26 Cumulative impacts

26.1 Introduction

This chapter provides an overview of the potential cumulative impacts associated with the construction and operation of the M4-M5 Link project. A detailed cumulative impact assessment methodology is presented in **Appendix C** (Cumulative impact assessment methodology). The methodology outlines the screening criteria applied in determining whether projects should be assessed for cumulative impacts, a list of projects considered but not included in the assessment, and a more detailed description of the projects that have been included.

Further information on the assessment of cumulative impacts can be found in the relevant technical assessments provided in **Appendix H** to **Appendix X**.

Cumulative impacts have been assessed and considered in two categories; impacts related to the overall WestConnex program of works and impacts from other related infrastructure projects or projects in the vicinity of the project. The identification of other developments that could occur in the vicinity of the project included relevant projects listed on the NSW Department of Planning and Environment's Major Projects website as State significant development or State significant infrastructure and known or proposed projects of a relevant scale or impact that involve activities that could result in a cumulative impact with the M4-M5 Link project.

26.2 Projects assessed

Following the application of the screening criteria to identified projects, the projects included in **Table 26-1** have been considered in the assessment of cumulative impacts for the project. The location of these projects is shown in **Figure 26-1**.

The list of projects identified can be broadly categorised as:

- **The WestConnex program of works**: this category includes the approved WestConnex projects of M4 Widening and King Georges Road Interchange Upgrade (completed construction and open to traffic) and the M4 East and New M5 (currently under construction)
- **Related NSW Roads and Maritime Services projects**: this category includes other related NSW Roads and Maritime Services (Roads and Maritime) projects that may interact with, be constructed, or operate within the vicinity of the project, such as the proposed future Sydney Gateway, Western Harbour Tunnel and Beaches Link and F6 Extension projects. As these projects are in the early planning stages, only limited information is available to inform a cumulative impact assessment. As such, a cumulative impact assessment has only been undertaken for key issues such as traffic, noise and vibration, air quality and human health risk
- **Other transport infrastructure projects**: This category includes public transport infrastructure such as light rail and metro such as the Sydney Metro City and Southwest and CBD and South East Light Rail (CSELR)
- **Other projects or strategic developments:** This category primarily includes urban development, other infrastructure and active transport projects. A number of the urban development projects are strategic in nature (ie are conceptual or in the early stages of planning), with limited detail available on specific impacts or timing of the various components.

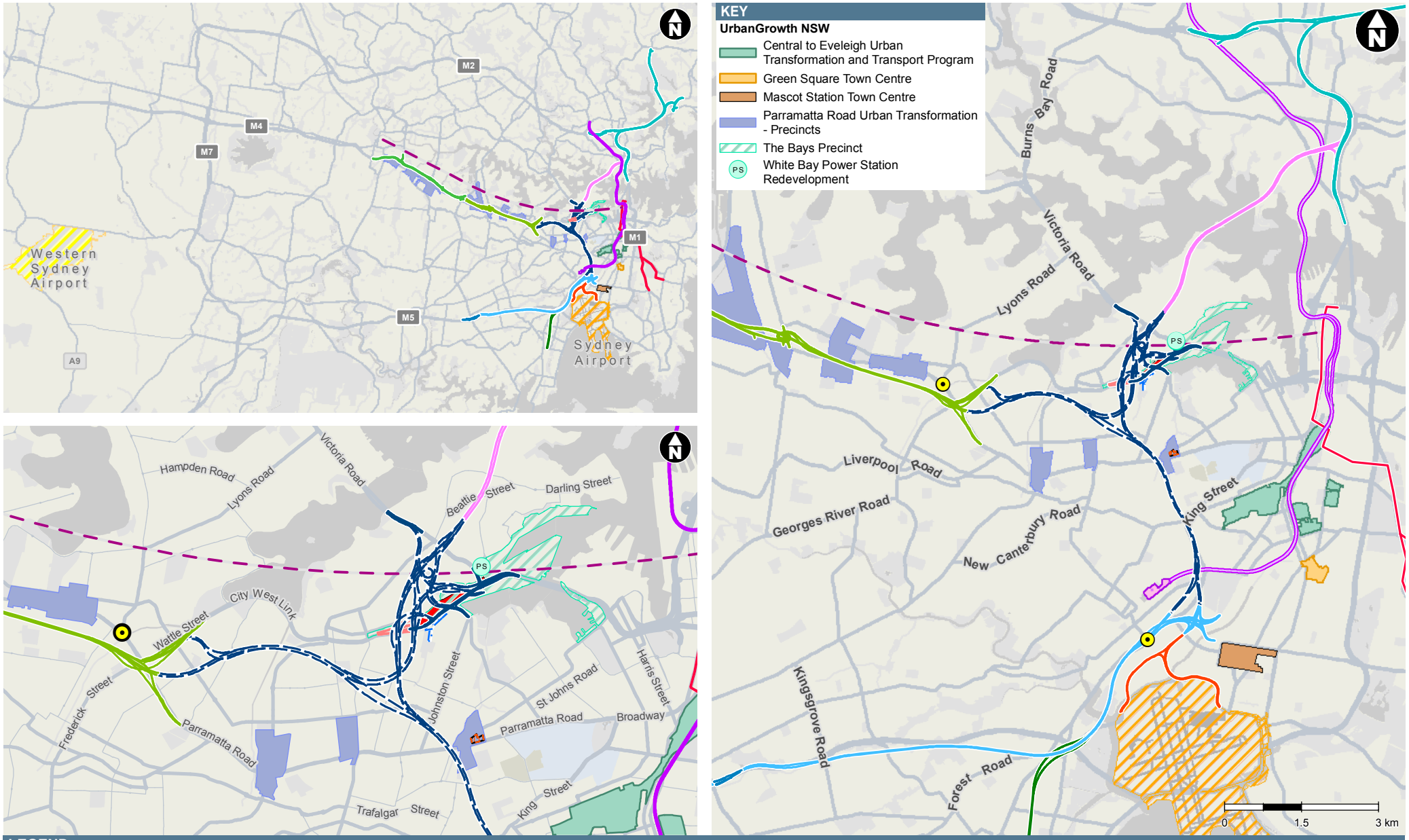
As described in **Appendix C** (Cumulative impact assessment methodology), a number of strategic projects (such as Western Sydney Airport) or land use/urban developments are already captured in the operational traffic modelling informing the cumulative operational assessments for traffic, air quality and noise and vibration and are therefore not discussed in detail in this chapter.

Table 26-1 Projects assessed in the cumulative impact assessment

Project name	Brief project description	Status
WestConnex program of works		
M4 Widening	Widening of the existing M4 Motorway from Parramatta to Homebush.	Planning approval under the *Environmental Planning and Assessment Act 1979* (EP&A Act) granted on 21 December 2014. Open to traffic.
M4 East	Extension of the M4 Motorway in tunnels between Homebush and Haberfield via Concord. Includes provision for a future connection to the M4-M5 Link at the Wattle Street interchange.	Planning approval under the EP&A Act granted on 11 February 2016. Under construction.
King Georges Road Interchange Upgrade	Upgrade of the King Georges Road interchange between the M5 West and the M5 East at Beverly Hills, in preparation for the New M5 project.	Planning approval under the EP&A Act granted on 3 March 2015. Open to traffic.
New M5	Duplication of the M5 East from King Georges Road in Beverly Hills with tunnels from Kingsgrove to a new interchange at St Peters. The St Peters interchange allows for connections to the proposed future Sydney Gateway project and an underground connection to the M4-M5 Link. The New M5 tunnels also include provision for a future connection to the proposed future F6 Extension.	Planning approval under the EP&A Act granted on 20 April 2016. Commonwealth approval under the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) granted on 11 July 2016. Under construction.
Other related projects		
Sydney Gateway	A high-capacity connection between the St Peters interchange (under construction as part of the New M5 project) and the Sydney Airport and Port Botany precinct.	Planning underway by Roads and Maritime and subject to separate environmental assessment and approval. For the purposes of this cumulative impact assessment, the Sydney Gateway project is conservatively assumed to be operational by 2023.
Western Harbour Tunnel and Beaches Link	Western Harbour Tunnel: Tunnels connecting to the M4-M5 Link at the Rozelle interchange, crossing underneath Sydney Harbour between the Birchgrove and Waverton areas, and connection with the Warringah Freeway at North Sydney. Beaches Link: Tunnels connecting to the Warringah Freeway, crossing underneath Middle Harbour and connecting with the Burnt Bridge Creek Deviation at Balgowlah and Wakehurst Parkway at Seaforth. It would also involve the duplication of the Wakehurst Parkway between Seaforth and Frenchs Forest.	Planning underway by Roads and Maritime and subject to separate environmental assessment and approval. For the purposes of this cumulative impact assessment, the Western Harbour Tunnel component is conservatively assumed to be operational by 2023, but construction may continue after the expected opening year of the M4-M5 Link project. For the purposes of this cumulative

Project name	Brief project description	Status
		impact assessment, the Beaches Link component is conservatively assumed to be operational by 2033.
F6 Extension	A proposed future motorway link between the New M5 at Arncliffe and the existing M1 Princes Highway at Loftus, generally along the alignment known as the F6 corridor.	Planning underway by Roads and Maritime and subject to separate environmental assessment and approval. For the purposes of this cumulative impact assessment, the F6 Extension is conservatively assumed to be operational by 2033.
Rozelle Rail Yards Site Management Works	Removal of existing rail and rail related infrastructure from the Rozelle Rail Yards, including vegetation, buildings and waste.	Works have commenced and are expected to take up to 12 months to complete.
Sydney Metro City and Southwest	The project comprises two stages: • Stage 1: Chatswood to Sydenham • Stage 2: Sydenham to Bankstown. The main project feature relevant to the cumulative impact assessment is the southern dive structure (about 400 metres in length) and tunnel portal north of Sydenham Station and south of Bedwin Road at Marrickville (called the Marrickville dive site) for Stage 1.	Stage 1 was approved in January 2017.
CBD and South East Light Rail – Rozelle Maintenance Depot	The CBD and South East Light Rail (CSELR) project includes a light rail vehicle stabling facility in Randwick and a maintenance depot at Rozelle, at the western end of the Rozelle Rail Yards site. When complete, the depot would be used by light rail drivers as well as maintenance facility operators to repair and service light rail vehicles.	Preparatory work for the depot, adjacent to Lilyfield Road and Catherine Street, began in April 2016. The depot is under construction. Works are expected to finish by early 2018.
Parramatta Road Corridor Urban Transformation Strategy (UrbanGrowth NSW 2016) (The strategy)	The corridor spans around 20 kilometres from Granville to Camperdown and includes eight identified urban renewal precincts including the Taverners Hill, Leichhardt and Camperdown precincts. The strategy identifies the 'Camperdown Triangle' at the intersection of Parramatta Road, Pyrmont Bridge Road and Mallett Street as a potential biomedical hub. The strategy identifies a public transport 'super stop' at the intersection of Pyrmont Bridge Road and Parramatta Road.	Future strategic government project.

Project name	Brief project description	Status
The Bays Precinct Urban Transformation Plan (UrbanGrowth NSW 2015) (Bays Precinct Transformation Plan)	The Bays Precinct, located about two kilometres west of the Sydney CBD, encompasses the areas around Blackwattle Bay, Rozelle Bay and White Bay and comprises eight 'destinations', including the Rozelle Rail Yards, White Bay Power Station, White Bay, and Rozelle Bay and Bays Waterways. The plan outlines a vision to transform these destinations over the short to medium term.	Future strategic government project. Preliminary investigation and consultation is underway for the development of the White Bay Power Station site.
Whites Creek naturalisation	Sydney Water is investigating the naturalisation of about 420 metres of Whites Creek about 200 metres west of its outlet at Rozelle Bay in Annandale. The purpose is to devise a restoration plan with a focus on developing naturalising solutions where possible.	Concept design ready (December 2016). The design and construction timelines for these works are not known.



