensitive receptors (PIARC 2008)
- Ventilation stacks need to be designed and sited accordingly, and discharge velocities from stacks must be assessed such that the required to assist dispersion of pollutants is achieved
- Emergency situations. When a fire occurs in a tunnel it is a requirement to be able to control the heat and other combustion products in the tunnel, to permit safe evacuation of occupants, and to provide the emergency services with a safe access route to deal with the fire and to rescue anyone trapped or injured.

A two-fold approach to ventilation design is generally adopted:

- The amount of fresh air required to dilute pollutants to acceptable levels is calculated based on the likely emissions from vehicles in the tunnel, and the ventilation system is designed accordingly. The choice and design of a suitable ventilation system depends on:
  - Tunnel length and geometry
  - Traffic flow and composition
  - Fresh air requirement under normal and specific traffic conditions
  - Admissible air pollution levels around tunnel portals
  - Fire safety considerations.
- Sensors are installed in the tunnel to initiate the operation of the ventilation system in order to maintain the level of pollutants below limit values, or to force the closure of the tunnel should certain limit values be exceeded.

Short tunnels can be adequately and safely ventilated by the piston effect. The external wind may also generate a flow of air within a tunnel due to the static air pressure difference between the portals.

There are three basic concepts for mechanical tunnel ventilation and these are described and illustrated in **section 4.5.1** in **Chapter 4** (Project development and alternatives)

- Longitudinal ventilation, whereby air is introduced to, or removed from, the tunnel at a limited number of points
- Transverse ventilation, whereby air may be introduced into a tunnel at regular points along its length, and extracted at corresponding points along its length
- Semi-transverse ventilation. Semi-transverse ventilation involves a combination of longitudinal and transverse ventilation. For example, fresh air can be delivered uniformly (and transversely) over the length of the tunnel, and exhaust air is removed longitudinally through the tunnel portals.

Jet fans may also be mounted within the tunnel space, usually at fixed intervals along the tunnel and near to the tunnel ceiling. Ventilation control is achieved by adjusting the number of fans in operation at any one time, with each unit being operated at full power or not running. A further refinement is available in installations where fan speed is controllable. The required level of ventilation at any particular time tends is determined in response to NO_x, CO and visibility levels.

The predicted criteria in-tunnel pollutant levels for this tunnel support the use of a longitudinal ventilation system for the project as the air quality criteria can be achieved under all traffic conditions within the tunnel.

Air treatment systems

There are several air treatment options for mitigating the effects of tunnel operation on both in-tunnel and ambient air quality. Where in-tunnel treatment technologies have been applied to road tunnels, these technologies have focused on the management and treatment of particulate matter. The most common of these is the electrostatic precipitator (ESP), often used for improving visibility in long tunnels. Other techniques include filtering, denitrification and biofiltration, agglomeration and scrubbing.

In Australia, the issue of air treatment frequently arises during the development of new tunnel projects. All tunnel projects rely instead on the primary approach of dilution of air pollution in the tunnel and effective dispersion though elevated outlets through ventilation systems (Cente d'Etudes des Tunnels (CETU) 2010, Roads and Maritime Services 2014d). Further details of air treatment systems and their use internationally are presented in **Appendix H**.

This air quality assessment demonstrates that ventilation outlets are effective at maintaining local air quality. Provision of a tunnel filtration system does not represent a feasible and reasonable mitigation measure, and is not being proposed.

- Of the systems that have been installed, the majority have subsequently been switched off or are currently being operated infrequently
- Air treatment systems have very high capital and operational costs
- A significant increase in the size of tunnel facilities is required to accommodate the equipment
- M4 East in-tunnel air pollutant levels, which are comparable to best practice and accepted elsewhere in Australia and throughout the world, would be achieved without filtration
- Emissions from the ventilation stacks of the M4 East tunnel would have a negligible impact on existing ambient pollutant concentrations.

In Australia a trial of an ESP trial in the Sydney M5 East westbound tunnel commenced in March 2010 and lasted 18 months. Roads and Maritime (formerly the Roads and Traffic Authority) undertook a six-month monitoring and analysis program of the ESP to review the system's performance.

In a review of the trial, AMOG (2012) concluded the following:

- The PM removal efficiency (for the air passing through the ESP) was around 65 per cent, compared with a target efficiency of 80 per cent. There was a corresponding improvement in in-tunnel visibility. After mixing the filtered air with the tunnel air, the net improvement was reduced to 29 per cent. This was reduced to a much lower overall improvement in visibility at the western end of the tunnel of six per cent, which may not have been perceptible to tunnel users
- The ESP was unable to effectively or, given the cost of the system, cost-effectively, remove PM
- Around 200 m^3/s of air was drawn through the ESP. It is possible that the ESP was operating at or beyond its air flow velocity limit. The efficiency of the ESP could be improved by significantly reducing the throughput of air or increasing the path length of the system. Both of these options would add to the capital cost of the system, and the space required
- A major concern was the unreliability of the ESP system, which meant that it could only be used for 84 per cent of the duration of the study
- The operation of the ESP should cease.

Mitigation of potential impacts by design

Tunnel design

- Minimal gradients. The main alignment tunnels will have a maximum uphill gradient of four per cent, which would result in lower emissions than steeper gradients
- Large tunnel cross-sectional area (around 90 square metres) to permit greater volume of air movement through the tunnel, resulting in greater dilution of vehicle emissions

Ventilation design and control

- Ventilation system designed and operated to achieve some of most stringent standards in the world for in-tunnel air quality, and to be effective at maintaining ambient air quality
- Design of the ventilation system would ensure no portal emissions

- Ventilation would be automatically controlled using real-time traffic data and feedback from air quality sensors in the tunnel, to ensure in-tunnel conditions are managed effectively in accordance with the agreed criteria
- Specific ventilation modes and procedures would be developed to manage breakdown, congested and emergency situations.
- Sampling points with safe access would be installed at the ventilation outlets during construction. The sampling points would be designed and located in accordance with the Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales (EPA 2007, or as updated), or an equivalent methodology approved by the Secretary in consultation with the EPA.

