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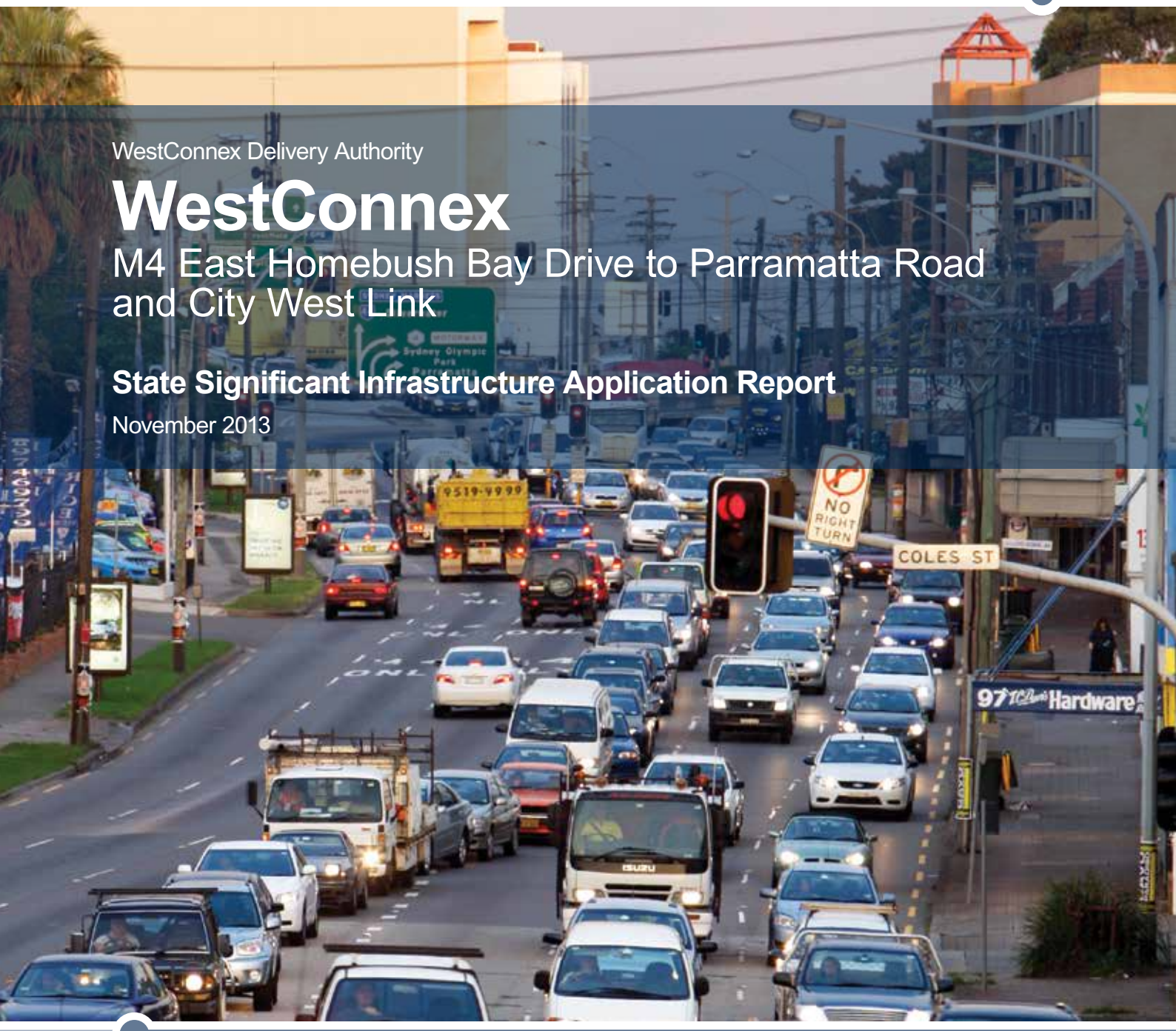

