Roads and Maritime Services

WestConnex

Update to Strategic Environmental Review

September 2015
Executive summary

**WestConnex**

WestConnex is a 33-kilometre integrated motorway that will extend the M4 Motorway east to the Camperdown area, south to Sydney Airport and duplicate the existing M5 East. The overall scheme will comprise a number of projects staged over a period of 10 years.

**Purpose of the Strategic Environmental Review**

A key part of the planning and development of WestConnex has been a consideration of potential environmental constraints and preparation of a Strategic Environmental Review (SER).

This SER is a high-level strategic document that identifies the major environmental benefits as well as the key challenges associated with WestConnex.

The SER considers how the project can be successfully developed and delivered in a sustainable way that avoids, manages and/or mitigates impacts to the environment. It is a strategic document that does not have a formal statutory role under the current New South Wales (NSW) planning system.

The SER is designed to provide an overarching discussion of the key issues and to set the scene for subsequent project-specific environmental impact assessment and approvals documents. The SER provides a foundation for early engagement with the community on key environmental considerations for the project.

The original SER was prepared in 2013. Since then, substantial further development has taken place on WestConnex including several key changes to the original reference scheme, including:

- **Enhancements to Stage 3 (the M4 – M5 Link) to accommodate a northern extension.** The alignment of this section of WestConnex has been revised so it follows the general alignment of the City West Link to Rozelle, before heading south via Camperdown to St Peters. The proposed Rozelle Interchange would offer connectivity for the Western Harbour Tunnel and Beaches Link project (being explored by Transport for NSW)

- **Enhancements to Stage 2 (the New M5) to provide ‘tunnel stubs’ for a future connection to the Southern Connector (part of Gateway to the South project, being led by Transport for NSW)**

- **An enhanced Sydney Gateway to connect WestConnex to the Sydney Airport and Port Botany precinct is actively being explored.**

There have also been developments in NSW Government policy, notably the release of *A Plan for Growing Sydney* by the Department of Planning and Environment DP&E in December 2014.

The SER has been updated to ensure appropriate consideration is given to all relevant environmental issues associated with delivery of the enhanced scheme. The updated SER is a key input to the WestConnex Updated Strategic Business Case.

There are no material differences in the outcomes of the original SER apart from the changed regulatory position on in-tunnel air quality following on from the outcomes of the assessment of the NorthConnex project.
The issues identified and the strategies outlined in the original SER were developed in consultation with representatives from key regulatory agencies with experience in delivering significant urban transport infrastructure.

The SER will remain relevant and promote consistency in assessment and management of environmental issues regardless of the final design and delivery staging options selected for WestConnex.

**Strategic priority issues**

Six strategic priority issues were identified as important for WestConnex to consider and effectively manage, including:

- Traffic and transport
- Air quality and tunnel ventilation
- Energy efficiency
- Noise and vibration
- Socio-economic considerations
- Construction impacts on communities.

**Traffic and transport**

WestConnex is a transformative urban motorway project and will provide improved access to the inner west and central Sydney and to key destinations such as Sydney Airport and Port Botany. It will also provide additional capacity on the M4 and M5 motorway corridors and the wider network.

WestConnex will deliver improved travel efficiency and reliability, enhanced economic productivity, improved road safety and surface road conditions and will lead to improved liveability by enabling public and active transport.

Key findings are that WestConnex will:

- Reduce travel times on the eastern sections of the M4 and M5 motorways
- Reduce travel time on Parramatta Road and the Princes Highway
- Enhance the productivity of commercial and freight generating land uses
- Improve motorway access for origins or destinations in the Central Business District (CBD), Sydney Airport, Port Botany, the inner west and eastern suburbs
- Improve road safety by reducing congestion and providing a bypass of a significant number of at-grade intersections, and incorporating innovative traffic flow technology
- Transfer traffic from key arterials such as Parramatta Road, providing a catalyst for urban renewal.

Transport planning and traffic management will be a critical consideration during the planning, design and delivery of each component of WestConnex. Traffic modelling will include detailed traffic assessments by specialist traffic modellers of the impacts of interchanges with the motorway to the main and local road network, tolling strategies and construction stages.

The traffic and transport arrangements during construction of each stage will be carefully managed and planned in consultation with local councils and the community. Notwithstanding, construction traffic is likely to be a highly visible aspect of the project. It can be expected that some parts of the community may experience construction fatigue as the
impacts of substantial construction activity in densely developed urban areas may continue for many years. Particular consideration will need to be given to innovative construction traffic solutions wherever available and feasible. For example, underground spoil loading with direct access to major arterial routes was an innovation adopted during the construction of the Lane Cove Tunnel and Cross City Tunnel projects and provided significant community benefits compared to the original plans, which involved construction access via local streets.

Air quality and tunnel ventilation

Broad stakeholder and community confidence in the effective management of air quality within tunnels and protection of local and regional air quality will be critical to the WestConnex solution. The original SER, included a strategic air quality assessment to evaluate the potential impact of WestConnex on regional and local air quality as well as in-tunnel air quality, ventilation outlets and tunnel portals.

Key findings were:

- Regional air quality is unlikely to change due to WestConnex (and this conclusion is unchanged)
- Transferring vehicles from surface roads into tunnels is likely to improve the air quality along existing surface roads, where surface traffic is reduced. However measuring local effects will need further, more detailed assessment based on the project-specific features and detailed traffic modelling
- In-tunnel air quality criteria will guide the ventilation design
- Locating ventilation outlets close to the tunnel portals would substantially improve the effectiveness and minimise costs and energy use for the system
- The most effective way to manage air quality both in and around tunnels is through vehicle fleet emission reductions
- The number of people using a road tunnel would increase substantially with WestConnex. However travel times would be less compared to without WestConnex due to improved traffic flow across the network.

Tunnel ventilation systems for WestConnex will be designed and operated to meet stringent in-tunnel; local and regional air quality criteria. Extensive detailed traffic and air quality modelling will be undertaken to ensure designs and operating strategies are effective and can demonstrate compliance with air quality criteria.

In-tunnel air quality criteria will be based on international best practice. This will take into account the in-tunnel air quality performance requirements in the planning approval for NorthConnex.

Air quality is nevertheless expected to be an issue of substantial community interest. WDA and the relevant government agencies will ensure transparent, comprehensive and factual information is made available to the community to inform this discussion.

Key issues for community acceptance are likely to be location and operation of ventilation outlets, air quality criteria for in-tunnel concentrations of nitrogen dioxide and fine particles.

The results of monitoring of earlier tunnel projects and detailed air quality modelling will be used to demonstrate how the proposed approach will protect air quality. Filtration of tunnel emissions is not envisaged as it is not required to meet air quality requirements.
Each WestConnex project will require suitable design, detailed assessment and evaluation for the protection of air quality and will include:

- Details of the alternative ventilation options (including filtration) considered during the tunnel design to meet the air quality criteria for the proposal
- Evidence to support selection of the proposed ventilation design
- The locations and designs of portals and ventilation outlets
- Operation requirements for portals and ventilation outlets
- Operation of surface roads and intersections
- A detailed assessment of any changes in air quality predicted as a result of the project, including ventilation outlet emissions and any changes in surface road traffic
- Construction activities.

DP&E, NSW Environment Protection Authority (EPA) and NSW Health will continue to be consulted throughout the planning, design, delivery, testing and ongoing monitoring and management of tunnel ventilation systems.

The NSW Government established the Advisory Committee on Tunnel Air Quality to provide a 'whole-of-government' understanding of the scientific and engineering issues informing road tunnel ventilation design and operation. The Advisory Committee draws on NSW, national and international experience.

The Committee is chaired by the NSW Chief Scientist and Engineer and includes representatives from the NSW Environment Protection Authority, NSW Health, Roads and Maritime Services, Department of Planning and Environment and independent international leaders in air quality.

The Committee is consulted on the development of the methodology for each air quality assessments undertaken for each stage of WestConnex.

**Energy efficiency**

Operation of road tunnels is particularly energy intensive and a key challenge for WestConnex will be to minimise energy use over its design life.

The SER has reviewed the potential energy use of both traffic and operation of the tunnel infrastructure. The key findings are:

- The net energy use from traffic with WestConnex compared to without WestConnex will be relatively unchanged because energy efficiency savings from improved traffic flow would be offset by tunnel ventilation energy requirements
- Tunnel ventilation and lighting represent the largest energy consuming activities for a tunnel
- Based on a total tunnel length of around 50 kilometres (twin 25 kilometre tunnels) and experience with a number of existing tunnels, the expected tunnel energy usage is expected to range between 70,000 and 340,000 megawatt hours per annum depending on the design and operational regime of the tunnel ventilation system. This is equivalent to the annual electricity consumption of around 11,000 and 56,000 households respectively.

Energy use in operating tunnel ventilation systems will vary between projects and is dependent on a number of factors. Appropriate performance-based air quality criteria will be
applied to WestConnex to ensure tunnel ventilation systems are designed and operated to meet air quality outcomes while minimising energy use.

Energy efficiency measures will be considered and incorporated into the design of tunnel ventilation, lighting and water management systems.

The Infrastructure Sustainability Council of Australia’s (ISCA) Infrastructure Sustainability Rating Tool Scorecard is generally used to score a range of sustainability indicators including energy efficiency. The scorecard will also be considered during design stages and planning for construction to establish specific requirements for energy use. This includes consideration of opportunities for using energy from renewable sources.

**Noise and vibration**

The *NSW State of the Environment 2012* report (EPA 2012a) notes that noise pollution is the second most common type of complaint received by the NSW Office of Environment and Heritage Environment Line.

The key noise challenge for WestConnex will be to construct major new infrastructure in a highly-congested urban environment, where much of the construction activity will be required to occur at night.

The key findings of the SER are:

- Construction noise is temporary but could impact on adjacent residences for significant periods of time due to the size of the construction task
- A large component of WestConnex will involve tunnelling therefore the potential for 24-hour noise and vibration issues from tunnelling techniques is possible.

The most common tunnelling techniques include road header, tunnel boring machine (TBM), rock hammering and drill and blast. There is good experience with the use of road header and TBM excavation techniques for tunnels in Sydney sandstone and the noise and vibration impacts are lower for these techniques. Rock hammering can cause significant regenerated noise and vibration. Drill and blast techniques typically generate higher noise and vibration impacts over short time periods, but they have been successfully used for limited cavern excavation in Sydney, including sites in proximity to sensitive areas. Further consideration would be given to this method of tunnelling as a balance between potentially more intense noise (but within acceptable levels) but reduced duration.

Construction noise impacts will be managed in accordance with the *Interim Construction Noise Guidelines* (DECC 2009a). Successfully managing construction noise impacts requires close consultation with the local community and proactive and responsive noise management measures. Where construction techniques are likely to result in higher noise impacts, significant additional engagement with the community and responsive management measures for sensitive receivers would be required.

Noise impacts resulting from the operation of the motorway will be assessed and managed in accordance with the *NSW Road Noise Policy* (DECCW 2011). Diversion of traffic into new tunnels is generally likely to reduce noise on some surface roads.

Detailed noise models will be prepared for each project and all reasonable and feasible mitigation measures will be incorporated into the road design to reduce noise impacts to sensitive receivers. Measures that may need to be considered include new or upgraded noise walls and noise treatment to buildings.

It is also expected that any new urban renewal development in the WestConnex corridor will be designed and constructed to address road traffic noise in accordance with clause 102 of *State Environmental Planning Policy (Infrastructure)* 2007.
**Socio-economic considerations**

WestConnex will connect the growth areas of Parramatta and surrounding western Sydney suburbs and areas in Sydney’s south west to key economic development areas in inner Sydney, including Sydney Airport and Port Botany.

The socio-economic assessment has been prepared as part of the SER to consider the potential impact of WestConnex on the following key strategic indicators:

- Productivity of business and industry
- Community health and safety
- Amenity and liveability
- Community facilities, community values access and connectivity.

The key findings of the SER are that WestConnex will:

- Impact positively on employment and economic growth in Sydney
- Improve access and connectivity to local centres and within and between suburbs. Some local access may be slightly less convenient for local traffic where surface motorway or interchange ramps are located within a new corridor
- Improve safety for road users, pedestrians and cyclists
- Improve access to social infrastructure and key community facilities including health, emergency services, open space and recreation facilities
- Improve liveability, amenity and provide opportunities for improved public transport access where traffic is transferred from existing roads to WestConnex
- Create social impacts due to the costs on the community and businesses of proposed tolling
- Cause temporary construction impacts on residents and businesses as a result of traffic disruption and amenity impacts
- Generate cumulative impacts and construction fatigue, particularly where projects overlap, due to a large and ongoing infrastructure construction project.

A range of mitigation and management strategies are proposed to offset the potential impacts. Many of these relate to appropriate consideration of access and connectivity throughout the design process. These considerations will also be implemented through the urban design strategy for WestConnex.

Close liaison with the community, State Government agencies and local councils will continue to be undertaken during design development to ensure that local community issues are appropriately addressed. A proactive community engagement program will continue to be implemented to identify and manage potential socio-economic impacts at a community level.

**Construction impacts on communities**

Given the scale and timeframe associated with WestConnex, construction issues are expected to be a challenge for the community particularly with respect to construction fatigue. Those locations where there are major project overlaps and/or interfaces will be of particular challenge.

Key construction stage cumulative issues are expected to include:

- Noise and vibration (particularly night time works)
- Local traffic impacts and accessibility
• Visual impact and amenity effects of construction compounds and associated sites and activities
• Spoil disposal and disposal routes.

The project-level environmental assessments will consider these issues from a cumulative impact perspective particularly with respect to noise, construction traffic, business disruptions and impacts on local amenity. Standard mitigation and management measures may require further strengthening. For example, more stringent night time noise controls may be required where communities have already been exposed to lengthy periods of disruption. These critical construction impact challenges will be identified and comprehensive construction management plans prepared as the projects progress through to the environmental assessment, detailed design and delivery stages.

**Other important environmental issues**

Other important environmental issues have also been identified and assessed at a strategic level. These issues are:

• Biodiversity
• Resource management
• Aboriginal heritage
• Non-Aboriginal heritage
• Climate change risk and adaptation
• Geology soils and water
• Hydrology/flooding
• Urban design, landscape and visual
• Land use and property.

Given the potential importance of these issues at the project level, each matter has been reviewed as part of this SER and, where relevant, overarching principles and performance outcomes were developed to ensure the issue is appropriately addressed at the project-level during assessment.

**Justification and conclusions**

WestConnex has been reviewed against core program objectives and justified on the basis of its strategic need and benefits, achieving its key objectives, absence of feasible alternatives and on the principles of Ecologically Sustainable Development (ESD).

In particular, WestConnex will deliver significant long-term benefits to the economic growth and development of NSW and to the nation. It will deliver substantial amenity benefits, improve the function of Sydney and will significantly improve traffic flow along key corridors.

This will provide an important catalyst for urban renewal in areas of the city that currently experience poor amenity due to excessive traffic on local and arterial roads.

There are likely to be several strategic environmental issues, but these will be able to be managed adequately and effectively through careful strategic planning, design development and delivery – using proven impact mitigation and management measures.

During construction some potential issues and impacts, while not unique to WestConnex, will potentially have a greater level of significance to the community due to its anticipated scale
and duration. Similarly, operational effects such as local and in-tunnel air quality will likely be of particular community interest.

There are unlikely to be any significant issues that cannot be effectively avoided, managed, minimised and/or mitigated to an acceptable level provided appropriate attention is given to defining clear and transparent performance outcomes at the project planning, design and delivery stages.

A proactive community and stakeholder engagement program is in place to ensure the project’s benefits, likely impacts and mitigation measures are clearly communicated. This will help to build confidence in the community about the management of environmental matters. All relevant government agencies will be engaged in identifying potential issues, developing practical outcome-based solutions and in proactively and transparently providing information to the community to inform project understanding and development.
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1 Introduction

1.1 Overview of WestConnex

WestConnex seeks to address the key challenges that road users in the Sydney region encounter on a daily basis, including:

- The missing link in the Sydney motorway network’s east-west spine created by the M4 Western Motorway (M4 Motorway) terminating at North Strathfield – constraining movements between Sydney’s west, its international gateways and key places of business
- Congestion, low travel speeds and unreliable travel times on the M4 Motorway, M5 East, Parramatta Road and in the Sydney Airport/Port Botany precinct that delay freight, public transport and add costs to business
- Poor urban amenity along Parramatta Road due to heavy traffic volumes and congestion throughout weekdays and on weekends.

WestConnex will be delivered in stages over a 10-year timeframe. The final staging of the scheme has been determined based on need, functional requirements for traffic management and funding availability.

Figure 1-1 shows the core elements of WestConnex.
Figure 1-1 Overview of WestConnex
1.2 Purpose of the Strategic Environmental Review

As part of the development of WestConnex, a Strategic Environmental Review (SER) initiated in 2013 aimed at:

- Reviewing, at a strategic level, the possible impacts of the total program, covering the full study area as potentially impacted
- Reviewing core project objectives with respect to meeting key environmental and social outcomes
- Providing a strategic framework to guide each of the individual projects comprising WestConnex including:
  - Overall justification
  - Policy issues associated with the assessment of impacts
  - Identification of potential long-term and cumulative impacts
  - Performance requirements and environmental outcomes
  - Strategic mitigation strategies and management measures.
- Consideration of the principles of Ecologically Sustainable Development (ESD) in the justification of the overall program.

In assessing impacts of the scheme, a methodology was developed to identify strategic priority issues and other important environmental issues (refer Section 5). This hierarchy was essential to ensuring that the SER provided a more detailed focus on the strategic priority issues for the program. A comprehensive assessment of all environmental issues for the individual projects will be provided through the project-based environmental assessments.

Development of the original SER involved consultation with key government agencies including NSW Department of Planning and Infrastructure (DP&I) (now Department of Planning and Environment, (DP&E)), NSW Health and NSW Environment Protection Authority (EPA). This engagement has continued since the release of the SER and will continue through future project phases.

The SER does not have a statutory basis nor is it intended to be a project priority setting or detailed environmental impact assessment. The SER is intended as a strategic consideration of environmental issues and possible constraints at a program level for input to the business case appraisal and the final delivery strategy.

Revision of the Strategic Environmental Review

The original SER was prepared in 2013. Since then, substantial further development has taken place on WestConnex including several key changes to the original Reference Scheme. These are described in Chapter 4.

There have also been developments in NSW Government policy including:

- The release of the Government’s State Priorities in September 2015
- The release of A Plan For Growing Sydney in December 2014 which replaced the Draft Metropolitan Strategy for Sydney to 2031
In addition, in January 2015, planning approval was granted for NorthConnex, a tolled motorway in twin nine-kilometre tunnels linking the M1 Pacific Motorway at Wahroonga to the Hills M2 Motorway at Carlingford.

This is the first major road tunnel project in Sydney since the Lane Cove Tunnel, which received planning approval in December 2002. In the intervening period, there has been a shift in the approach to the assessment of certain issues such as air quality.

WDA has reviewed the environmental assessment for NorthConnex and DP&E’s consideration of this, along with the planning approval to assess its potential implications for WestConnex.

In this context, the SER has been updated to ensure that appropriate consideration is given to all relevant environmental issues associated with delivery of the scheme.

There are no material differences in the outcomes of the original SER and this updated version apart from the changed regulatory position on in-tunnel air quality following on from the outcomes of the assessment of the NorthConnex project.

The updating of the SER has been carried out by the WDA. The original SER was initiated by the Sydney Motorways Project Office within Roads and Maritime Services, which has since been disbanded. References to SMPO have been retained where discussion refers to historical events.

The updated SER is a key input to the Updated WestConnex Strategic Business Case.

1.3 Consultation

WestConnex is one of the NSW Government’s major infrastructure projects. The NSW Government committed to WestConnex in response to a recommendation from Infrastructure NSW in the State Infrastructure Strategy in October 2012 (Infrastructure NSW 2012a). The commitment to this transformational project was underlined in the NSW Long Term Transport Master Plan (Transport Master Plan) in December 2012 (Transport for NSW 2012a).

1.3.1 Consultation leading up to release of the original SER

The original SER noted that development of the original business case for the NSW Government included:

- Identifying strategic issues by undertaking a research program involving community members, business owners, road users and stakeholders
- Reviewing issues raised associated with relevant current and previous motorway proposals along the M4 and M5 corridors
- Raising community awareness and providing information
- Holding targeted stakeholder and community discussions to seek ideas and opinions.

Consultation and research has found that the community and stakeholders have a high level of interest in the following strategic priority issues:

- Socio-economic
- Traffic and transport
- Air quality and tunnel ventilation
- Noise and vibration.

The issues raised in the initial rounds of consultation are summarised in Table 1-1.
Table 1-1  Summary of issues and considerations identified

<table>
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| Traffic and transport                  | • Impacts of existing and future traffic congestion and delays along the corridor.  
• Increased traffic volumes on local roads caused by changed access, road capacity and tolls.  
• Induced traffic caused by additional motorway capacity.  
• Impacts on existing public transport services, particularly buses.  
• Access for emergency services to incidents, particularly in tunnels.  
• Access to the many ‘urban villages’ and other employment, recreation, business and services destinations along the corridor.  
• Impacts of staged construction works and operations.  
• Road safety particularly in locations where there are limited breakdown lanes such as tunnels and viaducts.  
• Interchange locations and arrangements including increased travel distances and consideration of future land use and levels of traffic demand.  
• Potential changes to pedestrian and cycle access.  
• Levels of congestion on the motorway, at interchanges and on toll free alternative routes.  
• Need for coordinated improvements to public transport services being integrated with WestConnex.  
• Requested provision of wide travel lanes, rest areas and load checking locations for heavy vehicle operators.  
• Impacts for over dimension and high productivity vehicles needing to access key road transport delivery routes.  
• Need to improve peak hour and off peak access to Sydney Airport and the Port Botany precincts for passengers, freight and employees.  
• Need to better connect international gateways such as Sydney Airport with Sydney’s west using the M4 corridor. |
| Air quality and tunnel ventilation     | • Increased vehicle emissions (particularly from trucks).  
• Air pollution during operation and potential impacts on health particularly for communities close to ventilation outlet locations.  
• The potential for harmful air quality in any new tunnels.  
• Requests to address the perceived air quality deficiencies, including visible haze, in the M5 East tunnel.  
• Process for community and stakeholder engagement in finalising the locations of ventilation outlet and tunnel portals. |
| Noise and vibration                    | • Construction and operational noise impacts including on private properties and other sensitive receivers such as schools, recreation areas and places of worship.  
• Noisy out of hours works.  
• Blasting for tunnelling works.  
• Vibration impacts caused by tunnelling and operation on commercial and residential dwellings, particularly structures over 100 years old. |
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| Socio-economic                 | • Property acquisition and severance.  
• Amenity and associated impacts on property value during construction and operation.  
• Potential loss of parking for businesses during construction and operation.  
• Changing traffic patterns and impacts on the economies of smaller shopping precincts.  
• Relationship of the project with future growth areas.  
• Quality of life impacts caused by existing congestion and restricted ability to travel to other localities in the corridor.  
• Desire from local residents to return Parramatta Road to its former role as a ‘high street’ and destination for visitors.  
• Costs to businesses of the major congestion, low travel speeds and unreliable travel times.  
• Need for additional employment, accommodation, transport choices and community services for existing residents and the growing populations to be serviced by WestConnex.  
• Existing poor urban amenity along the Parramatta Road corridor due to heavy traffic volumes, low investment in the public domain and congestion throughout weekdays and on weekends.  
• Parramatta Road operating as a ‘natural barrier’ for pedestrians and road users isolating communities on either side.  
• Commercial road users manage the timing of their travel to minimise delays along the corridor.  
• Tolling being recognised as largely inevitable for WestConnex and needing to deliver value for money. |
| Energy efficiency              | • Potential limited availability of fossil fuels for future private vehicle use due to ‘peak oil’. |
| Climate change risk and adaptation | • Desire for infrastructure to be ‘future proofed’. |
| Landscape and visual           | • Visual impact on the landscape, views and residential properties from large infrastructure such as bridges, viaducts, noise walls and slots. |
| Land use and property          | • Opportunities for urban renewal in the inner west, including along Parramatta Road. |
| Contaminated land              | • Safe excavation and disposal of contaminated land along the corridor. |
| Non-Aboriginal heritage        | • The heritage value of residential areas and streetscapes along the corridor. |
| Process/justification          | • Alignment with whole of government planning initiatives such as long term transport plans and land use strategies.  
• Requests for more information about the project.  
• Requests for information on how stakeholders will be involved in the planning and delivery phases.  
• Requests for more definition on urban renewal and how this is enabled by motorways.  
• Role of other consent authorities in the planning and delivery process.  
• Broad support for WestConnex and a desire to see it operating as soon as possible. |
1.3.2 Consultation between September 2013 and April 2015

Further consultation has been carried out subsequent to the release of the original SER and has included the following activities to April 2015:

- **Letterbox drops:** Over 380,000 community update brochures have been distributed to residences and businesses.
- **Community consultation/information sessions:** Twenty five community information sessions have been held.
- **Static displays, staffed displays and environmental impact statement (EIS) public display/exhibition:** There have been more than 60 static, staffed and EIS public displays (including kiosks).
- **Information kiosks:** There have been over 9,500 visitors to the five information kiosks across Sydney (Parramatta, Burwood, Roselands, Hurstville, Royal Easter Show) and over 10,000 community update brochures have been distributed at the kiosks. In addition, 809 individuals have completed the WestConnex survey.
- **Email updates:** More than 30,000 email updates have been sent.
- **Stakeholder briefings and property owner meetings:** Around 500 stakeholder briefings and property owner meetings have been held (including property owner meetings, stakeholder meetings and other engagement activities).

Consultation has also been undertaken as part of the separate environmental assessments for the M4 East Widening project and King Georges Road Interchange Upgrade project with the issues and outcomes documented in the respective environmental approvals documents. Consultation activities included:

- Establishment of project information lines
- Establishment of separate project websites that were updated at key milestones during the environmental assessment (and which will be used to provide regular updates during construction)
- Preparation and distribution of community updates and project factsheets
- Community information sessions
- Government, council and industry stakeholder meetings and briefings
- Resident door knocks
- Consultation with special interest groups
- Meetings with affected property and business owners
- Staffed displays at local shopping centres
- Static displays at locations considered readily accessible to the community
- Media and newspaper advertising.

The range and nature of issues raised are broadly consistent with those identified in Table 1-1 but focused on the context of the respective projects and issues specific to those projects.

In April 2014, WDA released *WestConnex, Building for the Future: M4 East (Stage 1) Community Feedback Report* (NSW Government 2014c). This report outlines the consultation activities carried out during the M4 East concept design display period between late November 2013 and mid-February 2014. The purpose of the consultation was to develop an understanding of local community issues in order to take these forward for consideration.
during subsequent design development and in the environmental assessment, rather than during the formal statutory process when the EIS would be displayed.

The report provides a summary of feedback received via the project information line, project email, letters, community information sessions and other project meetings. The most common issues raised were:

- Property impacts, impacts on property values and property acquisition
- Impact on Ashfield Park and the residential areas of Homebush, Concord, Ashfield and Haberfield
- Air quality monitoring and concern about potential health impacts from tunnel and ventilation outlet emissions
- Lack of detail in the concept design particularly the location of project infrastructure and a request for more detailed information on traffic data and the business case
- Traffic modelling and traffic congestion
- Construction impacts including noise, vibration, dust and construction traffic impacts.

In November 2014, WDA announced the project, including the revised alignment for Stage 2, New M5 and interchange location in St Peters.

This announcement was supported by a comprehensive community engagement program, including:

- Distribution of community update and fact sheets
- Update to project website
- Email broadcast to subscribers
- Advertisements and flyer
- Four community information sessions
- Release of New M5 Project Overview
- Doorknocking of local properties
- Meetings and briefings
- Local business interviews and surveys.

1.3.3 Planned consultation

Consultation will continue during project development and will be aligned with the following project milestones:

- Prior to and during the exhibition of the M4 East (Stage 1B) EIS
- During project development and preparation of the EIS for the New M5.

1.3.4 Consultation during project construction

Consultation will continue during construction of the individual projects. This will occur via a project-specific Community Consultation Framework that will reflect the issues of the specific project and incorporate the relevant requirements of the planning approval for the project.

Key involvement activities and tools would include:

- Development and implementation of a detailed construction communications plan
• Notification of works (including targeted letterbox drops)
• A 24-hour project information phone line
• Transport Management Centre (TMC) communication channels; radio crosses and interviews, Variable Message Signs throughout the metropolitan network
• Live Traffic and Transport Info websites and TMC 24-hour Traffic Information Line
• Complaints management process
• Regular updates to the WestConnex website
• Newsletters, information brochures and fact sheets
• Clear signage at construction sites
• Media releases and project advertisements in local and metropolitan papers
• Construction updates (including for councils, emergency services and bus operators).

1.4 Structure of this report

Table 1-2 summarises the structure and content of this updated Strategic Environmental Review.

Table 1-2 Structure and content of updated SER

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<td>Describes the history of the development of the program and the alternatives considered.</td>
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<td>Provides descriptions of the individual projects comprising WestConnex, staging considerations and sustainability framework.</td>
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<td>Chapter 5 Methodology</td>
<td>Describes the methodology adopted for the SER including assessment methodology and selection of strategic priority issues and other important project level issues.</td>
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<td>Chapter 6 Assessment of strategic priority issues</td>
<td>Assessment of the strategic priority issues including traffic and transport; air quality and tunnel ventilation; energy efficiency; noise and vibration; socio-economic and construction impacts on communities.</td>
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<td>Chapter 7 Review of other important environmental issues</td>
<td>Assessment of other issues that would be important at the project level assessment stage.</td>
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<td>Chapter 8 Statutory planning</td>
<td>Outlines the statutory planning framework that currently applies to the individual WestConnex projects and notes the potential applicability of the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).</td>
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<td>Chapter 9 Justification</td>
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2 Strategic need

2.1 Why WestConnex?

WestConnex has been developed in response to a series of existing and anticipated future challenges that are routinely experienced by road users, businesses and the community who live and work in Sydney. These include a lack of connection to jobs, congested access to the airport and port facilities for travel or freight and disconnection of communities from services. Accordingly the development of WestConnex has focused on three core needs:

- Creating jobs
- Connecting communities
- Easing congestion.

2.1.1 Creating jobs

Importance of Sydney to the Australian economy

Sydney is Australia’s global city and its economic performance affects national prosperity and wellbeing, contributing more than 20 per cent of Australia’s GDP. Sydney is home to 43 per cent of Australia’s financial and insurance companies, more than half of the country’s top companies and is the regional headquarters of around 500 multinational corporations (RDA 2013). Sydney generates over 24 per cent of total economic output of NSW and employs over 2.2 million people (Infrastructure NSW 2012a, p44).

Sydney’s population is forecast to increase by 1.6 million to around 5.9 million people in 2031 with 900,000 of this population growth occurring in Western Sydney (DP&E 2014a). By 2031, Sydney’s economic output will almost double to $565 billion annually (Deloitte Access Economics 2012) and over 800,000 new jobs (Bureau of Transport Statistics 2014).

Sydney’s transport network underpins its economy and role as a global city. Improvements to the transport network in Sydney play a major role in responding to changes in employment and land use, increasing the reliability and productivity of the freight task and connecting people easily to their workplaces. In so doing, the transport network facilitates wellbeing through access to economic opportunity, reduced social exclusion and social disadvantage.

Economic significance of Sydney Airport and Port Botany

Sydney Airport moves around 36 million passengers and 650,000 tonnes of freight per annum. By 2033, these figures will increase to 75 million passengers and over one million tonnes of freight (SACL 2013). Almost 40 per cent of air passengers in the Sydney region are business travellers (Australian and NSW governments 2012).

The majority of access to Sydney Airport is by road based transport. Around 85 per cent of passengers use private cars, rental cars, taxis and shuttle-buses to access the airport (Australian and NSW governments 2012). Almost 80 per cent of airport employees commute by private vehicle and 94 per cent of ‘meeters and greeters’ access the airport by private vehicle (Australian and NSW Governments 2012). Landside access for all air freight is entirely road-based.