LEGEND

WestConnex
- King Georges Road Interchange Upgrade
- M4 East
- M4 Widening
- New M5
- M4-M5 Link tunnel
- M4-M5 Link surface roads
- Pyrmont Bridge Road tunnel site boundary
- Rozelle Rail Yards Site Management Works

Sydney Metro
- Sydney Metro City and Southwest
- Sydney Metro West
- Sydney Metro Marrickville dive site

Transport for NSW
- CBD and South East Light Rail (CSELR)
- (CSELR) Rozelle maintenance depot

RMS
- Proposed future Beaches Link
- Proposed future F6 Extension
- Proposed future Western Harbour Tunnel
- Proposed future Sydney Gateway
- RMS Pinch Points Program - Easing Sydney's Congestion

Other projects
- Sydney Airport Master Plan 2033
- Western Sydney Airport
- Whites Creek naturalisation

Figure 26-1 Projects included in the cumulative impact assessment

26.3 Nature of cumulative impacts

The assessment of potential cumulative impacts of the project has considered major developments that are proposed, have been approved (but not yet constructed), and/or would be constructed or operated at the same time as the planning, construction or operation of the M4-M5 Link project. Cumulative impacts are considered important to assess because in isolation, a particular impact from one project may be considered minor, but when the impact of multiple projects are considered, the impacts may be more substantial.

Impacts can be either adverse or beneficial. Where an adverse impact is considered likely, mitigation and/or management measures would be implemented to avoid or reduce those impacts. This chapter assumes that the specific mitigation and management measures outlined for the project in the various chapters of this environmental impact statement (EIS) have been applied and therefore focuses on the more strategic measures that may be implemented in coordination with other relevant projects. Project benefits, including the benefits of the overall WestConnex program of works, are discussed in **Chapter 3** (Strategic context and project need).

26.3.1 Construction phase cumulative impacts

Cumulative impacts arise through spatial proximity (ie how close one project might be to another) as well as temporal proximity (ie projects that occur in a similar timeframe or have overlapping schedules). This assessment defines these interactions as concurrent (simultaneous) or consecutive (back-to-back) project activities. Ancillary activities refer to works by utility and service providers to provide new or relocated utilities (such as electricity, telecommunications, water and sewage connections). These activities have been considered and assessed in the EIS (refer to **Appendix F** (Utilities Management Strategy) for further details). These works may also lead to local traffic disruptions, restrictions to access, noise and vibration impacts, potential dust generation and reduced visual amenity.

Indicative programs for construction of the various M4-M5 Link project components and construction ancillary facilities are outlined in **Chapter 6** (Construction work). These have been considered by the various technical specialists and incorporated into the technical working papers of this EIS, with the outcomes presented in the technical assessment chapters of the EIS (**Chapter 8** to **Chapter 27**). Final construction scheduling would be subject to the appointment of the successful construction contractor(s).

A consequence of concurrent or consecutive activities occurring over extended periods of time is the concept of construction fatigue. Construction fatigue can be experienced by receivers that are in the vicinity of concurrent or consecutive project construction activities where the activities overlap or have little or no break between the activities of one project, or multiple adjacent projects.

This cumulative impact assessment identifies three specific geographic areas where construction fatigue from concurrent or consecutive activities is likely to be experienced. These geographic areas are Haberfield/Ashfield, Rozelle and St Peters. **Figure 26-2**, **Figure 26-3** and **Figure 26-4** show these areas and the spatial and temporal overlap with other projects considered. The relevant projects with concurrent or consecutive construction timeframes is presented in **Table 26-2**.

Table 26-2 Projects that may result in construction fatigue with the M4-M5 Link project

Area	Project that may result in construction fatigue with the M4-M5 Link project
Parts of Haberfield/Ashfield	• M4 East
Parts of Rozelle	• Rozelle Rail Yards site management works • CBD and South East Light Rail – Rozelle maintenance depot • Proposed future Western Harbour Tunnel[1]
Parts of St Peters	• New M5 • Sydney Metro city and southwest (Chatswood to Sydenham)

Note: [1] A component of the proposed future Western Harbour Tunnel and Beaches Link project

Haberfield and Ashfield

Construction for the M4 East project is scheduled to continue until 2019. The M4 East construction sites at Haberfield/Ashfield include:

- The Northcote Street tunnel site (called the Northcote Street civil site (C3a) in this EIS)
- The Eastern ventilation facility site (called the Haberfield civil and tunnel site (C2a)/Haberfield civil site (C2b) in this EIS)
- The Wattle Street and Walker Avenue civil and tunnel site (called the Wattle Street civil and tunnel site (C1a) in this EIS)
- The Parramatta Road civil site (adjacent to the Parramatta Road West civil and tunnel site (C1b) in this EIS).

There would be overlap from the M4 East project at Haberfield with construction works associated with the M4-M5 Link project for a period of around six months if the Option B construction ancillary facility sites are used. During this overlap period the M4 East project works would be focussed on activities such as tunnel fitout, commissioning, surface road works, completion of structures such as the vent buildings and site rehabilitation/landscaping. The M4-M5 Link project would be focused on site establishment works such as building demolition, utility works and commencing work on the construction access tunnel.

The residential areas likely to be most impacted by construction fatigue include Wattle Street, Walker Avenue, Ramsay Street, Northcote Street, Wolseley Street, Alt Street, Bland Street and properties along Parramatta Road in the vicinity. Potential impacts include construction traffic, parking, construction noise and vibration, dust and visual impacts. There would be no overlap if the Option A construction ancillary facilities are utilised.

Rozelle

At Rozelle, the site management works at the Rozelle Rail Yards will occur over a period of 12 months and would be completed by mid-2018, prior to start of construction works for the M4–M5 Link project. The CSELR maintenance depot adjoins the proposed Rozelle civil and tunnel site (C5) to the west. Construction works for this project are progressing currently and are due for completion in early 2018, prior to the start of construction works for the M4–M5 Link project.

Details regarding construction of the Western Harbour Tunnel project are not available at this time as the project is in the early stages of design development. For the purposes of this assessment it has been assumed that there would be a construction site within the central portion of the Rozelle Rail Yards site and construction work would commence at the end of 2019 and continue through until approximately 2025. On this basis there may be a period of close to four years during which construction works for the two projects would overlap. The M4-M5 Link EIS has conservatively assumed that construction works for the two projects are occurring concurrently within the Rozelle Rail Yards and has assessed the potential impacts on this basis.

The residential areas likely to be most impacted by construction fatigue associated with these projects are the residential areas along and to the north of Lilyfield Road and users of Easton Park. To a lesser extent, the residential areas of Annandale and Lilyfield to the south of City West Link are also likely to be impacted. Potential impacts include construction traffic, construction noise and vibration, dust and visual impacts associated with building demolition, vegetation removal and construction activity at these sites.

St Peters

At St Peters, construction of the New M5 project is scheduled to continue until 2020. The most relevant New M5 construction sites in this area include:

- Campbell Road construction compound (a portion of which would be used by the M4-M5 Link project (called the Campbell Road civil and tunnel site (C10) in this EIS)
- Landfill closure construction compound

- Sydney Park construction compound
- Burrows Road construction compound.

During this overlap period the New M5 project works would be focussed on activities such as completing construction of the St Peters interchange, road upgrades, construction of the motorway operations complex, completing construction of the shared path and bridge over Campbell Road, demobilisation and landscaping. During this period, the M4-M5 Link project would be focused on initial road works, site establishment works, utility works and commencement of tunnelling works.

The residential areas likely to be most impacted by construction fatigue associated with the two projects include along Campbell Road, Campbell Street, Barwon Park Road and Crown Street in addition to users of Sydney Park. Potential impacts include construction traffic, construction noise and vibration, dust and visual impacts.

The Sydney Metro City and Southwest project Marrickville dive site is located around one kilometre to the northwest of Campbell Road civil and tunnel site. The Marrickville dive site will support two tunnel boring machines (TBMs) and construction of the southern services centre. Construction for the Sydney Metro City and Southwest project is proposed from 2018 to 2024 with main tunnelling works from the Marrickville dive site occurring between 2018 and 2020.