WestConnex Delivery Authority

WestConnex

M4 East Homebush Bay Drive to Parramatta Road and City West Link

State Significant Infrastructure Application Report

November 2013

WESTCONNEX

M4 East Homebush Bay Drive to Parramatta Road and City West Link

State Significant Infrastructure

Application Report

WestConnex Delivery Authority

November 2013

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Executive summary

The NSW Government is proposing to upgrade and extend the M4 Motorway from Homebush Bay Drive, Homebush, to Parramatta Road and City West Link (Wattle Street), Haberfield. The M4 East project would involve:

- Extension of the widening of the M4 Motorway east of Homebush Bay Drive to Concord Road and the western tunnel portal.
- Two three-lane tunnels (of about five kilometres in length) for both east-bound and west-bound directions between Powells Creek, North Strathfield and Parramatta Road, Haberfield.
- Modifications to the grade separated interchange at Concord Road.
- Entry and exit ramps between the tunnel and the surface road network at Concord Road, Parramatta Road and City West Link.

The NSW Government has established the WestConnex Delivery Authority (WDA) to deliver the WestConnex scheme. The Authority has been established as an independent public subsidiary corporation of Roads and Maritime Services (RMS). For the purpose of this initial planning application for the M4 East project, RMS will be the proponent. The WDA may exercise proponent functions for and on behalf of RMS in due course.

The project is a component of the WestConnex scheme, a proposed 33 kilometre integrated motorway to link Sydney's west with Sydney Airport and the Port Botany precinct. WestConnex will extend the M4 Motorway east to the Camperdown area and south to Sydney Airport and duplicate the existing M5 East. Other components of WestConnex include:

- Stage 1(a): M4 Widening – Church Street, Parramatta to Homebush Bay Drive.
- Stage 2: M5 East Airport Link – King Georges Road, Beverly Hills to St Peters.
- Stage 3: M4 South - Haberfield to St Peters via Camperdown.

The majority of the Stage 1(b) M4 East road works would be undertaken concurrently with Stage 1(a) M4 Widening road works.

WestConnex aims to accommodate the growing transport needs of greater Sydney and strengthen access to industrial and commercial centres, improving growth opportunities for local businesses. It is also designed to stimulate urban revitalisation along the Parramatta Road corridor.

The M4 East Homebush Bay Drive to Parramatta Road and City West Link project would include the following key features:

- Carriageway widening of the M4 Motorway between Homebush Bay Drive, Homebush and Powells Creek, North Strathfield.
- Two new three-lane tunnels in an east-bound and west-bound direction constructed from about Powells Creek, Homebush to Parramatta Road/ City West Link (Wattle Street), Haberfield. The tunnels would be about five kilometres in length, in each direction.

- Upgrading of the Concord Road interchange and realignment of surface roads at City West Link and Parramatta Road (at Wattle Street) to facilitate the connection of the proposed tunnel to the surface road network.
- Installation of tunnel ventilation systems including ventilation stacks.
- Associated road works on arterial roads in the vicinity of the project corridor such as Concord Road and City West Link. These road works may include reconfiguration of lanes and changes to traffic signalling as well as associated road works at locations to be determined during further concept development.
- Construction of road infrastructure and services to support the future implementation of the managed motorway including Intelligent Transport Systems (ITS) infrastructure.
- Installation of tolling gantries and control systems along the motorway.

RMS has formed the opinion that the impacts of the project on the issues listed below would be likely to significantly affect the environment and require the preparation of an environmental impact statement under the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). Accordingly, the project is State significant infrastructure under Part 5.1 of the EP&A Act. Approval from the Minister for Planning and Infrastructure is required for the project.

Preliminary environmental assessments carried out for the project indicate the following key issues will require detailed assessment and may require project specific impact management and safeguard measures:

- Noise and vibration.
- Traffic and transport.
- Air quality.
- Urban revitalisation, land use and property.
- Socio-economic impacts.
- Urban design and visual impact.
- Non-Aboriginal heritage.
- Energy efficiency.
- Resource use and waste management.

A number of other environmental issues have also been identified. These issues are outlined within this report and are considered to be of lesser consequence taking into consideration the project scope, the existing environment and the implementation of standard management and safeguard measures.