Several factors favour road transport to the airport. These include convenience when travelling with luggage, insensitivity to price where employers cover travel costs, shift workers travelling out of hours, public transport to limited destinations, and higher value, time
sensitive and often perishable freight. While mode share gains in public transport to Sydney Airport are expected with planned initiatives underway, demand for road travel will remain strong.

Port Botany throughput is forecast to grow from two million standard containers a year to seven million by 2031, an increase of 3.5 times (Transport for NSW 2012a, Infrastructure Australia 2012b). Around the port there is a high concentration of jobs relating to freight handling and supporting activities. Certain types of transport and logistics operators are attracted to the lower freight costs and faster connections that the port precinct offers. There are 2,500 jobs at the port and 11,000 in its surrounds. Around 75 per cent of jobs are in the freight generating sectors. Freight generating sectors include manufacturing, construction, utilities, wholesale and warehousing. This compares with about 15 per cent in the services sector.

There are three major trip patterns related to Port Botany reflecting travel between key economic activities:

- Longer trips between the port and freight hubs in Sydney’s west around the M4, M5 and M7 corridors, namely Chullora and Enfield to Silverwater, Western Sydney Employment Area, Moorebank to Prestons and Minto, Wetherill Park, Villawood, Bankstown, Blacktown to Seven Hills
- Short trips within the port/airport precinct east of the Princes Highway at St Peters, including empty container shuttling between storage parks at St Peters and adjacent to Port Botany
- Regional exports from across regional NSW, including the movement of empty containers from the metro area back to the regions for refill.

There are opportunities to shift more freight onto rail and this remains a priority for the NSW Government. However, assuming the target of doubling the share of container freight moved by rail is achieved by 2020, more than 70 per cent of Port Botany’s trade would still be moved by road, requiring investment in an efficient road network to support the port precinct.

**Supporting economic growth in the Global Economic Corridor and Sydney’s regional cities**

Sydney’s international gateways are part of the Global Economic Corridor (GEC), which extends northward through the CBD and on to Macquarie Park. The corridor provides for some 700,000 jobs, generates over 50 per cent of NSW’s total economic output (Infrastructure NSW 2012b) and attracts investment and people from around the region and the world (NSW Government 2013).

It is crucially important to serve the corridor not only with efficient connections to Sydney’s CBD, the international gateways and their surrounds, but also to ensure efficient and effective movement within and through the broader GEC itself.

Sydney Airport, Port Botany and Sydney CBD are co-located in the southern part of the GEC. In total, the corridor between Sydney CBD and the airport/port contains a total 530,000 jobs, which is forecast to grow to 735,000 by 2036, a 30 per cent increase. This represents around one-quarter of all of Sydney’s jobs. Of these, around 65,000 are in the immediate airport/port precinct in the south and 290,000 in the heart of Sydney’s CBD north.

Employment in the airport/port precinct is relatively dispersed compared to the CBD and other centres in the GEC, and generates high volumes of car-based trips. Around 60 per cent of journey to work trips in the precinct are made by car compared to only 25 per cent in the CBD (NSW Bureau of Transport Statistics 2012).

Strategically, it is also important to support the economic development of Sydney’s regional cities including Parramatta, Penrith and Liverpool. A Plan For Growing Sydney and the
Transport Master Plan both prioritise economic development in these centres to bring jobs closer to home. Transport access to and between these centres is a pre-condition for business investment and their economic development. In particular, a high quality road connection between Parramatta and the GEC would support Parramatta’s evolution as a potential second CBD for Sydney.

Moving freight and doing business on the road

While there are around 16,000 traffic movements across the three ‘port gates’ at Port Botany per day (Transport for NSW 2011), there are around 280,000 heavy commercial vehicle trips per day across Sydney (NSW Bureau of Transport Statistics 2010). For every import container, several further trips are generated as containers are emptied and their goods distributed.

A large share of traffic on Sydney roads is business related. Heavy vehicles are highly visible and comprise around 10 to 20 per cent of daily vehicles on motorways in Sydney. More notably, around 30 per cent of vehicles in the morning peak and 40 per cent during business hours are commercially registered (including heavy vehicles) on the M4 and M5 motorways. This is a similar case for Parramatta Road and General Holmes Drive (Transport for NSW 2011, Transport for NSW 2012a).

Road network investment will need to keep pace with this freight and business task to support economic productivity and to minimise congestion and business operating costs that impair growth and community wellbeing.

Tackling network constraints impinging on Sydney’s productivity

A key problem for Sydney’s road network is the underperformance of its east-west spine where the M4 Motorway terminates at North Strathfield. The absence of a high quality road network in Sydney’s inner west seriously constrains the efficiency of travel between major economic areas in Sydney’s GEC and its west.

The M4 Motorway ends 12 kilometres west of the CBD and 14 kilometres north-west of Sydney Airport and Port Botany – three of Sydney’s highest order land uses and trip generators. This missing link creates very high levels of congestion on Parramatta Road. This delays both long distance trips through to the east and local trips along and across Parramatta Road. As a result of this missing link, the south-eastern parts of the road network bear a much heavier traffic load than intended. Traffic uses the longer M4/Homebush Bay Drive/King Georges Road/M5 East route or M4/M7/M5/M5 East to travel south east and towards the airport/port precinct.

A second network constraint is congestion within the airport/port precinct, in part caused by a convergence of east-west and north-south travel with through local trips. This impairs high value freight and commercial trips to and from the airport and the port and the surrounding areas of Mascot, Green Square and Botany.

At present, General Holmes Drive, Southern Cross Drive and the two harbour crossings are stretched to provide both a north-south through function and a distributor function, providing access to intensive industries between the CBD and Sydney Airport/Port Botany.

These network problems fundamentally affect Sydney’s productivity causing travel on the network to be indirect, congested, and unreliable. While minor works or pinch point strategies will provide relief in the short term, a network approach to provide major new capacity will be needed for the coming decades.
2.1.2 Connecting communities

Forecast growth in three of Sydney's most constrained corridors

Strong population growth is forecast across Sydney, with population expected to grow to 5.9 million by 2031 (NSW Government 2014b). This strong growth in population will put added strain on a transport system that is already congested and will affect the three most constrained corridors of Sydney, the M4 Motorway, M5 East and the City to the Airport.

For the M4 corridor (spanning from the base of the Blue Mountains to the CBD), population growth will be the strongest, with around 123,000 new residents over the next 20 years. Employment is forecast to grow by 93,000 jobs. For the M5 corridor (from Campbeltown to Sydney Airport) some 113,000 new residents are expected, including some 52,000 new jobs. The city to the airport corridor will remain a job-rich part of Sydney with its population growing by around 86,000 new residents, and an additional 144,000 jobs.

New jobs will be attractive to those seeking new job opportunities that cannot be provided locally. While rail will continue to serve increasing demand for long distance trips to centres, the motorway and arterial network will continue to serve demand involving diverse and dispersed journey types.

Connecting residents in the west with jobs in the east

The NSW Long Term Transport Master Plan identified that Western Sydney is currently home to 47 per cent of Sydney's residents but only 37 per cent of Sydney's jobs (Transport for NSW 2012a). This disparity is due to a complex mix of factors including greater housing affordability in Sydney's west, and the existing employment zones and infrastructure that support stronger business investment and location decisions in the GEC and Sydney's eastern half more generally.

Despite strategic planning efforts, this will remain an ongoing challenge. Much of Sydney's population growth is expected to occur in Sydney's west, particularly the North West and South West Growth Centres. Jobs growth in Sydney's west, however, will not grow at the same pace.

This requires the transport network to serve a larger number of long distance trips between Sydney's west and east. It also means relatively more residents from Sydney's west travel to Sydney's east for employment, and spend longer on average commuting than their counterparts in Sydney's east. In 2006, around 170,000 work trips were made from Sydney's west to east, and only 75,000 in the opposite direction.

Consequently, nearly 85 per cent of people travelling to jobs in Sydney's west travel by car, compared with about 55 per cent of people travelling to work in Sydney's east. Residents in Sydney's west are far more car dependent. For example, a Campbeltown resident drives on average two and a half times the vehicle kilometres of an inner Sydney resident (Transport for NSW 2012a).

Connecting communities through urban renewal

The NSW Government has prioritised urban renewal to improve mixed income housing, housing affordability, employment access and public transport choice. A Plan for Growing Sydney seeks to support growth sustainably by planning major renewal and growth areas around existing and planned transport and road infrastructure (NSW Government 2014). Infill development brings people closer to jobs, and improves access to transport.

There is arguably no greater opportunity in Sydney for urban renewal than the Parramatta Road Corridor connecting the Sydney CBD and Parramatta. A Plan for Growing Sydney confirms the corridor will be a focus for increased housing, economic activity and social
infrastructure, especially around centres with good public transport access and amenity. An integrated land use and multimodal response will be required to service renewal of the corridor and to improve amenity in local movements along and across the corridor. As such, the urban renewal of the Parramatta Road Corridor relies initially on a major improvement to existing traffic conditions.

2.1.3 Easing congestion

Congestion costs impact on economic performance. It is estimated that congestion costs the NSW economy some $5.1 billion each year. By 2020, these costs will increase to about $8.8 billion (Transport for NSW 2012a). Around half of these costs are attributable to light commercial and heavy vehicles, with the other half to private vehicles. While light commercial and heavy vehicles are a smaller portion of the vehicle fleet, their value of time is greater and therefore the impact of congestion is more significant.

Congestion also reduces the safety of Sydney’s road network through highly urbanised areas. With lower-order roads forced to perform a higher-order function, road crashes and traffic incidents are more frequent. This impacts personal safety, property and performance of the road network.

Investing in major road infrastructure at the eastern end of Sydney’s M4 and M5 corridors and connecting them to key destinations in the city and airport/port precinct will ease congestion, enable more reliable travel, and will reduce the level of incidents on the road network, improving the safety of shorter, local trips on the arterial network.

2.1.4 Summary

In summary WestConnex will contribute to and support:

- The NSW and Australian governments’ priorities to improve the landside transport network that serves Sydney’s growing international gateways. This is critical to Sydney as Australia’s global city and to the efficiency of the GEC which underpins Sydney’s success
- The efficiency of moving goods and doing business in Sydney, supporting productivity and reducing transport and congestion costs by connecting key freight hubs, major centres, specialised precincts and households that rely on the flow of goods and services. This will also support key employment regions in Sydney’s west
- The evolution of a world class road transport network in Sydney. WestConnex will provide a connected and high quality motorway network. It will connect major places of economic activity and separate longer distance trips from arterial and local roads, freeing up capacity for local trips and supporting road safety, public and active transport and liveability
- Sydney’s growth, connecting residents in Sydney’s west with a wider range of jobs in Sydney’s east. WestConnex will improve access to jobs outside of centres, where public transport choice is limited and will bring jobs closer to where people live improving quality of life
- The transformation of the Parramatta Road corridor, reducing traffic and providing a catalyst for urban renewal and improved public transport opportunities.

The consequences of not proceeding with WestConnex are considerable. It would mean failing to go forward with a comprehensive and integrated land use and multimodal transport strategy that supports Sydney’s diverse transport needs to reinvigorate inner-city communities and drive long-term economic prosperity. Such a major investment in road
infrastructure will facilitate a step change in network performance and enable the delivery of a city transforming urban renewal corridor.

2.2 State planning context

In 2015, the NSW Premier announced a new set of State Priorities targeting growth and economic development. These include priorities of:

- Creating jobs
- Building infrastructure
- Encouraging business investment
- Boosting apprenticeships
- Improving road travel reliability.

These priorities provide a framework within which a number of plans and strategies that have been released by the NSW Government that reference WestConnex are considered. These include:

- NSW Long Term Transport Master Plan (Transport Master Plan).
- State Infrastructure Strategy (SIS).
- Rebuilding NSW, State Infrastructure Strategy 2014 Update (Rebuilding NSW).
- A Plan for Growing Sydney.

The NSW Long Term Transport Master Plan, the SIS (including Rebuilding NSW) and A Plan for Growing Sydney are the three major plans for shaping Sydney. Both the Transport Master Plan and the SIS identify WestConnex as critical to solving some of Sydney's major transport issues. Infrastructure NSW identified WestConnex as the highest priority project in the SIS.

2.2.1 NSW Long Term Transport Master Plan

The Transport Master Plan (Transport for NSW 2012a) provides a framework to deliver an integrated, modern transport system by identifying NSW’s transport actions and investment priorities over the next 20 years. Under this plan WestConnex is identified as a critical link in Sydney's motorway network and is an immediate priority for the NSW Government.

The Transport Master Plan recognises that WestConnex will support Sydney’s long term economic growth through improved motorway access and connections linking Sydney's international gateways including Sydney Airport and Port Botany and Western Sydney and employment areas across Sydney. Furthermore, it establishes that the program will relieve road congestion in the M4 and M5 corridors and increase capacity on these motorways for freight and heavy vehicle use, diverting these away from Parramatta Road. This will create opportunities for urban renewal along and around Parramatta Road, improving urban amenity along the corridor.

The Transport Master Plan includes measures that are complementary to WestConnex. These include:

- Implementation of a multi-modal package of improvements for delivery with WestConnex
- Development of integrated land use and transport outcomes to renew the Parramatta Road corridor in conjunction with the delivery of WestConnex
The multi-modal improvements will include complementary enhancements to the existing road network (including associated surface street changes, bus priority measures, heavy vehicle access improvement) redesign of bus services and facilities, improved access to rail stations and upgrades to cyclist and pedestrian facilities.

Renewal of the Parramatta Road Corridor (refer Section 3.2) will incorporate a number of the multi-modal improvements including upgrade of the strategic bus corridor along this route.

2.2.2 State Infrastructure Strategy

In September 2012 Infrastructure NSW delivered its State Infrastructure Strategy 2012-2032 to the NSW Government. This presented a 20-year strategy that identified and prioritised the delivery of critical public infrastructure to drive productivity and economic growth for NSW (Infrastructure NSW 2012a). Infrastructure NSW’s assessment of the State’s existing infrastructure highlighted critical deficiencies in urban road capacity and provided strategic options for delivery required to meet the challenges of population growth and substantial increases in freight volumes.

Infrastructure NSW identified that the most pressing investment needs were on the M4 and M5 corridors due to their importance to the freight and business transport tasks and connections to Global Sydney and the international gateways. WestConnex was identified as a critical program of work with a range of benefits including reducing congestion, providing opportunities for urban renewal along Parramatta Road, providing improved access to the major international gateways of Sydney Airport and Port Botany and improving industrial access and business efficiency along the M5 corridor.

In December 2012 the NSW Government released its State Infrastructure Strategy (SIS) (NSW Government 2012a), responding to the recommendations from Infrastructure NSW. The SIS identified the key deliverables and next steps in implementing WestConnex and design considerations which are reflected in the individual projects of the scheme.

2.2.3 State Infrastructure Strategy 2014

In June 2014, the NSW Government announced Rebuilding NSW, a plan to invest $20 billion in new productive infrastructure (NSW Government 2014a). Subsequently the Premier requested that Infrastructure NSW update its previous SIS advice to Government, taking the additional funding into consideration.

In November 2014, Infrastructure NSW presented its revised strategy which took into account the progress made in delivering new infrastructure as well as the additional funding available. Recommendations were made across all infrastructure portfolios including both transport and roads (Infrastructure NSW 2014).

Infrastructure NSW identified the value of augmenting WestConnex to provide greater north-south connectivity. The proposed northern and southern extensions would provide a western bypass of the Sydney CBD via a new ‘Western Harbour Tunnel and Beaches Link’ project, alleviating pressure on the existing north-south corridor of Sydney’s orbital network and reducing journey times from the city’s south. It recommended development of final business cases for the northern and southern extensions, with a view to procurement and delivery as toll roads within the next decade.

The NSW Government adopted all the recommendations made by Infrastructure NSW. The northern extension has been integrated into the realigned M4 – M5 Link project. The southern extension has become part of the Gateway to the South package of works as the Southern Connector project.
2.2.4 A Plan for Growing Sydney

A Plan for Growing Sydney (DP&E 2014) was released in December 2014 and replaced the Draft Metropolitan Strategy. A Plan for Growing Sydney is intended to guide land use planning decision-making for the next 20 years. It provides a framework based around four key goals to develop a competitive economy with world-class services and transport; to deliver greater housing choice to meet changing needs and lifestyles; to create communities that have a strong sense of wellbeing; and to safeguard the natural environment.

One of the plan’s goals is for a competitive economy with world-class services and transport. A Plan for Growing Sydney identifies a range of directions and supporting actions that are directly supported or complemented by WestConnex. These include enhancing capacity of Sydney’s gateways and freight networks, and expanding the Global Economic Corridor. WestConnex is also identified as contributing to urban renewal in the Parramatta Road Corridor through reducing through traffic on surface roads and allowing for significant improvements in local amenity.

2.2.5 NSW Freight and Ports Strategy 2013

The final NSW Freight and Ports Strategy (Freight and Ports Strategy) (Transport for NSW 2013a) was released in November 2013. The Freight and Ports Strategy sits alongside the Transport Master Plan and is a core component of NSW’s overall strategic planning framework. One of the objectives of the strategy includes delivering a freight network that efficiently supports the projected growth of the NSW economy.

The strategy includes an action to connect and complete Sydney’s motorway network including priority freight movements. It recognises that infrastructure provided through WestConnex will be a key component in expanding capacity on NSW roads which will provide benefits for freight movement, particularly around major freight activity centres including Sydney’s international gateways, Port Botany and Sydney Airport, which are concentrated around the M4 and M5 corridors.

2.2.6 Sydney’s Bus Future

Sydney’s Bus Future (Transport for NSW 2013c) is the NSW Government’s long term plan to redesign the city’s bus network to meet current and future customer needs through identifying short and longer term priorities for bus services across Sydney.

The Strategy identifies the Burwood to Sydney CBD via Parramatta Road corridor as a ‘Rapid bus route’ and key actions to facilitate the identified service improvements. The longer term actions include the provision of bus lanes on Parramatta Road to be completed in conjunction with WestConnex. The Strategy also flags improved bus services from Sydney Airport to the inner west, taking advantage of WestConnex to improve bus access across the Princes Highway.

2.3 National planning context

Infrastructure Australia provides support and advice to government, investors and infrastructure owners on issues regarding Australia’s current and future infrastructure needs, financing mechanisms, policy and pricing. Its goal is to adopt a national, strategic approach to infrastructure investment which addresses long-term social and economic objectives.

In the transport sector, Infrastructure Australia has identified large transformational projects on its priority list including integrating Sydney’s Motorway network and development of a Port Botany and Sydney Airport Transport Improvement Plan (NSW Government 2011) (which incorporates the M4 East extension and the M5 East upgrade (now the New M5) projects). In
2013, WestConnex was rated on Infrastructure Australia’s *Infrastructure Priority List Update* (Infrastructure Australia 2013) as ‘Early Stage’. In its 2014-2015 Assessment Brief, the recommended rating for WestConnex had changed to ‘Threshold’ (Infrastructure Australia no date).

In the 2012-13 Federal Budget, the Australian Government provisionally committed up to $25 million to the NSW Government to establish a Special Purpose Vehicle to develop motorway projects for Sydney (Infrastructure NSW 2012b). As a result, SMPO was established in late 2012 with responsibility for development of WestConnex and other motorway projects (SMPO has since been disbanded and responsibility transferred to WDA). Further funding has been made available by the Australian Government in the form of $1.5 billion in grant funding and a $2 billion concessional loan.

### 2.3.1 The National Urban Policy


*Productivity*

WestConnex is intended to play a key role in supporting economic growth and productivity by improving freight, commercial and business efficiency through reductions in congestion, better access to international gateways at Sydney Airport and Port Botany and better connected centres.

*Sustainability*

Sustainability is an important consideration that underpins all transport planning. By facilitating urban renewal, WestConnex can improve the ability of communities to utilise space more efficiently through densification, limiting the spatial expansion of the city. Densification supports the viability of public transport in existing areas.

Reducing congestion and through traffic in a number of communities will enable road space to be reallocated to public transport and has the potential to improve air quality in these areas. WestConnex presents major opportunities in the Parramatta to Sydney CBD corridor.

In 2015, WDA and Sydney Motorway Corporation formalised the WestConnex Sustainability Strategy, which describes how sustainability considerations will be integrated into planning, construction and operation of the scheme (refer Section 3.5). The Sustainability Strategy includes clear commitments and targets across a range of sustainability issues such as sustainable procurement, climate change adaptation, energy use, greenhouse gas emissions, water, waste, materials use, land, ecology, community health, urban design and workforce training and employment.

*Liveability*

Through addressing traffic on surface arterial roads, WestConnex will facilitate urban renewal and contribute to improved liveability, particularly in the Parramatta to Sydney CBD corridor. WestConnex has the potential to play a key role in facilitating social inclusion, by providing better access to employment locations and connecting people to social and cultural hubs.

*Governance*

A multi-agency steering committee for WestConnex has been established. It includes representatives from a number of NSW Government agencies and Federal representatives,
representing all aspects of the proposal. WestConnex is being developed under this governance structure.

2.3.2 National Ports Strategy

Infrastructure Australia together with the National Transport Commission developed the National Ports Strategy in 2011 (Infrastructure Australia 2010). This outlines the actions needed to facilitate trade growth and improve the efficiency of port-related freight movement across infrastructure networks delivering:

- Investment certainty, facilitating capacity expansion
- Efficient supply chains
- Timely and efficient approvals.

The National Ports Strategy provides valuable context for WestConnex and illustrates the need for improvements to the supply chain operating from Port Botany. WestConnex is intended to provide the ‘missing link’ on Sydney’s primary road freight network between the Port Botany precinct and Sydney's central west facilitating additional capacity on Sydney’s busiest freight and commercial road corridors. WestConnex will deliver improved land side transport capacity for Port Botany, as well as contribute to improved accessibility improving the productivity of national exports.

2.3.3 National Land Freight Strategy

Infrastructure Australia issued a discussion paper on a National Land Freight Strategy in 2011 (Infrastructure Australia 2011) and an update in 2012 (Infrastructure Australia 2012b) and sought formal submissions from industry and government on a range of issues. The purpose of considering a National Land Freight Strategy is to improve Australia’s productivity and economic performance through the efficient and reliable movement of goods through supply chains.

WestConnex is a project of great strategic importance for Sydney, NSW and Australia. It encompasses a long-term capital works program and requires the financial resources of the NSW and Federal governments as well as the private sector.

Therefore, the key alignment with the actions considered within the National Land Freight Strategy at this stage relates to the need for a long-term and targeted funding approach that considers a combination of Government and user-pays funding to support the delivery and ongoing maintenance and operations of this infrastructure.
3 Development of WestConnex

3.1 Background

WestConnex has evolved from a number of earlier schemes aimed at enhancing capacity and connecting the M4 and the M5 motorways. These have been integrated into a single streamlined scheme that addresses the objectives of the earlier schemes and provides for a staged development to provide progressive benefits.

WestConnex will also provide better connectivity than these previous schemes to large job centres and more efficient and effective freight movements to the airport and Port Botany precincts.

3.2 Relationship to other strategic plans and programs

As noted in Chapter 2, WestConnex is a key component of the NSW Long Term Transport Master Plan, the SIS and A Plan for Growing Sydney. WestConnex is also complementary to the following other strategic plans and programs:

- Parramatta Road Urban Transformation Program
- Sydney Airport – WestConnex Enabling Works
- Sydney Airport Master Plan 2033.

**Parramatta Road Urban Transformation Program**

In September 2015, UrbanGrowth NSW released the Draft Parramatta Road Urban Transformation Strategy, a 30-year plan outlining the revitalisation and growth plans for the 20 kilometre Parramatta Road corridor.

The vision, principles and strategic actions of the draft strategy will contribute to a future Parramatta Road corridor that is home to:

- 40,000 new homes for up to 70,000 people, close to transport and services
- Workplaces for productive and prosperous businesses that support 50,000 new jobs, with a focus on investment to support emerging employment generating industries in the corridor’s west
- Eight thriving precincts, each with diverse spaces and places, convenient walking and cycling paths, new housing and transport options and shops, services and workplaces
- Better public transport, the ability to walk or cycle, and easier ways to travel east-west and north-south.

**Sydney Airport – WestConnex Enabling Works**

The NSW Government is planning to upgrade roads around Sydney Airport and remove the General Holmes Drive level crossing. This will improve the movement of freight trains servicing Port Botany and improve traffic flow and access to the airport, Port Botany and, in the future, WestConnex. Upgrades are proposed in three precincts:

- **Airport east precinct**, in the area covering Wentworth Avenue, Botany Road, Mill Pond Road, Joyce Drive and General Holmes Drive, Mascot.
• **Airport west precinct**, in the vicinity of Marsh Street, Arncliffe.
• **Airport north precinct**, in the vicinity of O’Riordan Street, Mascot.

The key features of the proposed upgrade for the Airport east precinct will comprise:

• Widening of a key section of Joyce Drive (near the Domestic Terminal) to three lanes in each direction.
• Removal of the rail level crossing at General Holmes Drive with a road underpass to improve the movement of rail freight and improve access to the Airport.
• Improvements to two major intersections on Mill Pond Road to support future growth and access to the Airport.

The key features of the proposed upgrade for the Airport west precinct will comprise widening of Marsh Street and provision of a dedicated cycleway on the southern side of Marsh Street.

The proposed upgrades will complement Sydney Airport’s upgrades to the on-airport road network.

**Sydney Airport Master Plan 2033**

The Sydney Airport Master Plan 2033 (Airport Master Plan) (SACL 2014) establishes the strategic planning framework for the development and operation of the airport to 2033. Passenger forecasts indicate growth from 36.9 million passengers in 2012 to 74.3 million passengers in 2033. Once complete, the development will:

• Integrate the terminals for international and domestic/regional passengers
• Enhance airline efficiency and maximise flexibility to meet changing demand
• Provide greater opportunities for aircraft accommodation
• Optimise the land use within the airport
• Create transport interchanges to facilitate fast affordable and reliable access to transport.

Through the Airport Master Plan, Sydney Airport Corporation Limited (SACL) is committed to:

• Enabling reliable, sustainable and cost-effective transport options.
• Providing public transport facilities within airport precincts and increasing public transport mode share.
• Providing additional car parking facilities to meet growing demand.

The Airport Master Plan includes a number of road changes on surrounding roads to improve traffic flow in and around the airport. These include a new one-way road configuration for the T2/T3 precinct providing a dedicated entrance and exit road to the precinct exiting to Robey Street. Consultation is ongoing with WDA and Roads and Maritime Services to integrate with WestConnex to provide more reliable journey times to and from western Sydney and the CBD.

### 3.3 Sustainability

WDA recently released the WestConnex Sustainability Strategy that describes how sustainability considerations are integrated into the planning, construction and operation of the scheme.
WestConnex’s overarching sustainability objectives are to:

- Demonstrate sustainability leadership and continual improvement
- Protect and enhance the natural environment and local heritage
- Contribute to liveable communities (ease congestion, connect communities, integrate land use and transport planning and facilitate urban revitalisation)
- Optimise resource efficiency (materials, energy, water, land) and waste management
- Increased resilience to future climate
- Design allows for future transport needs (transport modes, extensions, access points)
- Sustainable procurement – whole of life environmental, social and economic considerations
- Maximise equitable training and employment opportunities.

The Strategy includes clear commitments and targets across a range of sustainability issues such as sustainable procurement, climate change adaptation, energy use, greenhouse gas emissions, water, waste, materials use, land, ecology, community health, urban design and workforce training and employment.
4 Description of WestConnex

WestConnex is a motorway scheme that will be delivered in three stages. WestConnex provides for northerly and southerly extensions of the Sydney motorway network, and enhancements around the north of Sydney Airport to connect to Port Botany. This is consistent with A Plan for Growing Sydney and the vision set out for Sydney motorways in the NSW Long Term Transport Master Plan and the SIS.

The three stages that comprise WestConnex are summarised in Table 4-1 and described in the following sections. Refer to Figure 1-1 for an overview of the scheme.

<table>
<thead>
<tr>
<th>Table 4-1 Summary of the core elements of WestConnex</th>
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<tbody>
<tr>
<td><strong>Stage</strong></td>
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<td><strong>Stage 1</strong></td>
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<td><strong>Stage 2</strong></td>
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<td><strong>Stage 3</strong></td>
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</table>

* Distances are approximate and will depend on options selected, staging, tie in and design.

4.1 Urban renewal

A major objective of WestConnex is to create and facilitate opportunities for urban renewal, improved liveability and transport improvements, primarily along and around Parramatta Road corridor but also in other areas. Planning for urban renewal will be carried out concurrently but under a separate process by UrbanGrowth NSW with DP&E.

4.1.1 Parramatta Road Corridor

Parramatta Road is the principal route connecting Sydney’s two most significant business districts (Sydney CBD, Parramatta), particularly between Sydney CBD and Strathfield where the M4 Motorway currently terminates. In addition to serving as a transport thoroughfare, Parramatta Road is a business corridor and acts as a link between the many places and communities along its length.

Since it was first built over 200 years ago, traffic volumes along Parramatta Road have increased with the growth of Sydney and have contributed to a decline in other activities along the corridor. A number of upgrades have occurred, but these have delivered short-ter, congestion relief.
Now, with up to 100,000 vehicles using the road daily, street level activity has progressively declined to varying degrees along the corridor and is reflected in erosion of commercial activities and greatly reduced amenity.

WestConnex will change the mix of surface traffic volumes by reducing and diverting through traffic as well as heavy vehicles travelling to Port Botany. The reduced congestion will provide an opportunity to increase liveability and productivity of the Parramatta Road corridor.

Traffic analysis indicates that by itself, WestConnex will reduce traffic demand on Parramatta Road by up to 45,000 vehicles on an average weekday.

Parramatta Road will be transformed from primarily a transit corridor, becoming a local access route and more liveable street, while remaining well connected to Sydney’s economic, social and cultural assets. UrbanGrowth NSW (2015) estimates that by 2050, up to 50,000 new dwellings could be delivered in the Parramatta Road corridor, supported by up to 50,000 new jobs.

4.1.2 Other urban renewal opportunities

In addition to the Parramatta Road Corridor, WestConnex is anticipated to support urban renewal in other locations including The Bays Precinct, Cooks Cove Specialised Centre, and the Greater Parramatta to Olympic Park Priority Growth Area.

The Bays Precinct is centred around Rozelle Bay and Blackwattle Bay. UrbanGrowth NSW is leading the whole-of-government approach to the revitalisation of the precinct through The Bays Precinct Urban Transformation Strategy, a 30-year strategy that will focus on the transformation of 50 hectares of land that is currently largely underutilised.

The M4–M5 Link will include an interchange at Rozelle to connect to City West Link, Victoria Road, the Anzac Bridge and the future Western Harbour Tunnel and Beaches Link project.

WestConnex Delivery Authority has been working with UrbanGrowth NSW to facilitate good urban development outcomes, balancing these with the operational requirements of the interchange, tunnel portals and related infrastructure.

The Cooks Cove Specialised Centre in the Rockdale local government area is adjacent to the WestConnex Stage 2 alignment. Construction of WestConnex is anticipated to provide greater certainty to medium and long term land use planning in this area.

The Greater Parramatta to Olympic Park Priority Growth Area will support businesses, improve the viability of expanded public transport, and revitalisation of the Parramatta CBD. The delivery of this growth area will be complemented by the additional road capacity provided by WestConnex.
5 Methodology

5.1 Overview

There are numerous methodologies and approaches to undertaking a strategic environmental review. In many ways the approach is similar in form and content to what is more formally recognised as a Strategic Environmental Assessment (SEA).

In broad terms, Therivel (2004) identifies a number of key elements that should make up a Strategic Environmental Assessment. These include:

- Should be a tool to improve the strategic action
- Promote participation of other stakeholders on sustainability and environmental issues
- Provides a focus on key environmental/sustainability outcomes, thresholds and limits at the appropriate plan making level
- Not be aimed at a detailed environmental assessment or a giant collection of base line data which does not focus on key issues
- Help to identify the best option and help assess alternative plans
- Aim to minimise negative impacts, optimise positive impacts and compensate for the loss of valuable features and benefits
- Apply the precautionary principle, that is, if the value of the development and impact are uncertain there should be the presumption of protecting what exists
- Mitigation should not take the form of an end-of-pipe solution rather be about strategies to manage actions, changing the action, influencing other organisations responses to actions
- Ensure actions do not exceed limits beyond which irreversible damage from impacts may occur. It therefore requires identification of such limits.