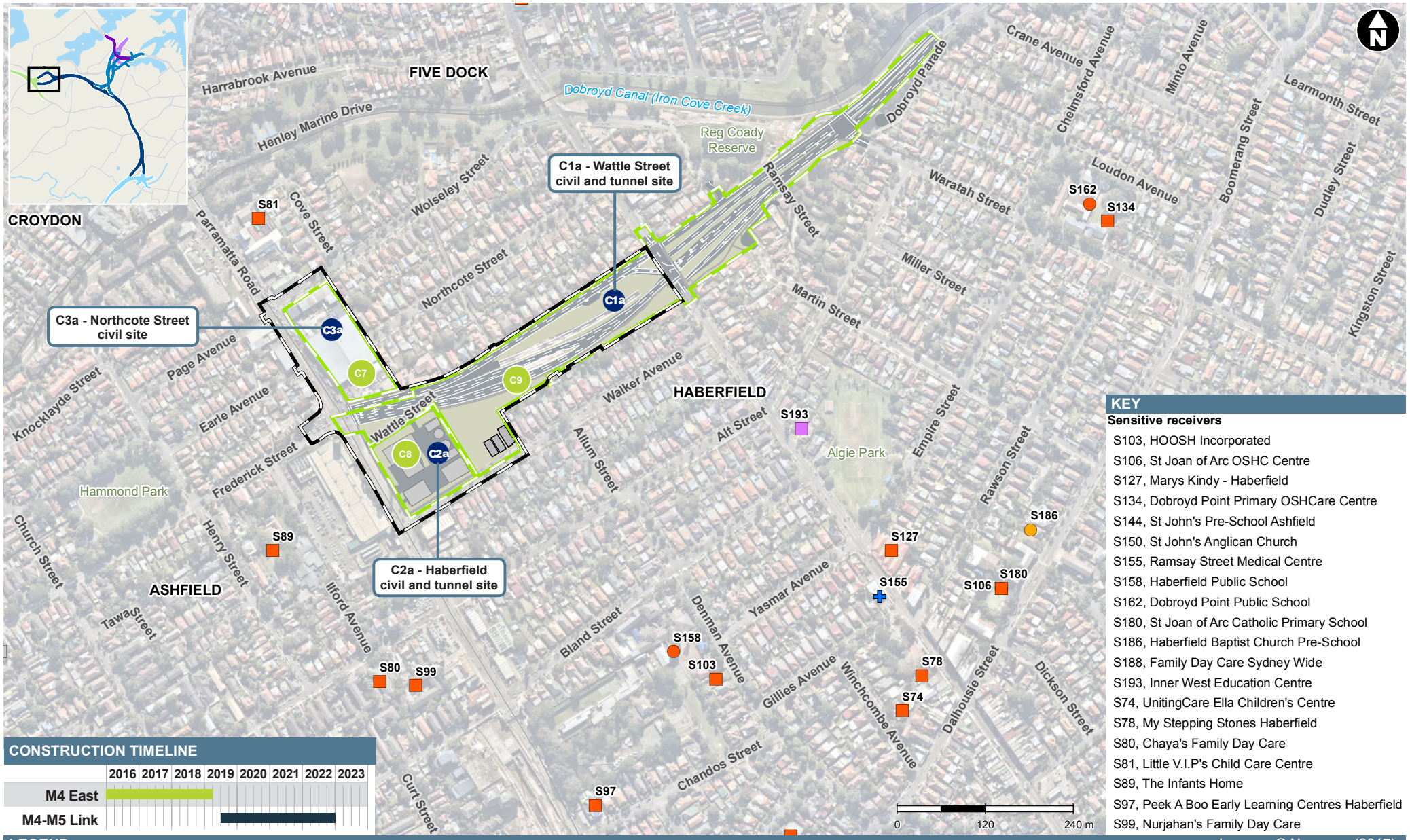
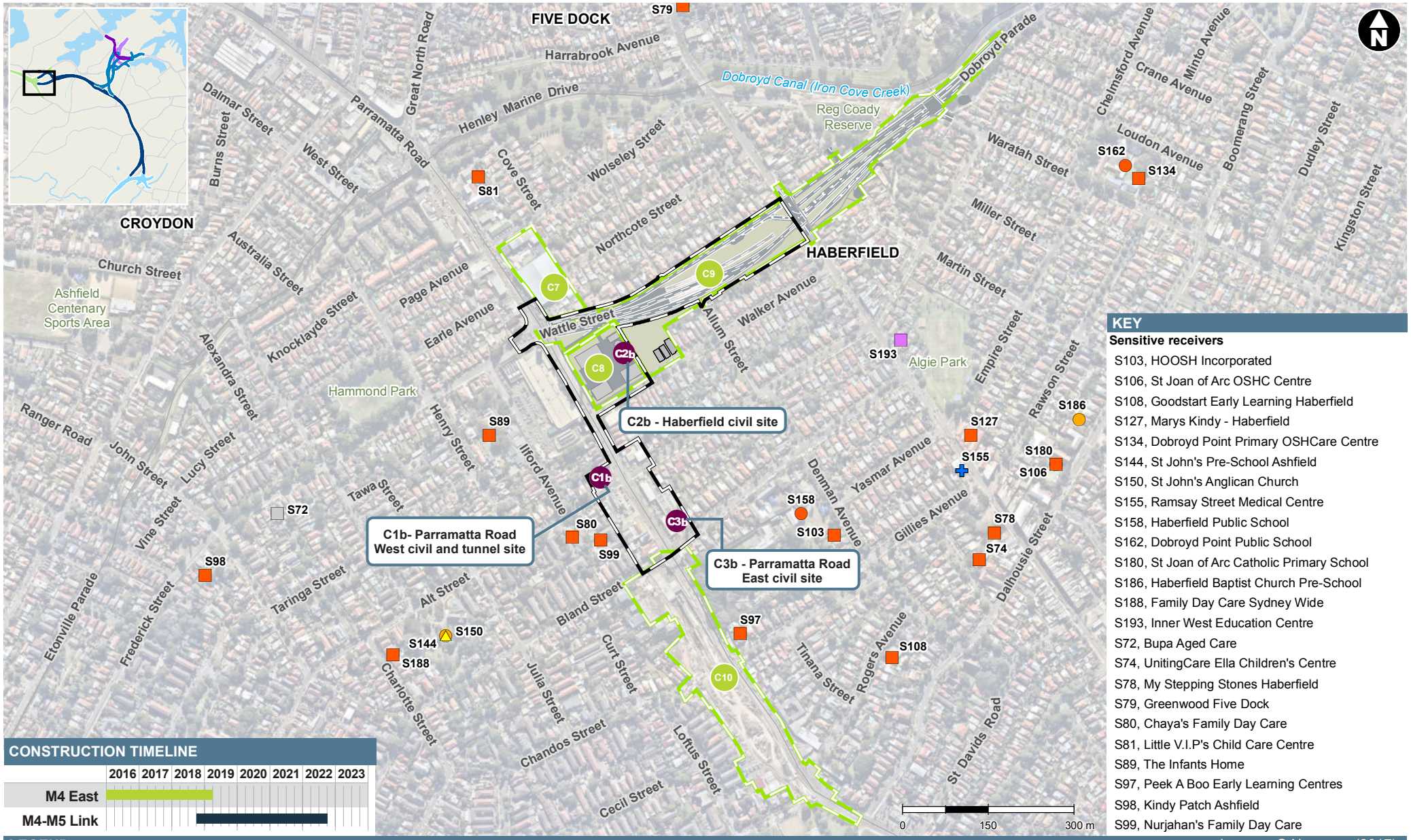


Figure 26-2 Cumulative construction impacts - Haberfield (Option A)



KEY

Sensitive receivers

- S103, HOOSH Incorporated
- S106, St Joan of Arc OSHC Centre
- S108, Goodstart Early Learning Haberfield
- S127, Marys Kindy - Haberfield
- S134, Dobroyd Point Primary OSHCare Centre
- S144, St John's Pre-School Ashfield
- S150, St John's Anglican Church
- S155, Ramsay Street Medical Centre
- S158, Haberfield Public School
- S162, Dobroyd Point Public School
- S180, St Joan of Arc Catholic Primary School
- S186, Haberfield Baptist Church Pre-School
- S188, Family Day Care Sydney Wide
- S193, Inner West Education Centre
- S72, Bupa Aged Care
- S74, UnitingCare Ella Children's Centre
- S78, My Stepping Stones Haberfield
- S79, Greenwood Five Dock
- S80, Chaya's Family Day Care
- S81, Little V.I.P's Child Care Centre
- S89, The Infants Home
- S97, Peek A Boo Early Learning Centres
- S98, Kindy Patch Ashfield
- S99, Nurjahan's Family Day Care

CONSTRUCTION TIMELINE

LEGEND

Existing features

- Light rail
- Light rail stop

WestConnex

- M4-M5 Link project footprint
- M4 East construction footprint

Sensitive receivers

- Aged Care
- Child Care
- Church
- Health
- Education
- Preschool
- School

M4 East

- C7 Northcote Street tunnel site
- C8 Eastern ventilation facility site
- C9 Wattle Street and Walker Avenue civil site
- C10 Parramatta Road civil site

Figure 26-3 Cumulative construction impacts - Haberfield (Option B)