Contents

Attachments

Abbreviations and glossary

Term	Definition
ABS	Australian Bureau of Statistics
Afflux	An increase in water level resulting from obstacles in the flow path.
AHD	Australian height datum
AHIMS	Aboriginal Heritage Information Management System
Alluvium	Relatively recent deposits of sedimentary material laid down in river/creek beds, floodplains, lakes, or at the base of mountain slopes.
Aquifer	An underground layer of water-bearing permeable rock or unconsolidated materials (gravel, sand, or silt) from which groundwater can be usefully extracted.
Batter	The slope of walls, embankments and cuttings, usually expressed as a ratio of horizontal distance unit to one vertical height unit, eg 2H:1V.
Carriageway	The portion of a roadway devoted to vehicular traffic generally delineated by kerbs, a verge or a median.
CBD	Central business district
CCTV	Closed circuit television
CEMP	Construction environmental management plan
CHAR	Cultural heritage assessment report
CO	Carbon monoxide
Community severance	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).
CO_2-e	Carbon dioxide equivalent
Culvert	An enclosed channel for conveying water below a road.
dB(A)	Decibels using the 'A' weighted scale, measured according to the frequency of the human ear.
DPI	Department of Primary Industries
DP&I	Department of Planning and Infrastructure
Endangered ecological community	As defined under the *Threatened Species Conservation Act 1995* and *Fisheries Management Act 1994* an ecological community that is likely to become extinct or is in immediate danger of extinction.
EIS	Environmental impact statement
EPA	NSW Environmental Protection Authority
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW).

Term	Definition
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth).
EMS	Environmental management system
Environmental assessment (process)	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.
Flood Immunity	Relates to the level at which a particular structure would be clear of a certain flood event.
FM Act	*Fisheries Management Act 1994*
Freeway	A toll free highway
GHG	Greenhouse gas
Grade separation	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.
Habitat	The place where an organism lives.
Interchange	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
ITS	Intelligent Transport Systems
km/h	Kilometres per hour
LALC	Local Aboriginal Land Council
LEP	Local Environmental Plan. A type of environmental planning instrument made under Part 3 of the EP&A Act.
LGA	Local government area
Motorway	A tolled highway.
NES	Matters of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999.
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
OEH	Office of Environment and Heritage
PACHCI	RMS' Procedure for Aboriginal Cultural Heritage Consultation and Investigation
Palaeovalley	An inactive river or stream valley that has been filled or buried by younger sediment.
$PM_{2.5}$	Airborne particulate matter with equivalent aerodynamic diameter of 2.5 microns or less.
PM_{10}	Airborne particulate matter (such as airborne dust or silt) with equivalent aerodynamic diameter of 10 microns or less.
RMS	NSW Roads and Maritime Services
RNP	*NSW Road noise policy*
SEPP	State environmental planning policy

Term	Definition
SER	Strategic Environmental Review
SHR	NSW State Heritage Register
SMPO	Sydney Motorways Project Office
tCO2-e	Tonnes of carbon dioxide equivalent. See 'CO2-e' for explanation.
TEU	Twenty-foot equivalent units (used to measure standard container sizes).
Threatened	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.
TSC Act	*Threatened Species Conservation Act 1995* (NSW)
Tunnel portal	The entrance/exit structures at each end of a tunnel.
Ventilation stack	The ventilation outlet structure for a tunnel.
VKT	Vehicle kilometres travelled
VMS	Variable message signs
WSUD	Water sensitive urban design

1 Introduction

1.1 Overview of the project

The NSW Government is proposing to upgrade and extend the M4 Motorway from Homebush Bay Drive, Homebush, to Parramatta Road and City West Link (Wattle Street), Haberfield (the M4 East project).

The M4 East project spans four local government areas including: Strathfield, Canada Bay, Burwood and Ashfield. It would include the widening of the existing motorway on the surface, new tunnels constructed under the northern side of the M4 Motorway and continuing east under Parramatta Road and upgrade of interchange points as well as entry and exit ramps to the tunnel and other infrastructure as described in this application report.