The methodology for the original SER aimed to be consistent with these key elements outlined by Therivel. This has not been changed for the updated SER.

5.2 Approach to the strategic environmental review

The overall approach to the SER is shown in Figure 5-1 with the key steps described as follows.
Figure 5-1  SER methodology flowchart
5.2.1 Identify goals, objectives and assessment criteria for WestConnex

The first step in the process was to identify the objectives and goals for WestConnex. This allowed a natural step to then be undertaken to identify assessment criteria. Goals and objectives for the overall scheme were first identified and these then led to more specific objectives for transport, environment, consultation and urban design.

5.2.2 Developing a list of potential priority strategic issues

In a traditional project environmental assessment approach identification and development of strategic environmental issues typically requires a detailed understanding the existing environment, including potential baseline investigations across a range of evident human and biophysical issues. For the SER process the information for the baseline environmental conditions was established through review of broader level strategic documents relevant to regional, state, national and global levels and included the following:

- State of Australian Cities 2012
- Action for Air
- NSW State of the Environment Report 2012
- NSW 2010 State of the Catchments Report (Sydney Metropolitan area)
- First things first – State Infrastructure Strategy 2012 to 2032
- Draft Metropolitan Plan for Sydney 2031
- NSW Long Term Transport Master Plan
- Department of Planning and Infrastructure subregional planning strategies (Central, West Central, South subregions).

For completeness the issues identified from strategic baseline reports were supplemented with other typical key issues based on experience with other major infrastructure projects situated in an urban context. The resultant list of potential strategic issues is shown in Appendix A – Table A.1.

While the Draft Metropolitan Plan for Sydney 2031 has since been superseded by A Plan For Growing Sydney, it is considered that there have been not been any substantive changes that would have material bearing on the SER analysis.

5.2.3 Screening process for prioritising strategic issues for further assessment

The next step was to determine priority strategic issues for further assessment from the long list for further assessment. Key factors in deciding what made an issue a strategic priority issue were as follows:

Relationship to core project objectives

An issue that could potentially impact on any of the core WestConnex objectives was considered as a strategic priority issue as it could have a bearing on the overall outcome and on a decision to proceed.

Highly sensitive issue with the community involving multiple government regulators

An issue that has been highly sensitive with the community on similar past projects and involves many government agencies in its assessment and regulation was considered to be a strategic priority issue.
Impacts could potentially occur over a much larger scale (regional, state, national or global level)

In keeping with the higher level principles of ESD and cumulative impact, any issue that could impact on the environment at a global, state or, as a minimum, regional area level was included as a strategic priority issue for further assessment.

Likely to be a potential key issue for all projects with potential for cumulative impacts

If an issue was identified as a key issue for all WestConnex projects then it will also represent a strategic priority issue for further assessment given the possibility of broad cumulative impacts.

Where environmental baseline stress/pressures are currently very high in the study area

As indicated in the literature, strategic assessment can be more effective in addressing cumulative impacts as it considers issues at a much broader level. Should a single project trigger an issue that will potentially impact on current environmental base-line pressures or stress points, it was considered to be a strategic priority issue for further assessment.

5.2.4 Shortlisting of priority strategic issues

Each of the issues was then screened through the process described above. This process is summarised in Table 5-1 with the resultant strategic priority issues (in no particular order) identified as follows:

- Traffic and transport
- Air quality including tunnel ventilation
- Energy efficiency
- Noise and vibration
- Socio-economic impacts
- Construction impacts on communities.

Further details on the rationale for selection of these as strategic priority issues are provided in Chapter 6.

A number of other important environmental issues have also been identified comprising biodiversity, resource management, Aboriginal heritage, non-Aboriginal heritage, climate change, geology soils and water, hydrology/flooding, urban design (including visual and landscape), land use and property. These issues are not considered to be of strategic priority taking into account the specifics of WestConnex, the existing environmental baseline situation and the ability to implement known management measures at the project level. Given the potential importance of these issues at the project level, each was reviewed and where relevant overarching principles and performance outcomes developed to drive consistent environmental performance and outcomes.

Further discussion on other important issues is provided in Chapter 7.

5.2.5 Scoping of priority strategic issues

Scoping of the assessment for the strategic priority issues was based firstly on a review of relevant baseline documents (refer to Section 5.2.2). General scoping requirements for strategic priority issues comprised:
• Strategic background/context and trends which included a description of the current study area situation with reference to relevant strategic environmental baseline documents
• Identification of strategic indicators
• A review which included a strategic assessment of the impacts of WestConnex on the relevant indicators and trends
• Identification of relevant strategic mitigation and management strategies
• Identification of project-level performance outcomes.

Scoping for the assessment of strategic priority issues was also tested in a number of technical workshops process involving the key government agencies whom will be expected to have a core regulator involvement in WestConnex, namely the EPA, NSW Health and DP&I (now DP&E).

Based on the issues raised at the agency workshop and others as identified by the study team, the resultant scoping requirements identified for the strategic assessment for each priority issue is described below.

Traffic and transport
The scoping requirements for traffic and transport were:

• Outline the transport context and drivers for WestConnex
• Assess the changes in traffic flow and composition on the Sydney arterial network with and without WestConnex
• Identify travel time savings with WestConnex along major routes
• Identify the change in traffic levels along the Parramatta Road corridor and the opportunities this creates for an improved urban environment.

Air quality including portal emissions
The resultant scoping requirements identified for the strategic assessment of air quality were:

• Regional/study area air shed review with and without WestConnex at an appropriate base year then at some time after full opening and operation
• Ventilation outlet (stack) emissions and performance requirements
• In-tunnel health impacts including consideration of visibility indicators and other air quality goals
• In-tunnel health impacts considering multiple tunnel use and hence longer exposure time to in-tunnel pollution.

Energy efficiency
The scoping requirements identified for the strategic assessment of energy efficiency were:

• Fuel use (construction and operation)
• Energy consumption – operation (street lighting, traffic signals, ventilation systems)
• NSW Government sustainability policies (including targets and strategies to improve Government efficiency in use of water, energy and transport)
• Green energy requirements for construction
- Renewable energy requirements.

**Noise and vibration**

The scoping requirements for the noise and vibration assessment were:

- Discuss the context of noise and vibration in relation to industry standards and broader public health considerations
- Identify how operational noise will be dealt with for specific components of WestConnex in accordance with the *NSW Road Noise Policy* (DECCW 2011) and other relevant guidelines
- Evaluate construction noise and vibration issues with specific reference to various tunnel excavation techniques and spoil haulage.

**Socio-economic**

The scoping requirements identified for the strategic assessment of liveable communities were:

- Land use integration, including optimisation of economic and community benefits from urban renewal
- Impacts on social infrastructure, including the impact on state/regional level social infrastructure (sport and recreation, health care, education) and changes in access to state/ regional level social infrastructure (improved or reduced access to these facilities)
- Community health and safety, including improved road safety for major arterials and local roads (through reduced rat running), and changes in community perceptions about health (due to changes in air quality, noise, location of ventilation outlets, increased surface road traffic)
- Changes in amenity, including changes in air quality/noise through reduction/improved flow of surface traffic
- Changes in urban amenity (‘gateway’ to city/airport and visual amenity)
- Access and connectivity, including changes to access and connectivity (potential to reduce/increase severance of communities) and opportunities for improved access for pedestrians, cyclists, and public transport users.
<table>
<thead>
<tr>
<th>Potential Issue</th>
<th>Factors assessed to determine strategic priority issue status</th>
<th>Key Strategic Issue</th>
<th>Key project issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic and transport</td>
<td>●</td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>Air quality and tunnel ventilation</td>
<td>●</td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>Energy efficiency and greenhouse gases</td>
<td>●</td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>Noise and vibration</td>
<td>●</td>
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<td>✔</td>
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<tr>
<td>Socio-economic</td>
<td>●</td>
<td></td>
<td>✔</td>
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<tr>
<td>Construction impacts on communities</td>
<td>●</td>
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<td>✔</td>
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<tr>
<td>Biodiversity</td>
<td>●</td>
<td></td>
<td>✔</td>
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<tr>
<td>Resource management</td>
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<tr>
<td>Aboriginal heritage</td>
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<tr>
<td>Non-Aboriginal heritage</td>
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<tr>
<td>Climate change resilience and vulnerability</td>
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<tr>
<td>Geology, soils and water (including contamination)</td>
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<tr>
<td>Hydrology and flooding</td>
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<tr>
<td>Urban design, landscape and visual</td>
<td>●</td>
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<td>✔</td>
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<tr>
<td>Land use and property</td>
<td>●</td>
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<table>
<thead>
<tr>
<th>Symbol Explanation</th>
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</thead>
<tbody>
<tr>
<td>● Potentially significant impact on strategic factor</td>
<td>Important issue but assessable at project level</td>
</tr>
</tbody>
</table>
Construction impacts on communities

Given the scale and timeframe associated with delivery of WestConnex, construction issues will need to be carefully managed to reduce impacts on the community, particularly with respect to construction fatigue.

Key construction stage cumulative issues to be assessed would include:

- Noise and vibration (particularly night time works)
- Local traffic impacts and accessibility
- Visual and lighting impacts and amenity effects of construction compounds and associated sites and activities
- Spoil disposal and disposal routes.

In particular cumulative impacts where there are major project overlaps and/or interfaces will be of particular challenge for community acceptance.
6 Assessment of priority strategic issues

6.1 Introduction
This section provides a strategic assessment of the priority issues as determined through the methodology outlined in Chapter 5. It also provides a guide to the project-level assessments including identification of potential long-term and cumulative impacts, performance requirements, expected environmental outcomes, mitigation strategies and management measures. Key challenges identified for each of the strategic priority issues have been highlighted at the beginning of each issue discussion.

6.2 Traffic and transport

WestConnex is a transformative urban motorway project and will provide improved access from the western and south western parts of Sydney to the inner west and central Sydney and to key destinations such as Sydney Airport and Port Botany. It will also reduce existing traffic congestion on the M4 and M5 motorways. Key benefits include: improved traffic efficiency, enhanced productivity of commercial and freight generating land uses, improved motorway access, improved road safety and improved liveability through transport improvements that cater for dispersed and diverse travel demands.

Transport planning and traffic management will be a critical consideration during the planning, design and delivery of each component of WestConnex.

Construction traffic is likely to be highly visible and particular consideration will need to be given to innovative construction traffic management solutions wherever available and feasible. This will be necessary to minimise impacts of construction traffic and reduce the risk of construction fatigue resulting from substantial construction activity in densely developed urban areas over many years.

6.2.1 Strategic background and context

Sydney’s strategic road network

Sydney has a complex transport network that must meet increasingly complex travel demands due to:

- The diversification of places of employment
- Urban infill and higher density housing within existing areas
- The ongoing spatial expansion of Sydney’s fringe.

Sydney’s transport network already services a population of 4.5 million people with some 15.5 million trips on an average week day. There is a large diversity in travel purposes. Commuters make up around 20 per cent of trips across an average working day. Even in the morning peak, this percentage only increases to around 29 per cent of trips. This highlights that while the road network is important in supporting commuting to work, it serves a diverse range of other purposes, many of which are not ideally served by public transport.
Sydney’s strategic road network operates as a network of motorways, which are supplemented by a number of key arterial routes.

Generally the motorways form an orbital ring road for Sydney and currently consist of route M1 (Sydney Harbour Tunnel and the Eastern Distributor), M2 Motorway (known as M2 Hills Motorway), the M5 Motorway (known as the M5 South West Motorway and the M5 East) and the M7 Motorway (known as Westlink M7) with the M4 Western Motorway providing the main east/west spine through the middle. The supplementary arterial routes generally run in a north-south direction and consist of the following:

- Route A3 (King Georges Road, Roberts Road, Centenary Drive and Homebush Bay Drive)
- Route A6 (extends from Pennant Hills Road/M2 Motorway in the north to Princes Highway/Heathcote Road in the south and includes Silverwater Road, St Hilliers Road, Rawson Street, Olympic Drive, Joseph Street, Rookwood Road and Fairford Road)
- Route A36 (Princes Highway)
- Route A28 (Cumberland Highway).

The Sydney strategic road network is illustrated in Figure 6-1.

The M4 Motorway and M5 Motorway corridors provide important and strategic access between Sydney’s east and west and south west. The M5 East in conjunction with the Eastern Distributor also provides improved access between the CBD, the lower North Shore and south-west of Sydney.

The M4 Western Motorway currently connects the Blue Mountains in the west, with Parramatta Road near Concord Road, in the east. From Concord Road at Strathfield, travellers can access Sydney’s CBD, the inner west and eastern suburbs via Parramatta Road and the City West Link. It carries around 100,000 vehicles per day, with about 10 to 20 per cent heavy vehicles. Significant traffic delays are experienced inbound in the AM peak period in the western sections of the motorway from Woodville Road to beyond James Ruse Drive. The limited capacity of the stretch between James Ruse Drive and Silverwater Road is recognised as being a significant pinch-point in the effective capacity, congesting throughput further along the motorway.

Critically, the M4 Motorway currently terminates at Strathfield, 12 kilometres west of the CBD. In the absence of a high quality motorway link to the east, vehicles – including a large proportion of heavy vehicles – are currently using the M5 East and key arterial roads such as Parramatta Road and King Georges Road, which adds to congestion in the corridor.

The M5 connects Sydney Airport and Port Botany with other sections of the wider network, including King Georges Road, the M31 Hume Motorway/Highway (which leads to Canberra and Melbourne) and the M7 Motorway (connecting the Western Sydney Employment Area). It also connects to the M1 leading (via the Eastern Distributor and Pacific Highway) to the northern NSW coast and Brisbane.

Weekday traffic volumes on the M5 Motorway corridor routinely exceed 100,000 vehicles per day resulting in congestion and delays in peak hours. Due to the levels of congestion in this corridor, incidents on the motorway cause high levels of congestion with resultant diversions of traffic putting further pressure on the surrounding road network.
Figure 6-1 Sydney strategic road network

Source: NSW Long Term Transport Master Plan, (Transport for NSW 2012a)
The main operational constraints on the M5 East are as follows:

- Traffic entering and merging onto the M5 Motorway at major interchanges causing slowing and congestion on the motorway, particularly at Marsh Street, Kingsgrove Road and King Georges Road.
- Currently a contra flow lane operates on the southbound carriageway of General Holmes Drive through the airport tunnel in the morning peak to cater for the northbound traffic volumes and provides easier access to Foreshore Road.
- The steep grade leading to the exit of the westbound M5 East tunnel impacts on travel speeds, particularly of heavy vehicles, which limits traffic capacity. In the same area, vehicles exiting to Kingsgrove Road generally travel in the right hand lane, further impacting on capacity.
- Key arterial roads on the surrounding road network, including General Holmes Drive and Airport Drive, are operating at or near capacity with limited opportunity for widening.

Incidents on the surrounding road network cause congestion, occasionally resulting in the closure of the M5 East tunnel. Major incidents in the tunnels may also require the closure of one or both tunnels to ensure the safety of the emergency services attending incidents.

Additional arterial roads parallel to the M5 East Motorway include Newbridge Road/Milperra Road/Canterbury Road/Stanmore Road (route A34) and Henry Lawson Drive/Stoney Creek Road/Forest Road. These roads are also congested for substantial periods of the day, with little capacity to cater for diverted traffic from the motorway. These roads are typically four and six lane arterial roads, in some cases undivided and without adequate turning lanes. Some sections have poor alignments, narrow lanes and uncontrolled access making them a challenge for heavy vehicles and prone to disruption as a result of incidents.

**Future demand drivers**

Good transport systems are necessary for economic activity, social and commercial interactions. All future scenarios to address Sydney’s growth as a global city will therefore require an efficient transportation outcome.

Future challenges for the transport sector are:

- **Underlying population growth.** Growth in population within the Greater Sydney Metropolitan Area, irrespective of all else, will drive the demand for increased travel. Even if the car mode share reduces, there will be a net growth in vehicle registrations and the amount of travel and hence continued pressure on motorway operations.

- **Commercial freight growth.** Port Botany and Sydney Airport generate significant road freight as do employment lands and strategic centres. As discussed, substantial increases in commercial road freight and business trips associated with these facilities is predicted. In particular container freight from the port will increase due to the opening of the new container berths and recent lifting of the cap on container movements. The increase in the road freight task is predicted to double over the next 20 years.

- **Energy prices/peak oil.** While the prospect of peak oil is emerging, vehicle technologies are rapidly progressing with vehicles powered by alternative energy sources predicted to reach mass market production in the foreseeable future. While this may shift demand away from fossil fuels, it is unlikely that the demand for travel will reduce sufficiently as consumers adapt to alternatives and hence travel demand on our major road network is likely to remain.
• **Emissions.** It is likely that there will be a shift to cleaner alternative fuels such as biofuels, natural gas, synthetic fuels and highly efficient hydrogen powered and electric vehicles. It is anticipated that while there may also be some dampening of road travel demand per capita, the underlying population growth will continue to result in peak periods where demand exceeds road network capacity.

There are a number of specific future drivers of demand that will further intensify levels of congestion in the corridor. These include jobs growth at:

- Sydney Airport and Port Botany
- Sydney Airport to CBD corridor
- The South West Growth Centre
- Western Sydney Airport at Badgerys Creek
- Western Sydney Employment Area
- Employment lands in the M4 Motorway and M5 Motorway corridors.

**Figure 6-2** shows the future demand drivers for Sydney's transport network. The functionality of airports and ports are critical success factors for all global cities. They are the international gateways for importing and exporting goods, business travellers and tourists.

*Rôle of WestConnex*

WestConnex addresses some of the most urgent and strategically important elements of the Transport Master Plan, the SIS and *A Plan for Growing Sydney.* The Transport Master Plan highlights the importance of improving integrated transport connections between Sydney's west, Sydney Airport and Port Botany.

WestConnex seeks to address the challenges that road users and the community encounter on a daily basis, including:

- The missing link in the Sydney motorway network's east-west spine created by the M4 Motorway terminating at North Strathfield – constraining movements between Sydney's west, its international gateways and key places of business
- Congestion, low travel speeds and unreliable travel times on the M4 Motorway, M5 East, Parramatta Road and in the Sydney Airport/Port Botany precinct that delay freight, public transport and add cost to business
- Poor urban amenity along Parramatta Road due to heavy traffic volumes and congestion throughout weekdays and on weekends.

These corridors comprise highly urbanised and complex communities with local concerns and issues that need to be incorporated into the detail of the transport solutions for the area.
Figure 6-2  Future population and employment drivers of demand

Source: NSW Government 2014b
6.2.2 Key strategic indicators

The key strategic indicators used to assess the success of WestConnex are:

- **Improved traffic efficiency** including for freight and public transport on the road network through the relief of road congestion to improve the speed, reliability and safety of travel in the M4 and M5 corridors and their parallel arterial roads
- **Enhanced productivity** of commercial and freight generating land uses strategically located near transport infrastructure
- **Improved motorway access** and connections linking Sydney’s international gateways and western and south western Sydney and places of business across the city in order to support Sydney’s long-term economic growth
- **Improved road safety**
- **Improved public transport options**, public and active transport improvements along and around Parramatta Road, and the reduction in traffic volumes, particularly heavy vehicles, on existing road corridors will create opportunities for urban renewal in roadside communities
- **Caters for diverse travel demands** along these corridors that are best met by road infrastructure.

6.2.3 Strategic review

*Improved traffic efficiency*

WestConnex will bring an increase in road capacity to both the M4 and M5 motorway corridors and create a new north-south link to serve the South Sydney/Airport and Port Botany areas, and the broader Global Economic Corridor. This increase in road capacity will generate improvements in travel time that will translate to future economic benefits. These benefits may be offset by changes in the time of travel from the shoulder periods around each peak, diminishing the peak travel time benefits but adding to the overall economic efficiency of the road network (for example more vehicles operating at the existing travel times) resulting in substantial overall economic benefit.

The preliminary traffic modelling undertaken for the original SER indicated there would be considerable congestion relief on some existing roads resulting from WestConnex. This noted that large reductions in traffic would be experienced on parts of Parramatta Road where traffic would be reduced in the order of 25 to 40 per cent. Current modelling is showing up to a 47 per cent reduction of traffic on some sections of Parramatta Road in 2031.

The most significant travel time savings with WestConnex fully in place will be realised by users on the M4 and M5 motorway corridors. Predicted travel time savings (from the revised traffic modelling) on key east-west and key north-south routes with the full implementation of WestConnex are shown in Tables 6-1 and 6-2 respectively. These are broadly consistent with the findings of the original SER with differences reflecting some minor changes in traffic distribution across the network.

The original SER noted that traffic outcomes are likely to be toll dependent (including the tolling regime of adjoining roads and alternative routes such as the Eastern Distributor and the M5 Southwest Motorway) and this remains unchanged. Traffic forecasts take into account toll levels and congestion on parallel routes.
Table 6-1  Travel times with WestConnex in 2031 AM peak – east-west routes

<table>
<thead>
<tr>
<th>Route (ordered from north to south)</th>
<th>Without WestConnex</th>
<th>With WestConnex</th>
<th>Percentage Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Eastbound (mins)</td>
<td>Westbound (mins)</td>
<td>Eastbound (mins)</td>
</tr>
<tr>
<td>M2 Motorway from Pennant Hills Road to Gore Hill Freeway</td>
<td>15</td>
<td>16</td>
<td>14</td>
</tr>
<tr>
<td>Victoria Road from Top Ryde to City West Link</td>
<td>33</td>
<td>45</td>
<td>29</td>
</tr>
<tr>
<td>M4 Western Motorway from Cumberland Highway to Concord</td>
<td>24</td>
<td>32</td>
<td>12</td>
</tr>
<tr>
<td>Great Western Highway from Cumberland Highway to M4 Western Motorway at Concord</td>
<td>45</td>
<td>41</td>
<td>47</td>
</tr>
<tr>
<td>Parramatta Road from M4 Western Motorway at Concord to Sydney CBD</td>
<td>43</td>
<td>53</td>
<td>37</td>
</tr>
<tr>
<td>Parramatta Road/City West Link (route A4) from M4 Western Motorway at Concord to Anzac Bridge</td>
<td>32</td>
<td>42</td>
<td>26</td>
</tr>
<tr>
<td>Hume Highway from King Georges Road to Parramatta Road</td>
<td>20</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Canterbury Road/New Canterbury Road/Stanmore Road/King St from King Georges Road to Sydney CBD (Route A34)</td>
<td>49</td>
<td>58</td>
<td>45</td>
</tr>
<tr>
<td>M5 South Western Motorway from King Georges Road to Sydney Airport</td>
<td>28</td>
<td>31</td>
<td>13</td>
</tr>
</tbody>
</table>

Note: Based on revised traffic modelling undertaken in 2015
### Table 6-2  Travel times with WestConnex in 2031 AM peak – north-south routes

<table>
<thead>
<tr>
<th>Route (ordered from west to east)</th>
<th>Without WestConnex</th>
<th>With WestConnex</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Northbound (mins)</td>
<td>Southbound (mins)</td>
</tr>
<tr>
<td>Silverwater Road/Woodville Road/Alfords Point Road (route A6) from M4 Western Motorway to M5 South Western Motorway</td>
<td>40 40</td>
<td>35 34</td>
</tr>
<tr>
<td>King Georges Road from M4 Western Motorway to M5 South Western Motorway</td>
<td>37 32</td>
<td>25 23</td>
</tr>
<tr>
<td>Punchbowl Road /Georges River Road /Frederick St from King Georges Road to City West Link</td>
<td>23 23</td>
<td>21 22</td>
</tr>
<tr>
<td>Princes Highway corridor from Sydney CBD to Sydney Airport/Port Botany</td>
<td>42 42</td>
<td>39 37</td>
</tr>
<tr>
<td>Botany Road corridor from Sydney CBD to Southern Cross Drive (route M1)</td>
<td>33 35</td>
<td>33 31</td>
</tr>
<tr>
<td>Eastern Distributor/Southern Cross Drive from Sydney CBD to Airport</td>
<td>21 28</td>
<td>18 23</td>
</tr>
</tbody>
</table>

### Enhanced productivity

WestConnex will assist in enhancing the productivity of commercial and freight generating land uses by improving road capacity and travel times.

Specifically, WestConnex will deliver an improved connection from the Western Sydney Employment Area to Sydney Airport and Port Botany. Located at the junction of the M7 and M4 motorways, the Western Sydney Employment Area currently contains 1500 hectares of land for industrial use and has the potential to generate more than 1000 net hectares of additional employment land. In particular, distribution centres for major companies that import goods from overseas are attracted to the site, being at the junction of two motorways and offering a large area of land suitable for major warehousing uses. For example, LG Electronics is operating at the Western Sydney Employment Area and a national distribution centre for the Coles Group has been constructed. Currently, the most reliable freight route between Eastern Creek and Port Botany/Sydney Airport is via the M7 and M5 East, as the M4 Motorway terminates at Strathfield. Improvements to the M4 Motorway will improve its attractiveness to freight, again reducing travel times and costs.

Increased road capacity will facilitate new opportunities for businesses to relocate to the M4, M5 and M4 – M5 Link corridors, and key approach roads. Changes in commute destinations as businesses relocate and origins for inter peak business activity might also be expected.

### Improved motorway access

Access to the wider Sydney network will be improved for vehicles with either origins or destinations in the Sydney CBD, Sydney Airport/Port Botany, south Sydney, inner west and eastern suburbs as well as north-west and south-west motorists. With the creation of these new road links and the generation of new and upgraded interchanges along the length of WestConnex, access between these areas will be improved.
Significant improvements in accessibility across the wider Sydney network will also occur for vehicles travelling between Western Sydney Employment Area at Eastern Creek and Port Botany.

A trip from Parramatta to Sydney Airport is predicted to be up to 50 minutes faster with WestConnex, avoiding up to 52 sets of traffic signals. This will represent a significant benefit to businesses (and their customers) located in the growing economic centres in and around Parramatta and further west. Similarly, a trip from Eastern Creek to Port Botany is predicted to be up to 50 minutes faster with 44 traffic signals avoided. This will represent a significant benefit to the freight, logistics and warehousing operators located in the Western Sydney Employment Area at the junction of the M4 and M7 motorways.

On the M5 corridor, travel time savings are predicted to be up to 15 minutes on the trip from Revesby to Port Botany, with a similar savings for the trip from Liverpool to Sydney Airport. While there will be no traffic signals avoided on these routes as the current route is already motorway standard, the improvements in travel time are a result of increased capacity on the M5 Motorway corridor.

**Improved road safety**

WestConnex is expected to deliver road safety benefits principally through the provision of a motorway-standard network that reduces congestion on large sections of the existing road network. A large proportion of the existing and forecast traffic demand will be able to avoid a significant number of at-grade signalised intersections on major arterial roads.

WestConnex will incorporate various elements of the ‘Smart Motorway’ (or ‘managed motorway’) concept of operations into its design, and will future proof for delivery of other elements. A Smart Motorway uses a range of innovative technology combined with new operating procedures to actively control traffic flow. Techniques such as varying the speed limits and metering on ramps at peak times are features of Smart Motorways all designed to improve traffic flow and reduce congestion.

A number of studies have been undertaken to determine the road safety impact of varying Smart Motorways. These studies have shown a neutral or positive impact with some showing a marked decrease in crashes, particularly rear end crashes of between 30 per cent and 40 per cent with injury severity down by eight per cent. For example, the M25 in the UK has had a Smart Motorway system since 1995 with improvements in overall journey time, reliability and a smoother traffic flow. Similar results are expected with the implementation of a Smart Motorway system for WestConnex. It should be noted that these potential safety improvements will only be realised with the implementation of Smart Motorways for WestConnex, and this will not be fully enabled at opening.

**Improved public transport options**

With reduced traffic on major arterial surface roads, there are opportunities for improvements to public transport through these corridors. Opportunity exists for development of new bus routes and enhanced public transport servicing. This could result in improved patronage.

In corridors where vehicle volumes are projected to decrease with the implementation of WestConnex, there may be the opportunity to re-allocate road space, to prioritise public transport, alter routes, or relocate bus stops and terminals.

For example, route shifting to the M4 Motorway will alter the traffic levels on parallel roads, particularly Parramatta Road. While this creates an opportunity to enhance public amenity on Parramatta Road, future traffic levels need to be identified to ensure that performance is consistent with its role in the network hierarchy.
The reductions in traffic volumes are expected to be a catalyst for the rejuvenation of urban life on Parramatta Road. The scheme will also enable significant improvements to bus operations, cycling and walking on and across Parramatta Road.

Express bus services may be able to use the new and upgraded roads more efficiently. Existing services will also benefit in areas where local traffic is reduced, such as in Sydenham, Marrickville, Tempe and along the Princes Highway. Parramatta Road bus services could be enhanced through the extension of current bus lanes and priority measures while north-south routes crossing Parramatta Road could also potentially see improvements.

WestConnex will provide scope for improving Sydney's bicycle and pedestrian facilities. In general, reduced traffic volumes from roads such as Parramatta Road, Princes Highway and the Sydenham/Marrickville area will free up these areas for pedestrian and bicycle use. There is also the possibility for improvements to north-south linkages across the Parramatta Road corridor, which will give pedestrians and bicycle users enhanced safety via the reduced traffic volumes on the corridor. As design and development of WestConnex progresses the opportunities for stakeholder consultation will increase, allowing for further exploration of potential pedestrian and bicycle initiatives.

Cater for diverse travel demands

Sydney's road network services a diverse range of users with varying demands and requirements. It is therefore essential that WestConnex caters for all road users.

Regional trips in and through the greater Sydney area will experience shorter and more reliable travel times due to the enhanced connectivity between Sydney's major motorways. Local trips will also be enhanced by WestConnex. Connectivity between WestConnex and local roads will provide ease of access for vehicles travelling to and from local areas, while greater motorway capacity will remove traffic from smaller local roads allowing for local trips to be completed in less time and with improved safety.

The benefits of WestConnex for light vehicle users are significant, especially during peak traffic periods.

Sydney's road network is also utilised by a diverse range of freight and business related vehicles. Freight and business movement are much more diverse than import-export journeys made by container freight trucks to and from Port Botany. Other freight vehicles (construction haulage trucks, waste and recycling trucks, postal and courier vans and trade utes) are also important, as are the less visible commercial trips (professional services, management services and sales representatives moving in cars).

Time savings delivered by WestConnex means more pick-ups and drop-offs each day for the freight industry. Similarly, for business it means more time on the job and less time in a vehicle. This directly translates to more productive use of drivers as labour and vehicles as capital. The incremental benefits accrued for individuals using WestConnex add up to significant productivity gains for Sydney, NSW and Australia.

6.2.4 Strategic mitigation and management strategies

WestConnex will be implemented in stages. In order to manage the resultant traffic disruption, traffic management measures may need to be implemented during construction to provide adequate capacity on temporary connections to the existing unimproved sections of the road network.

Effective traffic management during construction will also require detailed planning and assessment at the project level. Maintaining a safe environment for road users, including buses, pedestrians and cyclists, will be a priority during construction. The potential for safety impacts, for instance due to temporary road arrangements or the close proximity of
construction activities to normal traffic will be assessed. Further assessment of construction impacts is provided in Section 6.7.

Some temporary disruptions and delays to traffic will be experienced during construction due to the narrowing of existing lanes, speed restrictions and temporary road closures. Management measures will be put in place to minimise these impacts.

Construction staging will affect traffic on adjacent feeder routes, such as the M5 Motorway and Southern Cross Drive. As the construction of WestConnex will be staged with multiple separate projects, different construction access roads, varying construction material and spoil routes will be affected. These will be addressed in the context of staged construction programming.

There is the potential for a temporary shift of traffic from a motorway to alternative routes, such as Victoria Road/Hills M2 Motorway in the case of the M4 Motorway, and Canterbury Road or the tunnel closure detour route via West Botany Street/Forest Road/Stoney Creek Road, in the case of the M5 corridor, particularly during peak periods. These road corridors also experience high traffic volumes and have limited spare capacity. Minimising these impacts will be critical during construction.

Minimal impact on pedestrian access is expected given that the majority of works will be undertaken within existing motorway corridors or for new tunnels. However, temporary impacts on pedestrian access may be experienced on adjacent roads where access ramps and upgrading of existing roads are required.