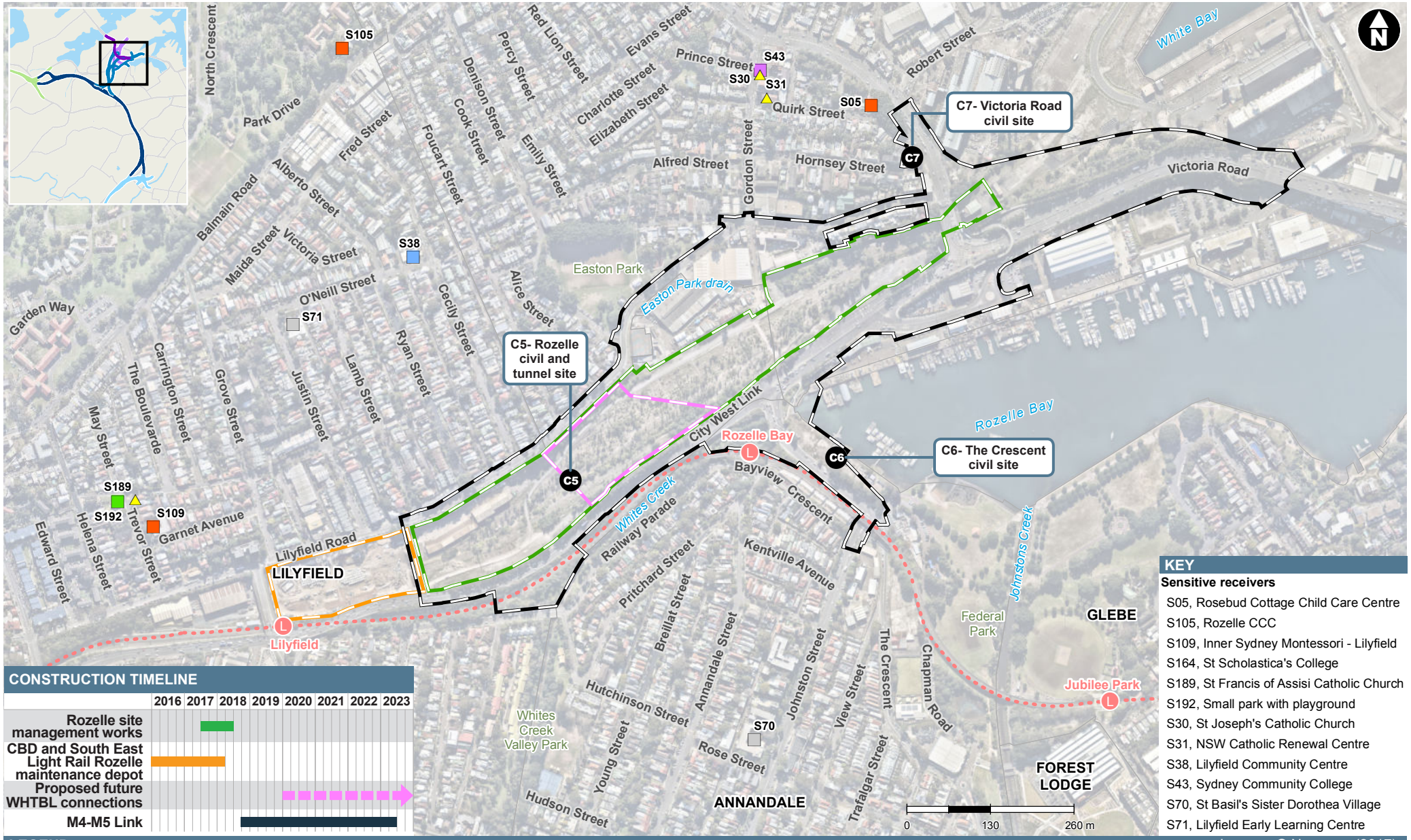


Figure 26-4 Cumulative construction impacts - Rozelle Rail Yards

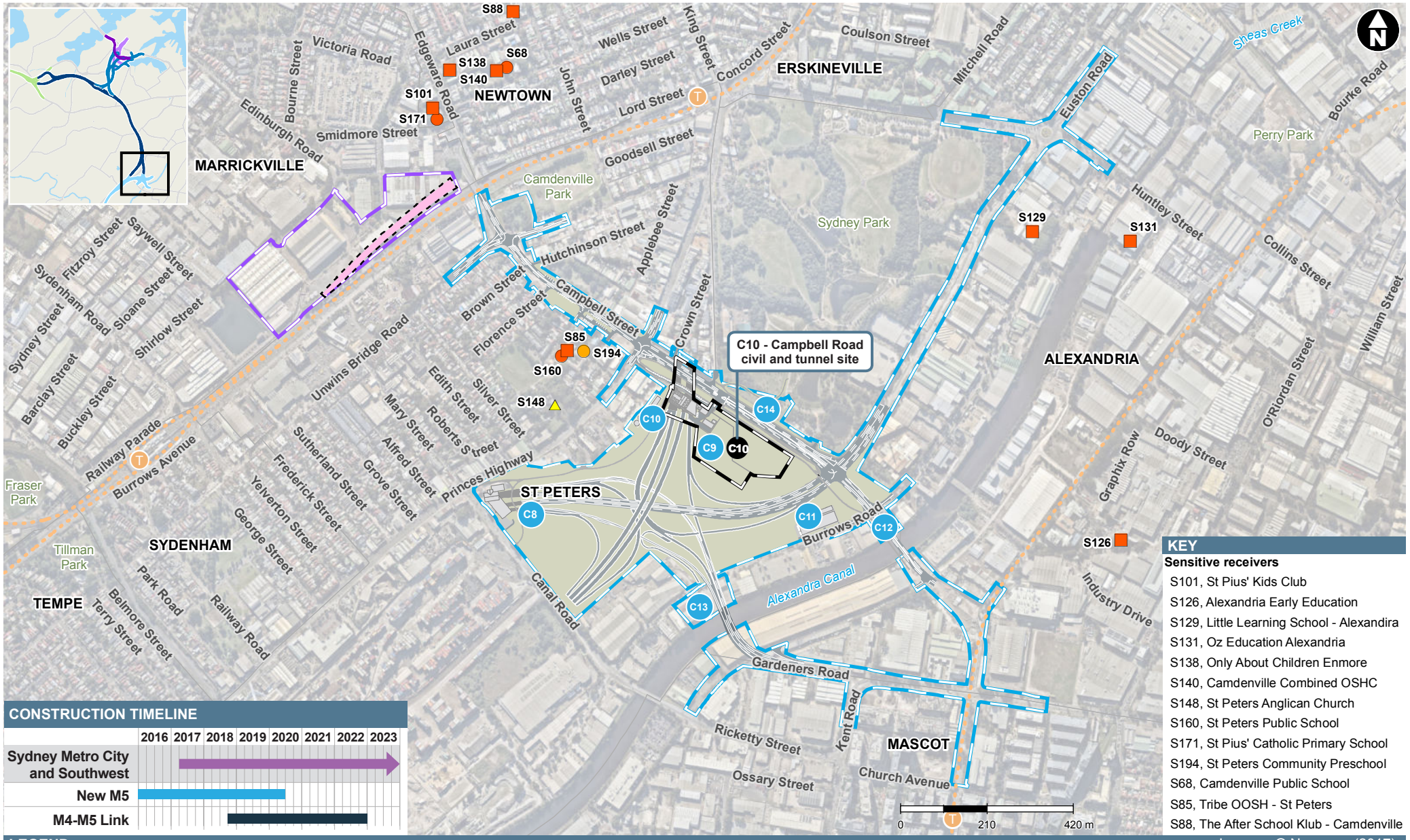


Figure 26-5 Cumulative construction impacts - St Peters

26.3.2 Operational phase cumulative impacts

As described in **Appendix C** (Cumulative impact assessment methodology), a number of strategic projects or land use/urban developments are already captured in the operational traffic modelling informing the cumulative operational assessments for traffic, air quality, noise and vibration, human health risk and social and economic environment and are therefore not discussed in detail in this chapter.

The traffic assessment included modelling of cumulative operational traffic scenarios at 2023 (year of opening) and 2033 (ten years after opening). The modelling predicted traffic from the operation of the approved WestConnex projects and the M4-M5 Link as well as a number of proposed motorway projects, as shown in **Table 26-3**.

The traffic modelling was based on land use and employment forecasts for metropolitan Sydney including forecasts for proposed growth precincts such as the Parramatta Road corridor, Bays Precinct, Central to Eveleigh corridor, Green Square and Mascot town centre. The modelling also included a range of approved and proposed major road and public transport projects including CSELR and Sydney Metro City and Southwest. It also included forecast growth in the Sydney Airport and Port Botany precinct and the Western Sydney Airport at Badgerys Creek.

The cumulative assessment for the quantitative modelling scenarios has been discussed in detail in their respective assessments, such as traffic and transport (**Appendix H** (Technical working paper: Traffic and transport)), air quality (**Appendix I** (Technical working paper: Air quality)) and noise and vibration (**Appendix J** (Technical working paper: Noise and vibration)). This chapter only provides a summary of the key outcomes of the operational cumulative impact assessment.

Table 26-3 Cumulative operational scenarios as defined for the traffic, air quality, noise and human health assessments

Scenario description			Projects included													
Traffic/ Air quality	Noise and vibration	Human health risk	Existing road network	M4 Widening	M4 East	KGRIU[a]	New M5	M4-M5 Link	NorthConnex	Sydney Gateway	Western Harbour Tunnel[b]	Beaches Link[b]	F6 Extension	M4 Widening	M4 East	KGRIU[a]
Do minimum	No Build	Without Project	✓	✓	✓	✓	✓		✓							
2023 – Do Something (DS)	2023 Build Do-something	2023 With project	✓	✓	✓	✓	✓	✓	✓							
2023 – Do Something Cumulative (DSC)	2023 Build Do-something plus	2033 With project cumulative	✓	✓	✓	✓	✓	✓	✓	✓	✓					
2033 – Do Something	2033 Build Do-something	2033 With project	✓	✓	✓	✓	✓	✓	✓							
2033 – Do Something Cumulative	2033 Build Do-something plus	2033 With project cumulative	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Notes:[a] KGRIU = King Georges Road Interchange Upgrade [b] A component of the proposed future Western Harbour Tunnel and Beaches Link project

26.3.3 Type of assessment

Depending on the environmental issue, the type of assessment undertaken in this EIS could be quantitative (such as predictive through modelling), qualitative, or a combination of both. The projects

included in the cumulative impact assessment have been evaluated by technical specialists for the relevant key issues as identified in **Table 26-1**.

As described in **Appendix C** (Cumulative impact assessment methodology), a number of strategic projects (such as Western Sydney Airport) or land use/urban developments are already captured in the operational traffic modelling informing the cumulative operational assessments for traffic, air quality and noise and vibration and are therefore not discussed in detail in this chapter.

In accordance with the Secretary's Environmental Assessment Requirements (SEARs) for the M4-M5 Link project, all key issues have been considered for the approved WestConnex component projects. This is to provide a cumulative impact assessment of the WestConnex program of works to date.

In some cases projects are in the early stages of design development and an EIS has not been prepared. In these cases, reasonable assumptions have been made in assessing potential cumulative impacts and these will need to be confirmed during the EIS assessments for these projects based on available information at that time. In the case of the proposed future Sydney Gateway project, the assumption is that the same design will be assessed as was assessed in the New M5 EIS.

26.4 Assessment of potential cumulative impacts

26.4.1 Traffic and transport

The cumulative traffic and transport assessment examines construction and operational traffic generation for future scenarios and capacity of the road network to manage the predicted changes in traffic volumes, as well as the impact on public and active transport. A detailed assessment of the potential construction and operational cumulative impacts is provided in **Appendix H** (Technical working paper: Traffic and transport).

Construction

Establishment of construction-based ancillary facilities for the project is associated with heavy and light vehicle movements, but only some of these sites (ie the tunnelling sites) would have heavy vehicle movements associated with spoil haulage. The traffic modelling for the cumulative construction assessment was undertaken for the year 2021, as it is considered to be the highest traffic-generating year of construction and therefore assesses the worst case construction traffic scenario.

The construction of the M4 East and New M5 projects are expected to be completed in 2019 and 2020. Therefore there would be an overlap with the construction of the M4-M5 Link project for a period of up to 12-18 months, subject to project approval. During this period of overlaptunnelling construction, the largest generator of heavy vehicle traffic, is unlikely to cause a substantial cumulative impact in terms of additional heavy vehicles on the road network from these three projects being under construction concurrently.

Elements of the construction program for the M4-M5 Link are assumed to occur concurrently with the construction of proposed future Sydney Gateway project, with both projects scheduled for completion in 2023. The EIS for the proposed future Sydney Gateway project would need to consider the cumulative impacts with the M4-M5 Link construction.

The construction of the proposed future Western Harbour Tunnel is assumed to overlap with the M4-M5 Link construction and the likely trip generation for heavy and light vehicles has been added to the cumulative construction assessment presented in this EIS.

Analysis indicates that the impact from additional Western Harbour Tunnel construction traffic on the road network is minimal, with most intersections operating at the same level of service (LoS). A few intersections along Wattle Street and Parramatta Road are forecast to experience a slight worsening in level of service during the AM and PM peak periods as a result of construction traffic, namely:

- Parramatta Road/Wattle Street intersection in the AM peak hour
- Parramatta Road/Harris Road and Parramatta Road/Croydon Road/Arlington Street intersections in the AM peak hour
- Wattle Street/Ramsay Street in the PM peak hour.

These cumulative impacts on the operation of the road network would not be experienced for the duration of the construction period and would be subject to further assessment in the Western Harbour Tunnel EIS.

Elements of the M4-M5 Link construction program would also occur concurrently with the construction of the Sydney Metro City and Southwest project (Stage 1: Chatswood to Sydenham). Construction traffic from the Sydney Metro Marrickville dive site, which is some distance to the west, may use the Princes Highway, which would also be used by traffic from the M4-M5 Link construction site at Campbell Road.

Site management works would occur within the Rozelle Rail Yards before the commencement of construction of the M4-M5 Link. Site management works have commenced, with completion planned for mid-2018. Due to the timing of works, there would be no concurrent traffic impacts with the M4-M5 Link. However, as the works would occur consecutively (ie back-to-back), residents in the vicinity would experience traffic impacts from both projects being undertaken consecutively.

Impacts on public and active transport

On-road public transport in the cumulative construction scenario would generally experience levels of service as they do under the project construction scenario with a small reduction in levels of service in some locations due to the increased demand generated by the Western Harbour Tunnel construction traffic (which would be subject to a separate EIS).

The potential impacts on pedestrians and cyclists at the Rozelle civil and tunnel site, potentially in the form of additional light vehicle movements along Lilyfield Road, would likely be lengthened due to the construction of the proposed future Western Harbour Tunnel.

Operation

Potential cumulative operational traffic impacts for 2023 and 2023 are summarised in **Table 26-4**.

While the construction impact of the proposed future Western Harbour Tunnel and Beaches Link entry and exit ramps connecting to City West Link/The Crescent is assessed, the operational traffic impact of these ramps has not been included. A preliminary assessment with these ramps operational has been carried out and indicates that there is likely to be some reduction in traffic on the Western Distributor and Sydney Harbour Bridge, as more traffic would be able to access the proposed future Western Harbour Tunnel and Beaches Link. However, there is likely to be increased traffic on City West Link, The Crescent and Johnston Street. The impacts of these entry and exit ramps would be assessed in detail as part of future environmental assessment for the proposed future Western Harbour Tunnel and Beaches Link.