The NSW Government has established the WestConnex Delivery Authority (WDA) to deliver the WestConnex scheme. The Authority has been established as an independent public subsidiary corporation of Roads and Maritime Services (RMS). For the purpose of this initial planning application for the M4 East project, RMS will be the proponent. The WDA may exercise proponent functions for and on behalf of RMS in due course.

The M4 East project is a component of the WestConnex scheme. Other components of WestConnex include:

- Stage 1(a): M4 Widening – Church Street, Parramatta to Homebush Bay Drive
- Stage 2: M5 East Airport Link – King Georges Road, Beverly Hills to St Peters
- Stage 3: M4 South - Haberfield to St Peters via Camperdown

These components will be assessed separately as each stage is developed further. An application report has been submitted for Stage 1(a) M4 Widening. Parts of the Stage 1(b) M4 East construction works may be undertaken concurrently with the Stage 1(a) M4 Widening road works. Separate applications will be made for Stages 2 and 3 following further concept development.

WestConnex would extend the M4 Motorway east to the Camperdown area and south to Sydney Airport and duplicate the existing M5 East as an integrated scheme. The strategic benefits of WestConnex are outlined in Section 2.1 of this report and the regional context of the scheme is shown in Figure 1-1.

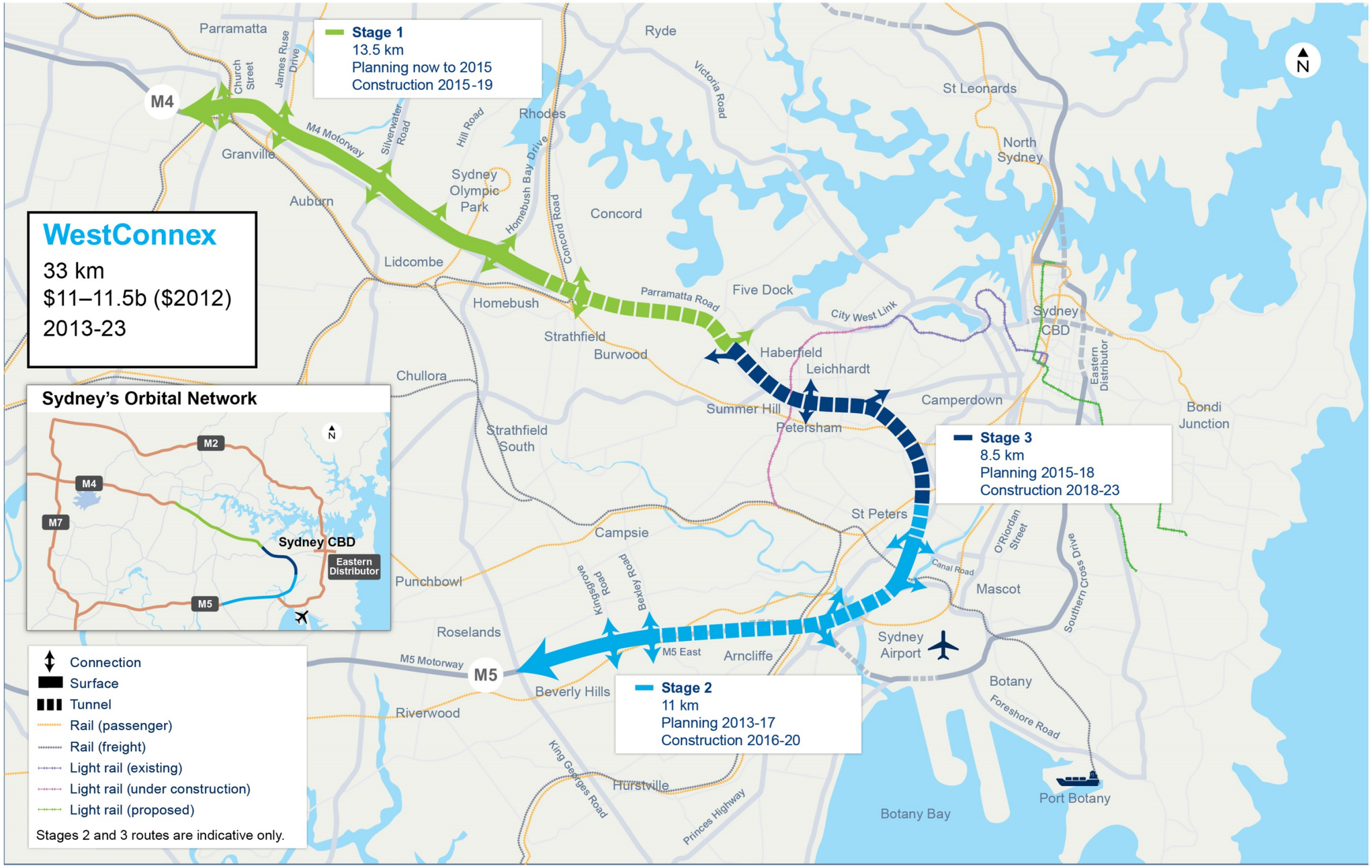

Figure 1-1 **Overview of WestConnex scheme**

The M4 East Homebush Bay Drive to Parramatta Road and City West Link project would include the following key features:

- Extension of the widening of the M4 Motorway east of Homebush Bay Drive to Concord Road and the western tunnel portal.
- Two new three-lane tunnels in an east-bound and west-bound direction constructed from about Powells Creek to Parramatta Road at Haberfield/ Ashfield. The tunnels would be about five kilometres in length, with additional length required for the ramps, in each direction.
- Upgrading of the Concord Road interchange and realignment of surface roads at City West Link and Parramatta Road (east of Wattle Street) to facilitate the connection of the proposed tunnel to the surface road network.
- Installation of tunnel ventilation systems including ventilation stacks.
- Associated road works on arterial roads in the vicinity of the project corridor such as Concord Road and City West Link. These road works may include reconfiguration of lanes and changes to traffic signalling as well as associated road works at locations to be determined during further concept development.