9.9.3 Monitoring of external air quality

Ambient air quality would be monitored continuously for at least twelve months prior to project opening.

Ambient air quality monitoring stations would be established at the following locations as a minimum:

- Two ground level receptors near the western ventilation outlet, at locations suitable for detecting any impact on air quality from the outlet
- Two ground level receptors near the eastern ventilation outlet/s, at locations suitable for detecting any impact on air quality from the outlet/s
- One location along Parramatta Road, at a location suitable for detecting any impact on air quality along Parramatta Road
- One location away from any of the locations at (a), (b) and (c) suitable for providing background ambient air quality reference data for the project area.

The establishment and operation of the stations would be undertaken in accordance with recognised Australian standards and undertaken by an organisation accredited by NATA for this purpose and approved by the Secretary in consultation with the EPA and the AQCCC. The quality of the monitoring results shall be assured through a NATA accredited process prior to the data being considered as a basis for compliance/auditing purposes.

The monitoring stations would operate for a minimum of two years after project opening and the monitoring results would be made publicly available and would be subject to an independent audit.

10 Noise and vibration

This chapter outlines the potential noise and vibration impacts associated with the M4 East project (the project). A detailed noise and vibration assessment has been undertaken for the project and is included in **Appendix I**.

The Secretary of the NSW Department of Planning and Environment has issued a set of environmental assessment requirements for the project; these are referred to as Secretary's Environmental Assessment Requirements (SEARs). **Table 10.1** sets out these requirements as they relate to noise and vibration, and identifies where they have been addressed in this environmental impact statement (EIS).

Table 10.1 Secretary's Environmental Assessment Requirements – noise and vibration

Secretary's Environmental Assessment Requirement	Where addressed in the EIS
An assessment of the noise impacts of the project during operation, consistent with the Road Noise Policy (EPA 2011) and NSW Industrial Noise Policy (EPA 2000). The assessment must include specific consideration of impacts to receivers (dwellings, child care centres, educational establishments, hospitals, motels, nursing homes, or places of worship), including specific consideration of sleep disturbance and, as relevant, the characteristics of noise (eg. low frequency noise), and identify reasonable and feasible mitigation measures	**Section 10.5** (this chapter)
An assessment of construction noise and vibration impacts, consistent with the Interim Construction Noise Guideline (DECCW 2009) and Assessing Vibration: a technical guideline (DEC 2006). The assessment must have regard to the nature of construction activities (including transport, tonal or impulsive noise-generating works and the removal of operational noise barriers, as relevant), the intensity and duration of noise and vibration impacts, the nature, sensitivity and impact to potentially affected receivers, the need to balance timely conclusion of noise and vibration-generating works with periods of receiver respite, and other factors that may influence the timing and duration of construction activities (such as traffic management), and mitigation and management measures.	**Section 10.4**
The assessment should present, as relevant, an indication of potential for works outside standard working hours, including predicted levels and exceedances, justification for the activity and discussion of available mitigation and management measures.	**Section 6.7.2** in **Chapter 6** (Construction work) for justification and discussion of out of hours work

10.1 Assessment methodology

The assessment methodology for noise and vibration impacts has generally involved:

- Identification of the study area
- Identification and classification of sensitive receivers
- Background noise monitoring
- Calibration of noise models using background data
- Modelling of construction and operational noise

- Assessment of noise models against relevant noise criteria for construction works, construction and operational traffic and operational infrastructure
- Identification of feasible and reasonable mitigation and management measures.

The *Interim Construction Noise Guideline* (Department of Environment and Climate Change (DECC) 2009) (ICNG) defines ‘feasible’ and ‘reasonable’ as:

- Feasible: A work practice or abatement measure is feasible if it is capable of being put into practice or of being engineered and is practical to build given project constraints such as safety and maintenance requirements
- Reasonable: Selecting reasonable measures from those that are feasible involves making a judgment to determine whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the measure.

10.1.1 Study area

The study area for the noise and vibration assessment has been established to include:

- For construction noise and vibration:
  - Noise sensitive receivers located close to construction activities and ancillary facilities
- For operational noise:
  - An area encompassing the project and a 600 metre buffer for the operational assessment
  - Noise sensitive receivers located close to above ground operational ancillary facilities.

10.1.2 Noise sensitive receivers

Noise sensitive receivers within the study area have been identified using a combination of aerial photography and desktop analysis.

Based on this assessment, the following buildings were identified within the study area:

- 6,484 residential buildings (including aged care facilities/nursing homes)
- 478 commercial/industrial buildings
- 88 educational facility buildings (ie individual school buildings)
- 11 child care centre buildings
- 16 building used for medical purposes
- 16 buildings forming part of places of worship
- 19 open space areas, including 14 active open space areas and five passive open space areas
- Eight hotels (including motels)
- Seven buildings containing cafes and bars.

The locations of these sensitive receivers are shown on **Figure 10.1**. The above numbers only include the number of buildings and do not include the number of floors (i.e. receivers).

For the purpose of the assessment, it was not feasible to confirm the number of dwellings within each property and therefore the assessment counts each floor of a multi-storey property as an individual ‘receiver’.

The study area has been divided into multiple noise catchment areas (NCAs) for the purposes of the assessment. A total of 21 NCAs have been identified along the project. These NCAs reflect changes in land use and ambient noise environments. The extent of each NCA is shown on **Figure 10.1**.