Table 26-4 Cumulative operational traffic impacts (2023 and 2033)

Location	Potential cumulative traffic outcomes - 2023	Potential cumulative traffic outcomes - 2033
M4-M5 Link Mainline tunnels	Compared to the 2023 'with project' scenario, the 2023 'cumulative' scenario analysis indicates traffic volumes on the M4-M5 Link mainline tunnels are forecast to generally be denser with a corresponding reduction in level of service (LoS) in the peak hours. However, the M4-M5 Link Motorway are still forecast to generally operate at LoS D or better.	The 2033 'cumulative' scenario analysis indicates forecast traffic flows on the M4-M5 Link mainline tunnels would be denser compared to the 2033 'with project' scenario, with a corresponding reduction in level of service in the peak hours. Sections of the M4-M5 Link mainline tunnels are forecast to operate at LoS E in peak hours, particularly around the merge and diverge locations, such as where the Wattle Street interchange ramps connect with the M4-M5 Link mainline tunnels. Even with this increased density, average motorway speeds are forecast to be 60 km/h or above in the peak hours.
Metropolitan network efficiency	The metropolitan road network productivity improves in 2023, with the inclusion of the proposed future Sydney Gateway and Western Harbour Tunnel. There is a drop in the daily vehicle kilometres travelled (VKT) and vehicle hours travelled (VHT) on the arterial network with an increase in kilometres travelled along the motorway routes, a greater distance could be travelled on the road network in a shorter time.	Metropolitan road network productivity improves in 2033, with the inclusion of the proposed future Sydney Gateway, Western Harbour Tunnel and Beaches Link and the F6 Extension projects. There is a drop in the daily VKT and VHT on the arterial network with an increase in kilometres travelled along the motorway routes. As in 2023, overall, a greater distance could be travelled on the road network in a shorter time.
Parallel routes analysis	See description for 2033.	As a result of the additional road network capacity provided by the project, traffic volumes on parallel routes compared to a 'without project' scenario is predicted to significantly decrease on: • City West Link and Parramatta Road, east of the M4 East • Stanmore Road in Stanmore • Lyons Road in Russell Lea • Southern Cross Drive and the Sydney Harbour Tunnel. The M4-M5 Link would provide alternative parallel options to the roads listed above together with the proposed future Sydney Gateway, Western Harbour Tunnel and Beaches Link and the F6 Extension in the 2023 and 2033 'cumulative' scenarios. A decrease in the daily volume of heavy vehicles on surface roads such as Parramatta Road, City West Link, Stanmore Road, Sydenham Road, Marrickville Road and King Street is also forecast, as heavy vehicles shift onto the M4-M5 Link and the other

Location	Potential cumulative traffic outcomes - 2023	Potential cumulative traffic outcomes - 2033
		motorways included in the 'cumulative' scenarios. In the 2033 'cumulative' scenario, increases are forecast in daily two-way volumes on Johnston Street, north of Parramatta Road in Annandale and Gladesville Bridge in the 'cumulative' scenario. These increases reflect the forecast demand to and from the Rozelle area due to the new connectivity being provided by the Rozelle interchange.
Metropolitan travel time	See description for 2033.	In the 2023 and 2033 cumulative scenarios, peak period travel times are forecast to further reduce, by comparison to a 'with project' scenario, on a number of key travel routes such as between the M4 corridor and the Sydney Airport/Port Botany precinct. This is as a result of traffic shifting from surface roads to the M4-M5 Link and the other motorways included in the 'cumulative' scenarios.
Wattle Street interchange	The 2023 AM peak hour 'cumulative' conditions are forecast to be similar to those for the 'with project' scenario, with the main cause of congestion remaining the forecast demand for City West Link. There would be an increase in average speed on the modelled road network due to the higher proportion of vehicles using the M4-M5 Link in the 'cumulative' scenario. The 2023 PM peak hour 'cumulative' conditions are forecast to be similar to those for the 'with project' scenario, with the main cause of congestion remaining the forecast demand to Frederick Street. As in the 'with project' scenario, significant queues are forecast on the Parramatta Road eastbound approach to Wattle Street and on Wattle Street itself. There would be an increase in average speed on the modelled road network due to the higher proportion of vehicles using the M4-M5 Link in the 'cumulative' scenario. Performance across the majority of the modelled road network is consistent between 'with project' and 'cumulative' scenarios, with intersections performing at the same or better levels of service.	During the 2033 AM peak hour, the 'cumulative' scenario is forecast to experience a minor increase in overall average speed due to a forecast increased demand for the M4-M5 Link mainline tunnels when compared to the 'with project' scenario. Congestion on Wattle Street/Dobroyd Parade would impact motorists approaching the Wattle Street interchange from side roads – this would be experienced in both 'with project' and 'cumulative' scenarios. The 2033 PM peak hour 'cumulative' conditions are forecast to be similar to those for the 'with project' scenario, with the forecast demand for Frederick Street remaining the main cause of congestion. Performance across the majority of the modelled road network would be consistent between 'with project' and 'cumulative' scenarios, with intersections performing at the same or better levels of service.
Rozelle interchange	During the 2023 AM peak hour, an increase in demand is forecast for the 'cumulative' scenario over the 'with project' scenario. In	As in 2023, the 2033 'cumulative' scenario provides some benefit to the Western Distributor and Anzac Bridge, due to the forecast shift in

Location	Potential cumulative traffic outcomes - 2023	Potential cumulative traffic outcomes - 2033
	spite of this increase, the 'cumulative' network would provide benefits to the Western Distributor and Anzac Bridge operation as traffic is forecast to shift from the Sydney Harbour Bridge to the proposed future Western Harbour Tunnel, During the 2023 PM peak hour, the forecast demand for the 'cumulative' scenario increases by about 10 per cent over the 'with project' scenario. In spite of this increase, the modelled network is forecast to operate better than in the 'cumulative' case. Again, this is due to traffic being forecast to shift from the Sydney Harbour Bridge to the proposed future Western Harbour Tunnel. The forecast intersection performances in the 2023 'cumulative' scenario are similar to the 'with project' scenario.	traffic from the Anzac Bridge and Sydney Harbour Bridge to the proposed future Western Harbour Tunnel. This reassignment results in better flow for northbound traffic on Western Distributor towards Sydney Harbour Bridge with improved network performance. As in 2023, the 2033 'cumulative' network is forecast to perform better compared to the 'with project' case, despite a 15 per cent increase in forecast demand, due to the shift in traffic from the Sydney Harbour Bridge to the proposed future Western Harbour Tunnel. The forecast intersection performances in the 2033 'cumulative' scenario are similar to the 'with project' scenario.
St Peters interchange	The AM peak hour network performance results in the 2023 cumulative scenario show overall improvement compared to the 2023 'with project' scenario. Despite the higher forecast total demand, total travel time is shorter, indicating less congestion in the modelled network around the St Peters interchange. This is due to the proposed future Sydney Gateway improving connectivity between St Peters interchange and Sydney Airport precinct, removing traffic from the Mascot area. The PM peak hour network performance results show a similar trend to the AM peak hour. Many intersections in the modelled road network are forecast to operate at similar or better levels of service, due to the contribution of the proposed future Sydney Gateway.	In the 2033 AM peak hour, the modelled network is forecast to operate better than the 'with project' scenario, although not as significant an improvement as in 2023 due to the growth in traffic across the modelled network. Total forecast demand is higher than in the 'with project' scenario, however more vehicles are forecast to reach their destination, indicating less congestion than under the 'with project' scenario. This is due to the proposed future Sydney Gateway improving connectivity between St Peters interchange and the Sydney Airport precinct, removing traffic from the Mascot area. The 2033 PM peak hour network performance results show improved network operation in the 'cumulative' scenario compared to the 'with project' scenario. Total travel time in the modelled road network is forecast to be shorter, with a doubling in average speed on the network. Many intersections within the modelled road network are forecast to operate at similar or better levels of service when compared to the 'with project' scenario, due to the contribution of the proposed future Sydney Gateway.

Public transport

Potential impacts to public transport in the cumulative scenarios are generally similar to the general traffic network performance assessments. On-road public transport would experience similar levels of service as they do under the 'with project' scenarios with a reduction in levels of service in some locations, due to the increased demand generated by the cumulative projects, and improvements in other locations, where the 'cumulative' network provides benefits to the surface road network.

Active transport

Positive cumulative impacts on active transport include the upgrade, extension and connectivity of pedestrian and cycle routes linking areas of public open space as a result of the combined suite of projects included in this cumulative assessment. This is presented in the active transport strategy presented in **Appendix N** (Technical working paper: Active transport strategy).

26.4.2 Air quality

The cumulative impact assessment for air quality focuses on the cumulative change in airborne pollutants as a result of the construction and operation of the M4-M5 Link project in combination with the other relevant projects presented in **Table 26-1**..

WestConnex projects

Construction

For all construction activities, a key aim is to prevent significant effects on receptors through the use of effective mitigation as described in **section 26.3.1**. There are three geographic locations that will experience a degree of combined construction impacts from multiple projects, these are at Haberfield, Rozelle and St Peters, which are each located within proximity to sensitive receivers.

These overlapping areas may experience extended periods of construction on a site-by-site and activity-by-activity basis. Irrespective of the duration, the generation of dust, which may cause amenity impacts to the surrounding community, can be effectively controlled. Air quality impacts from the activities expected during construction are manageable through well established and effective management and mitigation measures. Cumulative air quality impacts during construction are therefore not expected to be significant.

Operation

The operational component of the air quality assessment examines both in-tunnel air quality as well as surface ambient air quality and the changes under different operational scenarios and is reported on in **Appendix I** (Technical working paper: Air quality).

The project ventilation system is designed for coordinated operation with adjacent tunnel projects (ie the WestConnex M4 East and New M5 projects and the proposed future Western Harbour Tunnel and Beaches Link project), with complete or partial air exchange at project boundaries when necessary to ensure in-tunnel air quality is maintained throughout the tunnel network. The ventilation system is designed to have complete exchange of tunnel air between the proposed future Western Harbour Tunnel and Beaches Link project and the M4-M5 Link project at the Rozelle ventilation facility.

For in-tunnel air quality, the project would meet the in-tunnel criterion for nitrogen dioxide (NO_2) as an average concentration along any route through the tunnel network, and irrespective of contributions from other tunnel projects, therefore cumulative impacts on NO_2 emissions are not relevant.

For ambient air quality, the air quality assessment uses changes in background air quality over time, plus surface traffic flows and emissions from ventilation outlets as key contributors to changes in air quality within and around the project footprint. The assessment presents each of the pollutants in the air quality assessment and uses the 'residential, workplace and recreational (RWR) receptors' as locations to measure the change. The RWR represent 86,375 individual receptors across the modelled network. The sections below summarise the key findings of the assessment for the 'Do something' (DS) and 'Do something cumulative' (DSC) scenarios as compared with the 'Do minimum' (DM) scenario (ie without the project).

Table 26-5 Cumulative operational air quality impacts (2023 and 2033)

Pollutant	Outcomes of the operational cumulative assessment
Carbon monoxide (CO) 1-hour concentration	The one-hour CO criterion for NSW was not exceeded at any of the RWR receptors in any scenario. The highest one-hour concentrations in any DS or DSC scenario was predicted to be 7.7 mg/m^3 as compared to the criterion of 30 mg/m^3.
NO_2 annual mean	The annual mean NO_2 criterion for NSW of 62 µg/m^3 was not exceeded at any of the RWR receptors in the DSC scenario. Only around 0.1 per cent of receptors were predicted to have an increase of greater than 2 µg/m^3 and there was a reduction in annual mean NO_2 at between or around 80 per cent and 85 per cent of receptors, providing a benefit to the majority of receptors.
NO_2 maximum 1-hour mean	The maximum one-hour mean NO_2 concentration was predicted to be exceeded by 3.8 per cent of the RWR receptors in 2023 and less than 1 per cent in the 2033 DSC scenarios. These are compared to the DM scenario where 6.6 per cent of the RWR were predicted to experience an exceedance in 2023 and 2.3 per cent in 2033.
Particulate matter (PM_{10} annual mean)	The concentration at the majority of receptors was below 20 µg/m^3, with only a very small proportion of receptors having a concentration exceeding the criterion of 25 µg/m^3. The 2023 DS predicted 26.5 µg/m^3 while the 2023 DSC scenario was marginally less at 25.9 µg/m^3. For the 2033 DS, the predicted maximum was 26.1 µg/m^3 while for the 2033 DSC, it was marginally less at 25.8 µg/m^3.
Particulate matter (PM_{10} 24-hour mean)	The predicted results for the DSC scenarios were significantly influenced by the high PM_{10} background concentration of about 93 per cent of the criterion for 2023 and 2033. PM_{10} 24 hour mean concentrations at the majority of RWR receptors was above the NSW impact assessment criterion of 50 µg/m^3 both with and without the project.
Particulate matter ($PM_{2.5}$ annual mean)	Similar to the PM_{10} pollutant, the $PM_{2.5}$ background concentration is already very high and at most RWR receptors is close to the NSW criterion of 8 µg/m^3. For the 2023 DSC scenario there is a maximum increase of 2.2 µg/m^3 compared to 1.2 µg/m^3 for the 2023 DS scenario. For the 2033 DSC scenario there is a maximum increase of 2.3 µg/m^3 compared to 1.4 µg/m^3 for the 2033 DS scenario. The predicted maximum values for the decrease in $PM_{2.5}$ annual mean concentrations is similar for the DS and DSC scenarios for both 2023 and 2033.
Particulate matter (24-hour mean $PM_{2.5}$)	Similar to 24-hour mean PM_{10}, as a result of the high background levels, the concentrations predicted at all receptors was above the NSW impact assessment criterion of 25 µg/m^3 for 24 hour mean $PM_{2.5}$ concentrations. Again with the DSC scenarios predicting marginally lower concentrations than the DS scenario for the same year.