- Construction of road infrastructure and services to support the future implementation of the managed motorway including Intelligent Transport Systems (ITS) infrastructure which would include:
    - Traffic signals.
    - Vehicle detection devices.
    - Variable message signs (VMS).
    - Closed circuit television (CCTV).
    - Emergency telephones.
    - Variable speed limit signs.
    - Cabling and fixed signage.
- Installation of tolling gantries and control systems along the motorway.

The M4 East project does not include work required for reconfiguring Parramatta Road as part of urban revitalisation. The project would not include surveys, test drilling, test excavations, geotechnical investigations, utility adjustments or other tests, surveys, sampling or investigation for the purposes of the design or assessment of the project.

A description of the M4 East project is provided in Section 3. Key features are shown in Figure 1-2.

1.2 Purpose of this document

This report has been prepared to support a State significant infrastructure application under section 115X of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

RMS has formed the opinion that the M4 East project is likely to significantly affect the environment and requires the preparation of an environmental impact statement under the EP&A Act. The M4 East project does not require development consent under Part 4 of the EP&A Act. Accordingly, as per clause 14 and Schedule 3 of State Environmental Planning Policy (State and Regional Development) 2011, the project is State significant infrastructure under Part 5.1 of the EP&A Act and requires the approval of the Minister for Planning and Infrastructure.

The requirements of clause 192 of the Environmental Planning and Assessment Regulation 2000 for applications seeking approval of the Minister for Planning and Infrastructure to carry out State significant infrastructure are addressed in Attachment A to this report.

The purpose of this application report is to assist the formulation of environmental assessment requirements by the Director-General under section 115Y of the EP&A Act.

The application report:

- Describes the project.
- Considers the potential environmental issues for the project.
- Identifies key environmental issues for the project.

The application report and Director-General's environmental assessment requirements would inform the preparation of an environmental impact statement for the M4 East project. The form and content of the environmental impact statement would be in accordance with clauses 6 and 7 of Schedule 2 of the Environmental Planning and Assessment Regulation 2000.