### 6.2.5 Project level performance requirements and outcomes

The preliminary and revised traffic analyses were undertaken for WestConnex using a Strategic Road Assignment Model to evaluate future transport network performance, with and without specific elements of WestConnex. This included testing of scope and tolling options, impacts of induced traffic and mode shifting, and impacts on the existing road network. This strategic modelling has informed early design and options assessment.

Traffic and transport impact assessments will also be undertaken for individual projects as part of the planning approval process. This assessment will identify potential impacts and nominate mitigation measures to minimise impacts. It will include forecast traffic volumes for the WestConnex project and the local road network, including:

- Detailed traffic modelling for the project and the local and regional road networks
- Travel time analysis
- An assessment of the performance of key interchanges and intersections by undertaking an Level of Service analysis at key locations
- An assessment of operational traffic impacts including an assessment of existing local and regional traffic volumes and traffic patterns against forecast volumes and potential changes to traffic patterns associated with the project and public transport impacts
- An assessment of the impacts of the project on road users including motorists, public transport, freight, pedestrians and cyclists; on local and regional road networks
- An assessment of traffic impacts on motorway traffic and the surrounding network over the staged WestConnex construction period
- An assessment of construction traffic impacts including route identification, number, frequency and size of construction related vehicles, the nature of existing traffic, and the need to close, divert or otherwise reconfigure elements of the road network associated with construction of the project
- An assessment of cumulative construction impacts, particularly with regard to major projects under construction in the vicinity of WestConnex
- Recommendations for detailed operational and construction traffic and transport mitigation measures, including preparation of construction environmental management plans incorporating traffic management plans.

6.3 Air quality and tunnel ventilation

Broad stakeholder and community confidence in the effective management of in-tunnel air quality and the protection of local and regional air quality will be critical to community acceptance of road tunnels as an effective transport solution. This issue is especially important for WestConnex as the tunnels are likely to be the longest in Australia and there is an imperative to ensure both in-tunnel and local (external) air quality standards are achieved.

Well-designed ventilation outlets are very effective at dispersing tunnel emissions. Experience from previous motorway tunnel projects both in Sydney and other areas of the world, has demonstrated that modelling of air dispersion is robust and conservative and that tunnel emissions do not measurably impact on local or regional air quality.

6.3.1 Strategic background and context

Air quality and tunnel ventilation is an important strategic issue for WestConnex.

Typically, air quality is quantified by the concentrations of air pollutants in the ambient air, where an air pollutant is a substance known to have potential to cause health, nuisance and/or environmental effects. With regard to human health, the air pollutants most relevant to WestConnex will be those associated with motor vehicle emissions; in particular:

- Carbon monoxide (CO)
- Oxides of nitrogen (NOx), primarily nitrogen dioxide (NO₂)
- Particulate matter, especially particles with equivalent aerodynamic diameters of 10 microns or less, that is, PM₁₀ and PM₂.₅
- Air toxics, including benzene, toluene, xylenes, formaldehyde and polycyclic aromatic hydrocarbons.

Health research identifies PM₂.₅ and smaller particles (for example, PM₁) as a particular concern. Ozone (a secondary air pollutant formed when primary air pollutants react with other substances) is relevant on a regional scale.

National standards for air quality set by the National Environmental Protection Council of Australia (NEPC) as part of the National Environment Protection Measures (NEPM). To measure compliance with national standards, the Office of Environment and Heritage (OEH) has established a network of monitoring stations across NSW and up-to-date records are published on the OEH website.

The monitoring data collected by the OEH are also used to identify trends in air quality and for developing plans to reduce emissions to air and improve local and regional air quality. Current air quality trends are summarised in the *NSW State of the Environment 2012* (EPA 2012a).
Air quality in the Sydney region has improved since the 1980s, largely due to initiatives to reduce air emissions from industry, motor vehicles, businesses and homes. The State of the Environment report notes that concentrations of four of the six main indicators of air quality (carbon monoxide, nitrogen dioxide, sulphur dioxide and lead) have complied with national air quality standards in recent years. However, national standards of ozone (a key component of photochemical smog which appears as a white haze in summer) and particulate matter (PM$_{10}$) are exceeded in Sydney mostly due to bushfires or dust storms.

NorthConnex

NorthConnex will be a tolled motorway in twin nine-kilometre tunnels linking the M1 Pacific Motorway at Wahroonga to the Hills M2 Motorway at Carlingford. The EIS for NorthConnex (RMS 2014a) was on public exhibition from 15 July to 12 September 2014, with planning approval granted on 13 January 2015. As part of updating the SER, the environmental assessment and DP&E’s consideration of this, along with the planning approval, has been reviewed to assess potential implications for assessment of air quality issues for WestConnex.

External and in-tunnel air quality were key issues, both for public authorities and the community. These were considered separately by DP&E in its assessment report (DP&E 2014).

The environmental assessment for NorthConnex (RMS 2014a, 2014b) identified two general operational scenarios with respect to consideration of in-tunnel air quality:

- 40–80 km/h, representing ‘normal’ operation, and
- <40 km/h, representing low speed and congested conditions.

In its consideration of in-tunnel air quality issues associated with the NorthConnex project, DP&E (2014b, pp42-43), drawing on advice provided by the NSW Government’s Advisory Committee on Tunnel Air Quality (ACTAQ) (ACTAQ 2014c), noted:

“Carbon monoxide (CO) has historically been a good marker for motor vehicle emissions, and to date has been the basis of in-tunnel air quality criteria”

and

“[However,] due to improved vehicle technology, CO levels are falling making other pollutants such as NO$_2$ the main determinants for the protection of health. In contrast to CO, there are no in-tunnel health based air quality guidelines established in NSW for NO$_2$”

In addition to CO and visibility limits, the NorthConnex project approval specifies a concentration limit of 0.5 ppm for NO$_2$ (over a 15-minute averaging period) as an average along the length of the tunnel across all traffic conditions.

DP&E (and EPA) accepted that the project was likely to meet all external air quality criteria. DP&E noted that there was continuing community support for filtration of tunnel air to improve external air quality outcomes, however, it reiterated that this was unlikely to be a long-term focus for managing emissions from tunnels. ACTAQ (2014b) concludes the most effective way to manage air quality both in and around tunnels is through vehicle fleet emission reductions.

It is noted that the environmental assessment requirements (DP&E 2015) for the M4 East and New M5 include a specific requirement to ‘demonstrate how the project and ventilation design ensures that concentrations of air emissions meet NSW, national and international best practice for in-tunnel and ambient air quality, and taking into consideration the approved criteria for the NorthConnex project.’
6.3.2 Key strategic indicators

Motor vehicles are a major source of human-generated air pollution in Sydney, contributing 62 per cent of oxides of nitrogen (NOx) emissions, 24 per cent of volatile organic compound (VOC) emissions, and 13 per cent of PM2.5 emissions during 2008.

While motor vehicles are contributors to particle pollution, there are many other sources of particles from both natural processes (for example bushfires) and human activities (such as wood burning, quarrying and mining) (EPA, 2012).

Newer vehicles produce significantly less emissions than older vehicles. Increasingly better fuels, improved technology and stringent emission standards have contributed to this improvement, which is forecast to continue in the future. For example:

- Cars built since 2013 emit only three per cent of the oxides of nitrogen emitted by vehicles built in 1976
- Diesel trucks manufactured from 2011 emit only eight per cent of the particulate matter emitted by vehicles built in 1996.

For the operation of WestConnex, compliance considerations for air quality criteria would include:

- Near-roadside air pollutant concentrations due to changes in traffic volumes. The nature of any changes in concentrations will depend on the projected traffic volumes, mode of travel, road grade and mix of vehicles
- In tunnel air pollutant concentrations
- Air pollutant concentrations in the vicinity of tunnel ventilation outlets
- Exposure to air pollutants for people using multiple tunnels.

Construction activities may result in temporary increases in dust (particulate matter) during clearing, earthworks and material handling activities. The nature of any increase in dust will depend on the scale of activities and quantities of material handled. In practice however, air quality impacts can be avoided by the implementation of standard dust management measures.

Strategic indicators of air quality impacts for WestConnex will be the level of compliance with the air quality criteria set by the EPA. These criteria, including the NEPM advisory reporting standards for PM$_{2.5}$, are outlined in Table 6-3. This table focuses on ‘criteria’ pollutants – those substances which are general indicators of air quality.

In addition to the criteria listed in Table 6-3, the EPA also specifies air quality criteria for many other substances including air toxics such as benzene, toluene, xylenes, formaldehyde and polycyclic aromatic hydrocarbons.

Criteria for these substances will be relevant to the detailed project level assessments of WestConnex. There are currently no EPA air quality criteria for PM$_{2.5}$, however the national standards (NEPM) were amended in 2003 to include advisory reporting standards for PM$_{2.5}$. These standards are also included in Table 6-3.
### Table 6-3  
**Air quality assessment criteria**

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Averaging time</th>
<th>Criterion</th>
<th>Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon monoxide (CO)</td>
<td>Maximum 1-hour average</td>
<td>25 ppm (30 mg/m³)</td>
<td>EPA</td>
</tr>
<tr>
<td></td>
<td>Maximum 8-hour average</td>
<td>9 ppm (10 mg/m³)</td>
<td>EPA</td>
</tr>
<tr>
<td>Particulate matter (PM₁₀)</td>
<td>Maximum 24-hour average</td>
<td>50 µg/m³</td>
<td>EPA</td>
</tr>
<tr>
<td></td>
<td>Annual average</td>
<td>30 µg/m³</td>
<td>EPA</td>
</tr>
<tr>
<td>Particulate matter (PM₂.₅)</td>
<td>Maximum 24-hour average</td>
<td>25 µg/m³</td>
<td>NEPM</td>
</tr>
<tr>
<td></td>
<td>Annual average</td>
<td>8 µg/m³</td>
<td>NEPM</td>
</tr>
<tr>
<td>Nitrogen dioxide (NO₂)</td>
<td>Maximum 1-hour average</td>
<td>12 pphm (246 µg/m³)</td>
<td>EPA</td>
</tr>
<tr>
<td></td>
<td>Annual average</td>
<td>3 pphm (62 µg/m³)</td>
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</tr>
<tr>
<td>Ozone</td>
<td>Maximum 1-hour average</td>
<td>10 pphm (200 µg/m³)</td>
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</tr>
<tr>
<td></td>
<td>Maximum 4-hour average</td>
<td>8 pphm (150 µg/m³)</td>
<td>EPA</td>
</tr>
</tbody>
</table>

ppm = parts per million. pphm = parts per hundred million. µg/m³ = micrograms per cubic metre

1 In July 2014, the NEPC (Australian Government 2014) released an impact statement for a draft variation to the air quality NEPM. Amongst other matters, this proposed a change to the criteria for PM₁₀ as follows:
- Maximum 24-hour average: 40-50 µg/m³.
- Annual average: No standard with consideration of 20 µg/m³.

#### 6.3.3 Strategic review

**General airshed (ambient) air quality**

The original SER examined the potential impacts of WestConnex on existing air quality by quantifying the broad change in air emissions with and without WestConnex. The principal objective was to determine how regional air quality may change with WestConnex, and to determine whether air quality criteria would be compromised.

This was done by:

- Modelling of Sydney region traffic movements for a base year (2011), and for 2021 and 2031 scenarios, with and without WestConnex.
- Estimating total emissions of CO, NOₓ and PM₁₀ from each road type (residential, arterial and highway/freeway) and aggregating emissions of each pollutant to determine the total annual emissions of CO, NOₓ and PM₁₀, for each scenario. Emissions were estimated using factors developed by the EPA and taking account of anticipated changes in vehicle technology and emission standards over time. PM₂.₅ emissions were estimated by assuming that 96 per cent of the PM₁₀ is PM₂.₅. This was based on measurements made by Environment Australia (2003).
- Comparing changes in emissions under each scenario.

The significance of changes in emissions under each scenario was assessed in terms of the potential for influencing existing air quality, and the level of compliance with ambient air quality criteria.

The traffic modelling for the original SER showed very little change in Vehicle Kilometres Travelled with and without WestConnex (refer Figure 6-3), although a shift from arterial to the freer flowing highway/freeway mode of travel was predicted with WestConnex.

A general reduction in emissions over time was identified, largely driven by improvements in vehicle technology and the introduction of new emission standards. It was noted that the
levels of emissions with and without WestConnex were essentially the same (that is, less than one per cent difference). Based on the results, it was concluded that there was unlikely to be any direct effect of WestConnex on the existing regional air quality and the level of compliance with air quality criteria.

For CO and NO\textsubscript{x}, the decrease in emissions from 2011 to 2031 was attributed to projected improvements of vehicle technology and emission standards over time. Key assumptions included the introduction of new emission standards from 2013 onwards. The PM\textsubscript{10} and PM\textsubscript{2.5} emissions also reflected changed emission standards but with a slight upward trend due to the more significant contribution of non-exhaust emissions (such as from brake and tyre wear) with increased vehicle numbers.

The updated traffic modelling produced similar results to the original traffic modelling, that is, there is very little difference in Vehicle Kilometres Travelled with and without WestConnex across the Sydney region (refer Figure 6-4). The patterns and trends in total emissions for CO, NO\textsubscript{x} and PM\textsubscript{10} and PM\textsubscript{10} noted in the original SER would therefore be expected to be similar.

![Figure 6-3 Daily network traffic statistics (based on preliminary traffic modelling)](image)

Source: pers. comm. RMS (March 2013)
Local air quality – surface roads

At the local level, air quality effects will be influenced by the emissions associated with vehicles on surface roads and in tunnels. These local effects will be the subject of further investigation at the project level assessment, but typically the effect of introducing a tunnel will provide a general improvement to local air quality on surface roads where traffic numbers are reduced.

By way of an example, the Lane Cove Tunnel demonstrates the effect on local air quality due to removing emissions from a surface road (Epping Road) and redistributing via tunnel ventilation outlets. The Lane Cove Tunnel is a 3.6 kilometre-long road tunnel that connects the M2 Motorway at North Ryde with the Gore Hill Freeway at Artarmon. It was opened in March 2007 and aimed to remove congestion from Epping Road. The tunnel is ventilated by one outlet at each end.

Extensive (year-long) air quality monitoring has been conducted at seven locations in the vicinity of Lane Cove Tunnel, including near ventilation outlets and along Epping Road. The data collected before and after opening of the tunnel were reviewed by Holmes et al (2011) with the main findings of the review being:

- Concentrations of CO, NO₂ and PM₁₀ decreased after the opening of the Lane Cove Tunnel. This result was consistent across the metropolitan area and reflected ongoing reductions in vehicle emissions due to more stringent fuel and motor vehicle standards

- No exceedances of CO, NO₂ and PM₁₀ criteria were attributed to air discharged from the tunnel ventilation outlets
• Measured CO, NO₂ and PM₁₀ concentrations were well below the predictions made in the EIS for the Lane Cove Tunnel

• There were overall improvements to roadside air quality along Epping Road. This reflected the decrease in traffic volumes on the local surface roads.

While there will be some differences in design and features of WestConnex, the air quality outcomes from Lane Cove Tunnel highlight the potential local air quality benefits from removing traffic from surface roads with a suitably-designed, ventilated tunnel.

Local air quality – ventilation outlets

WestConnex will include a number of road tunnels that will require ventilation, typically by way of suitably located ventilation outlets. Ventilation outlets provide an effective means for dispersing air from a road tunnel and delivering positive local air quality outcomes. This is primarily because tunnel air is discharged well above ground level allowing dispersion into the atmosphere and creating a separation from the majority of the population.

Notwithstanding these benefits, air discharged from tunnel ventilation outlets would be subject to investigation as part of a detailed air quality assessment, once the project and ventilation design has been further developed. The assessment would be based on the location and design characteristics of the outlet, emissions to air (as determined from in-tunnel information), buildings and land use, prevailing meteorology, and topographical effects to determine any changes in air pollutant concentrations at sensitive receptor locations.

The air quality assessment would inform the ventilation outlet design parameters and operating conditions to make sure that compliance with air quality criteria is achieved at all sensitive receptor locations. The assessment would also consider the net air quality effect of each project due to transferring traffic from surface roads to a ventilated tunnel.

Well-designed ventilation outlets result in no measurable change in local air quality. A ventilation outlet located close to the tunnel portal is the most cost effective and energy efficient location.

The Lane Cove Tunnel is an example of a well-designed ventilation outlet causing no discernible change in local air quality. Monitoring data collected for the Lane Cove Tunnel has shown no discernible impact and no exceedances of air quality criteria have been attributed to emissions from the outlets.

Similarly ambient air quality monitoring has been and continues to be undertaken in the vicinity of the ventilation outlet for the M5 East Tunnel. The monitoring is carried out at five locations, with continuous measurement of CO, NO₂ and PM₁₀ concentrations. Since opening in December 2001, the M5 East Tunnel has been operating within the ambient air quality goals set in the December 1997 Planning Minister's approval for the project.

Local air quality – portal emissions

Portal emissions are defined as the discharge of in-tunnel air from the tunnel entry or exit points. The most recent road tunnels constructed in Sydney (including the M5 East, Cross City Tunnel and Lane Cove Tunnel) have all been designed to avoid portal emissions and tunnel air is discharged primarily from ventilation outlets. This mode of operation is reflected in the conditions of approval for these tunnel projects.

For example the conditions of approval for the M5 East Tunnel state that ‘the ventilation system for the main tunnel (Bexley Road to Marsh Street) must be designed to avoid air emissions, through the portals, as far as is practical.’ Similarly, the Cross City Tunnel and Lane Cove Tunnel both operate under conditions which state that ‘the tunnel ventilation system shall be designed, constructed and operated to avoid emissions of tunnel air from the
portals’. Each of Brisbane’s road tunnels (North South Bypass Tunnel, Airport Link and Northern Link) have been designed to operate without the need for portal emissions.

There are some circumstances when portal emissions are permitted, such as emergency situations, accidents and breakdowns, and during major maintenance periods. The potential air quality impacts of portal emissions during these circumstances is usually quantified in the project assessment phase using computer-based air dispersion modelling (see for example, Lane Cove Tunnel EIS, Cross City Tunnel EIS).

Notwithstanding, it is recognised that desired air quality outcomes can still be achieved with portal emissions. For example, an energy audit commissioned in 2010 for Melbourne’s City Link Domain Tunnel and Burnley Tunnel (which prohibits portal emissions except under special circumstances) identified that energy savings could be made by shutting down the tunnel ventilation system (otherwise operating 24 hours, 7 days a week) during low traffic periods and in effect allowing portal emissions.

After an extensive five week trial to monitor portal emissions supported by comprehensive air quality modelling, the ‘switch off’ practice was accepted and subsequently the Victorian EPA licence was modified. The ventilation fans are now permitted to be turned off from 8 pm to 4 am when the least amount of traffic is using the tunnels.

This approach has led to:

- Average annual energy savings of over four per cent
- Electricity savings of approximate 900 MW/hr
- Reduction in annual electricity costs of approximately $95,000
- No reported breaches of air quality criteria.

The Burnley Tunnel case study indicated that the adoption of performance based targets for portal areas can potentially deliver desired air quality outcomes and at the same time result in significant energy savings.

Treatment of emissions

The effectiveness of the treatment of tunnel emissions has been evaluated by government regulators including the EPA and the then DP&I as part of the environmental assessment phase of a number of existing Sydney road tunnels including the M5 East Tunnel, Cross City Tunnel and Lane Cove Tunnel. It has also been subject of numerous NSW Legislative Council (Upper House) Inquiries and independent scientific reviews including by the CSIRO. In general these evaluations have indicated that it is more cost effective to reduce pollutants at the source using improved fuel standards and engine technology.

An air quality filtration pilot plant was installed in the M5 East Tunnel in 2010 and trialled over an 18-month period in an effort to address concerns regarding in-tunnel haze and, indirectly, emissions from the outlet. The filtration plant was designed to reduce particulate matter and NO₂ concentrations.

Evaluation of the trial identified that it is more beneficial to focus on cleaner vehicles that will result in greater benefits to air quality, both in-tunnel and in the ambient air, at the local and regional scales. This is consistent with the conclusions of the National Health and Medical Research Council that the most effective way to manage air quality both in and around tunnels is through vehicle fleet emission reductions (NHMRC 2008).

In-tunnel air quality

At the time the original SER was prepared, the total length of tunnels was 22.6 kilometres based on the Reference Designs for the M4 East and New M5, and the Base Case Design
for the M4–M5 Link, with the final length subject to final detailed design. The total length of tunnels for the current (2015) WestConnex ultimate configuration is 25 kilometres.

In consideration of the potential for journeys involving multiple tunnel use the original SER considered the potential related health effects on people driving extensively in tunnels. This was done by identifying in-tunnel air quality criteria, potential exposure, and measures to minimise motorist exposure.

To protect the safety and health of tunnel users, in-tunnel air quality criteria are established in jurisdictions around the world. Globally, the most widely adopted in-tunnel exposure limits are for CO. This choice is supported by CO being the only traffic-dominated air pollutant for which WHO guidelines exist for exposure durations relevant to passage through a road tunnel (typically a few minutes). NSW has adopted the WHO CO guidelines as compliance criteria since the Eastern Distributor tunnel in 1999.

In the past a CO guideline has been used because of the serious short-term health effects and it was assumed this guideline also provided adequate protection for the full range of constituents of road traffic air emissions. However, emissions of NO₂ have increased in relative importance due to:

- Emission standards for CO from new petrol cars reducing much more than emission standards for NOx (until the introduction of Euro 3 in 2006)
- The increasing penetration of diesel cars as a proportion of the vehicle fleet. Diesel cars emit significantly more NO₂ and less CO than petrol cars.

Consequently, there is relatively more NO₂ compared with CO in tunnel air than was previously the case. This is recognised around the world and has led many bodies to consider or implement in-tunnel NO₂ criteria in addition to the current CO criterion.

While the effects of short-term exposure to CO are well understood, there is limited available health information on which to develop an in-tunnel NO₂ standard. Different authorities have applied different levels and different exposure times, reflecting scientific uncertainties and different precautionary stances. Table 6-4 lists the NO₂ criteria that have been adopted nationally and internationally. The most stringent in-tunnel NO₂ guideline being applied around the world is the French design goal of 0.4 ppm.
Table 6-4  Relevant in-tunnel air quality guidelines adopted internationally

<table>
<thead>
<tr>
<th>Jurisdiction/Project</th>
<th>In-tunnel NO\textsubscript{2} criteria</th>
<th>Design or Compliance</th>
<th>Averaging Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSW/NorthConnex\textsuperscript{1}</td>
<td>0.5 ppm&lt;br&gt;Tunnel average</td>
<td>Both</td>
<td>15 minutes</td>
</tr>
<tr>
<td>Brisbane City Council/Clem 7 (2007)/Legacy Way (2010) tunnels\textsuperscript{2}</td>
<td>1 ppm&lt;br&gt;Average</td>
<td>Both</td>
<td>None given</td>
</tr>
<tr>
<td>PIARC\textsuperscript{3}</td>
<td>1 ppm&lt;br&gt;Tunnel average</td>
<td>Design only</td>
<td>None given</td>
</tr>
<tr>
<td>New Zealand\textsuperscript{4}</td>
<td>1 ppm</td>
<td>Design only</td>
<td>15 minutes</td>
</tr>
<tr>
<td>Hong Kong\textsuperscript{5}</td>
<td>1 ppm</td>
<td>Design only</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Norway\textsuperscript{6}</td>
<td>0.75 ppm&lt;br&gt;Tunnel midpoint (equivalent to tunnel average)</td>
<td>Both</td>
<td>15 minutes</td>
</tr>
<tr>
<td>France\textsuperscript{7}</td>
<td>0.4 ppm</td>
<td>Design only</td>
<td>15 minutes</td>
</tr>
</tbody>
</table>

Reference URLs:

1  https://majorprojects.affinitylive.com/public/163aa1c9b211c5d126fe2468a30e597/Instrument%20of%20Approval.pdf

The original SER included an assessment (based on the preliminary traffic modelling) to assess potential changes to the length of time motorists using road tunnels would be expected to spend in a tunnel environment following completion of WestConnex (assumed at the time to be 2026). Modelling was undertaken for only the morning and afternoon peak periods and calculated an average value for motorists travelling through multiple tunnels in a single journey.

The analysis drew the following conclusions:

- By 2026, without WestConnex, motorists (including motorcyclists and passengers) using tunnels in the Sydney road network were expected to significantly increase their time spent in a tunnel environment with the proportion of vehicles spending 10 or more minutes in any one trip increasing from one per cent to around 30 per cent in the morning and afternoon peaks.
- Over 10 per cent of motorists in tunnels would spend more than 15 minutes in a tunnel environment in any one trip.
- By 2026, with WestConnex, there would be substantially more motorists in a road tunnel environment; however none (with the potential exception of incidents) would spend more than 15 minutes in a tunnel. The proportion spending more than 10 minutes would decline from around 30 per cent to 11 per cent. This was attributed to...
there being less congestion leading to better traffic flow through tunnels and therefore motorists would spend less time actually in tunnels.

The assessment of changes to potential total time that motorists could spend in a tunnel environment has been revised (based on the revised traffic modelling) to reflect the changes to WestConnex since the original analysis. The results of the assessment (using 2012 as a baseline condition) with and without WestConnex in 2031 are provided in Table 6-5.

Table 6-5 Time spent in road tunnels in the Sydney road network

<table>
<thead>
<tr>
<th>Time in tunnel (minutes)</th>
<th>Base year (2012)</th>
<th>2031 without WestConnex</th>
<th>2031 with WestConnex</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AM peak</td>
<td>PM peak</td>
<td>AM peak</td>
</tr>
<tr>
<td>&gt;0-5</td>
<td>75%</td>
<td>94%</td>
<td>37%</td>
</tr>
<tr>
<td>5-10</td>
<td>24%</td>
<td>5%</td>
<td>27%</td>
</tr>
<tr>
<td>10-15</td>
<td>1%</td>
<td>0%</td>
<td>20%</td>
</tr>
<tr>
<td>15-20</td>
<td>0%</td>
<td>0%</td>
<td>11%</td>
</tr>
<tr>
<td>20-25</td>
<td>0%</td>
<td>0%</td>
<td>4%</td>
</tr>
<tr>
<td>25+</td>
<td>0%</td>
<td>0%</td>
<td>1%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Notes: Table is based on single trips where use of a tunnel is involved. A zero percentage excludes incidents in the tunnel.

The assessment in the original SER was based on a maximum tunnel length journey of 22.6 kilometres. This distance has increased by 2.4 kilometres largely due to moving the alignment of the M4–M5 Link northward to provide better connectivity to the future Western Harbour Tunnel and Beaches Link. Intuitively this would result in some journeys taking longer and this is reflected in Table 6-5 by four to five per cent of journeys having a duration of 15 to 25 minutes in tunnel where previously all times within tunnel were of a duration of 15 minutes or less.

The penetration of pollutants into the vehicle is also a key factor influencing exposure. Air exchange rate (AER) for vehicles is highly variable between vehicles. In summary, the more sealed a vehicle cabin is, the lower its AER will be. A lower AER will result in a slower exchange of tunnel air to the vehicle cabin, leading to lower internal concentrations while inside a tunnel. However, this can also result in longer persistence of contaminated air within the vehicle after leaving the tunnel (NHMRC 2008, NIWA 2010).

Summary of strategic assessment of air quality

In summary, the review of the potential impacts of WestConnex on air quality indicators suggests that:

- Regional air quality is unlikely to change due to WestConnex (unchanged from the original SER)
- Transferring vehicles from surface roads into tunnels will improve the air quality along existing surface roads where surface traffic is reduced
- The ventilation design will be based on international best practice criteria
- Locating ventilation outlets close to the tunnel portal would substantially minimise costs and energy use for the system.
• The most effective way to manage air quality both in and around tunnels is through vehicle fleet emission reductions

• The number of people using a road tunnel would increase substantially with WestConnex. However, the maximum time spent in tunnels would be less compared to without WestConnex due to improved traffic flow across the network.

6.3.4 Strategic mitigation and management strategies

Construction stage:

Air quality issues can arise during the construction of most road projects if emissions to air are not properly managed. However, in most cases air quality impacts can be avoided through the development and implementation of suitable construction environmental management plans. Best practice management measures and safeguards (particularly dust suppression measures) will be implemented during construction of WestConnex.

Operation stage

WestConnex will be designed so that air quality criteria are not exceeded at sensitive receiver locations as a result of the project operation. Design of the infrastructure, including ventilation outlet location and height, portal location and emissions will be informed by the air quality impact assessment.

The most effective measure for reducing health risks associated with exposure to air pollutants in road tunnels is to reduce emissions from the source by employing policy measures focused on reducing pollutant emissions. This notwithstanding, design development will take into account the in-tunnel air quality performance requirements specified in the NorthConnex planning approval.

The restriction on infiltration of pollutants into a vehicle cabin greatly reduces occupant exposure relative to pollutant concentrations. A highly effective method of reducing the risks to the health of individuals from vehicle fleet pollutant exposure is to close vehicle windows prior to entering the tunnel, switching off ventilation fans, and setting the vents to ‘recirculate’. These actions are very effective in reducing internal pollutant concentrations. However, vents and windows should be re-opened to release any pollutants that did infiltrate during the tunnel trip.

6.3.5 Project level performance requirements and outcomes

WestConnex will be required to deliver outcomes that protect both local air quality and vehicle occupants while using tunnels. The most important outcome will be the level of compliance with air quality criteria (such as those listed in Table 6-3).

Key elements of the scheme that will require suitable design, detailed assessment and evaluation for the protection of air quality include:

• Construction activities
• Tunnel ventilation systems and ventilation outlets
• Portals and operational requirements
• Operation of surface roads and intersections.

The required outcome for WestConnex will be compliance with all relevant air quality criteria, including potential cumulative effects. The current air quality criteria are those specified by the EPA and summarised for air pollutants in Table 6-3. The assessments will also consider the approved criteria for the NorthConnex project.
Energy use in operating major road tunnel ventilation systems is a significant consideration. A key challenge for WestConnex will be to minimise energy use over its operational life.

Application of appropriate performance based air quality criteria for the project will allow tunnel ventilation systems to be designed and operated to meet air quality outcomes while minimising energy use.

6.4 Energy efficiency

Achieving efficient use of energy is a key goal for a project the scale of WestConnex. Minimising energy use where possible will help reduce construction and operating costs and deliver more sustainable infrastructure. Energy consumption and greenhouse gas emissions are useful indicators for energy efficiency.

Energy consumption for WestConnex will be greatest with regard to operation of the tunnel ventilation systems. Managing this energy use is a high priority for the scheme and will require the need to minimise energy usage where possible and consider the use of renewable energy for any residual energy requirements.

While there may be a suite of indicators to measure energy efficiency, for a road project the size of WestConnex, greenhouse gas emissions are a useful indicator and this is explored in detail below.

The NSW State of Environment 2012 report (EPA 2012a) indicates that transport emissions are currently the third fastest growing component of NSW-generated greenhouse gases (after electricity generation and industrial processes) with road transport accounting for 90 per cent of all NSW transport emissions.

6.4.2 Key strategic indicators

The NSW State of Environment 2012 report (EPA 2012a) indicates that annual greenhouse gas emissions in NSW have remained steady since 1989-90, with per capita emissions generally below the national average.

Transport for NSW's Transport Environment and Sustainability Policy Framework (Transport for NSW 2013b) includes a specific commitment to ‘use Transport for NSW's energy sources more efficiently and reduce its greenhouse gas emissions’. The Framework includes an action plan requiring major road projects to 'identify greenhouse gas emission sources at project planning stage and measures taken, where cost effective, to reduce these emissions through design and construction processes'.

In July 2014, the NSW Government released the NSW Government Resource Efficiency Policy (NSW Government 2014d), replacing the previous NSW Government Sustainability Policy. The policy supports goals and targets in NSW 2012 and facilitates delivery of various Government sustainability-related actions and strategies. The policy establishes seven measures, targets and minimum standards relating to energy efficiency.
6.4.3 Strategic review

General

The SER has drawn from the above examples and other existing literature to develop a set of strategies for incorporating energy efficiency throughout the design process.

For the purposes of the SER a benchmarking approach was undertaken based on extrapolation of energy consumption data obtained from the completed M5 East, Eastern Distributor, Lane Cove and Melbourne CityLink tunnels. Further assessment will be undertaken at the project assessment stage when detailed design information is available, particularly regarding tunnel and ventilation system design.