Regional air quality

The changes in the total emissions resulting from the project are shown in **Table 26-6**. These changes can be viewed as a proxy for the projects and the cumulative scenario's impact on regional air quality which, on the basis of the results, are likely to be negligible. The graphs show minimal change between the DM, DS and DSC scenarios and all are significantly lower than the 'Base Year (2015)' emissions without any of the projects assessed in the DS or DSC in operation. For example:

- The increases in the oxides of nitrogen (NO_X) emissions for the assessed road network in a given year ranged from 71 to 174 tonnes per year. These values equate to a very small proportion (around 0.3 per cent) of anthropogenic NO_X emissions in the Sydney airshed in 2016 (around 53,700 tonnes)
- The increases in NO_X in a given year are much smaller than the projected reductions in emissions between 2015 and 2033 (around 2,340 tonnes per year).

Overall, it is concluded that the cumulative impacts on regional air quality would be negligible, and undetectable in ambient air quality measurements at background locations.

26.4.3 Noise and vibration

An assessment of the potential construction and operational impact of the M4-M5 Link is provided in **Chapter 10** (Noise and vibration) and is detailed in **Appendix J** (Technical working paper: Noise and vibration).

Construction

Cumulative construction noise impacts can be divided into two groups:

- Concurrent noise impacts, where more than one work activity is carried out at the same time and in the same location, such that the same receiver is potentially impacted. Concurrent construction noise impacts include construction civil and tunnelling sites which may operate simultaneously during any period. These construction areas are anticipated to include relatively stationary noise sources which operate for the majority of the construction period
- Consecutive noise impacts, where receivers are exposed to construction noise impacts from the construction of separate and consecutive nearby projects. Generally construction noise impact assessments consider the duration of a project in isolation, whereas the potential impacts from the identified consecutive projects are likely to be perceived to be longer by affected receivers.

Appendix J (Technical working paper: Noise and vibration) includes an assessment of concurrent construction impacts for each of the M4-M5 Link construction sites along with an assessment of consecutive impacts where approved or currently under construction projects occur within close proximity to an M4-M5 link project site. The following section provides discussion for sites where both consecutive and current construction impacts are predicted to occur.

Table 26-6 Cumulative operational noise impacts

Concurrent construction impacts	Consecutive construction impacts
Cumulative construction noise impacts - Haberfield Option A	
Given the number of work sites associated with the project within the Haberfield area, it is likely that receivers would occasionally be subject to potential noise impacts from concurrent activities. This would most likely be apparent during the night-time period where predicted noise levels may exceed the noise management level (NML) by up to 10 dBA.	The M4 East project, together with the M4-M5 Link, tie in to Wattle Street at Haberfield, where receivers would likely be exposed to extended impacts associated with the consecutive construction of both projects. The receivers most likely to be affected by consecutive construction impacts are: • Receivers adjoining the Northcote Street civil site (C3a). This site is currently a tunnel site for the M4 East project, with an acoustic shed constructed across the site • Receivers adjoining Wattle Street and Walker Avenue, which have line of sight to the Wattle Street civil and tunnel site (C1a) and the Haberfield civil and tunnel site (C2a).
Cumulative construction noise impacts – Haberfield/Ashfield Option B	
As above, due to the number of construction sites in the Haberfield/Ashfield area, it is likely that receivers would occasionally be subject to night-time period cumulative impacts. This is predicted to exceed the NML by greater than 20 dBA within noise catchment area (NCA) NCA01.	As above, receivers most likely to be affected by consecutive construction impacts from the M4 East and M4-M5 Link projects are: • Receivers adjoining the Parramatta Road West civil and tunnel cite (C1b), Parramatta Road East civil site (C3b) and Haberfield civil site (C2b), between Walker Avenue and Chandos Street.
Cumulative construction noise impacts – Rozelle	
Tunnelling works activities for the M4-M5 Link and the proposed future Western Harbour Tunnel project may be carried out simultaneously. Cumulative construction noise impacts may be apparent during out-of-hours works periods where cumulative impacts are predicted to result in NML	The Rozelle area would likely be subject to construction impacts from works associated with other infrastructure projects, including the under construction CBD and South East Light Rail Rozelle maintenance depot. The receivers most likely to be affected by consecutive construction impacts are: • Receivers adjoining Lilyfield Road between Justin

Concurrent construction impacts	Consecutive construction impacts
exceedances of up to 20 dBA during the night-time period.	Street and Ryan Street (NCA16 and NCA19) • Receivers adjoining Brenan Street between Starling Street and White Street (NCA15).
Cumulative construction noise impacts – St Peters	
Given that tunnelling works activities may be carried out simultaneously at St Peters for the New M5 and M4-M5 Link projects, cumulative construction noise impacts may be apparent during out-of-hours works periods where cumulative impacts are predicted to result in NML exceedances of up to 20 dBA during the night-time period.	Excluding short-term works such as pavement and utility works, receivers located within NCA48 and NCA49, which front Campbell Road, are predicted to experience up to 10 dBA exceedances of the project NMLs (during the night-time period) during construction of the M4-M5 Link project. Whilst the magnitude of the predicted exceedance is relatively low, these impacts are predicted at receivers who would likely have been exposed to significant noise impacts from the New M5 project.

Potential management and mitigation measures

For concurrent cumulative construction noise impacts, mitigation (where relevant) could include scheduling use of high noise items of plant during less sensitive periods, increased height of construction hoarding, upgraded acoustic shed performance, noise monitoring, notification and respite offers, where appropriate.

In situations where consecutive long-term construction noise impacts occur, at-receiver noise mitigation could be considered, where appropriate, once options for a- source noise mitigation and management measures have been exhausted. Where it can be determined reasonable and feasible, the implementation of operational mitigation measures such as architectural treatments during construction may reduce cumulative impacts from concurrent construction activities, particularly for areas of overlapping works.

Operation

Potential cumulative operational noise impacts have been evaluated in the 'Do Something Plus' scenario (see **Table 26-3**) to represent the impacts of the future traffic from M4-M5 Link in conjunction with traffic from other major road projects.

Maps showing the location of receivers which are predicted to exceed the Roads and Maritime *Noise Mitigation Guideline* (2015b) (NMG) in the cumulative 'Do Something Plus' scenario are presented in **Appendix J** (Technical working paper: Noise and vibration).

The key findings of the cumulative assessment indicates that:

- The total number of receivers eligible for consideration of additional noise mitigation is predicted to decrease from 431 in the 'Do Something' scenario to 409 in the 'Do Something Plus' scenario which is typically due to traffic being removed from surface roads and instead using the M4-M5 Link tunnels
- There are more triggered receivers in the 'Do Something Plus' scenario in NCA21 (south of City West Link) compared to the 'Do Something scenario'. This is due to cumulative traffic volumes of potential future projects anticipated to add traffic to the surface section of the project in this area
- There are less triggered receivers in the 'Do Something Plus' scenario in NCA25 (adjacent to Victoria Road and Lilyfield Road) compared to the 'Do Something scenario' due to a reduction in traffic for this section
- There are marginal differences between the scenarios elsewhere in the study area.

The majority of noise exceedances (in both the 'Do Something' and 'Do Something Plus' scenarios) are located in the vicinity of Victoria Road at Iron Cove and Victoria Road near Lilyfield Road and occur in part as a result of the demolition of existing buildings which act as a barrier to noise and as a result of widening of the road carriageway. A range of mitigation options are available to address exceedances from cumulative road traffic noise including use of low noise road pavement, noise barriers or architectural 'at property' treatments.

26.4.4 Human health

The results of the cumulative human health risk assessment discussed in this section is based on the outcomes of the air quality operational assessment, which has been derived from the traffic modelling. Construction fatigue is the main focus of the construction phase, while effects of emissions from the project as a result of the overall WestConnex program of works and other related projects are the focus of the operational phase.

Further details are provided in **Chapter 11** (Human health risk) and **Appendix K** (Technical working paper: Human health risk assessment).

Construction

As described in **section 26.3.1**, construction fatigue relates to receivers that experience construction impacts from multiple projects over an extended period of time with few or no breaks between construction periods. Other impacts on health and wellbeing are associated with cumulative traffic impacts (including spoil vehicle movements, partial and/or complete closure of roads and active transport links, reduced street parking, and relocation of bus stops). Impacts on views and visual amenity from multiple concurrent or consecutive projects may also increase the levels of stress and anxiety experienced by community receptors.

Operation

This section provides a summary of the potential impacts to human health that may be experienced from air quality impacts under the cumulative modelling scenario for 2023 (opening year) and 2033, assuming the projects outlined in **Table 26-1**are operational.

In-tunnel air quality

While concentrations of pollutants from vehicle emissions are higher within the tunnel (compared with outside the tunnel), and with the completion of a number of tunnel projects (approved or proposed) there is the potential for exposures to occur within a network of tunnels over varying periods of time, depending on the journey. The assessment of potential exposures inside these tunnels, has indicated:

- Where windows are up and ventilation is on recirculation, exposure to nitrogen dioxide inside vehicles is expected to be below the current health based guidelines. In congested conditions inside the tunnels, it is not considered likely that significant adverse health effects would occur. Placing ventilation on recirculation with windows closed is also expected to minimise exposures to particulates during travel through the tunnels
- For motorcyclists, where there is no opportunity to minimise exposures through the use of ventilation, there is the potential for higher levels of exposure to NO_2 and particulates. These exposures, under normal conditions, are not expected to result in adverse health effects. When the tunnels are congested it is expected that motorcyclists would spend less time in the tunnels than passenger vehicles and trucks (due to lane filtering), limiting the duration of exposure and the potential for adverse health effects
- For individuals who regularly use tunnels for commuting or as part of their employment there is the potential for repeated exposures to higher levels of NO_2 and particulates during the day. While these exposures are not likely to be additive, in terms of potential health effects, it is important that these road users utilise ventilation on recirculation whenever they are using the tunnels.

Where advice to place ventilation on recirculation when using the tunnel or the proposed network of tunnels is followed, it is not expected to result in carbon dioxide levels inside the vehicle that may adversely affect driver safety. However, where Roads and Maritime provides specific advice to drivers entering road tunnels to put ventilation on recirculation, it is recommended that further advice is provided that recirculation should be switched off at some point after using the tunnel network and not left on for an extended period of time.

Ambient air quality

The human health risk assessment evaluated the principal pollutants from the air quality assessment and determined that these pollutants, including VOCs, PAHs, CO and NO_2, were not associated with any acute or chronic risk issues in the local community, when considered cumulatively with other projects. The cumulative health risk assessment concludes that predicted changes for ground level particulate matter (PM_{10} and $PM_{2.5}$) due to the 'cumulative' scenario (compared to the 'with project' scenario) are unlikely to be measureable.

For receptors located at elevated heights, such as in high rise buildings, the assessment concluded that at a height of 10 metres the maximum predicted change in $PM_{2.5}$ in the 'cumulative' scenario (compared to the 'with project' scenario) is lower than at ground level.