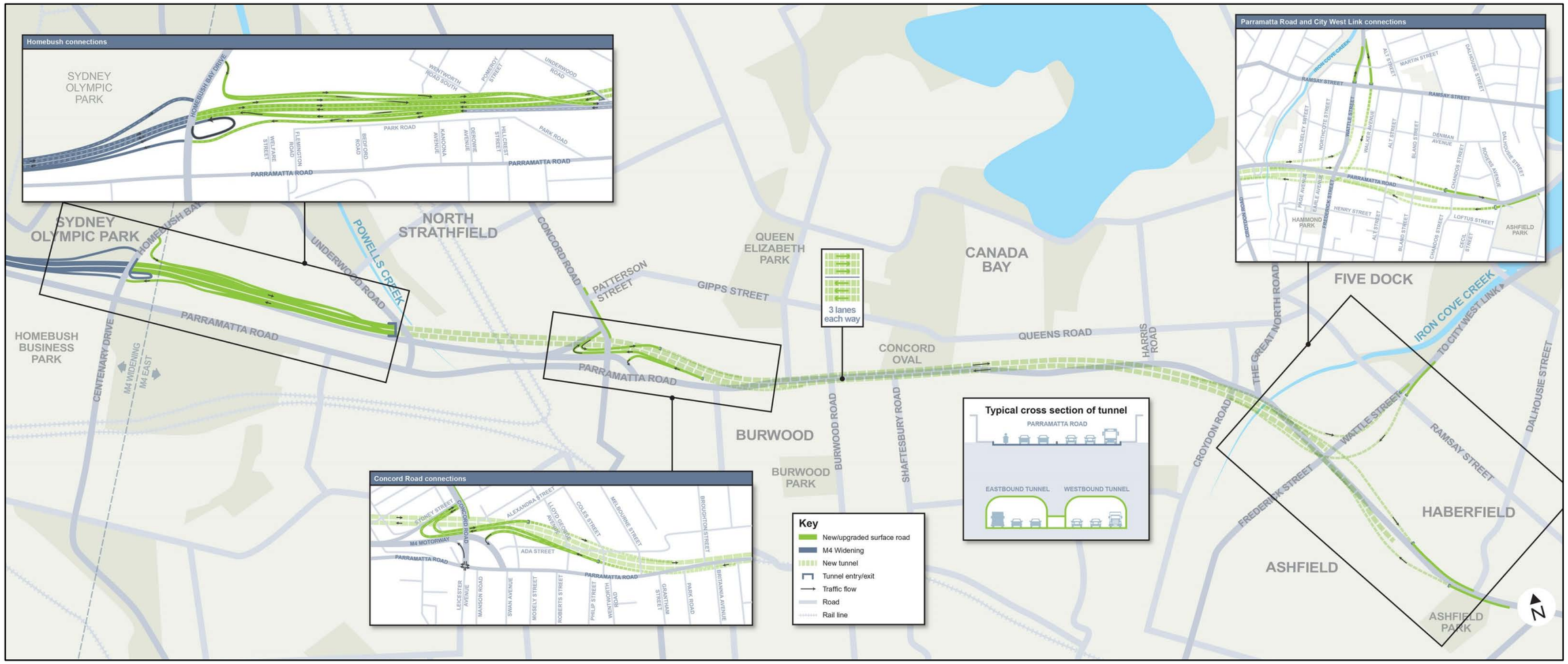

Figure 1.2 - M4 East Homebush Bay Drive to Parramatta Road and City West Link project location and key features

2 Background

2.1 Strategic context and project need

2.1.1 M4 East Homebush Bay Drive to Parramatta Road and City West Link

WestConnex is one of the NSW Government's major infrastructure priorities. The M4 East Homebush Bay Drive to Parramatta Road and City West Link project is one component of the WestConnex scheme and will be the second project to be delivered.

The M4 Motorway and Parramatta Road currently operate as an important link between employment and industry located in the Sydney CBD, Port Botany and the Sydney Airport to the east and housing and employment in Parramatta to the west. The M4 Motorway and Parramatta Road currently experience heavy traffic congestion particularly during peak travel times, resulting in slow speeds, unreliable travel times for motorists and freight vehicles, as well as poor amenity for residents and businesses located along Parramatta Road.