Traffic energy consumption

The original SER included an assessment of transport-related CO₂ emissions with and without WestConnex. Emissions associated with daily average traffic flows using WestConnex or the road network were estimated for 2021 and 2031 against the base year of 2011. The analysis shows that emissions generated by traffic flows will be the largest source of emissions for WestConnex. These forecasts are shown in Figure 6-5.

![Figure 6-5 Estimated GHG emission forecasts for traffic](image)

It can be seen that the net contribution of daily CO₂ emissions with WestConnex compared to without WestConnex will be relatively unchanged. Based on the revised traffic modelling, the quantum of emissions will increase, however, the original conclusion regarding the pattern of daily CO₂ emissions with and without WestConnex still stands.

Consistent with the air quality assessment, it is expected that energy consumption and therefore emissions generated by the growth in traffic in the corridors will be offset by improvements in travel times and improvements in vehicle and fuel efficiency.

Operational energy efficiency

The main energy consumption for operation of WestConnex will be from operation of the tunnel ventilation systems, lighting and water use due to maintenance activities.
By way of example Figure 6-6 shows the energy distribution for CityLink tunnels as reported by Transurban. As can be seen, tunnel ventilation represents the largest energy consuming activity, followed by lighting and water handling (water pumping). For WestConnex a similar operational energy distribution is expected with lighting assumed to account for a slightly larger contribution.

**Figure 6-6 Energy distribution for CityLink tunnels**

*Source Transurban 2012*

For the purposes of understanding the potential implications for energy consumption, a further review was undertaken on tunnel ventilation energy requirements and is discussed as follows.

**Tunnel ventilation energy consumption**

Road tunnels across Australia have a wide range of energy demands depending largely on road design (particularly grade), tunnel ventilation requirements (including ventilation outlet location and emission volumes) and traffic volumes (particularly number of trucks).

For the purposes of this review megawatt hours per tunnel kilometres (MWh/km) has been used as an indicator to review potential energy consumption. Indicative energy consumption of four road tunnel projects has been considered, as seen in Table 6-6, comparing energy consumption in megawatt hours (MWh) per year to tunnel length. The data obtained provides a range of potential energy consumption scenarios.
Table 6-6 Indicative tunnel energy consumption

<table>
<thead>
<tr>
<th>Project</th>
<th>Energy consumption (MWh) per annum</th>
<th>Total (2-way) tunnel length (km)</th>
<th>MWh/km per annum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern Distributor(^1,5)</td>
<td>4,400</td>
<td>3.2</td>
<td>1,375</td>
</tr>
<tr>
<td>M5 East(^2,3)</td>
<td>54,000</td>
<td>8</td>
<td>6,750</td>
</tr>
<tr>
<td>CityLink(^4) (Melbourne)</td>
<td>21,500</td>
<td>5</td>
<td>4,300</td>
</tr>
<tr>
<td>Lane Cove Tunnel(^5)</td>
<td>15,400</td>
<td>7.2</td>
<td>2,139</td>
</tr>
</tbody>
</table>

1. The Eastern Distributor operates with managed portal emissions.
2. M5 East includes twin 4 kilometre tunnels. The calculation above assumes energy consumption equivalent in both east and west bound tunnels.
3. M5 East has a re-circulation type ventilation system and a 1 kilometre exhaust tunnel to Turrella.
4. CityLink comprises two tunnels: Burnley Tunnel which is 3.4 kilometres and Domain Tunnel which is 1.6 kilometres.
5. Calculation assumes energy consumption equivalent in both tunnels.

Extrapolation from the existing tunnels noted in Table 6-6 indicates potential energy consumption of between 1400 MWh per year to over 6500 MWh per year per kilometre of tunnel could be expected.

Applying this to WestConnex (with around 50 kilometres in total of new tunnels, and assuming separate tunnels in each direction) indicates a potential range of energy consumption of between 70,000 and 340,000 MWh per year depending on tunnel ventilation system efficiencies. This equates to the same energy consumption as about 11,000 to 56,000 households.

Energy use in operating major road tunnel ventilation systems is a significant consideration and can vary substantially between projects depending upon a number of factors. Through the implementation of good road design, efficient ventilation design and community acceptable air quality outcomes, considerable reduction in energy consumption and associated greenhouse savings can be achieved.

6.4.4 Strategic mitigation and management strategies

**Road design/tunnel ventilation**

The main potential opportunities to reduce energy consumption include:

- *Road design* – particularly minimising tunnel grades (the adopted maximum tunnel grades are four per cent for the mainline tunnels and six per cent for tunnel ramps)
- *Ventilation design* – both at a macro design level and also at an operational level to reduce requirements for mechanical ventilation
- *Portal emissions* – reviewing the current no portal emission requirement that has applied to all recent road tunnels in Sydney (including M5 East, Cross City Tunnel and the Lane Cove Tunnel) provided performance-based air quality outcomes can be demonstrated in the portal areas
- *Improved fan efficiency* – larger fans, slower speeds, smaller pitch angles, aerodynamic blades, and better operating point
- *Improved installation efficiency* – direct fans towards tunnel centreline to avoid frictional losses. Specific opportunities include:
  - Tilting the jetfans towards the tunnel centreline
  - Slanting the silencers at either end of a jetfan
o Installing deflection vanes at one or both ends of a jetfan
o Converging the nozzles at one or both ends of a jetfan.

Road lighting and signalling – low energy consuming state of the art lighting and signalling systems (such as LED globes) will be considered in order to reduce energy consumption associated with those activities

Carbon intensity of fuel source – the carbon intensity of energy purchased from the grid in NSW is 245kg CO₂-e/GJ. In contrast, gas has a carbon intensity of 51.2kg CO₂-e/GJ (DCCEE 2012). In some instances gas can be suitable substitute for electricity. A switch to a reliance on gas would present a significant reduction in the carbon emissions associated with powering the proposed ventilation systems for WestConnex. This switch is subject to the availability of gas supply infrastructure to the source and the type of ventilation system(s) chosen

Renewable energy and GreenPower – the NSW Government Resource Efficiency Policy (NSW Government 2014d) specifies that, with one exception, all general government sector agencies are required to negotiate contract specifications to purchase accredited GreenPower for Contract 776 – Supply of Electricity – Small Sites and Contract 777 – Supply of Electricity – Large Sites. Where agencies purchase electricity outside Contracts 776 and 777, specifications to purchase a minimum of six per cent GreenPower are to be applied. This would be addressed through the procurement process for WestConnex.

Distributed energy solutions such as solar power generation on site and/or cogeneration and trigeneration may also be appropriate subject to detailed design requirements and, in the case of cogeneration or trigeneration, availability of a suitable fuel source. Similarly, consideration will also be given, where practicable and cost effective, to offset operational emissions through other means such as carbon sequestration (tree planting). Offsite energy generation or carbon reduction would also be considered as a mechanism to completely offset energy demand or greenhouse gas emissions associated with the program. Investment in a commercial solar farm that would produce energy and feed this energy into the grid is one such example.

6.4.5 Project level performance requirements and outcomes

The ISCA’s Infrastructure Sustainability Rating Tool Scorecard sets out specific requirements relating to energy and carbon for large infrastructure projects. These broadly fall into the following three categories:

- Energy and carbon reduction opportunities
- Energy and carbon monitoring
- Renewable energy.

Specific targets have been developed for WestConnex based on these categories, including:

- Complete Scope 1, 2, 3 greenhouse gas emissions footprints undertaken in order to develop a reference case
- Implement identified energy reduction activities across all emissions scopes
- Investigate further opportunities for renewable energy use such as providing 20 to 40 per cent of energy from renewable sources for the infrastructure lifecycle.

Detailed design and development of the individual projects has taken consideration of these targets.
WestConnex would comply with the applicable requirements of the NSW Government Resource Efficiency Policy.

The following performance requirements have been incorporated into the contracts for the M4 East and New M5:

- The Contractor must develop and implement an Energy Efficiency and Greenhouse Gas Emissions Strategy and Management Plan to:
  - improve energy efficiency; and
  - reduce greenhouse gas emissions for the construction and operational stages.
- The Contractor must demonstrate to WDA that opportunities to maximise construction and operational energy efficiency have been identified and analysed.

6.5 Noise and vibration

WestConnex will lead to both reductions and increases in road traffic noise at various locations. Noise reductions will occur due to reduced traffic levels along arterial routes such as Parramatta Road and with the transfer of surface traffic to tunnel sections. Increases will potentially occur along widened sections of surface motorway and arterial roads, and at upgraded interchanges and tunnel portals. Developing feasible and reasonable noise mitigation measures to address traffic noise increases will be important.

Noise and construction vibration will need to be actively managed and mitigated in order to reduce the risk of long construction periods over many years causing construction fatigue. More intensive construction techniques such as blasting may be considered in specific locations to reduce construction timeframes subject to community acceptance.

6.5.1 Strategic background and context

Roads and Maritime Services views road traffic noise as an important environmental issue and addresses road traffic noise through a range of approaches.

This is particularly relevant given the State of Environment report (EPA 2012a) identifies noise as a key environmental issue. The State of Environment report indicates that noise pollution is the second most common type of complaint call received by the OEH Environment Line (EPA 2012, p.15). In 2010-11, the Environment Line received 2,635 noise incident reports with noisy vehicles representing 39 per cent of all complaints. The State of Environment report also indicates that reports received are not considered to be an accurate indicator of the extent of noise pollution and typically understate it.

At a project level, the assessment of operational noise impacts for road projects is guided by the NSW Road Noise Policy (RNP) (DECCW 2011). This is supported by the Noise Criteria Guideline (RMS 2014d) and Noise Mitigation Guideline (RMS 2014e) which assist in the application of criteria and the development of noise mitigation measures where required.

The noise environment is determined by project specific noise monitoring to establish background noise levels. Modelling is conducted to predict future noise levels and to identify where noise mitigation is required to address project impacts. Noise mitigation measures that are typically used include noise barriers, pavement treatments and acoustic treatment of buildings.
**Existing situation and trends**

Road traffic noise is a significant issue within Sydney due to large traffic volumes and an expanding road network. With an increase in transport needs as the Sydney region expands to accommodate a growing population, there is a corresponding stress on the existing road network and an increase in environmental impact due to vehicle noise.

The World Health Organisation (WHO) has identified the health implications of transport noise and has developed guidelines to address potential impacts on the general population. The WHO guidelines for issues concerning noise and health include the *Night Noise Guidelines for Europe* (WHO 2009) (NNGE), and the *Burden of Disease from Environmental Noise* (WHO 2011) (BDE-Noise).

Roads and Maritime Services has a framework for managing at-source and receiver noise issues which impact on human health through the RNP, *State Environmental Planning Policy (Infrastructure) 2007* (ISEPP) and guidelines. The ISEPP (clause 102) requires residential developments near major roads to have measures in place so that noise is not exceeded above comfortable levels within residences.


As Sydney grows, managing traffic noise due to higher population densities will become an issue of increasing significance, and one that will demand the highest level of management and integration at the planning stages during project inception.

Improvement of amenity by reducing road traffic noise is identified as a consideration in *A Plan for Growing Sydney* with regard to revitalisation of existing suburbs.

All of the above considerations are relevant to WestConnex, which will be a transformative project in relation to access. WestConnex will lead to substantial changes in traffic flows and distribution.

Some areas will experience higher levels of traffic-related noise where widened or new surface sections of motorway are constructed. Other areas will experience traffic noise reduction where traffic is transferred from existing arterial roads, particularly where tunnel sections are provided. New and upgraded interchanges will be developed which have the potential to concentrate traffic (and therefore noise).

### 6.5.2 Key strategic indicators

The appropriate strategic operational traffic noise indicators for WestConnex are the noise assessment criteria set out in the RNP. These will be established for each project through noise assessments conducted as part of the planning approval process.

Under the RNP, road development is either classified as ‘new road’ or ‘redevelopment of an existing road’. Each road classification has a base criterion for both day and night time assessment periods. The criteria for night time recognises the quality of the noise environment necessary for restful sleep.

The *Interim Construction Noise Guideline* (ICNG) (DECC 2009a) sets out criteria to address construction noise impacts. The criteria are expressed as construction noise management levels, which typically apply at the boundary of any property that is exposed to construction noise. The construction noise management levels relate to the background noise at any location.
The *NSW Industrial Noise Policy* (INP) (EPA 2000) provides guidance for establishing noise assessment and management criteria and assessing operational noise impacts from development sites.

The INP is relevant to WestConnex with regard to the operation of operational facilities like tunnel ventilation systems.

The recommended assessment objectives vary depending on the potentially affected receivers, the time of day, and the type of noise source. The INP has an amenity criterion (which also takes into account sleep arousal) and an intrusiveness criterion that have to be considered.

Vibration is typically related to the construction phase of a road project. Vibration criteria are established to address human comfort and structural damage. Guidelines for vibration include the following:

- **Human comfort – Assessing Vibration – a technical guideline** (DECC 2006)
- **Structural damage – AS2187.2-2006 Explosives-Storage, Transport and Use (Appendix J) and Structural Vibration, Part 3: Effect of Vibration on Structures** (DIN 4150-3)
- Standards Australia, 1997, Australian Standard AS2670.2 *Evaluation of human exposure to whole-body vibration*
- British Standards Institution, 1993, BS7385: Part 2 *Evaluation and measurement of vibration in buildings*, 0 580 22188 1
- British Standards Institution, 2009, BS5228:2009 Part 2 *Code of Practice for noise and vibration control on construction and open sites-vibration*

### 6.5.3 Strategic review

**Operational noise**

WestConnex will lead to substantial changes in operational traffic noise levels for arterial roads in the vicinity of the program and in the vicinity of the motorway corridor.

Increases in traffic noise may occur along sections of motorway that are to be widened, such as the M4 Motorway between Parramatta and Haberfield, and new surface sections and network integration work in places like St Peters and Mascot. Decreases in noise levels will result from transfer of traffic from parallel arterial routes.

Most of WestConnex will comprise tunnel. Transfer of traffic from surface road to tunnel will result in a reduction in noise impacts for residential and other noise-sensitive receivers in a number of areas. A prime example of this is Parramatta Road from Concord to Haberfield; where average weekday traffic volumes will reduce by around 45,000 vehicles.

For locations where traffic noise levels exceed RNP criteria, consideration will be given to reasonable and feasible noise mitigation measures. These will be determined on an individual project basis and will selected in consultation with affected residents and other noise-sensitive receivers. Locations that will require particular attention include interchanges where the footprint of the roadway is larger and noise sources may be elevated, and tunnel portals where noise transmitted along the tunnel may be emitted.
Due to the scale of WestConnex, noise assessments will also need to consider impacts on the wider network where traffic levels change substantially on arterial roads.

**Construction noise and vibration**

Noise will be generated for each WestConnex project during the construction period. Although the noise from construction activities is not a permanent noise source, it will need to be managed appropriately, to reduce the potential to impact on noise-sensitive receivers. Construction noise may also have the potential to generate short term health impacts due to sleep disturbance or disruption of normal routines where out-of-hours works are required.

Construction related impacts will need to be managed over a long time period. It should be noted, however that no one receiver would be subject to noise for the whole length of the scheme. In addition, significant sections of the program are in tunnel with substantially less impact in relation to noise and vibration. Construction impacts will be most evident in areas where existing motorways are being widened (such as the M4 Widening and the western section of the M5 East) and along new surface sections and at tunnel portals.

In order to minimise the impacts of construction noise and vibration on receivers adjacent to the proposal, a reduction in overall construction times can be considered. Reductions in construction times can be achieved, in many instances, by the application of the most expedient construction techniques combined with the current best practice methods. In some instances by negotiation with property owners, higher construction noise and vibration levels may be deemed acceptable if the duration of particular activities is substantially reduced.

The range of potential impacts of construction on sensitive receivers includes airborne noise, ground-borne vibration and ground-borne (regenerated) noise. The mechanism for airborne noise from construction is well understood and is function of the type of activity being undertaken, the equipment being used and the proximity to receiver locations. Due to the nature of construction noise, work hours are generally restricted to manage the environmental impact on the community. In areas where noise is concentrated, temporary noise barriers and acoustic enclosures may also be effective in mitigating airborne noise.

Sources of vibration impacts are generally not able to be seen (especially in relation to tunnelling) but can cause anxiety within the community. During tunnelling works, vibration can impact as ground-borne vibration and/or ground-borne noise. Ground-borne vibration is transmitted through the ground and into a building or structure to create a sensation of movement in the building envelope or its contents. Ground-borne noise is caused by the vibration travelling through the ground and then through walls, floors, etc when it reaches residences.

Both types of vibration impacts may occur during tunnelling works depending on the type of tunnelling technique used, the distance to a receiver location and the type of ground being excavated. There are several construction methods that may be adopted for tunnelling projects and the following factors should be taken into consideration when selecting the best method for any given project:

- Tunnel dimensions
- Tunnel geometry
- Length of tunnel, total volume to be excavated
- Geological and rock mechanical conditions
- Ground water level and expected water inflow
- Vibration restrictions
- Allowed ground settlements.
Tunnelling methods

The commonly used tunnelling methods are drill and blast, tunnel boring machines (TBMs), rock hammers and roadheaders.

Drill and blast methods used for tunnelling in medium to hard rock can be applied to a wide range of rock conditions. The benefits of this method include versatile equipment, fast start-up and relatively low capital cost. Blast vibrations are generally of a high level but short duration. Blast vibrations and noise impacts can restrict the use of drill and blast in some sensitive areas. Alternatively, controlled blasting methods with reduced advanced rate can be adopted in sensitive areas.

Hard-Rock TBMs can be used in relatively soft to hard rock conditions and are best when rock fracturing and weakness zones are predictable. The TBM has a high initial cost and only becomes economical for long tunnels. The TBM has a fast rate of excavation and produces a smooth tunnel with low rock reinforcement cost.

Roadheaders can be used for tunnelling in stable rock conditions of low-to-medium hardness. In harder rock conditions, use of roadheaders is limited by a shorter lifetime of tools and therefore increased costs. Vibration levels from a roadheader are usually much lower than the drill and blast method but higher than a TBM. However, the impact of vibration and noise on the surface is negligible if the tunnels are located at relatively deeper depths (generally greater than 20 metres).

The geology along the WestConnex alignment is predominantly sandstone, siltstone and shale. This is an ideal medium for tunnelling with appropriate measures to identify geotechnical risks. TBM and roadheaders are two common tunnel construction methods used in NSW in similar ground conditions with limited application of drill and blast method.

In the Rozelle area, cut and cover tunnel construction methods may be required due to the presence of fill materials and estuarine sediments. This type of tunnel construction may also be used around tunnel portals where tunnels are near the ground surface.

6.5.4 Strategic mitigation and management strategies

A balance between construction cost, environmental impacts, and construction time will be necessary to deliver WestConnex. As discussed above, in applying the most expedient methods to construct infrastructure for particular projects, it may be possible (by negotiation with affected property owners) to increase the operational limit or threshold for some non-critical criteria such as the Human Comfort Criteria (vibration), which is substantially lower than levels where building damage will occur. Increases in vibration limits may also be possible for WestConnex where negotiated property agreements with affected residents are available.

Short term exceedances of some non-critical criteria are permitted in line with the NSW EPA's vibration guidelines, where available methods for reducing the vibration are explored. Exceedances of these criteria do not affect property and do not have a lasting impact; therefore may be mitigated through management measures.

During the design of WestConnex, opportunities exist to maximise the noise reduction benefits to the community through design options and consideration of both existing and future development sites adjacent to the scheme. Identifying future land use adjacent to surface roads will enable mitigation measures to be strategically placed and may avoid a more costly future retrofitting program.

The reduction of construction timeframes for key elements of WestConnex will have dual benefits for the community. Providing a shorter project delivery schedule minimises short term construction impacts and will deliver individual projects within a shorter timeframe.
providing potential operational noise benefits to local communities. Techniques to expedite the construction process such as efficient tunnelling techniques as well as the full range of construction practices will be considered where the impacts can be effectively managed.

A proactive community program to explain the benefits, impacts and proposed mitigation measures for the project is underway. Early consultation and transparent communication will provide a good platform for community views to be considered in selecting appropriate mitigation measures and construction techniques.

6.5.5 Project level performance requirements and outcomes

Noise-based performance requirements for WestConnex will be in accordance with the NSW RNP and the ICNG as part of environmental assessments for individual projects.

Project level performance will be assessed through noise monitoring to measure the effectiveness of noise mitigation measures and compliance with noise criteria. Further discussion of construction impacts, particularly on amenity, is provided in Section 6.7.

Those locations where there are major project overlaps and/or interfaces will be particularly prone to construction fatigue. Accordingly, standard mitigation and management measures may require further strengthening. For example, more stringent night-time noise controls may be required where communities have already been exposed to lengthy periods of disruption. These critical construction impact challenges will be identified as the individual projects progress through the detailed design and delivery stages.

Each project will have a well-developed and individually-tailored noise and vibration strategy, which specifically addresses noise and vibration issues, and provides early community engagement and responsive noise management measures.

6.6 Socio-economic

From a socio-economic perspective, WestConnex can deliver progressive benefits in terms of accessibility, liveability and economic growth. This is important to offset potential disruption during construction and to build long-term community support for the program.

WestConnex will also provide the catalyst for urban renewal along Parramatta Road. Opportunities exist to provide improved amenity and liveability, improved public and active transport, high quality housing and employment areas along this corridor.

On a regional basis an opportunity exists to maximise the economic benefits from improved accessibility to Sydney Airport, Port Botany, Sydney CBD and the Western Sydney Employment Area.

6.6.1 Strategic background and context

Regional context

WestConnex is located within the following three subregions of A Plan for Growing Sydney:

- **Central**, comprising Ashfield, Strathfield, Burwood, Canada Bay, Leichhardt, Marrickville, City of Sydney, and Botany Bay LGAs
- **West Central**, comprising Auburn, Holroyd, and Parramatta LGAs
- **South**, comprising Rockdale, Canterbury and Hurstville LGAs.
WestConnex will connect the growth areas of Parramatta and surrounding western Sydney suburbs to key economic development areas in inner Sydney, including Sydney Airport and Port Botany to the east.

Population and demography

The Central and West Central subregions will play a key role providing for future population growth in the Sydney Region, as well as growth in employment and housing. About 625,000 additional jobs will be developed in the Sydney Region by 2031, with over half of these jobs planned to be located in these subregions.

Communities in the area potentially impacted by WestConnex are varied. For example, communities towards inner Sydney generally comprise younger people, lone person or group households. Towards western Sydney, communities generally comprise younger and more varied households, high levels of cultural diversity with large proportions of people who speak a language other than English, and households with lower incomes.

Economy

The Sydney Region is critical to the performance of the NSW and Australian economies, contributing about 75 per cent of NSW’s gross state product (GSP) and 25 per cent of total economic output. The region also serves as a global hub in the Asia-Pacific Region.

The key services in the Sydney CBD and eastern part of the study area include finance and insurance services and professional, scientific and technical services. Towards the western part of the study area, key services include manufacturing and transport, postal and warehousing. The LGAs of western Sydney are the largest employers in the Sydney Region, accounting for about one third of total employment in the Sydney Region (AEC Group 2012).

Tourism is also an important industry within the Sydney region attracting 2.6 million international overnight visitors and 7.8 million domestic overnight visitors to Sydney in the 12 months to September 2012 (Destination NSW 2012). In the 12 months to December 2014 these numbers had increased to nearly three million international overnight visitors and 8.5 million domestic visitors (Destination NSW 2015).

A Plan for Growing Sydney identifies the need to develop economic centres in multiple CBDs to ensure that access to these centres is equitable and efficient and that economic growth is spread throughout the Sydney Region. Future economic activity will continue to be focused in the western ‘strategic centres’, including Parramatta, Liverpool and Penrith, as well as existing strategic centres, such as the Sydney CBD and North Sydney (NSW Government 2013a).

Key future economic growth areas identified in A Plan for Growing Sydney relevant to WestConnex include:

- **The Global Economic Corridor**, extending from Port Botany and Sydney Airport, through Sydney CBD and North Sydney, to Macquarie Park in the north. Priorities within the Global Economic Corridor include the creation of 173,000 additional jobs; extending the corridor toward Parramatta and Norwest and creating 40,000 additional jobs in this extended section; and implementing works to relieve major congestion around Sydney Airport and Port Botany.

- **Parramatta Road corridor**, which connects the Sydney CBD and North Sydney with Parramatta via Sydney Olympic Park along Parramatta Road and the M4 Western Motorway. Priorities include the delivery of improved road connections through WestConnex, particularly to local centres to generate investment, as well as a focus on Sydney Olympic Park as a ‘specialised precinct’ to be a major area of future employment.
• **Parramatta**, which is the economic focal point for western Sydney and considered Sydney’s second largest concentration of employment in the Sydney Region. Priorities include the creation of 21,000 additional jobs in the Parramatta CBD and 7000 additional jobs in the nearby suburbs of Westmead and Rydalmere.

• The **Western Sydney Employment Area**, which is located at the intersection of the M7 and M4 Motorways near Eastern Creek. This area will expand on an existing employment cluster, involving the investigation of 10,000 hectares of additional employment land to the south-west and will encourage the growth of industrial, freight, logistics and research functions in this area.

**Social infrastructure**

Social infrastructure refers to community facilities, services and networks, which enable individuals, groups and communities meet their social needs, maximise their potential for development and enhance community well-being. It includes community support, education and training, sport and recreation, cultural, health, and emergency facilities and services (OUM 2007).

A wide range of regional level social infrastructure is located within or near to WestConnex. These facilities serve the needs of communities within the Sydney Region and wider NSW. These include:

• **Educational facilities**, including the University of Sydney, University of Technology Sydney and the University of New South Wales in the Sydney CBD and inner-west suburbs as well as the University of Western Sydney in the Parramatta CBD.

• **Sport and recreational facilities** offering state, national and international level facilities, including:
  - **Sydney Olympic Park**, which offers a range of local, regional and international level sporting facilities including the State Sports Centre, Sydney Olympic Park Tennis Centre, and Athletics Centre, as well as various informal facilities such as walking and cycling trails, picnic areas and parks including Bicentennial Park.
  - **National Parks**, including the Sydney Harbour National Park and Royal National Park and Georges River National Park to the south.
  - **Major urban parks** including Western Sydney Parklands and Western Sydney Regional Park to the west and Victoria Park, Centennial Park and Sydney Park in or near to the Sydney CBD.
  - **Major golf courses** including The Lakes Golf Club, Eastlake Golf Course and Australian Golf Club near the Sydney Kingsford Smith Airport, which host national and international golf events, such as the Australian Golf Open.

• **Health and medical facilities**, including Prince of Wales Hospital and Royal Prince Alfred Hospital near the Sydney CBD and Westmead Private Hospital to the west. About 70 per cent of NSW health assets are located in the western suburbs of Westmead, Liverpool, Bankstown and Concord as well as St George in the east.

• **Cultural and tourism facilities**, which are mainly located in the Sydney CBD including the Sydney Opera House, Sydney Harbour Bridge, Sydney Harbour, Sydney Convention and Exhibition Centre as well as various national and state level museums, art galleries and theatres.

A range of social infrastructure serving the day-to-day needs of local residents is also located within local centres within the study area.
**Future development**

The previous Draft Metropolitan Strategy identified nine ‘city shapers’ to guide and influence future development in the Sydney Region. Those relevant to WestConnex included Global Sydney, Parramatta, Parramatta Road corridor, and Western Sydney Employment Area. These indicated key areas of change and investment critical to the growth of the Sydney Region. These areas have been carried over into *A Plan for Growing Sydney*.

The NSW Government will also encourage economic growth along the Global Economic Corridor, which extends from Port Botany and Sydney Airport, through Sydney CBD to Parramatta via Macquarie Park with ‘secondary corridors’ from Macquarie Park to Norwest (Baulkham Hills) and to Sydney Olympic Park.

*A Plan for Growing Sydney* also identifies strategic centres within each subregion. These include Green Square (East), Kogarah and Hurstville (South), and Rouse Hill (West). The Northwest Growth Centre and South West Growth Centre to the west of Parramatta are also experiencing growth and development.

**Liveability and amenity**

The Property Council of Australia (2012) undertook a survey of the liveability of Australian cities. Those factors that were identified by Sydney residents as contributing to a liveable city were: a safe place for people and their property; an affordable city; to have a good standard of living, and having good employment and economic opportunities.

Compared to other cities, Sydney residents identified the city’s good employment and economic opportunities, vibrant cultural entertainment scene and good climate as contributing to the liveability of the city. A good healthcare service and a good public transport service also contributed to Sydney’s liveability. The road network and traffic congestion were identified as factors detracting from the liveability of the city (Property Council of Australia 2012).

Relevant issues for WestConnex regarding liveability and amenity include:

- The need to ensure that road works complement rather than compete with existing and proposed freight and passenger rail, buses and light rail
- Need for improved public transport along and across the Parramatta Road corridor
- Desire for improved urban amenity along the Parramatta Road corridor. Consultation feedback demonstrates that poor urban amenity along Parramatta road exists due to heavy traffic volumes, low investment in the public domain and congestion throughout weekdays and weekends. This congestion causes Parramatta Road to act as a ‘natural barrier’ to pedestrians and road users on either side
- Need to minimise noise and air quality impacts of new road infrastructure on sensitive receivers such as schools, recreation areas and places of worship
- Need to mitigate and manage impacts on and access to businesses and property in close proximity to the new road infrastructure
- Importance of protecting heritage values of residential areas and streetscapes along the corridor as well as outdoor recreation areas
- Need to minimise and manage impacts on local business operations and enhance where possible (NSW Government 2012). Consultation feedback suggests that WestConnex is an opportunity to improve productivity of business and industry due to a decrease in congestion, lower travel speeds and unreliable travel times. Parking for local businesses during construction and operation of WestConnex was identified as a concern.
Access and connectivity

The study area offers a wide range of transport infrastructure, including Sydney Kingsford Smith Airport, major motorway networks, public transport facilities, including bus and train, and cycling and pedestrian facilities.

The Sydney Region currently comprises over 160 kilometres of uninterrupted motorways, arterial and other main roads. Key existing transport connections potentially influenced by WestConnex include:

- M4 Motorway, connecting Concord with Lapstone at the foot of the Blue Mountains
- M5 South-West Motorway, connecting Sydney CBD with the south western suburbs
- M5 East, connecting the south western suburbs with Sydney Kingsford Smith Airport, Port Botany and surrounding areas
- Westlink M7, connecting the western suburbs with the Sydney CBD
- Homebush Bay Drive/King Georges Road (route A3), connecting with the M4 Western Motorway and providing a north-south connection.

Sydney’s roads are a critical part of the city’s transport network, directly supporting around 75 per cent of the 17.6 million trips made every weekday. This includes heavy and light commercial vehicles, cars, buses, motorbikes and scooters. It is anticipated that travel by private vehicle will remain the dominant form of travel in Sydney over the next 20 years (NSW Government 2012b).

As Western Sydney continues to grow, efficient east-west transport connections for private and freight vehicles to Western Sydney centres are becoming constrained, with increased traffic volumes. This has resulted in increased congestion, longer travel times and decreasing travel reliability. As such, the Draft Metropolitan Strategy identified improved transport connections to Western Sydney as a priority (and this has been carried forward into A Plan for Growing Sydney).

Locally, increased traffic on surface roads has created a barrier to local transport movements, including for pedestrians and cyclists. In particular, current traffic volumes on roads such as Parramatta Road have created a barrier to local traffic movements across and along the road.

Sydney Airport is currently the only major airport serving the Greater Sydney Metropolitan Area, catering for more than 290,000 aircraft movements. Sydney Airport is the primary gateway for intra-state, inter-state and international visitors to Sydney and wider NSW. In 2011-12, the airport provided for 36 million passenger movements, which is expected to double by 2033. Sydney Airport is also a major freight hub, handling around 530,000 tonnes of air freight in 2011, of which about 395,000 tonnes comprised international air freight. The total volume of freight is projected to double by 2033 (SACL 2014).