At a height of 30 metres, the maximum predicted change in $PM_{2.5}$ in the 'cumulative' scenario (compared to the 'with project' scenario) is significantly greater than at a height of 10 metres. Predicted levels at this height are considered unacceptable for future high-rise development in the vicinity. The impacts identified at 30 metres above ground are localised and close to the ventilation outlets, with the maximum increases more specifically located adjacent to the Campbell Road ventilation facility at the St Peters interchange. Conversely, at the closest existing residential area, the maximum increase at a height or 30 metres is considered to result in a risk which is tolerable/acceptable.

Planning controls (including re-zonings) for land in the vicinity of the proposed Campbell Road ventilation facility at St Peters interchange are required to ensure future developments at heights 30 metres or higher are not adversely impacted by the ventilation outlets. Development of planning controls would be supported by detailed modelling addressing all relevant pollutants and averaging periods.

Mitigation and management measures for cumulative human health impacts are the same for project impacts and are outlined in **Chapter 11** (Human health risk).

26.4.5 Urban design and visual amenity

The urban design and visual impact cumulative assessment focuses on the changes to the landscape character and visual amenity that result from the combined effects of the WestConnex projects and other relevant projects as outlined in **Table 26-1**.. This is summarised below and is supported by further detail in **Appendix O** (Technical working paper: Landscape and visual impact).

M4 East

The majority of the works associated with the M4 East project at Haberfield and Ashfield would either be completed or close to completion when the M4-M5 Link construction period commences. The overlapping projects would result in a large number of nearby residents in Haberfield and Ashfield being subject to a further four to five years of motorway construction work within their neighbourhood. This would also affect motorists who regularly travel through the area. This would result in a high cumulative visual amenity impact on affected Haberfield and Ashfield residents due to the continued presence of visible construction facilities and construction activities over this period.

New M5

The majority of the works associated with the New M5 project at St Peters would be almost complete when the M4-M5 Link construction period commences. The completed New M5 works would provide substantial levels of amenity for local residents within the vicinity of the construction site, notwithstanding the early stage of landscape development. New motorway infrastructure including the interchange, ventilation outlets, motorway operations complex and associated infrastructure would be visible together with the open space area along the south side of Campbell Road and the extensive landscape setting.

The number of sensitive residential receptors affected by the project is considered likely to be relatively small. However, for this small group of residents, the project would result in a further prolonged period of construction. The project is also likely to extend impacts on users of Sydney Park and motorists who regularly drive through this area.

Rozelle Rail Yards site management works

Once the site management works are completed, the landscape character of the site would be altered through the removal of vegetation, structures and redundant rail infrastructure, and subsequent increase in the extent of open land and a largely vacant site. While the site management works are unlikely to result in a significant impact, there is a potential for cumulative visual impacts when considered in conjunction with the M4-M5 Link project because of the change to the existing environment. Once the M4-M5 Link is completed, part of the site will be used for operational infrastructure associated with the motorway and the balance of the land will be made available for use as open space and landscaping.

Western Harbour Tunnel

As limited information is available on the project, for the purposes of this EIS, it is assumed that the construction of the Western Harbour Tunnel will involve surface works at the Rozelle Rail Yards during construction of the M4-M5 Link and beyond 2023. This suggests that visual impacts associated with construction activities from the M4-M5 Link would occur concurrently and consecutively.

This would result in the proposed open space area at Rozelle Rail Yards being delivered in stages – the first stage in late 2023 and the next stage some time post 2023 after completion of the Western Harbour Tunnel construction. This would extend the visual impacts associated with construction for a longer duration at Rozelle.

CSELR – Rozelle Maintenance Depot

The CSELR Rozelle maintenance depot at the western end of the Rozelle Rail Yards may result in cumulative impacts when considered in conjunction with the M4-M5 Link project. Removal of vegetation, which has been undertaken as part of the CSELR project, has provided unfiltered views at some locations to the construction areas and could lead to more prominent views to parts of the M4-M5 Link project for sensitive receptors such as the residences along Lilyfield Road.

The Bays Precinct Transformation

Due to The Bays Precinct only being in its early strategic planning stages, no detailed assessment of landscape and visual impacts has been undertaken. The sensitivity of The Bays Precinct to change can be considered low due to the existing poor amenity provided by the current industrial and port related land uses and in some areas, derelict, built form.

The M4-M5 Link project would create a significant area of open space and improved active transport connectivity which would be available to service people working, living and visiting The Bays Precinct. There is an opportunity for integration between the sites to ensure a balanced outcome from a visual amenity, active transport and heritage perspective. Roads and Maritime has been working with UrbanGrowth NSW to ensure their plans for The Bays Precinct have been considered in relation to the design of the Rozelle interchange.

26.4.6 Social and economic

This summary of cumulative social and economic impacts is supported by the findings in **Appendix P** (Technical working paper: Social and economic). The focus of the cumulative social and economic impacts associated with transport and infrastructure projects include:

- Construction fatigue, entailing extended periods of construction, impacting local amenity, disruption to traffic and pedestrian networks
- Incremental loss or severance of open space
- Impact on property value or rent return due to ongoing project works as a result of multiple projects
- Economic effects, including changes to business operation and revenues
- Construction traffic from multiple projects placing additional pressure on road networks and parking capacity.

The assessment of cumulative impacts includes those activities that may overlap with the timing of the construction of the M4-M5 Link project, or have recently been completed. These are outlined in **Table 26-1**..

When completed, WestConnex is predicted to deliver beneficial cumulative impacts to the community, including increased travel speeds and reduced travel time through local streets, improved connectivity and reliability and opportunities for urban renewal. WestConnex, while delivering longer-term benefits, is likely to result in some adverse social and economic cumulative impacts for the community during the construction phases of the various component projects. The health effects of construction fatigue through annoyance, stress and anxiety have been covered in the health risk assessment section.

At Haberfield and Ashfield, the overlap between the M4 East and M4-M5 Link projects is likely to result in continuous construction activity for around seven years, which is expected to contribute further to traffic delays for customers and staff of businesses in the locality, in addition to extended periods of amenity impacts due to increases in noise and dust levels and changes in visual amenity.

At St Peters, residents and businesses located in areas of overlap with the New M5 project and the M4-M5 Link, could experience cumulative amenity impacts due to increases in traffic, changes in traffic patterns, parking, construction noise and vibration, and changes in visual amenity due to new infrastructure associated with these projects.

Coordination between and the projects in the planning of possible disruptions would assist in minimising potential cumulative impacts.

Positive cumulative impacts to local businesses and the economy would likely result from the concurrent construction activity associated with the WestConnex program of works and related projects such as the proposed future Sydney Gateway, Western Harbour Tunnel and Beaches Link and F6 Extension projects, which is likely to intensify employment and stimulus impacts. The demand for labour for major projects such as WestConnex and other similar projects in the area would increase employment opportunities for local residents. There is potential for wages to increase due to high demand for construction workers and opportunities for local businesses to supply goods or services for construction of these projects. Business turnover is also likely to increase due to demand.

As a result, there would be cumulative benefits of the projects, resulting in significant increases in travel speeds through the local road network, a reduction in average travel times and improved business and freight connectivity.

26.4.7 Non-Aboriginal heritage

This assessment of the potential cumulative impacts is supported by **Appendix U** (Technical working paper: Non-Aboriginal heritage).

The projects included in this assessment and their overall heritage impact rating are presented in**Table 26-1**..

Table 26-7 Overall heritage impact ratings for the WestConnex projects

WestConnex project	Overall heritage impact rating
New M5	Moderate adverse
King Georges Road Interchange Upgrade	Nil
M4 Widening	Nil
M4 East	Major adverse
M4-M5 Link	Moderate adverse
Other relevant projects	**Overall heritage impact rating**
CSELR	Nil
Rozelle Rail Yards site management works	Minor adverse
Combined	Major adverse

The WestConnex program of works as a whole has potentially wide reaching impacts on the urban fabric of greater metropolitan Sydney, including on items and areas of heritage significance. The overall cumulative impacts of the entire WestConnex program of works to date can be described as major and irreversible given the scale of the project, primarily the impacts to the Haberfield area heritage conservation area from the M4 East project.

The site management works and M4-M5 Link project at the Rozelle Rail Yards would permanently remove evidence of the rail infrastructure heritage and character of the site. However, the project would reuse and incorporate heritage elements in the urban design and landscape plan for Rozelle, acknowledging heritage themes and interpretation of area.

The heritage fabric, features and values of the items and areas in which these projects are located are being subjected to increased development pressures. While these projects will be transformative and place-making, they will lead to impacts on heritage items and the associated cultural and social values that they provide.

26.4.8 Biodiversity

The cumulative impact assessment for biodiversity focuses on the identification of conservation significant species found within the broader study areas of each of the relevant WestConnex and related projects and also assesses the extent to which their habitat has been removed. The assessment only examines the species which are in common across two or more projects, these are the threatened Grey-headed Flying Fox, the Eastern Bentwing-bat and the Yellow-bellied Sheathtail-bat.

A detailed assessment of the potential construction and operational impact of the M4-M5 Link is provided in **Chapter 18** (Biodiversity) and is supported by **Appendix S** (Technical working paper: Biodiversity).

Table 26-8 provides a summary of the impacts to the biodiversity features as a result of the combined relevant projects examined as part of this cumulative assessment. While very little native vegetation would be removed collectively, the removal of exotic and planted vegetation that species use for foraging has been identified as a contributor to the overall impact of the WestConnex program of works.

Table 26-8 Summary of cumulative impacts

Project	Area (hectares)			
	Native vegetation	Non-native vegetation (urban exotic and native cover)	Grey-headed Flying-fox	Microbats (Eastern Bentwing-bat and Yellow-bellied Sheathtail-bat)
M4 East	-	15.70	15.70	15.70
M4 Widening	0.54	8.84	8.84	8.84
New M5	3.31	10.80	14.11	-
King Georges Road Interchange Upgrade	0.01	3.23	3.23	3.23
M4-M5 Link	-	4.49	4.49	3.78[1]
WestConnex Subtotal	**3.86**	**43.06**	**Up to 46.37**	**Up to 31.55**
Rozelle Rail Yards site management works	-	7.12[2]	7.12[2]	7.12[2]
Total	**Around 3.86**	**Around 50.18**	**Up to 53.49**	**Up to 38.67**

Notes:
[1] Habitat for the microbats was only considered to be present within the vicinity of the Rozelle Rail Yards and not across the whole project footprint.
[2] Area estimated for this cumulative impact assessment

The impacts of the WestConnex program of works and other related projects have been assessed and consistent management measures have been identified. In total, approximately 3.86 hectares of native vegetation would be impacted by the WestConnex program of works, which is not significant in

the context of existing native vegetation across the Sydney Basin. No native vegetation is to be removed as part of the M4-M5 Link project.

Around 50.18 hectares of exotic and planted vegetation (mapped as 'urban exotic and native cover') would be removed and represents potential foraging habitat for the Grey-headed Flying-fox. A total of 4.49 hectares of urban exotic and native cover is to be removed by the M4-M5 Link project and a further 7.12 hectares is to be removed by the Rozelle Rail Yards site management works.

Some 38.67 hectares of the native vegetation and urban and exotic vegetation to be removed has also been identified as potential foraging habitat for the Eastern Bentwing-bat and Yellow-bellied Sheathtail-bat.

The cumulative impacts to Grey-headed Flying-fox and the threatened microbats would not result in a significant impact. No camps or breeding sites would be impacted and the removal of potential feed trees and foraging habitat would be negligible in the context of existing available foraging habitat for these species. Offset for individual trees would be integrated into landscape plans for the individual projects, and would provide foraging habitat for species such as the Grey-headed Flying-fox and microbats.