In April 2014, the Commonwealth Government designated Badgerys Creek as the site for the Second Sydney Airport. According to the Department of Infrastructure and Regional Development’s website (consulted 8 May 2015), the airport is planned to commence operation in the mid-2020s. Development of the airport would be staged in response to demand. Initially it would have only one runway but would have the capacity to grow over time. Accordingly, Sydney Airport will remain Sydney’s primary airport for the foreseeable future.

A primary freight road is located along Parramatta Road, M4 Western Motorway and M5 East Freeway, with connections to Port Botany and Sydney Airport. Along these corridors, intermodal terminals are located at Clyde, others proposed at Enfield and Moorebank.
The public transport system supports a significant number of commuters travelling to and from Sydney’s major centres. For example, around 75 per cent of peak hour commuters to Sydney CBD and around 45 per cent to Parramatta CBD travel by public transport.

Sydney Trains provides an extensive passenger rail service to those communities near WestConnex with services extending between the Blue Mountains and Sydney CBD, to the Southern Highlands. Sydney Buses operates more than 300 regular routes and 5000 school bus services across the Sydney metropolitan area, extending into Parramatta and nearby western suburbs. Western Sydney Buses operates between Liverpool and Parramatta.

Cycle and pedestrian networks are generally localised with various shared and dedicated paths throughout the Sydney Region. National and regional parks generally provide cycle and pedestrian facilities.

6.6.2 Key strategic indicators

A number of key strategic indicators relevant to liveability and the socio-economic environment include:

- Productivity of business and industry, including changes in access and connectivity to employment and commercial, travel time savings and reliability for freight and commuters
- Community health and safety, including changes in crash rates, reduction in traffic on local streets, and likely community perceptions about health due to changes in air quality
- Amenity and liveability, including changes in local and regional air quality, noise and vibration, and urban amenity
- Community facilities, including direct and indirect impacts on state or regional level facilities, such as sport and recreation, health care and education facilities
- Community values, including impacts on places or features likely to be important to regional communities as well as changes in social equity, such as access to housing, employment, services or customers
- Access and connectivity, including changes in the level of severance between communities, and changes in access for pedestrians, cyclists, public transport users and road users.

6.6.3 Strategic review

Productivity of business and industry

WestConnex will impact positively on employment and economic growth and development within western Sydney and the greater Sydney region more broadly, through improved access to major economic and employment areas. These include:

- Sydney CBD
- Sydney Airport and Port Botany
- Parramatta CBD and the Western Sydney Employment Area
- Major centres at Blacktown, Burwood and Bankstown
- Specialised precincts, including Westmead Hospital, Rhodes Business Park, Sydney Olympic Park, and Bankstown Airport-Milperra.
Increased capacity of the motorway network will assist in reducing congestion and access constraints for freight transport. In particular, WestConnex will reduce transport costs for business and industry through travel time savings and greater reliability of freight movements.

WestConnex will provide improved access for freight to and from Port Botany as well as improved motorway access for passengers, freight and employees to Sydney Airport via the Sydney Gateway connection linking to St Peters. This will support future growth and development within these areas, and economic development within the greater Sydney region and NSW more broadly.

WestConnex will provide opportunities to improve the commercial and business environment in some locations such as Parramatta and Princes Highway through the reduction in surface traffic. In particular, WestConnex will provide opportunities for the revitalisation of local centres along the Parramatta Road Corridor, attracting new investment and diversifying commercial uses. Reducing surface traffic along Parramatta Road will also provide opportunities to improve linkages between the local centres and to surrounding areas.

Impacts on businesses will also occur as a result of property acquisition for surface works, including new connections, surface roads, widening of existing motorways, tunnel infrastructure and construction worksites. This may require potentially directly impacted businesses to relocate. The ability for these businesses to relocate locally will depend on the nature and the specific requirements of the impacted businesses.

Impacts on businesses may also occur through changes in access due to surface works. The level of impact on individual businesses will depend on the nature of the business and the extent of the change in access.

Construction of WestConnex will impact positively on employment through the creation of about 10,000 construction-related jobs, both directly and indirectly for business and industry supplying services to WestConnex’s construction. Construction of WestConnex will also provide opportunities for construction-related business and industry.

During construction, impacts on business and industry may also result from:

- Traffic disruptions and delays due to surface road works, including for freight transport and commuters
- Increased noise and dust from construction activities, impacting on local amenity for businesses near to surface works
- Access disruptions for businesses near surface works, including potential changes to physical access or visibility of some businesses near construction works.

Community health and safety

Community health depends on a range of factors including access to health and community facilities, personal risk factors, levels of physical activity, and environmental qualities such as safety and amenity.

WestConnex will provide improved safety particularly for road users, including motorists, pedestrians and cyclists. In addition, a reduction in surface traffic volumes, particularly of heavy vehicles on the Princes Highway/King Street and Parramatta Road will improve safety for cyclists and pedestrians.

A reduction in through traffic on local streets and within commercial centres will improve safety for local communities and reduce the potential for conflict between vehicles and pedestrians and cyclists. This will assist in encouraging increased walking and cycling, providing beneficial impacts for the health and well-being of local communities.
WestConnex will improve access to major regional level health, medical and emergency services such as Prince of Wales Hospital and Royal Prince Alfred Hospital near the Sydney CBD, Westmead Private Hospital to the west and St George Hospital to the south by reducing travel times and improving traffic congestion.

WestConnex will improve access to regional level open space and recreation facilities, such as Sydney Olympic Park, Western Sydney Parklands and Sydney Harbour. This will support increased physical activity and participation in recreation.

At a local level, potential impacts may occur for health, medical and emergency services located near construction works. Direct property impacts, changes in local access, traffic disruptions and delays, and impacts on local amenity would also result.

Community health benefits may also result from improvements in air quality due to a reduction in exposure to vehicle emissions. This will be particularly relevant at properties where vehicle emissions will be removed from the surface road and redistributed via tunnel ventilation (refer Section 6.3 for further information on air quality).

Some residents, business owners or employees affected by WestConnex, such as through property acquisition or proximity to construction works, may experience stress and anxiety due to potential changes or project impacts. This may impact on health and well-being for some individuals, particularly those that may be more vulnerable to change, such as elderly, people on fixed or low incomes, or people with a disability.

During construction, impacts on community health and safety could result from:

- Increase in construction traffic, including heavy vehicles, impacting on road safety
- Changes in access for pedestrians and cyclists near to construction works, reducing legibility and sight lines
- Potential creation of unsafe public places near worksites and surface works
- Increased noise and dust from construction activities for communities nearest to the surface works.

Liveability and amenity

Overall, WestConnex will improve liveability and amenity for residents and business within the study area and Greater Sydney Metropolitan Region, by improving travel and access for work, business and leisure.

WestConnex will assist in reducing surface traffic volumes in some areas, resulting in beneficial changes to liveability and amenity through:

- Improved amenity, including easier and safer access for pedestrians and cyclists
- Reductions in traffic volumes and subsequent improvements in local air quality (refer Section 6.3)
- General improved traffic noise environment
- Improved access for motorists, pedestrians and cyclists, including to and within local centres and suburbs
- Potential improvements in access for public transport users.

WestConnex will provide opportunities to improve the urban amenity of some local centres, such as along Parramatta Road, through the reduction in surface traffic. This will provide an opportunity to revitalise and regenerate these local centres through land use change and diversification of commercial uses offered, including those uses that will benefit from an improved urban environment.
During operation, a tolling system will be implemented, which will be capped. Social impacts typically associated with toll roads include discouraging unnecessary trips therefore providing environmental benefits; discouraging some motorists from using the new facility; and depending on whether the toll rate is set high, traffic may divert onto parallel roads (The World Bank Group undated).

During construction, impacts on liveability and amenity for residents in the study area and the Greater Sydney Metropolitan Region could result from:

- Increased noise and dust from construction activities, impacting on communities nearest to construction worksites and work areas
- Vibration from tunnelling construction, potentially impacting on amenity for occupants of buildings above or near the tunnel alignment
- Increased construction traffic, including haulage vehicles, resulting in increased traffic noise and disruptions for communities along haulage routes and potential impacts on road safety
- Delays and disruptions for road users near construction works, including motorists, pedestrians, cyclists and public transport users.

Management of construction impacts will require detailed planning and assessment for each project. Maintaining a safe environment for road users and adjoining residents will be a critical issue during construction. Best practice management measures and safeguards will be implemented during the construction of WestConnex.

**Social infrastructure**

Overall, WestConnex will improve access for communities within the Greater Sydney Metropolitan Region to regional level social infrastructure, such as:

- International and domestic terminals at Sydney Airport
- Sport and recreation facilities at Sydney Olympic Park and Western Sydney Parklands
- Major hospitals such as the Royal Prince Alfred Hospital at Camperdown, Prince of Wales Hospital at Randwick, Westmead Hospital at Parramatta and St George Hospital at Kogarah
- Tertiary education facilities, including the University of Sydney at Camperdown, the University of Technology Sydney at Ultimo, the University of NSW at Kensington and the University of Western Sydney at Parramatta
- Cultural and tourist facilities in Sydney CBD.

WestConnex will support improved access to community services and facilities in major regional centres including at Parramatta, Liverpool and Sydney CBD, as well as facilities in local centres in those areas where surface traffic is reduced.

WestConnex may directly impact on some community facilities located nearest to surface works through property acquisition or changes in local access.

During construction, potential impacts on social infrastructure will include:

- Impacts on amenity for users of community facilities near construction works, due to increased noise, dust, vibration and construction traffic
- Possible disruptions for emergency services due to surface road works.
Access and connectivity

WestConnex, once built, will improve access and connectivity for residents, businesses and visitors within the study area and the Greater Sydney Metropolitan Region. In particular, WestConnex will reduce traffic volumes on the M5 East and on Parramatta Road (refer Section 6.2). This will reduce congestion, providing travel time savings, improved travel reliability and improved connections to the regional road network.

Locally, WestConnex will provide the catalyst to improve access and connectivity to local centres and within and between suburbs by transferring through traffic to motorway standard roads. This will support safer access for pedestrians and cyclists and reduce barriers to local traffic movements.

In particular, minimising increases in surface traffic on Parramatta Road will assist in managing the ‘barrier effect’ this road has on local movements. This will provide opportunities to improve connectivity between suburbs located on either side of the road as well as improved access for motorists, pedestrians and cyclists to local centres. Changes to surface traffic on Parramatta Road also provide opportunities to improve public transport connections using the road.

WestConnex has the potential to impact on local access and connectivity in some areas. In particular, widening of surface roads such as the M4 and M5 East motorways has the potential to increase perceived barriers to local traffic movements. Surface works also have the potential to change local movements due to possible road closures or changes in traffic flows.

During construction, potential impacts on local access and connectivity could result from:

- Surface works and construction activities resulting in changes to traffic conditions and possible delays and disruptions for road users
- Increased construction traffic, including heavy vehicles, potentially impacting on safety for road users
- Changes to pedestrian and cycle connections near to construction works, impacting on safe access for pedestrians and cyclists.

6.6.4 Strategic mitigation and management strategies

A range of mitigation and management strategies have been identified to manage potential impacts on and maximise benefits for the socio-economic environment of the study area associated with WestConnex.

However it is recognised that many of these issues go beyond the control and authority of just WDA, particularly with respect to land use and development changes. WDA will therefore work collaboratively with agencies and organisations to ensure WestConnex is integrated into the broader strategies for the management of these issues. The following agencies and organisations will be consulted with and provided opportunity for input at various stages of the scheme:

- Local councils and Regional Organisations of Councils
- NSW Emergency Services including NSW Police, Ambulance Service and Fire & Rescue
- Private bus operators
- Sydney Airport Corporation Limited
- Port Botany operators and associated rail and road operators
- Affected landholders
- Other affected stakeholders as relevant.

Potential strategies are indicated in Table 6-7.
<table>
<thead>
<tr>
<th>Impacts</th>
<th>Strategy</th>
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</table>
| Accessibility benefits and shared social equity | • Proactive involvement and coordination of investigations into complementary public transport services including related infrastructure.  
• Traffic management strategies and safety improvements for surface streets with reduced traffic due to WestConnex.  
• Integrate land use planning along WestConnex with *A Plan for Growing Sydney*, particularly at a local government level.  
• Improve access and road connections to and between regional level social infrastructure, particularly Sydney Olympic Park. |
| Community severance | • Develop urban design strategies to enhance community connectivity including but not limited to early consultation, pedestrian crossing, links and overpasses.  
• Consider opportunities to enhance connectivity during the design development process including local roads, public transport routes, cycle routes and pedestrian access along and across WestConnex.  
• Early consultation with communities along WestConnex to discuss whether severance is a perceived community concern. |
| Community health and safety | • Appropriate tunnel ventilation design to protect the health and safety of tunnel users and communities.  
• Explore the use of Crime Prevention through Environmental Design (CPTED) principles during the design development process, particularly along the surface road sections of WestConnex. Natural surveillance, lighting, walkways, signage and landscape should be considered including areas immediately surrounding the motorway affected by construction. |
| Productivity benefits for business and industry | • Ensure WestConnex integrates freight strategies associated with the development of the rail freight network and associated intermodal facilities.  
• Freight management strategies to facilitate increased movement of freight vehicles between Port Botany, Sydney Kingsford Smith Airport, Parramatta and Western Sydney Employment Area due to WestConnex. |
| Liveability | • Explore urban renewal opportunities, particularly along Parramatta Road and the M4 Western Motorway to support sustainable population and economic growth with reference to *A Plan for Growing Sydney*, the Urban Renewal SEPP and Design Quality of Residential Flat Development (SEPP 65).  
• As part of master planning, develop urban design strategies to ensure healthy, cohesive and inclusive communities along WestConnex. Upgraded surface road areas, such as Parramatta Road, should be designed to be welcoming and walkable for pedestrians, and inclusive for wheelchairs, prams and other mobility requirements.  
• Investigate the use of residual land parcels generated from potential property acquisition for community facilities, such as new open space. |
| Urban growth | • Support new housing development and employment opportunities in Western Sydney, through improved transport connections, travel reliability and travel saving times particularly between major centres, Sydney CBD, Port Botany, Sydney Airport and Parramatta CBD. |
6.6.5 Project level performance requirements and outcomes

The performance outcomes for WestConnex in managing potential socio-economic impacts during construction and operation involve avoiding, minimising and managing adverse impacts on the socio-economic environment.

Disturbance to residents and businesses nearest to the construction works will be minimised by:

- Management of construction traffic
- Implementation of noise attenuation and dust mitigation measures
- Implementation of measures to manage vibration caused by construction activities
- Implementation of measures to minimise visual intrusion and light spill.

Early and ongoing consultation will be undertaken with managers of community services and facilities to identify potential impacts on the use of these services and facilities and effective mitigation strategies to manage impacts. This will include timing of key construction activities to avoid peak use times or major events at key facilities.

Open space areas disturbed by construction activities will be reinstated as soon as practicable unless otherwise agreed with the owner/manager.

Detailed design will be undertaken with consideration of visual and urban design objectives and principles for WestConnex.

Tunnel ventilation outlets will be designed to protect the health and safety of all users, including worst-case for exposure such as slow speeds and less well-sealed vehicles. Tunnel ventilation outlets will also be designed in a way that minimises impacts on nearby sensitive receivers, such as schools, aged care, child care and residential areas.

Community engagement – informed community

- The community will be provided with regular project updates, given prior notice of project activities and provided contact details for enquiries. Where required, affected individuals or groups will be consulted directly.

Property impacts – impacts on property owners minimised

- All property acquisitions will be negotiated generally in accordance with the Roads and Maritime Services land acquisition information guide (RMS 2014c), and compensation will be assessed under the provisions of the Land Acquisition (Just Terms Compensation) Act 1991. The principal departure from the acquisition process is that acquisitions will be carried out prior to obtaining planning approval with the negotiation period (to reach mutually agreed acquisition terms) running in parallel with the compulsory acquisition notification period (rather than in sequence).
- Property access will be maintained for the duration of construction unless otherwise agreed with the owner. Temporary access requirements will be assessed, designed and managed in consultation with affected landowners and/or occupants.

A number of other strategic socio-economic mitigation strategies have been identified for the project assessments with respect to traffic and transport, noise and air quality.

Traffic and transport

Impacts on motorists, pedestrians, cyclists and public transport users will be minimised. Additionally, the following traffic and transport related performance requirements and outcomes will be undertaken:
- Minimise disruptions to public transport services by appropriate traffic management arrangements
- Avoid and minimise disruptions to emergency services access by appropriate traffic management arrangements & consultation with emergency services
- Ensure alternative pedestrian and cycle routes are available prior to commencement of construction, as required. The identification of alternative pedestrian and cycle routes will be determined with the consideration of CPTED principles and will consider the pedestrian needs of elderly people and people requiring mobility aids
- Minimise, rehabilitate and reinstate pedestrian and cycle routes disrupted by construction activities as soon as practicable. If necessary, routes would be relocated to provide better future access
- Minimise amenity impacts on surrounding sensitive receivers during construction such as noise, vibration and dust.

6.7 Impact on communities during construction of WestConnex

It is recognised that construction of major road projects such as WestConnex has the potential to be disruptive for the communities where construction will occur. In some cases, overlapping stages have the potential to extend the duration of construction impacts experienced by the community.

A key challenge for the WestConnex program will be to effectively manage the potential impacts through careful planning of staging, effective traffic management and the implementation of site-specific environmental safeguards and management measures. These measures will be incorporated into the detailed design and delivery phase of each project within the WestConnex program.

Construction traffic is likely to be a highly visible and particular consideration will need to be given to innovative construction traffic solutions wherever available and feasible in order to reduce the risks of construction fatigue.

6.7.1 Strategic background and context

Construction impacts are common to all major road projects but given their temporary nature: they typically do not represent a strategic issue. However, given the scale and timeframe associated with WestConnex, construction issues are expected to be a more substantial challenge for the community, particularly with respect to construction fatigue, where there are overlaps or interfaces between adjacent WestConnex projects.

Construction fatigue may also be experienced where WestConnex interfaces with areas of adjacent infrastructure projects including Sydney’s Light Rail and Sydney Metro. Additional management measures may be necessary around these interface areas to reduce construction impacts to local communities.

Some of the communities potentially affected already experience environmental stresses due to traffic and aircraft noise, traffic congestion, and amenity and liveability issues.

Consideration of potential construction impacts needs to consider issues such as noise and vibration, air quality and water management, traffic management and cumulative effects on local communities.
6.7.2 **Key strategic indicators**

Key strategic indicators are proposed for each of the priority strategic and other important environmental issues identified in Chapters 6 and 7 of the SER. In the case of noise and vibration, air quality and water management the indicators relate to specific legislation and guidelines. For traffic, the key strategic indicators relate to efficiency of the Sydney strategic road network and road safety. The criteria and level of compliance established against relevant policies and guidelines for each of these issues will need to be managed during each stage of construction of WestConnex.

6.7.3 **Strategic review**

The scale of construction impacts relates to potential types and number of activities being undertaken in each stage. Typical construction activities associated with large scale road infrastructure projects that have the potential to cause impacts include site establishment works, spoil excavation, handling and transport, site vegetation clearing, traffic impacts and accessibility, volume of heavy vehicles and machinery operating on site, containment of site works and proximity of works to sensitive receivers.

Particular focus will need to be given to areas of intensive construction activity including site compounds, interchanges, tunnel portals and major structures.

One of the key challenges in the construction of road related infrastructure is managing the level of construction noise and vibration generated. As discussed in Section 6.5, the range of potential impacts of construction on sensitive receivers includes airborne noise, ground-borne vibration and ground-borne (regenerated) noise. Noise sources include operation of construction plant and equipment, construction traffic, and from specific activities such as excavation and drilling.

Potential traffic impacts will also need to be effectively managed, including construction traffic movements generated from spoil disposal, materials deliveries and the construction workforce. These generate additional traffic in the vicinity of worksites and can also lead to issues with parking. Another potential source of traffic disruption where works are undertaken on existing motorway sections and arterial roads are by lane closures, vehicles accessing construction worksites and speed restrictions.

Air quality issues relate to dust generation and emissions from construction plant and equipment. Water management considerations include management of runoff from excavated areas, groundwater control and protection of waterways and the drainage system from material or chemical spills.

An additional key challenge will be management of impacts on businesses directly or indirectly affected by the construction activities. Potential construction impacts are likely to include changes to access arrangements, diminished parking availability and slower trips.

The cumulative effect of these potential construction impacts will require the development of site-specific solutions to mitigate impacts combined with ongoing community engagement.

6.7.4 **Strategic mitigation and management strategies**

Construction management measures will be implemented to minimise construction impacts throughout WestConnex. In most cases, impacts can be satisfactorily mitigated through development and implementation of best practice construction environmental safeguards and management measures.

Staging will be planned to minimise overlap of construction impacts between stages. Where overlap occurs, consideration will be given to additional controls to manage construction
fatigue for local communities. These may include more stringent controls and opportunities for relief on weekends and at other times.

In some instances communities may prefer to accept more intense construction impacts where the duration of construction can be substantially reduced. An example of this is the potential to use controlled blasting for construction of tunnel sections instead of a road header or tunnel boring machine. The application of such techniques will need cooperation and acceptance by local residents and the implementation of appropriate environmental controls.

Where possible, the proposed construction works would be programmed to minimise the impact on traffic using local and regional road networks. As discussed above, traffic management including accessibility, temporary increases in heavy vehicle traffic movements and other temporary disruptions during construction will be a critical issue that will require detailed planning and assessment for each project. Traffic management plans will be prepared for each work site with consideration of mitigating and managing construction traffic impacts on local roads and the Sydney strategic road network.

6.7.5 Project level performance requirements and outcomes

WestConnex will be required to deliver outcomes that protect the community from construction impacts throughout each stage. Performance requirements for WestConnex will be in accordance with relevant criteria and guidelines to be assessed as part of the environmental assessments for the individual projects.

The project-level environmental assessments will need to consider construction impacts from a cumulative perspective and may require adjustments to the typical mitigation and management measures. For example, more stringent night-time noise controls may be required where communities have already been exposed to lengthy periods of disruption. These critical construction impact challenges will be identified and addressed as the projects progress through the detailed design and delivery stages.
7 Review of other important environmental issues

7.1 Introduction

Other environmental factors have also been reviewed and, where relevant, overarching principles and performance outcomes have been developed to drive consistent environmental performance and outcomes.

For completeness a search of the EPBC Protected Matters Search Tool was carried out for the study area. The search identified a number of Matters of National Environmental Significance (MNES) within or adjacent to WestConnex and these have been discussed in the following sections of this report.

All environmental assessment and related management measures to minimise and mitigate impacts will be documented as part of specific environmental impact statements developed for each project.

7.2 Biodiversity

7.2.1 Strategic background and context

WestConnex is located within the Sydney Basin Bioregion within the Sydney Metro–Cumberland catchment management sub-region. Prior to European settlement, the natural vegetation of this area was dominated by grassy eucalypt woodlands, interspersed with taller eucalypt forests in regularly inundated floodplain areas.

The Cumberland Plain is one of the most heavily disturbed areas within the bioregion being highly altered with severe pressure from the growth of the Greater Sydney Metropolitan Area (DEWHA 2010). Extensive vegetation clearing, initially for agriculture and subsequently for residential and infrastructure development has since resulted in the loss of the vast majority of this native vegetation (Land and Property Information NSW 2013). Native vegetation on the Cumberland Plain, including the study area, has been reduced to a patchwork of small isolated forest and woodland fragments. Much of this vegetation is in poor condition due to weed invasion and other disturbances associated with urban expansion and infrastructure development, resulting in the loss of a large proportion of the region’s pre-European biodiversity.

Mammal and bird species have been particularly affected with many species in these groups considered likely to be extinct on the Cumberland Plain (NSW Scientific Committee 2009).

Existing biodiversity resources are now characterised by:

- Areas of remnant native terrestrial habitats and ecological communities that are generally small, highly fragmented and under pressure from threatening processes and edge effects. Parks and reserves may support remnant native habitats and ecological communities
- Areas of created terrestrial habitat through planting of native and exotic plant species in defined revegetation areas, public parks and private gardens
- Fauna that has adapted to fragmented and modified habitats
- Estuarine and aquatic habitats associated with Botany Bay, Wolli Creek and Alexandra Canal in the east, Duck Creek, Haslams Creek, Powells Creek, Homebush
Bay, Canada Bay in the west, and Hawthorn Canal, Rozelle Bay and White Bay in the northeast.

Within the area potentially impacted by WestConnex, there are a number of locations supporting significant species, populations and their habitats, and ecological communities that are subject to pressures from adjacent land uses and development.

Despite the limited habitat in the study area, some threatened fauna species listed under the Threatened Species Conservation Act 1995 (TSC Act) and/or the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) or their habitats are likely to occur. Key fauna species likely to occur within the WestConnex corridor (and their protection status) are provided in Table 7-1.

### Table 7-1 Threatened species likely to occur within WestConnex corridor

<table>
<thead>
<tr>
<th>Common name</th>
<th>Scientific name</th>
<th>TSC Act status</th>
<th>EPBC Act Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green and Golden Bell Frog</td>
<td><em>Litorea aurea</em></td>
<td>E</td>
<td>V</td>
</tr>
<tr>
<td>Eastern Bent-wing Bat</td>
<td><em>Miniopterus schreibersii</em></td>
<td>V</td>
<td>–</td>
</tr>
<tr>
<td>Southern Myotis</td>
<td><em>Myotis macropus</em></td>
<td>V</td>
<td>–</td>
</tr>
<tr>
<td>Grey-headed Flying-fox</td>
<td><em>Pteropus poliocephalus</em></td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>Long-nosed Bandicoot</td>
<td><em>Perameles nasuta</em></td>
<td>E2</td>
<td>–</td>
</tr>
<tr>
<td>Black Bittern</td>
<td><em>Ixobrychus flavicollis</em></td>
<td>V</td>
<td>–</td>
</tr>
<tr>
<td>Swift Parrot</td>
<td><em>Lathamus discolor</em></td>
<td>E</td>
<td>E</td>
</tr>
<tr>
<td>Regent Honeyeater</td>
<td><em>Anthochaera phrygia</em></td>
<td>CE</td>
<td>E</td>
</tr>
<tr>
<td>Australasian Bittern</td>
<td><em>Botaurus poiciloptilus</em></td>
<td>E</td>
<td>E</td>
</tr>
<tr>
<td>Loggerhead Turtle</td>
<td><em>Caretta caretta</em></td>
<td>E</td>
<td>E</td>
</tr>
<tr>
<td>Green Turtle</td>
<td><em>Chelonia mydas</em></td>
<td>E</td>
<td>E</td>
</tr>
<tr>
<td>Leatherback Turtle</td>
<td><em>Dermochelys coriacea</em></td>
<td>E</td>
<td>E</td>
</tr>
<tr>
<td>Hawksbill Turtle</td>
<td><em>Eretmochelys imbricate</em></td>
<td>–</td>
<td>V</td>
</tr>
<tr>
<td>Flatback Turtle</td>
<td><em>Natator depressus</em></td>
<td>–</td>
<td>V</td>
</tr>
</tbody>
</table>

1: E = Endangered, CE = Critically Endangered, E2 = Endangered population under the TSC Act., V = Vulnerable under the FM Act (Black Cod) or TSC Act (all other species).

2: E = Endangered, V = Vulnerable, M = Migratory under the EPBC Act.

Some patches of vegetation in the WestConnex corridor may be consistent with Threatened Ecological Communities listed under the TSC Act and Endangered Ecological Communities listed under the EPBC Act. Threatened and Endangered communities potentially occurring within the WestConnex corridor include:

- Castlereagh Ironbark Forest (EPBC Act)
- Western Sydney Dry Woodland (EBPC Act)
- Estuarine Mangrove Forest (TSC Act)
- Estuarine Swamp Oak Forest (TSC Act)
- Castlereagh Ironbark Forest (TSC Act)
• Coastal Sandstone Foreshores Forest (TSC Act)
• Hinterland River-flat Paperbark Swamp (TSC Act)
• Estuarine Reedland (TSC Act).

7.2.2 Preliminary assessment

For the initial SER, impacts on biodiversity were not generally considered a key strategic review issue given the highly modified nature of the area potentially impacted the high degree of knowledge of the area and the ability of the project design process to avoid key areas. It was noted that while important remnant pockets remained, there were considered to be no areas of particular outstanding value at a state, national or international level that may be substantially impacted by WestConnex were identified.

However, during the environmental assessment for the New M5, a potential impact on a Commonwealth listed ecological community, Cooks River/Castlereagh Ironbark Forest of the Sydney Basin Bioregion, was identified. A referral to the Commonwealth Department of the Environment was made on 17 July 2015. Impacts will be assessed under the existing bilateral agreement between the Commonwealth and NSW.

Assessment of impacts of WestConnex on biodiversity will also be guided by the requirements of the EP&A Act as well as the relevant requirements of Schedule 2, Part 3 of the Environmental Planning and Assessment Regulation 2000, the TSC Act, EPBC Act and the Fisheries Management Act 1994.

Reference will be made to the NSW biodiversity offsets policy for major projects (NSW Government, 2014e) which commenced on 1 October 2014. The policy clarifies, standardises and improves biodiversity offsetting for major SSI and SSD project approvals. The policy is underpinned by the Framework for Biodiversity Assessment (NSW Government, 2014f) which sets out the process for assessing biodiversity impacts on a proposed development site and determining the biodiversity offset requirements for those impacts.

Planning and development of component projects of WestConnex is guided by the ‘avoid-mitigate-offset’ hierarchy. In project route and options development, areas that support important biodiversity will be identified and avoided where possible. Where impacts are unavoidable, measures that mitigate impacts will be developed, and offsets determined, if required.

7.2.3 Project level performance requirements and outcomes

Key requirements for project level assessment will include:

• Survey and analysis of all areas impacted by the proposal, including ancillary and adjacent areas, to identify the presence and extent of protected flora and fauna, critical habitat, threatened species, populations and ecological communities. Analysis may include assessment of significance, extent and condition and inter-relationships with adjacent areas. This will include database searches such as the Bionet – Atlas of NSW Wildlife, EPBC Protected Matters Database Search tool, OEH vegetation types database and the OEH BioBanking Threatened Species Profile Database

• Identification of type and degree of impact on terrestrial and aquatic flora and fauna, critical habitat, threatened species, populations and ecological communities, quantifying numbers of individuals or areas of impact. Impacts include direct and indirect impacts, including barriers to movement, edge effects and cumulative effects

• Identification of mitigation measures that reduce intensity and extent of impacts, and or measures to offsets impacts. Assessment of the effectiveness of proposed
measures in reducing adverse impacts on species, populations and ecological impacts and comment on the net impact following the implementation of measures will also be undertaken.

7.3 Resource management

7.3.1 Strategic background and context

The resources used in the development of WestConnex will be substantial, requiring natural aggregates, cement, asphalt, steel and other construction materials. Raw and processed materials will be required for construction of WestConnex. These materials will include concrete, steel, imported fill and fuel to power construction equipment and water. The quantity and types of materials required for construction will be further defined during detailed design.

Additionally, due to the amount of tunnelling required for the scheme, a large quantity of surplus spoil will be produced which will require careful management to ensure it is reused where possible.

7.3.2 Preliminary assessment

WestConnex will require extensive excavation for tunnel works and to facilitate the construction of foundations and services. Without significant fill areas, there is likely to be a large surplus of spoil associated with its construction. The majority of spoil is likely to be generated through tunnelling operations comprising rock and virgin excavated natural material (VENM). Sandstone cuttings from road-headers have a wide particle size distribution and can readily be used as fill material.

Construction of the project will see varying amounts of waste produced. Construction wastes generated will include fill material, general construction and demolition waste, acid sulfate soils, vegetation waste, packaging materials and liquid wastes. Operational wastes (which will be much smaller in quantity) may include spills and leakages from vehicles, litter generated by road users and sediment from the water treatment plant.

At this strategic review stage specific spoil beneficial reuse options have not been identified, as these are greatly depend on specific construction timing, generation rates, demand induced by other developments in the area and specific construction industry needs. Managing the use of resources phase will be most appropriately undertaken on a project-by-project basis within the hierarchy framework of avoid, reduce, reuse and recycle.

The reuse or recycling of all clean and/or treated spoil will be on the basis that:

- Reuse of spoil generated from construction activities is maximised
- Where practicable all clean excavated natural material is either reused on the project or otherwise made available for reuse elsewhere in preference to disposal to landfill.

7.3.3 Project level performance requirements and outcomes

Key requirements for the individual project assessments will include the following actions:

- Undertake a cut and fill balance assessment to establish the volume of spoil likely to require disposal/reuse during construction
- Identify future potential receiving sites/projects for the excess spoil
- Assess environmental impacts associated with spoil disposal including traffic, land use, noise and air quality
- Identify the approximate resource requirements for the project and assess the resource use impacts of the project
- Identify specific waste impacts of the project and the waste management approach
- Identify strategies for reducing waste such as the use of recycled materials, bulk delivery of goods to minimise packaging and arrangements with suppliers to return any unused construction materials.

7.4 Aboriginal heritage

7.4.1 Strategic background and context

The Sydney Basin has a rich indigenous heritage. Aboriginal occupation focused on accessing resources from diverse ecological areas, seasons and conditions. Smaller rivers, creeks and swamps remained constant and reliable places that attracted camping, fishing and inter-clan contact, as well as facilitating travel. Aboriginal occupation in the Sydney area is known to have extended beyond the last glacial maximum, when the environment was drier and significantly cooler and the permanent water sources even more critical to survival.

WestConnex traverses the boundaries of several Local Aboriginal Land Council (LALC) groups including the Metropolitan, Deerubbin and Gandangara LALCs. Consultation with Aboriginal stakeholders will be a necessary and important component for the individual project assessments.

There is evidence of Aboriginal occupation throughout the study area, with areas of plentiful food resources associated with shorelines, riparian zones and adjacent areas including Botany Bay, Cooks River, Wolli Creek, Haslams Creek, Homebush Bay, Parramatta River and Sydney Harbour. During urban development, many of these areas have been covered by fill, concealing original formations. Some evidence of Aboriginal occupation may also be present along movement pathways, meeting and camping sites, which were often associated with ridgelines. There is one recorded Aboriginal heritage item in the vicinity of the former Rozelle Rail Yards.

7.4.2 Preliminary assessment

Given that there are likely to be relatively few known Aboriginal heritage sites potentially impacted by WestConnex, the highly modified nature of the area and the ability of project design to avoid key areas, it is considered unlikely that WestConnex will have a major impact on Aboriginal heritage. An Aboriginal cultural heritage assessment report (CHAR) for the area potentially affected by each WestConnex project will be prepared in accordance with the following policy documents and heritage guidelines:

- Procedure for Aboriginal Cultural Heritage Consultation and Investigation (PACHCI) (RTA 2011)
- Aboriginal Cultural Heritage Consultation Requirements for Proponents (DECCW 2010)
- Code of Practice for Archaeological investigation of Aboriginal Objects in NSW (DECCW 2010).
7.4.3 Project level performance requirements and outcomes

Key requirements for the project level assessments will include:

- Review existing information, local, NSW and Commonwealth Heritage lists, including the OEH’s Aboriginal Heritage Information Management System (AHIMS) database
- Consult with Local Aboriginal Land Councils, elders groups and other relevant Aboriginal groups and individuals
- Undertake field investigations accompanied by representative members of the local Aboriginal community to determine the presence of Aboriginal sites and/or potential sites and determine the significance of these sites
- Model the Holocene shoreline to assist in identifying potential risk areas for Aboriginal archaeological remains
- Recommend the preservation, recording, excavation or destruction of any sites that are to be developed and where impacts cannot be avoided.

7.5 Non-Aboriginal heritage

7.5.1 Strategic background and context

WestConnex covers parts of Sydney that were occupied from soon after the arrival of the First Fleet in 1788, initially as remote outposts in the bush, through to bordering farms and settlements and eventually as inner-city suburbs. WestConnex will represent the latest connection between Sydney and its second city at Parramatta.

Early Sydney travel routes were probably built largely on existing Aboriginal pathways and many of these eventually consolidated into road alignments. Travel was easiest along ridgelines, but the route between Sydney and Parramatta had to run across the heads of numerous small coves and bays, each one requiring crossing swamp, estuary or creeks before rising over the next ridge and down into another cove. Travel by boat, and eventually by rail was always preferred. Settlement along this corridor began primarily with large land grants, often subdivided into farms, or often let into small estates, of which little remains. Yasmar, with its extensive intact garden is the only remaining mid-19th century villa of the many that lined Parramatta Road.

The road southwards through Newtown crossed the near AB Sparke’s Tempe House, rapidly climbing the next ridge away from the wetlands. The margins of Botany Bay were low-lying, swampy and were mainly used by market gardeners and a range of noxious industries restricted to there, including tanning and fell-mongering. Later chemical and industrial uses built on this well-established land-use.

The growth of Sydney Airport has resulted in major modifications to the alignment of the mouth of the Alexandra Canal. Its use as an airfield stemmed from an earlier life as Ascot Race Course. The Alexandra Canal was a rare use in an Australian context of canalisation as a transport method. The land between it and Tempe has been used for a variety of industrial purposes over time, but a small mid-late 19th century residential core remains. More recent use of these low-lying lands has included regional open space, playing fields and habitat conservation.

The region surrounding the current M5 East corridor was densely forested at the time of British colonisation, which led to the early utilisation of the area for timber-related supplies, including not just wood for construction and heating, but also the collection of bark and the production of charcoal for light industry. Once cleared, the region also was home to small-scale farming and horticulture. Various industrial activities have also occurred in the region.
The Mashman Pottery and Tile Works opened at Kingsgrove in 1908, where it operated until 2011. A sandstone quarry operated at Wilcox’s Hill in what is now Bardwell Valley from the 1920s to the 1960s. Both the quarry and the Mashman Pottery are listed on current LEPs.

There are numerous non-Aboriginal heritage items identified within the area potentially impacted by WestConnex. These include items listed on the State Heritage Register as well as items of local significance. The Sydney (Kingsford Smith) Airport Group is the only Commonwealth Heritage place identified from the EPBC Protected Matters search. There are no World Heritage or National Heritage Places recorded within the proposed WestConnex corridor.

Key non-Aboriginal heritage items that have been identified through preliminary searches include:

- Electricity Substation No.167, Auburn
- Homebush Railway Station Group, Homebush
- Yasmar training facility, Haberfield
- White Bay Power Station, Rozelle
- Glebe Railway Viaduct, Glebe
- Eveleigh Railway Workshops, Eveleigh
- St Peters Station Railway Group, St Peters
- Sydney (Kingsford Smith) Airport Group, Mascot
- Alexandra Canal, Alexandria
- St Peter’s Church of England and Grounds, Marrickville
- Commonwealth Water and Sewerage Pumping Station No. 38, Mascot
- Western Outfall Main Sewer (Rockdale to Homebush)
- Arncliffe Railway Station, Illawarra Railway, Arncliffe
- Arncliffe Market Gardens, Arncliffe
- Dappeto, 171 Wollongong Rd, Banksia.

Key heritage items that may be directly or indirectly impacted by WestConnex include:

- The former Arnott’s factory which is located immediately adjacent to the north eastern side of the existing M4 carriageway. Construction of additional lanes in this area has the potential to directly impact on the heritage values of this building
- Yasmar training facility which is located immediately adjacent to Parramatta Road
- Hawthorne Canal
- Brick pits and associated structures between Sydney Park Road and Canal Road
- Alexandra Canal where construction of the viaduct will cross the canal
- Arncliffe Market Gardens which could be affected by construction of tunnel portals and surface roadways
- Sydney Airport within which construction of new roads and upgrading of some roads may occur.
7.5.2 Preliminary assessment

Potential impacts to non-Aboriginal heritage will be minimised due to the ability of project design to avoid key areas and the fact that the majority of the project will be within existing road corridors.

Assessment of impacts of WestConnex on non-Aboriginal heritage will be further investigated as part of the environmental impact assessment for the component projects and undertaken in accordance with the Burra Charter and the NSW Heritage Office (2001), Assessing Heritage Significance, NSW Heritage Manual 2 and Assessing Significance for Historical Archaeological Sites and Relics (Heritage Branch 2009) including cumulative impacts and cultural landscape impacts.

7.5.3 Project level performance requirements and outcomes

Standard requirements for the project level assessments will include:

- Detailed searches of non-Aboriginal heritage items
- Detailed historical research to identify potential non-Aboriginal archaeological sites. To include analysis of historic, maps, plans and aerial photos in archives and libraries, such as Mitchell Library, State Archives and Local Studies Libraries
- An understanding and assessment of the visual heritage aspects of the local area
- Targeted surveys to identify curtilages of heritage items
- An assessment of potential impacts to the known State and local heritage items adjacent to the project
- Archaeological investigations, where required, to determine the presence of potential archaeological items and the potential impacts as a result of the project
- Consultation with stakeholders such as the OEH (Heritage Branch) and local councils
- Consultation with the community to provide information on the relative social importance of sites and areas such as Parramatta Road.

7.6 Climate change risk and adaptation

7.6.1 Strategic background and context

Climate change represents a potential strategic challenge for the design, construction and management of road infrastructure projects. The predicted changes in climatic variables such as rainfall, temperature and an increase in the frequency of extreme weather events will have both a potentially direct and indirect impact on WestConnex.

The Intergovernmental Panel on Climate Change (IPCC), the world’s leading authority on climate change science, stated that ‘warming of the climate system is unequivocal’ (IPCC 2014). Current climate projections produced by the Australian and NSW governments indicate that the climate of Sydney is likely to change significantly over the operating life of WestConnex.

Of particular relevance to Australia is that the impact of the El Nino-La Nina weather cycle is projected to intensify. That is, during El Nino, Sydney is expected to be hotter and drier and during La Nina, wetter and cooler. During El Nino, drought conditions are likely to be more intense because of higher temperatures.
Key strategic indicators

WestConnex is expected to have an operating life that extends beyond 2100. The accuracy of climate change projections diminishes substantially beyond 2050. As such this review has focused on the risks to 2050, however where possible, risks to 2100 have also been considered.

The original SER considered the following reports in identifying potential changes to key climate variables for the Greater Sydney Metropolitan Area:

- *Impacts of Climate Change on Natural Hazards Profile: Statewide Overview* (DECCW 2010a)
- *NSW Climate Impact Profile: The Impacts of Climate Change on the Biophysical Environment of New South Wales* (DECCW 2010b). This report has been used to provide temperature projections, mean and seasonal rainfall changes, river erosion projections for this study
- *Climate Change in Australia* (CSIRO 2007a). This has been used for climate projections to 2100 and to supplement the above report (DECCW 2010b)
- *Floodplain Risk Management Guideline: Practical Consideration of Climate Change* (DECC 2007), based on *Climate Change in the Sydney Metropolitan Catchments* (CSIRO 2007b). This has been used to estimate changes to rainfall intensity and identify changes to return periods of extreme rainfall events for flood risk analysis.

Based on consideration of the above reports, the projected change in key climate variables for 2050 (minimum and maximum emissions scenarios) for the Greater Sydney Metropolitan Region that needs to be considered for WestConnex are summarised as follows:

- The mean daily maximum and minimum temperatures are expected to increase in all seasons. The magnitude of the projected increases ranges from 1.5 to 3°C
- Summer rainfall is projected to increase across the Sydney and Central Coast Region, with smaller increases predicted for autumn and spring. Winter rainfall is likely to decrease moderately
- Increased evaporation is likely in spring and summer, however modelling does not provide a clear pattern for autumn and winter
- Projected increases in sea levels for the NSW coast are 40 centimetres by 2050 and 90 centimetres by 2100
- Within the Sydney basin, the change in extreme rainfall will likely be between -3 per cent and +12 per cent up to 2030 and -7 per cent and +10 per cent up to 2070. These increases are estimated to impact frequency, magnitude and volume of flood events
- Increased incidence of flooding is likely to put infrastructure and property at greater flood risk
- The greatest changes in wind speed (increases) are likely to occur in summer. This coincides with the expected increase in storm activity for the same period.

In updating the SER, the following reports were considered:

- *Metropolitan Sydney, Climate change snapshot* (OEH 2014)
- *Climate Change in Australia* (CSIRO 2015).

The projected changes in key climate variables noted in these reports are generally in line with those noted above.
7.6.2 Preliminary assessment

A preliminary assessment of the climate change risks that may impact on WestConnex are shown in Table 7-2 together with typical management measures. A more detailed climate change risk assessment will be undertaken for each individual project to better quantify the risks and develop specific controls.

Table 7-2 Highest potential climate change risks (without mitigation)

<table>
<thead>
<tr>
<th>Potential hazards</th>
<th>Typical management measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>More frequent road inundation and closures resulting in reduced infrastructure life, increased maintenance costs and increased road safety concerns.</td>
<td>Detailed rainfall and runoff assessments undertaken to ensure road design can cope with predicted changes in the frequency, severity and quantity of rainfall specific to each project. Downscaled climatic models used to differentiate between modelled changes in Sydney’s east and Sydney’s west. Engineering solutions developed based on the findings of the above.</td>
</tr>
<tr>
<td>More frequent road safety issues arising from:</td>
<td>Engineering solutions to be developed to improve safety for each project (both at construction and operation phases) caused by changing and variable climatic conditions. Engineering solutions developed based on findings of a formal (quantitative) climate change risk assessment undertaken at project level assessment. Downscale climate modelling should be undertaken to understand impacts (natural hazards) specific to the Greater Sydney Metropolitan Region.</td>
</tr>
<tr>
<td>• Damage to roads, tunnels and bridges from flooding</td>
<td></td>
</tr>
<tr>
<td>• Damage to road infrastructure and signage from high winds</td>
<td></td>
</tr>
<tr>
<td>• Road closure and impacts on local roads from reduced traffic</td>
<td></td>
</tr>
<tr>
<td>Severe storms may result in full or partial road closure creating bottlenecks and stress on surrounding infrastructure.</td>
<td>Develop emergency response plans specific to each project with a view of understanding how it and surrounding transport infrastructure can cope with predicted changes in climatic conditions.</td>
</tr>
</tbody>
</table>

The highest potential hazards relate to the impact of WestConnex operating efficiently in light of increased natural hazards. As a major transport link, WestConnex will be expected to be operational even under the additional stresses posed by climate change. As such, a climate change risk assessment specific to each of the projects would be considered where appropriate to identify and quantify specific climate risks and if applicable specific adaptation actions incorporated in the design. Through this approach any identified risks will be either significantly reduced or totally negated.

7.7 Geology, soils and water

7.7.1 Strategic background and context

WestConnex is contained within the wider Sydney Basin. The geology of the area is derived from the Wianamatta Group and is predominantly underlain by the Ashfield Shale formation, capping the Hawkesbury Sandstone formation.

In some parts of the study area, the Ashfield Shale and Hawkesbury Sandstone formations are overlain by discontinuous Quaternary age alluvium deposits associated with streams, which comprise sand, silt and clay. The Hawkesbury Sandstone is a significant aquifer and
groundwater flow is mainly via fracture networks and faults, with minor flow via primary porosity.

Soil types in the area are generally alluvial, highly erosive or residual. Three soil landscapes (Birrong, Blacktown, Disturbed) are encountered across the study area. The M4 Motorway is located near the Parramatta River and therefore there is potential for some of the study area to be reclaimed land or landfill and consequently classified as a disturbed soil (McLoughlin 2000).

There is potential to encounter acid sulfate soils over the area potentially affected by WestConnex, predominately being class 2, but grading to classes 4 and 5. The Alexandra Canal has been identified as class 1 acid sulfate soils. There are also several areas of class 1 acid sulfate soils at the western end of Rozelle Bay.

WestConnex is located primarily within the Lower Parramatta River Catchment. These catchments are highly urbanised with large sections of open channels replaced with concrete lined channels. The remaining natural channels are impacted by erosion and sedimentation.

The main waterways within the Lower Parramatta River Catchment include A’Becketts Creek, Duck Creek, Duck River, Haslams Creek and Powell’s Creek. The main waterways in the Catchment include the Cooks River and its tributaries such as Coxs Creek, Cup and Saucer Creek, Wolli Creek, Bardwell Creek, Muddy Creek and Alexandra Canal.

The nearest wetland of international importance (Ramsar) to the program is Towra Point Nature Reserve, which is located within 10 kilometres of the program. Eve Street Marsh, Arncliffe, is the only nationally important wetland found in proximity to WestConnex.

The water quality of creeks is largely influenced by stormwater, aquatic weeds and erosion which are attributable to the catchment in which these creeks reside. Sewer overflows, particularly during high rainfall events, also influence water quality in these catchments, providing additional sources of nitrogen, phosphorus, suspended solids.

7.7.2 Preliminary assessment

Soil and water issues are commonly encountered on all road projects and are generally adequately managed through standard Roads and Maritime Services’ management measures and safeguards, which include consideration during the detailed design process and the development of construction soil and water management plans.

On the basis of proven control, management and mitigation measures, impacts on soil and water quality from WestConnex are expected to be minimal.

7.7.3 Project level performance requirements and outcomes

Key requirements for the project level assessments will include:

- Management measures for erosion and sedimentation which will be designed in accordance with Managing Urban Stormwater: Soils and Construction – Volume 2D Main road construction (DECC 2008) and installed in consultation with a soil conservation specialist
- Undertake assessment and develop management measures for acid sulfate soils in accordance with NSW Acid Sulfate Soils Manual (ASS Manual)
- Development and implementation of a maintenance and inspection program to ensure ongoing effectiveness.
• Storage of oils, chemicals, toxic substances, flammable and combustible liquids and potentially hazardous or contaminating activities, including, but not limited to refuelling stations and washing construction vehicles to meet all relevant requirements
• Management of existing sediment basins prior to the commencement of construction
• Development and implementation of an ‘unexpected finds’ protocol for contamination
• Provision of permanent stream protection and/or energy dissipation measures, as appropriate, at affected culverts downstream of transverse culvert outlets to minimise scour and erosion of the natural waterways, if required and where sufficient space is available
• Design of basins, where practicable, to detain any increase in peak flows attributable to WestConnex and aim to capture a ‘first flush’ of road surfaces
• Assessment of sensitivity of the receiving environment in relation to pollutants from road runoff
• Consideration of the need for treatment of acute pollution (spills) incidents and pollution from general road runoff
• Assessment of potential impacts on existing groundwater systems/regimes and requirements for any approvals from NSW Office of Water.

7.8 Hydrology and flooding

7.8.1 Strategic background and context
WestConnex will be situated within a number of local catchment areas – primarily within the Lower Parramatta River and Rozelle Bay.

As noted previously, these catchments are highly urbanised with large sections of natural channels replaced with concrete-lined channels. The main waterways in the Cooks River catchment include the and its tributaries such as Coxs Creek, Cup and Saucer Creek, Wolli Creek, Bardwell Creek, Muddy Creek and Alexandra Canal. The main waterways within the Lower Parramatta River Catchment include A’Becketts Creek, Duck Creek, Duck River, Haslams Creek, Powell’s Creek, Saleyards Creek, and Dobroyd Canal. The main waterway in the Rozelle Bay catchment is Johnstons Creek; a smaller waterway, Whites Creek, also drains to Rozelle Bay.

7.8.2 Preliminary assessment
The potential key flood risks exist largely in four areas: adjacent to Cooks River and Alexandra Canal (as flood conditions are also affected by the high tide levels in Botany Bay), Wolli Creek, Rozelle Bay and at a number of locations along Parramatta Road.

As indicated in Section 7.6, climate variability could cause more intense and extreme rainfall into the future over the various sub-catchments.

Construction of WestConnex will have the potential for the following major hydrology and flooding related impacts:

• Potential changes to flood behaviour and changes to flood flow distribution from earthworks and construction activities.
• Potential direct impacts in the case that a large flood event occurs during the construction period.
Operation of the project has the potential for the following hydrology and flooding related impacts:

- Potential impacts to peak flood levels due to the new road surface. However, the new road surface will only represent a small portion of the total catchment and the increase in impervious area will be minimal.
- Modifications to the conveyance of stormwater through the system (for example, the installation of pipes and open channels) may alter the velocity, location and magnitude of floods.
- Cuttings and embankment have potential to cause changes to groundwater levels and flows.

As indicated in Section 7.6, the flood immunity of WestConnex may be affected by the ramifications of climate variability, including the possible increase in intensity and frequency of storm events and the rise in sea level. Under climate variability, the potential risk of flooding events impacting the project increases.

### 7.8.3 Project level performance requirements and outcomes

Key requirements for the project level assessments will include:

- Identify the existing local and regional hydrology including surface runoff, streams and control structures.
- Where relevant and appropriate, undertake a comprehensive hydrology and flood impact assessment to determine the current and potential changes to flow regimes of both surface and groundwater. Determine the effect that these changes will have on peak flood levels, duration of flood events and the level of flood risk to existing and future developments.
- Assess the sensitivity of the results under the influence of various climate variability scenarios, including an increase in the intensity of rainfall and the impacts of sea level rise.
- Investigate the risks and management measures surrounding the potential flooding of the project.

Key strategic mitigation measures will include:

- Roads and Maritime Services’ standard safeguards and management measures for hydrology and flooding will be applied to the project. These include:
  - Limiting the extent of obstructions within rivers, creeks and drains as far as practicable at all times during construction.
  - Removing construction infrastructure and equipment in the event of a forecast flood on any of the sub-catchments.
  - Providing suitable scour protection to the bridge abutments, piers and banks during construction.
- Additional management measures for the project may include:
  - Consideration of water sensitive urban design (WSUD) principles in the design of the motorway.
  - Upgrades to existing stormwater infrastructure, such as culverts, may need to be considered to account for a change in the stormwater runoff regime.
  - Incorporation of climate variability impacts into the design.
Outcomes from further hydrology and flooding assessment will be considered and, where appropriate to the project, also be applied.

7.9 Urban design strategy, landscape character and visual impact

7.9.1 Strategic background and context

WestConnex will comprise at-grade, tunnel and viaduct carriageways. The route runs in a broad arc from the M4 Motorway near Parramatta, alongside Parramatta Road and Sydney Olympic Park, through the inner west suburbs to Rozelle, alongside Sydney Airport and Port Botany and connecting to the existing M5 at Kingsgrove. This is a corridor of diverse character zones from residential suburbs to industrial areas all of differing constraints, features, sensitivities to change and opportunities.

WestConnex will have a transformative effect on the character of Sydney and the areas in which it is located. By providing improved connectivity, the perception and prestige of Sydney as a global destination and place to live will be improved. The project will improve the liveability and desirability of the city and its suburbs, connectivity within the region and local areas, the economic viability and productivity of the city and suburbs, and the visual experience of the community and transport customers.

Through reorganisation of traffic, new connections within the city will be created improving access to jobs, homes and recreation. Further benefits will flow from the project with opportunities for renewal of suburbs and improvements in pedestrian and public transport accessibility.

Urban design dictates the way in which people interact with their environments. When included at the outset of a project, it provides an opportunity to maximise project benefits whilst minimising adverse impacts on environments and communities. Urban design brings together the disciplines of architecture, planning and landscape architecture to treat a project holistically. Successful implementation of an urban design strategy will ensure a quality built form outcome in a human-centred environment.

7.9.2 Preliminary assessment

Urban design policy

- WestConnex will be designed and implemented in accordance with the WestConnex Motorway Urban Design Framework.

Urban design objectives

The Framework sets out six key urban design objectives for the WestConnex project:

- Leading edge environmental responsiveness
- Connectivity and legibility
- Place making
- Liveability and urban renewal
- Memorable identity and a safe, pleasant experience
- A new quality benchmark.

Each stage of the project will be developed in accordance with these objectives.
Urban design process

A consistent approach to urban design is being and will continue to be applied across the individual component projects. This provides a coherent, unified design vision for the transport corridor ensuring a consistent high quality approach and outcome across all work. Further guideline documents that will be used to inform the urban design include:

- Beyond the Pavement
- Bridge Aesthetics
- The Landscape Guideline
- Shotcrete Design Guidelines
- Noise Wall Design Guidelines
- Guidelines for Landscape Character and Visual Impact Assessment
- Contributing to Liveable Communities: Roads and Links and Places.

7.9.3 Project level performance requirements and outcomes

For each section of WestConnex to be implemented, the following urban design tasks will be carried out:

- Contextual analysis to identify the community, natural and built values, the landscape types and character zones and the present and future opportunities and constraints
- Assessment of the urban design objectives for the project
- Input into the development of an integrated urban design, transport and engineering concept
- Production of landscape character and visual impact assessment to improve the design outcome and report on landscape character and visual impacts and their management (including production of visualisations of project outcomes)
- Input into the detailed development of the project design including journey experience, surface impacts and connections, built form structures and landscape design outcomes
- Input into the development of the design and monitoring of the outcomes.

7.10 Land use and property

7.10.1 Strategic background and context

Land uses immediately adjacent to the proposed corridor are diverse and comprise a mix of industrial, residential, commercial, and retail development as well as open space and some recreational areas. Land uses have been broadly characterised geographically by the LGAs and are described below.

The Holroyd, Parramatta and Auburn LGAs at the western end of the M4 Motorway comprise light industrial warehouse type development and commercial precincts interspersed with areas of residential development. Sydney Olympic Park is located to the north of the M4 Motorway within the Auburn LGA which contains sporting facilities and commercial development parklands.
Land uses surrounding Parramatta Road along the alignment of the proposed M4 East project generally comprise a mix of enterprise/business corridors, industrial development interspersed with low to medium residential development and open space and recreational facilities including Concord Oval, St Luke’s Park, Charles Heath Reserve and Five Dock Leisure Centre.

At the City West Link interface, land uses adjacent to Parramatta Road and immediately south along connecting roads comprise predominantly mixed use and light industrial development.

The M4-M5 Link traverses the Leichhardt, City of Sydney, and Marrickville LGAs. Land use along the general alignment is varied and includes low density residential development with pockets of higher density residential development, neighbourhood retail areas and open space areas. Areas of local centres comprising retail development are concentrated around the railway lines at the interface between the Marrickville and City of Sydney LGAs. The southern end of the proposed alignment comprises open space in the form of Sydney Park.

An enterprise corridor fronts along the Princes Highway with industrial warehouse type development forming the interface with the New M5 project.

Land use in the vicinity of the Rozelle Interchange is largely low density residential development. Other land uses include public open space areas, the Rozelle Rail Yards which lie between the City West Link and Lilyfield Road, and the port area which lies further to the east taking in Glebe Island and White Bay.

The Strathfield LGA to the east of the M4 Motorway comprises medium to high density residential areas, commercial precincts and retail development including the Flemington Markets to the south of Parramatta Road. Within Canada Bay and Burwood LGAs, land uses surrounding the M4 Motorway comprise commercial/retail development which interface between the road and adjoining residential development. Land uses within the Ashfield LGA in proximity to WestConnex is largely residential, and generally detached dwellings.

At the interface with the proposed M5 East, within the Rockdale LGA, land use generally comprises residential areas and sports and recreational areas including Cahill Park, Kogarah Golf Course, Riverine Park and Barton Park Golf Range. The Cooks River separates this land from Sydney Airport to the east and the suburb of Tempe to the north.

The area potentially affected by WestConnex along the New M5 alignment on the opposite side of the Alexandra Canal is within the Marrickville LGA. Land uses surrounding WestConnex generally comprise sports and recreational open space including Tempe Recreation Reserve and St Peters Park. Industrial development generally comprises large warehouse type development or freight container storage areas.

Within the Botany Bay LGA, land uses are largely comprised of Sydney Airport and surrounds, industrial and commercial development areas and some areas of residential development interspersed with local centres between O’Riordan Street, Mascot and Botany Road, Botany.

The suburbs of Narwee and Beverly Hills within Canterbury LGA, contain mostly low to medium density residential development with large areas of open space including the Canterbury Municipal Golf Course and Beverley Grove Park interfacing much of the freeway.

7.10.2 Preliminary assessment

WestConnex will largely be located within an established motorway corridor with additional parts largely in tunnel. As such, impacts will relate to potential property acquisition and existing access arrangements. All property acquisitions will be negotiated generally in accordance with the Roads and Maritime Services Land Acquisition Information Guide (RMS 2014c), and compensation will be assessed under the provisions of the Land Acquisition
(Just Terms Compensation) Act 1991. The principal departure from the acquisition process is that acquisitions will be carried out prior to obtaining planning approval with the negotiation period (to reach mutually agreed acquisition terms) running in parallel with the compulsory acquisition notification period (rather than in sequence).

Impacts on property owners will be minimised by maintaining property access where possible and in consultation with landholders for the duration of construction. Temporary access requirements will be assessed, designed and managed and rehabilitation will be prepared in consultation with affected landholders.

Other impacts on land with the project include severance of land use where the motorway may fragment land and affect the subsequent use of and functionality of residual land parcels. Another issue for the project is crossing or impinging on Commonwealth land especially around Sydney Airport. This will require special management during detailed design to ensure that Commonwealth land is not impacted.

7.10.3 Project level performance requirements and outcomes

Key requirements for the project level assessments will include:

- Identification of the local land uses, existing access arrangements and potential property acquisition for both public and private land adjacent to WestConnex
- Assessment of the potential impacts of WestConnex on the property, land use and access arrangements for both construction and operation
- Identification of appropriate management and safeguard measures to minimise these impacts
- Consultation with the public, managers of community facilities, and stakeholders to inform a description of existing values, impacts and management and safeguard measures
- Consultation of directly affected property owners about property acquisition, including timing, compensation arrangements and potential impacts.
8 Statutory planning

8.1 NSW planning framework

Major infrastructure developments undertaken by NSW public authorities typically fall under Part 5 of the EP&A Act, or Part 5.1 in the case of 'State significant infrastructure' (SSI).

WestConnex is designated ‘critical SSI’ under section 115V of the EP&A Act and through the effect of State Environmental Planning Policy (State and Regional Development) 2011 (SRD SEPP). At the time of writing, the critical SSI designation only applies to the following parts of WestConnex:

- M4 Widening project
- M4 East project
- King Georges Road Interchange Upgrade project
- Ancillary development related to the above three projects.

A full description of the scope of the designation is provided in Schedule 5 to the SRD SEPP.

The environmental assessment requirements for the New M5 Project were issued on 5 March 2015 under section 115Y of the EP&A Act. The New M5 Project is designated SSI.

Under the current planning framework, it is anticipated that all remaining projects would similarly be designated SSI (or critical SSI through an amendment to Schedule 5 of the SRD SEPP).

The planning approval pathway under Part 5.1 of the EP&A Act is shown in Figure 8-1.

8.2 Commonwealth planning framework

Components of WestConnex that have an impact on Commonwealth land, air space, or an impact on one or more of the matters protected under the EPBC Act may require approval under relevant Commonwealth legislation. In the case of the EPBC Act, the process is entirely separate to any NSW planning law requirements and would occur on an individual project basis.

There is an existing assessment bilateral agreement in place under the EPBC Act; this commenced operation from 26 February 2015. There is no approval bilateral agreement currently in place.

As noted in Section 7.2.2, during the environmental assessment for the New M5, a potential impact on a Commonwealth listed ecological community, Cooks River/Castlereagh Ironbark Forest of the Sydney Basin Bioregion, was identified. A referral to the Department of the Environment was made on 17 July 2015. Impacts will be assessed under the existing bilateral agreement.
Figure 8-1  Current planning approval pathway under Part 5.1 of the EP&A Act
9 Justification

This chapter outlines the reasons justifying the need for WestConnex. Justification is based on the strategic need for the program and takes into account alternatives and the principles of ESD.

9.1 Strategic need for WestConnex

In summary, WestConnex is needed to:

- Provide the missing link in the Sydney motorway network’s east-west spine created by the M4 terminating at Strathfield – constraining movements between Sydney’s west, its international gateways and key places of business
- Address major congestion, low travel speeds and unreliable travel times on the M4 Motorway, M5 East, Parramatta Road and in the Sydney Airport/Port Botany precinct that delay freight, public transport and add cost to business
- Address poor urban amenity along the Parramatta Road corridor due to heavy traffic volumes and congestion throughout weekdays and on weekends
- Provide additional road capacity and north-south connectivity to relieve surface congestion in Sydney's inner west
- Improve capacity and access for freight movements to and from the Port Botany and Sydney Airport precinct, providing a major boost to the productivity of NSW and the Australian economy more broadly
- Improve road access to Sydney Airport for passengers, freight and employees
- Provide new opportunities for urban renewal in the inner west, including along Parramatta Road, especially east of North Strathfield
- Improve liveability for residents and business in the corridor
- Improve road safety on both the new WestConnex infrastructure and surface roads
- Provide for new opportunities for land development and wider land use planning changes
- Provide for opportunities for public transport improvements.