26.4.9 Soil and water quality

The cumulative impacts assessment for soil and water quality focuses on the potential for contaminated soil and water to cross project boundaries.. Cumulative impacts of this nature are unlikely to occur during the operations phase or on projects that are widely separated. This section therefore addresses the construction phase for projects that overlap or are in close proximity to each other.

Review of EIS documents for the various approved projects located in proximity to the M4-M5 Link project, including M4 East and New M5 indicate that the disturbance and management of contaminated soil, fill, sediment, surface water and groundwater as a result of construction and operational activities are unlikely to have a more significant impact on ecological and human health receptors or sensitive environments than they would if undertaken as discrete projects, provided the proposed management and mitigation measures documented in the respective EISs are implemented, maintained and monitored.

There are minimal adverse cumulative contamination impacts anticipated to occur as part of the construction or operation of the M4-M5 Link project. Risks to human health and the environment would be mitigated through implementation of management measures outlined in **Chapter 11** (Human health risk) and **Appendix K** (Technical working paper: Human health risk assessment).

The construction and operation of the M4-M5 Link project is not anticipated to create additional soil or groundwater contamination to that already identified within the project footprint as a result of historical land use activities. The appropriate management of contamination and waste materials disturbed during the construction phase of the project would likely result in an overall improvement in the condition of the land at project completion. The project would incorporate remediation and management of existing contamination as part of the construction phase, and to make the land suitable for the proposed final land use. Site suitability for the proposed land use(s) would be determined by an independent NSW EPA accredited site auditor engaged for the project.

Further assessment of cumulative impacts associated with contamination and groundwater contamination are discussed in **Appendix R** of the EIS (Technical working paper: Contamination) and **Appendix T** of the EIS (Technical working paper: Groundwater).

26.4.10 Surface water flooding and drainage

This cumulative assessment focusses on the capacity of the drainage network to accommodate the M4-M5 Link project in combination with other relevant projects. A detailed assessment of the potential construction and operational impact of the M4-M5 Link is provided in **Chapter 17** (Flooding and drainage) and is supported by **Appendix Q** (Technical working paper: Surface water and flooding).

WestConnex projects

Table 26-14 provides a summary of the findings of the cumulative impact assessment for the M4-M5 Link project in relation to surface water and flooding in the context of other WestConnex projects.

Table 26-9 Summary of impacts on surface water and flooding – WestConnex program of works

Project name	Key assessment findings	Project impact
M4 Widening and King Georges Road Interchange Upgrade	• No surface water receptors in common with the M4-M5 Link project therefore no direct cumulative impacts on surface water bodies or water quality • Potential for cumulative water quality impacts on downstream sensitive environments such as the Parramatta River Estuary, Cooks River and Botany Bay • No common surface catchments with the M4-M5 Link project there no potential cumulative flood impacts are anticipated.	Negligible impact
M4 East	• Potential cumulative surface water quality impacts could impact on the one common receptor, Dobroyd Canal (Iron Cove Creek) and downstream environments (including Iron Cove and the Parramatta River Estuary) • Impacts are associated with increased pollutant loading to Dobroyd Canal (Iron Cove Creek) from stormwater runoff or the discharge of poorly treated tunnel water • The M4-M5 Link connection to the Wattle Street interchange will not alter the surface layout or levels. Accordingly, there are no cumulative flooding impacts expected at the Wattle Street interchange.	Negligible impact
New M5	• Potential cumulative surface water quality impacts could impact on one common receptor the M4-M5 Link ie. Alexandra Canal as well as downstream sensitive environments such as the Cooks River and Botany Bay • The M4-M5 Link connection to the St Peters interchange will not alter the surface layout or levels. Accordingly, there are no cumulative flooding impacts expected at the St Peters interchange • Slight increase in tunnel wastewater discharging from the Arncilffe operational water treatment plant to the Cooks River due to the portion of M4-M5 Link tunnel drainage draining to the New M5 system.	Negligible impact

Other relevant projects

Cumulative impacts considered for other approved or proposed projects proposed in the vicinity of the M4-M5 Link project footprint are summarised in **Table 26-10**.

Table 26-10 Summary of impacts on surface water and flooding – other relevant projects

Project name	Key assessment findings	Potential residual impact
CBD and South East Light Rail Rozelle maintenance depot	• Surface water from the depot will be discharged to the Rozelle Rail Yards as surface flow	Low impact
Sydney Metro City and Southwest	• Waterloo Station, part of the Sydney Metro project, is located within the Alexandra Canal catchment and could therefore impact on Alexandra Canal and downstream sensitive environments (Cooks River and Botany Bay) • The aboveground station infrastructure would have a negligible impact on the existing surface hydrology or	Negligible impact

	existing flood behaviour.	
Whites Creek naturalisation	• Potential sedimentation of Whites Creek during earthworks • Flooding impacts during operation are not expected.	Low impact

The approved WestConnex component projects are considered unlikely to have a significant cumulative impact on receiving water receptors or sensitive environments provided the proposed management measures are implemented, maintained and monitored. There are minor adverse cumulative surface water quality or flooding impacts anticipated and the residual risk to common receptors and sensitive environments downstream would be low.

The flood modelling for the M4-M5 Link included the anticipated surface discharge from the CSELR Rozelle maintenance depot adjacent to the Rozelle Rail Yards. The modelling results were fed into the concept design for the Rozelle interchange, which accommodates flows across the site into Rozelle Bay. The detailed design for M4-M5 Link would need to consider the final design of the Rozelle maintenance depot drainage system further.

The Sydney Metro City and Southwest project, specifically the proposed Waterloo Station, would have negligible surface water impacts with the implementation of appropriate measures, therefore there are no anticipated cumulative water quality or flooding impacts with the M4-M5 Link.

The M4-M5 Link project works at Whites Creek together with the proposed naturalisation works by Sydney Water could have potential impacts on flooding and sedimentation of the channel, however this is expected to be a low impact, as suitable measures will be put in place during detailed design and construction.

26.4.11 Groundwater

The potential cumulative impact on groundwater focuses on impacts related to the quality and quantity of the groundwater resource and how it can affect groundwater dependent ecosystems. This typically arises from groundwater drawdown which as it draws in water from surrounding locations, it can have a potential effect on groundwater quality. This is discussed in detail in **Appendix T** (Technical working paper: Groundwater).

This cumulative impact assessment quantitatively assesses (through modelling) the potential impacts of other WestConnex tunnel projects (ie the M4 East and New M5 projects) and qualitatively assesses the potential impacts of other relevant projects such as the Sydney Metro City and Southwest, as outlined below. The construction and operational groundwater impacts of the M4-M5 Link are described in **Chapter 19** (Groundwater).

WestConnex projects

During construction, cumulative impacts on groundwater would be greatest at either end of the mainline tunnel alignment where the M4-M5 Link tunnels would overlap with the tunnels for the M4 East tunnels at the Wattle Street interchange and with the New M5 tunnels at the St Peters interchange.

Once all three of these WestConnex tunnel projects are operational, groundwater drawdown due to the cumulative impact of the three tunnel projects is not expected to be greater than in any one section of the overall project footprint. The tunnels and associated lining for each project would be designed and constructed to comply with the groundwater inflow criterion of one litre per second per kilometre for any kilometre length of tunnel. Consequently, the groundwater inflows along the tunnels would vary within a known range. A comprehensive groundwater monitoring program would be required for each project to confirm that the actual inflows do not exceed the criterion and drawdown does not exceed predictions.

Long term cumulative groundwater tunnel inflows due to the WestConnex tunnel projects may cause groundwater salinity to increase due to surface water from tidal reaches being drawn into or towards the tunnels. Initially, the saline water would be a small fraction of total tunnel ingress but this is expected to increase over time as water is drawn from further afield, although it is expected to always be a minor component of total inflow volume.

Other relevant projects

The Sydney Metro City and Southwest rail tunnels are to be constructed as undrained (tanked) tunnels that would cross the M4-M5 Link project alignment near St Peters. As the twin Sydney Metro tunnels are to be constructed as tanked tunnels, there will be negligible impacts on groundwater drawdown. The station boxes are to be constructed and operated as drained shafts and will extract groundwater from the local hydrogeological regime over time. The closest drained structure is proposed at Marrickville Station which is some distance to the west of the M4-M5 Link, and as such is considered unlikely to have significant cumulative impacts on groundwater drawdown.

There is potential for the concrete lined tunnels of the Sydney Metro project to create a partial hydraulic barrier to groundwater flow, however the risk is considered low since the tunnels are constructed below the water table.

The Western Harbour Tunnel project has potential to have cumulative groundwater impacts with the M4-M5 Link project in the Rozelle area. At this stage only limited information is available about the proposed design and construction methodology for the Western Harbour Tunnel project and as a result no meaningful analysis of impacts is possible at this time. Cumulative groundwater impacts should be addressed in the future as part of the EIS for the Western Harbour Tunnel project.

26.4.12 Aboriginal heritage

Potential cumulative impacts on Aboriginal heritage relates to the extent and number of registered AHIMS sites likely to be disturbed by the construction activities of a number of projects, including the M4-M5 Link, as outlined below. Further details on these potential cumulative impacts are provided in **Appendix V** (Technical working paper: Aboriginal heritage).

Potential impacts of the M4-M5 Link on Aboriginal heritage are summarised in **Chapter 21** (Aboriginal heritage). The findings of the assessment indicated no significant impacts on Aboriginal heritage items.

None of the approved component projects of the WestConnex program of works have any significant impact on Aboriginal heritage, therefore there are no cumulative impacts associated with these projects and the M4-M5 Link. No other projects were identified that could result in potential cumulative impacts on Aboriginal heritage.

26.5 Management of cumulative impacts

Construction impacts would be minimised through further consideration during detailed design and construction planning, application of appropriate management and mitigation measures, and consultation with affected residents and stakeholders. The construction strategy for the project (and the broader WestConnex program of works) focuses on balancing the need for construction to occur in a safe and efficient manner while managing constructability constraints and minimising cumulative impacts on the community, environment, road users and the surrounding road network.

The design of the project has carefully considered minimising construction fatigue as far as practical. The intent is to reduce the overall cumulative or consecutive impacts on the community over a longer period.

Each of the study disciplines presented in this EIS have identified site specific management measures to reduce the potential impact to acceptable levels. This cumulative assessment has been undertaken assuming that those management measures are implemented at the appropriate time.

Assuming that the practical mitigation measures for each key factor are already in place, the cumulative mitigation focussed on a broader level, focussing on the opportunities around inter-project coordination and communication with stakeholders. Mitigation and management measures for the cumulative scenario are constrained by only being able to be applied to the M4-M5 Link project and not those others that have already been approved.

Table 26-11 presents a summary of mitigation and management measures aimed at facilitating the reduction of cumulative impacts from the M4-M5 Link project and the other relevant projects included in this assessment.

Table 26-11 Proposed mitigation and management measures for cumulative impacts

Issues	Potential cumulative impact	Proposed mitigation measures
Social and economic; traffic and transport; air quality; noise and vibration	Ongoing construction impacts on the local community throughout the construction phase of the M4-M5 Link	• The effective management of cumulative impacts on the affected community requires oversight and direction from one overarching body such as a government department/agency or local council • Multi-party engagement and cooperation is needed to ensure all contributors to impacts are working together to minimise the effects or enhance the benefits of multiple projects occurring concurrently or consecutively • Communication strategies across the various projects should be managed to be consistent in their messaging to the community to avoid confusion.