As indicated in the Transport Master Plan, WestConnex is a key project in providing a step change in Sydney’s connectivity. It is considered a critical link in Sydney’s motorway network, particularly with respect to its function as an international gateway and urban renewal opportunities. It will ease congestion, connect communities and create jobs.

WestConnex will be delivered as part of an integrated package of transport improvements across Sydney including complementary enhancements to the existing road network (including associated surface street changes, bus priority measures, heavy vehicle access improvements) redesign of bus services and facilities, improved access to rail stations and upgrades to cyclist and pedestrian facilities.

Similarly, A Plan for Growing Sydney identifies WestConnex as essential to support major planning renewal and growth areas, including in the Parramatta Road corridor where it will allow for significant improvements to local amenity by curtailing growth of through-traffic on surface roads, and allowing for enhanced north-south local connectivity.
9.2 Principles of ecologically sustainable development

Ecologically sustainable development (ESD) is development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends.

The EP&A Act recognises that ESD requires the effective integration of economic and environmental considerations in decision-making processes. There are four main principles supporting the achievement of ESD:

- Precautionary principle
- Intergenerational equity
- Conservation of biological diversity and ecological integrity
- Improved valuation and pricing of environmental resources.

9.2.1 Precautionary principle

The precautionary principle deals with certainty in decision-making. It provides that where there is a threat of serious or irreversible environmental damage, the absence of full scientific certainty should not be used as a reason to postpone measures to prevent environmental degradation.

The threat of serious or irreversible environmental damage is one of the essential preconditions to the engagement of the precautionary principle. A key benefit of the SER is the ability to identify broader, longer-term and cumulative environmental issues which are often more difficult to address at the project level.

The SER did not identify a strategic level threat of serious or irreversible environmental damage. The design development process for WestConnex will address the strategic level impacts identified in this SER. The potential environmental impacts arising from WestConnex on a project basis will be assessed in detail through the planning approval process for each project. Experience with similar projects in the Sydney region indicates that predicted impacts can be appropriately managed and mitigated.

9.2.2 Intergenerational equity

Intergenerational equity is the concept of fairness between people of different generations. In this context, it refers to the need to minimise the passing on of economic, social and environmental costs to future generations. Intra-generational equity is the related concept of fairness between people of the same generation. It is also called social equity, and refers to the need for fairness in the distribution of economic, social and environmental costs and benefits.

Strategic intergenerational and intra-generational impacts of WestConnex have been reviewed in the socio-economic section of this report.

Key benefits identified include:

- Positive impact on employment in areas of disadvantage
- Improved access to key employment lands
- Reduced through traffic on local streets
- Improved access to regional recreational centres and local parks
- Enhanced social equity by improving access for the disabled, elderly, and for parents with young children
• Providing a positive legacy road (Parramatta Road) for future generations. Most significantly, with the improvements to urban amenity and providing the key enabler as a city-shaping corridor

• Providing long-term benefits in terms of the environment and urban living by linking land use and transport planning and deliver on the State’s strategic objectives for improved urban environments with reliable transport access

• It will also meet future generations’ transport needs which will be critical in allowing those generations the same, if not better, transport opportunities than current generations.

9.2.3 Conservation of biological diversity and ecological integrity

Given the highly disturbed environment within the vicinity of WestConnex, the strategic environmental review did not identify biodiversity conservation and ecological integrity as a priority issue for strategic assessment. Notwithstanding key performance indicators have been identified with an outcome sought of identifying, avoiding, minimising and mitigating impacts.

9.2.4 Improved valuation, pricing and incentive mechanisms

The principle of internalising environmental costs into decision-making requires consideration of all environmental resources which may be affected by a project, including air, water, land and living things.

While the social impacts and environmental resources have not been accorded a monetary value, the value placed is inherent and an integral part of the development of project design features and in the scoping of environmental investigations, planning and design of impact mitigation measures to minimise adverse environmental impacts.

Ongoing and detailed design of the project together with project specific environmental impact assessment will represent further commitment to the recognition of the value of reducing environmental impacts.
10 Conclusions

10.1 General

WestConnex will deliver significant long-term benefits to the economic growth and development of NSW and to the nation. It will deliver substantial amenity and environmental benefits, improve the function of the city and assist to reduce the negative effects of traffic congestion along key corridors. This will provide an important catalyst for urban renewal in areas of the city that currently experience poor amenity due to excessive traffic on local and arterial roads.

There are likely to be several significant strategic environmental issues, but these will be able to be managed adequately and effectively through careful strategic planning, design development and delivery – using proven impact mitigation and management measures.

During construction some potential issues and impacts, while not unique to WestConnex, will potentially have a greater level of significance to the community due to its anticipated scale and duration. Similarly operational cumulative effects such as local and in-tunnel air quality will be of particular community interest.

There are unlikely to be any significant issues that cannot be effectively avoided, managed, minimised and/or mitigated to an acceptable level provided appropriate attention is given to defining clear and transparent performance outcomes at the project planning, design and delivery stages.

Notwithstanding, it is recognised that appropriate technical management of potential impacts and issues may not necessarily always result in community acceptance and confidence in their effectiveness. It is intended that all relevant government agencies will be engaged in identifying potential issues, developing practical outcome based solutions and being proactive and transparent in providing information to the community to inform discussion.

10.2 Next steps

Detailed environmental assessment will be undertaken on a project specific basis as part of the planning approval process and will comprehensively address all environmental issues for each of the projects.

This will include details on project-specific environmental management, mitigation measures and safeguards as well as environmental monitoring and auditing requirements. This has commenced for the M4 East and New M5 projects, and the findings of the SER have been considered and incorporated into these assessments as appropriate.

Community consultation will be comprehensive and ongoing as each element of WestConnex is further refined and developed.

For the important and related urban renewal components, the mechanism for approval and delivery will be subject to further discussion with DP&E. It is anticipated that UrbanGrowth NSW will manage the planning and development process for acquired land in partnership with DP&E. This process will occur separately to the planning approvals process for WestConnex.
11 References

Advisory Committee on Tunnel Air Quality (ACTAQ) 2014a, Initial Report on Tunnel Air Quality, NSW Government, Sydney, Australia.

Advisory Committee on Tunnel Air Quality (ACTAQ) 2014b, Options for Treating road tunnel emissions, Technical Paper 8, NSW Government, Sydney, Australia.

Advisory Committee on Tunnel Air Quality (ACTAQ) 2014c, Criteria for In-Tunnel and Ambient Air Quality, Technical Paper 11, NSW Government, Sydney, Australia.


Australian Government 2011, Our Cities, Our Future – A National Urban Policy for a productive, sustainable and liveable future, Department of Infrastructure and Transport, ACT.


Commonwealth Scientific and Industrial Research Organisation (CSIRO) 2007a, Climate Change in Australia, CSIRO, Australia.

Commonwealth Scientific and Industrial Research Organisation (CSIRO) 2007b, Climate change in the Sydney Metropolitan Catchments, CSIRO, Australia.


Department of Climate Change and Energy Efficiency (DCCEE) 2012, *Australian National Greenhouse Accounts Factors*, Department of Climate Change and Energy Efficiency, Australia.


Department of Environment and Climate Change (DECC) 2009a, *Interim Construction Noise Guidelines*, DECC, Sydney, Australia,


Department of Environment, Climate Change and Water NSW (DECCW) 2010a, *Impacts of Climate Change on Natural Hazards Profile: Statewide Overview*. DECCW, Sydney, Australia.

Department of Environment, Climate Change and Water NSW (DECCW) 2010b, *NSW Climate impact profile, the impacts of climate change on the biophysical environment of New South Wales*. DECCW, Sydney Australia.

Department of Environment, Climate Change and Water NSW (DECCW) 2011, *NSW Road Noise Policy*, DECCW, Sydney, Australia.


Department of Planning and Environment (DP&E) 2015, *New M5 Secretary’s Environmental Assessment Requirements*, issued 5 March 2015, DP&E, Sydney, Australia.


Environment Protection Authority 2000, NSW Industrial Noise Policy, EPA, Sydney, Australia.


Heritage Branch 2009, Assessing significance for historical archaeological sites and relics, Heritage Branch Department of Planning, Sydney, Australia.


Infrastructure Australia 2010, National Ports Strategy – Infrastructure for an economically, socially, and environmentally sustainable future, Infrastructure Australia, Canberra, Australia.


Infrastructure Australia 2012a, Australian Infrastructure Progress and Action: A report to the Council of Australian Governments, Infrastructure Australia, Canberra, Australia.

Infrastructure Australia 2012b, National Land Freight Strategy Update, Infrastructure Australia, Canberra, Australia.

Infrastructure Australia 2013, Infrastructure Priority List Update – December 2013, Infrastructure Australia, Canberra, Australia.

Infrastructure Australia no date, 2014-2015 Assessment Brief, Infrastructure Australia, Canberra, Australia.

Infrastructure NSW 2012a, First things first: The State Infrastructure Strategy 2012-2032, Infrastructure NSW, Sydney, Australia.

Infrastructure NSW 2012b, WestConnex–Sydney’s next motorway priority, Infrastructure NSW, Sydney, Australia.


National Health and Medical Research Council (NHMRC) 2008, *Air Quality in and Around Traffic Tunnels*. National Health and Medical Research Council, Canberra, Australia.

National Institute of Water and Atmospheric Research (NIWA) 2010, *Guidance for the Management of Air Quality in Road Tunnels in New Zealand*: NIWA, Auckland, New Zealand


NSW Department of Premier and Cabinet 2011, *NSW 2021: A plan to make NSW number one*, DPC, Sydney, Australia.


Transport for NSW (Transport for NSW) 2011, *Commercial Number Plate Survey Transport for NSW*, Sydney, Australia.
Transport for NSW (Transport for NSW) 2012a, NSW Long Term Transport Master Plan, Transport for NSW, Sydney, Australia.

Transport for NSW (Transport for NSW) 2012b, NSW Sustainable design guidelines for rail, Transport for NSW, Sydney, Australia.

Transport for NSW (Transport for NSW) 2013a, NSW Freight and Ports Strategy, State of New South Wales, Transport for NSW, Sydney, Australia.


Transport for NSW (Transport for NSW) 2013c, Sydney’s Bus Future, Transport for NSW, Sydney, Australia.


UrbanGrowth NSW 2015, New Parramatta Road – Draft Parramatta Road Urban Renewal Strategy, UrbanGrowth NSW, Sydney, NSW.

VicRoads Environmental Sustainability 2011, Integrated VicRoads Environmental Sustainability Tool (INVEST), VicRoads, Melbourne, Australia.

World Health Organization (WHO) 2009, Night noise guidelines for Europe, WHO, Copenhagen, Denmark.

World Health Organization (WHO) 2011, Burden of disease from environmental noise: quantification of healthy life years lost in Europe, WHO, Copenhagen, Denmark.

## Abbreviations and glossary

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong></td>
<td></td>
</tr>
<tr>
<td>100-year ARI Flood event</td>
<td>Refers to the flood event that occurs, on average, once every 100 years. Also known as the 100-year Average Recurrence Interval (ARI) of a flood. These events are of a random nature. It is possible to have 100-year floods in successive years. Similarly, a 100-year flood event may not occur for 200 years and may not be the largest flood in the last 100 years. This also applies to 5-year and 20-year ARI flood events.</td>
</tr>
<tr>
<td>AADT</td>
<td>Annual average daily traffic, the total volume of traffic passing a roadside observation point over a period of a year, divided by the number of days per year.</td>
</tr>
<tr>
<td>Aboriginal scarred tree</td>
<td>Aboriginal scarred trees show evidence of bark or timber removal by Aboriginal people for traditional purposes. Scarred trees provide significant evidence of Aboriginal occupation in what is now a highly modified landscape. There are few developed agricultural areas remaining in the world with preserved signs of pre-modern Indigenous activity. This makes scarred trees in south-east Australia records of human activity of potential world importance (Department of Environment and Conservation 2005 – now Office of Environment and Heritage).</td>
</tr>
<tr>
<td>ABS</td>
<td>Australian Bureau of Statistics</td>
</tr>
<tr>
<td>Acute noise levels</td>
<td>Road traffic noise levels received at private dwellings that are greater than 65dB(A) Leq(15hr) (day) and 60 dB(A) Leq(9hr) (night), as presented in Practice Note IV, Step 3, part (2) of the RTA’s (2001) Environmental Noise Management Manual.</td>
</tr>
<tr>
<td>AER</td>
<td>Air exchange rate</td>
</tr>
<tr>
<td>Afflux</td>
<td>An increase in water level resulting from obstacles in the flow path.</td>
</tr>
<tr>
<td>AHD</td>
<td>Australian height datum is the datum (adopted by the National Mapping Council of Australia) to which all vertical control mapping is to be referred.</td>
</tr>
<tr>
<td>AHIMS</td>
<td>Aboriginal Heritage Information Management System</td>
</tr>
<tr>
<td>Alluvium</td>
<td>Relatively recent deposits of sedimentary material laid down in river/creek beds, floodplains, lakes, or at the base of mountain slopes.</td>
</tr>
<tr>
<td>Annual Recurrence Interval (ARI)</td>
<td>Long-term average number of years between the occurrence of a flood as big as or larger than the selected event. For example ARI 10 = 10 year annual recurrence interval.</td>
</tr>
<tr>
<td>Aquifer</td>
<td>An underground layer of water-bearing permeable rock or unconsolidated materials (gravel, sand, or silt) from which groundwater can be abstracted.</td>
</tr>
<tr>
<td>Aquitard</td>
<td>A bed of low permeability along an aquifer that prevents seepage.</td>
</tr>
<tr>
<td><strong>B</strong></td>
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</tr>
<tr>
<td>Batter</td>
<td>The slope of walls, embankments and cuttings, usually expressed as a ratio of horizontal distance unit to one vertical height unit. For example 2H:1V.</td>
</tr>
<tr>
<td>BITRE</td>
<td>Bureau of Infrastructure, Transport and Regional Economics</td>
</tr>
<tr>
<td><strong>C</strong></td>
<td></td>
</tr>
<tr>
<td>Carriageway</td>
<td>The portion of a roadway devoted to vehicular traffic generally delineated by kerbs, a verge or a median.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
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<tr>
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</tr>
<tr>
<td>CBD</td>
<td>Central Business District</td>
</tr>
<tr>
<td>CEMP</td>
<td>Construction environmental management plan</td>
</tr>
<tr>
<td>CHAR</td>
<td>Cultural heritage assessment report.</td>
</tr>
<tr>
<td>CO</td>
<td>Carbon monoxide.</td>
</tr>
<tr>
<td>CO₂-e</td>
<td>Carbon dioxide equivalent. Enables emissions of different gases to be added together and compared with carbon dioxide. Calculated by multiplying the actual mass of emissions by the appropriate Global Warming Potential factor.</td>
</tr>
<tr>
<td>COAG</td>
<td>Council of Australian Governments</td>
</tr>
<tr>
<td>Community severance</td>
<td>If a large or busy road cuts through an area, it can have the effect of separating parts of a community by limiting people’s ability or desire to move through that area, which in turn can reduce accessibility to key services and damage local social network and community ‘cohesion’. The cumulative impact of psychological and physical barriers to movement and social participation created by transport infrastructure is what constitutes ‘community severance’ (UK Department of Transport 2006).</td>
</tr>
<tr>
<td>CPTED</td>
<td>Crime Prevention Through Environmental Design</td>
</tr>
<tr>
<td>Critical habitat</td>
<td>The habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species’ critical habitat in the recovery strategy or in an action plan for the species.</td>
</tr>
<tr>
<td>CSIRO</td>
<td>Commonwealth Scientific and Industrial Research Organisation</td>
</tr>
<tr>
<td>Culvert</td>
<td>An enclosed channel for conveying water below a road.</td>
</tr>
<tr>
<td>Curtillage</td>
<td>The land immediately surrounding a house or dwelling, including any closely associated buildings and structures.</td>
</tr>
<tr>
<td>Cutting</td>
<td>An open excavation. A formation resulting from the construction of the road below the existing ground level after material is cut out or excavated.</td>
</tr>
<tr>
<td>dB(A)</td>
<td>Decibels using the ‘A’ weighted scale, measured according to the frequency of the human ear.</td>
</tr>
<tr>
<td>DECCW</td>
<td>Former Department of Environment, Climate Change and Water</td>
</tr>
<tr>
<td>DP&amp;E</td>
<td>NSW Department of Planning and Environment</td>
</tr>
<tr>
<td>DP&amp;I</td>
<td>NSW Department of Planning and Infrastructure (now DP&amp;E)</td>
</tr>
<tr>
<td>E</td>
<td>The process of extracting, moving and depositing earth during construction.</td>
</tr>
<tr>
<td>Earthwork</td>
<td>The relative volumes of materials excavated from cuttings and materials placed in fill embankments. A road design generally targets equal volumes of cut and fill materials, hence giving a balanced earthwork.</td>
</tr>
<tr>
<td>Earthwork balance</td>
<td>The relative volumes of materials excavated from cuttings and materials placed in fill embankments. A road design generally targets equal volumes of cut and fill materials, hence giving a balanced earthwork.</td>
</tr>
<tr>
<td>Edge effects</td>
<td>A change in species composition, physical conditions or other ecological factors at the boundary between two ecosystems OR the ecological changes that occur at the boundaries of ecosystems (including changes in species composition, gradients of moisture, sunlight, soil and air temperature, wind speed and other factors).</td>
</tr>
<tr>
<td>Endangered ecological community</td>
<td>As defined under the <em>Threatened Species Conservation Act 1995</em>, an ecological community that is likely to become extinct or is in immediate danger of extinction.</td>
</tr>
<tr>
<td>EIS</td>
<td>Environmental impact statement</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
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<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
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<tr>
<td>EPA</td>
<td>NSW Environment Protection Authority</td>
</tr>
<tr>
<td>EP&amp;A Act</td>
<td><em>Environmental Planning and Assessment Act 1979 (NSW)</em>. Provides the legislative framework for land use planning and development assessment in NSW.</td>
</tr>
<tr>
<td>EPBC or EPBC Act</td>
<td><em>Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)</em>. Provides for the protection of the environment, especially matters of national environmental significance, and provides a national assessment and approvals process.</td>
</tr>
<tr>
<td>EMS</td>
<td>Environmental management system: a management approach that enables an organisation to identify, monitor and control its environmental aspects. An EMS is part of the overall management system, which includes organisational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining the environmental policy.</td>
</tr>
<tr>
<td>ENMM</td>
<td>RTA’s <em>Environmental Noise Management Manual</em></td>
</tr>
<tr>
<td>Environmental assessment (process)</td>
<td>A specialised part of the decision-making process, where the environmental impact of a development or proposal or activity is considered in detail, together with other aspects of the development.</td>
</tr>
<tr>
<td>ESD</td>
<td>Ecologically sustainable development. Development which uses, conserves and enhances societal resources such that ecological processes on which life depends, are maintained and the total quality of life, now and in the future, can be increased.</td>
</tr>
<tr>
<td>F</td>
<td>Flood immunity: Relates to the level at which a particular structure would be clear of a certain flood event.</td>
</tr>
<tr>
<td>G</td>
<td></td>
</tr>
<tr>
<td>GDP</td>
<td>Gross domestic product</td>
</tr>
<tr>
<td>GHG</td>
<td>Greenhouse gas</td>
</tr>
<tr>
<td>Grade separation</td>
<td>The use of an underpass or overpass to separate road, rail or other traffic that cross each other, so that crossing movements do not conflict.</td>
</tr>
<tr>
<td>Greater Sydney Metropolitan Area/Region</td>
<td>A general term to define Sydney and its surrounding metropolitan areas covering the entire Sydney basin, the Lower Hunter and the Illawarra.</td>
</tr>
<tr>
<td>GSP</td>
<td>Gross state product</td>
</tr>
<tr>
<td>H</td>
<td></td>
</tr>
<tr>
<td>Habitat</td>
<td>The place where an organism lives. Habitats are measurable and can be described by their flora and physical components.</td>
</tr>
<tr>
<td>I</td>
<td></td>
</tr>
<tr>
<td>ICNG</td>
<td><em>Interim Construction Noise Guideline (July 2009)</em></td>
</tr>
<tr>
<td>Interchange</td>
<td>A grade separate junction between roads where the local road passes above or beneath the highway via bridge or underpass structure with one or more interconnecting roadways.</td>
</tr>
<tr>
<td>IPCC</td>
<td>Intergovernmental Panel on Climate Change</td>
</tr>
<tr>
<td>ISCA</td>
<td>Infrastructure Sustainability Council of Australia</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
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<tr>
<td>ISEPP</td>
<td>State Environmental Planning Policy (Infrastructure) 2007</td>
</tr>
<tr>
<td>L</td>
<td></td>
</tr>
<tr>
<td>LA1</td>
<td>The level at which noise is exceeded for one per cent of the sample period. During the sample period, the noise level is below the LA1 level for 99 per cent of the time.</td>
</tr>
<tr>
<td>LA10</td>
<td>The noise level that is exceeded for 10 per cent of the sample period. During the sample period, the noise level is below the LA10 level for 90 per cent of the time. The LA10 is a common noise descriptor for environmental noise and road traffic noise.</td>
</tr>
<tr>
<td>LA90</td>
<td>The noise level which is exceeded for 90 per cent of the sample period. During the sample period, the noise level is below the LA90 level for 10 per cent of the time. This measure is commonly referred to as the background noise level.</td>
</tr>
<tr>
<td>LAeq</td>
<td>The equivalent continuous sound level (LAeq) is the average energy of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is also a common measure of environmental noise and road traffic noise.</td>
</tr>
<tr>
<td>Lamax</td>
<td>The maximum noise level over a sample period is the maximum level, measured on fast response, during the sample period.</td>
</tr>
<tr>
<td>LALC</td>
<td>Local Aboriginal Land Council</td>
</tr>
<tr>
<td>LEP</td>
<td>Local Environmental Plan. A type of planning instrument made under Part 3 of the EP&amp;A Act</td>
</tr>
<tr>
<td>LGA</td>
<td>Local government area</td>
</tr>
<tr>
<td>LoS</td>
<td>Level of service, a fundamental performance measure used in the planning, design and operation of roads. It provides the basis for determining the number of lanes to be provided in the road network.</td>
</tr>
<tr>
<td>LLTMP</td>
<td>NSW Long Term Transport Master Plan</td>
</tr>
<tr>
<td>M</td>
<td></td>
</tr>
<tr>
<td>MNES</td>
<td>Matter(s) of national environmental significance under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999.</td>
</tr>
<tr>
<td>MWh</td>
<td>Megawatt hours</td>
</tr>
<tr>
<td>N</td>
<td></td>
</tr>
<tr>
<td>NAP</td>
<td>Noise Abatement Program</td>
</tr>
<tr>
<td>NEPC</td>
<td>National Environment Protection Council</td>
</tr>
<tr>
<td>NEPM</td>
<td>National Environment Protection Measure(s)</td>
</tr>
<tr>
<td>NHMRC</td>
<td>National Health and Medical Research Council</td>
</tr>
<tr>
<td>NIWA</td>
<td>National Institute of Water and Atmospheric Research (New Zealand)</td>
</tr>
<tr>
<td>NO2</td>
<td>Nitrogen dioxide</td>
</tr>
<tr>
<td>NOx</td>
<td>Oxides of nitrogen</td>
</tr>
<tr>
<td>NPW Act</td>
<td>National Parks and Wildlife Act 1974 (NSW)</td>
</tr>
<tr>
<td>NPWS</td>
<td>National Parks and Wildlife Service</td>
</tr>
<tr>
<td>NSFC</td>
<td>Northern Sydney Freight Corridor</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
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<td>---------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------</td>
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<tr>
<td>NSW</td>
<td>New South Wales</td>
</tr>
<tr>
<td>O</td>
<td></td>
</tr>
<tr>
<td>OEH</td>
<td>NSW Office of Environment and Heritage (formerly Department of Environment, Climate Change and Water)</td>
</tr>
<tr>
<td>P</td>
<td></td>
</tr>
<tr>
<td>PACHCI</td>
<td>RMS Procedure for Aboriginal Cultural Heritage Consultation and Investigation</td>
</tr>
<tr>
<td>PAD</td>
<td>Potential archaeological deposit: any location considered to have moderate to high potential for subsurface archaeological material.</td>
</tr>
<tr>
<td>Palaeovalley</td>
<td>An inactive river or stream valley that has been filled or buried by younger sediment.</td>
</tr>
<tr>
<td>PEA</td>
<td>Preliminary Environmental Assessment</td>
</tr>
<tr>
<td>PIARC</td>
<td>World Road Association – Permanent International Association of Road Congress</td>
</tr>
<tr>
<td>PM₂·₅</td>
<td>Airborne particulate matter with equivalent aerodynamic diameter of 2.5 microns or less.</td>
</tr>
<tr>
<td>PM₁₀</td>
<td>Airborne particulate matter (such as airborne dust or silt) with equivalent aerodynamic diameter of 10 microns or less.</td>
</tr>
<tr>
<td>POEO Act</td>
<td>Protection of the Environment Operations Act 1997 (NSW)</td>
</tr>
<tr>
<td>PPI</td>
<td>Public Priority Infrastructure</td>
</tr>
<tr>
<td>pphm</td>
<td>Parts per hundred million</td>
</tr>
<tr>
<td>ppm</td>
<td>Parts per million</td>
</tr>
<tr>
<td>Probable maximum flood (PMF)</td>
<td>Largest flood that could conceivably occur at a particular location, which defines the extent of flood prone land (the floodplain).</td>
</tr>
<tr>
<td>R</td>
<td></td>
</tr>
<tr>
<td>RBL</td>
<td>The rating background level (RBL) for a specified time period is the median value of the average background level (ABL) values for the period over all of the days measured. There is therefore an RBL value for each period – daytime, evening and night-time.</td>
</tr>
<tr>
<td>REF</td>
<td>Review of environmental factors</td>
</tr>
<tr>
<td>RET</td>
<td>Federal Renewable Energy Target</td>
</tr>
<tr>
<td>RL</td>
<td>Reduced level - relative height above mean sea level</td>
</tr>
<tr>
<td>RMS</td>
<td>NSW Roads and Maritime Services</td>
</tr>
<tr>
<td>RNP</td>
<td>NSW Road Noise Policy</td>
</tr>
<tr>
<td>RTA</td>
<td>Former NSW Roads and Transport Authority (now part of RMS)</td>
</tr>
<tr>
<td>S</td>
<td></td>
</tr>
<tr>
<td>SAACL</td>
<td>Sydney Airport Corporation Limited</td>
</tr>
<tr>
<td>SCA</td>
<td>Sydney Catchment Authority</td>
</tr>
<tr>
<td>SEPP</td>
<td>State Environmental Planning Policy. A type of planning instrument made under Part 3 of the EP&amp;A Act</td>
</tr>
<tr>
<td>SER</td>
<td>Strategic environmental review</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
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</tr>
<tr>
<td>SEWPaC</td>
<td>Former Commonwealth Department of Sustainability, Environment, Water, Population and Communities (previously DEWHA). The department is responsible for implementing the Australian Government's policies to protect national environment and heritage, including the EPBC Act.</td>
</tr>
<tr>
<td>SHR</td>
<td>NSW State heritage register</td>
</tr>
<tr>
<td>SIS</td>
<td>State Infrastructure Strategy 2012-2032</td>
</tr>
<tr>
<td>SMC</td>
<td>Sydney Motorway Corporation</td>
</tr>
<tr>
<td>SMPO</td>
<td>Sydney Motorways Project Office</td>
</tr>
<tr>
<td>SoE</td>
<td>State of the Environment</td>
</tr>
<tr>
<td>STP</td>
<td>Sewage treatment plant</td>
</tr>
<tr>
<td>TBM</td>
<td>Tunnel boring machines</td>
</tr>
<tr>
<td>tCO2-e</td>
<td>Tonnes of carbon dioxide equivalent. See ‘CO2-e’ for explanation</td>
</tr>
<tr>
<td>Threatened</td>
<td>As defined under the NSW Threatened Species Conservation Act 1995, a species, population or ecological community that is likely to become extinct or is in immediate danger of extinction.</td>
</tr>
<tr>
<td>TMC</td>
<td>Transport Management Centre</td>
</tr>
<tr>
<td>TPH</td>
<td>Total petroleum hydrocarbon</td>
</tr>
<tr>
<td>TSC Act</td>
<td>Threatened Species Conservation Act 1995 (NSW)</td>
</tr>
<tr>
<td>Tunnel portal</td>
<td>The entrance/exit structures at each end of a tunnel.</td>
</tr>
<tr>
<td>µg/m³</td>
<td>Micrograms per cubic metre</td>
</tr>
<tr>
<td>µS/cm</td>
<td>Microsiemens per centimetre (a measure of electrical conductivity)</td>
</tr>
<tr>
<td>Viaduct</td>
<td>A long bridge generally composed of a series of spans over land, which carried a road, or railway. The term is used to distinguish an aqueduct, which is a bridge, supporting a pipe, or channel, carrying water.</td>
</tr>
<tr>
<td>VKT</td>
<td>Vehicle kilometres travelled</td>
</tr>
<tr>
<td>VOC</td>
<td>Volatile organic compound(s)</td>
</tr>
<tr>
<td>WDA</td>
<td>WestConnex Delivery Authority</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organisation</td>
</tr>
<tr>
<td>WSUD</td>
<td>Water sensitive urban design</td>
</tr>
</tbody>
</table>
Appendix A
Potential strategic issues
### Table A-1 Potential strategic issues for review identified through broad strategic documents

<table>
<thead>
<tr>
<th>Issue</th>
<th>Strategic indicators</th>
<th>Current Trend (source)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Traffic and transport</strong></td>
<td>Public transport use (overall and trips)</td>
<td>Increasing (^{(1)})</td>
</tr>
<tr>
<td></td>
<td>Vehicle kilometres travelled (total and per person)</td>
<td>Stable (^{(1)})</td>
</tr>
<tr>
<td></td>
<td>Mode of transport (GMR key centres)</td>
<td>Stable (^{(1)})</td>
</tr>
<tr>
<td></td>
<td>Travel times</td>
<td>Decreasing (^{(2)})</td>
</tr>
<tr>
<td></td>
<td>Increase in walking and cycling</td>
<td>Increasing (^{(2)})</td>
</tr>
<tr>
<td></td>
<td>Customer experience with transport services</td>
<td>Stable (^{(2)})</td>
</tr>
<tr>
<td></td>
<td>Road safety</td>
<td>Increasing (^{(2)})</td>
</tr>
<tr>
<td><strong>Greenhouse gas emissions</strong></td>
<td>Atmospheric concentrations of greenhouse gases</td>
<td>Increasing (^{(1)})</td>
</tr>
<tr>
<td></td>
<td>Total annual NSW greenhouse gas emission</td>
<td>Increasing (^{(1)})</td>
</tr>
<tr>
<td></td>
<td>Annual NSW per capita greenhouse gas emissions</td>
<td>Decreasing (^{(1)})</td>
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<tr>
<td><strong>Waste and recycling</strong></td>
<td>Total and per person solid waste disposal</td>
<td>Decreasing (^{(1)})</td>
</tr>
<tr>
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<td>Total and per person solid waste recycled</td>
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<tr>
<td><strong>Energy efficiency</strong></td>
<td>Total NSW energy use</td>
<td>Increasing (^{(1)})</td>
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<td>NSW renewable energy supply (^{(1)})</td>
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<td>Energy use per capita</td>
<td>Decreasing (^{(1)})</td>
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<tr>
<td><strong>Socio-economic</strong></td>
<td>Productivity of business and industry</td>
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<td>Community health and safety</td>
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<td>Amenity and liveability</td>
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<td>Community facilities</td>
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<td>Community values</td>
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<td>Access and connectivity</td>
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<td><strong>Noise</strong></td>
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<td>Increase in the number of Aboriginal culturally significant objects and places protected (^{(1)})</td>
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<td>Air quality concentrations of ozone</td>
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<td>concentrations of particles (PM10)</td>
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<td>concentrations of carbon monoxide</td>
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Sources:

(1) NSW State of the Environment Report 2012 (EPA 2012a)
(2) State of Australian Cities 2012