The M4 East Homebush Bay Drive to Parramatta Road and City West Link project, together with the Stage 1(a): M4 Widening project, is needed to:

- Support the economic development of Sydney by providing a high quality and efficient road connection for motorists and freight vehicles to connect between Global Sydney and Parramatta.
- Provide opportunities to transform Parramatta Road as well as local centres that exist alongside Parramatta Road. Provide better connectivity between local centres adjacent to Parramatta Road, particularly as Sydney Olympic Park grows.
- Provide additional capacity to address existing traffic congestion on the M4 Motorway and Parramatta Road by separating longer distance through traffic from local traffic. This traffic congestion is currently causing poor amenity along Parramatta Road and places constraints on the operation of existing businesses and efficient movement of freight.
- Provide for growing travel demand due to population and employment growth in the local area including high growth localities in the Parramatta to Strathfield corridor, including Sydney Olympic Park and Burwood.

2.1.2 WestConnex

It is a NSW Government commitment to deliver WestConnex for Sydney in response to the key recommendations from Infrastructure NSW in its State Infrastructure Strategy (Infrastructure NSW 2012) and Transport for NSW's (TfNSW's) *Long Term Transport Master Plan* (LTTMP) (TfNSW 2102). In addition, the *Draft Metropolitan Strategy for Sydney to 2031* (Draft Metropolitan Strategy) (NSW Government 2013) identifies WestConnex as an important corridor and a catalyst for major urban revitalisation.

WestConnex aims to accommodate the growing transport needs of greater Sydney and strengthen access for industry to commercial centres, improving growth opportunities for local businesses (SMPO 2013). It is also designed to provide opportunities to stimulate urban revitalisation along the Parramatta Road corridor.

WestConnex seeks to address the challenges that road users and the community encounter on a daily basis, moving between western Sydney, the CBD and the Port Botany/Sydney Airport precincts 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 and M5 East Freeway, Parramatta Road and in the Sydney Airport/Port Botany precinct that delay freight, private and business trips and public transport (buses) adding cost to doing business in Sydney.
- Poor urban amenity along Parramatta Road and Sydney's inner west due to heavy traffic volumes and congestion throughout weekdays and on weekends.

The impacts of these challenges are significant given around 30 per cent of Sydney's population (1.2 million people) and around 30 per cent of its employment (600,000 jobs) are located within the broader M4 Motorway and M5 East corridors (NSW BTS 2012). These corridors comprise highly urbanised and complex communities with local concerns and issues which need to be incorporated into the detail of the transport solutions for the area.

WestConnex also responds to future strategic challenges pertinent to Sydney's economic productivity and liveability, including:

- Population growth of around 1.3 million people and jobs growth of 625,000 by 2031 (NSW BTS 2012) in the Sydney Region, generating significant demand for travel on an already constrained network. This represents almost one-quarter of Sydney's population growth and around one-third of new jobs.
- An additional 36 million passengers forecast at Sydney Airport by 2033 (SACL 2013, p.38), resulting in significant vehicle trip generation on a heavily constrained and complex part of the road network. Traffic in the Sydney Airport precinct includes a mixture of airport traffic and through traffic destined for Port Botany, Sydney CBD and Sydney's north.
- Annual container trade through Port Botany in 2010 was around two million standard containers measured as twenty-foot equivalent units (TEUs) and is growing at a faster rate than previously forecast (TfNSW, 2012). Given available capacity at the port itself, it is assumed that Port Botany will remain the primary container facility for NSW if landside access is improved. There is the potential for Port Botany to cater for seven million TEU in the longer term. While freight rail will play an increasing role in the future, this high growth in trade would need to be accommodated by road. In line with population and employment growth, non-containerised freight and commercial trips are also forecast to grow across a wide range of sectors, all of which will be road-based trips.
- The Enfield Intermodal Terminal located about 18 kilometres west of Port Botany (currently under construction) is likely to generate more freight vehicle trips on the M4 Motorway and King Georges Road, when complete.

The Draft Metropolitan Strategy (NSW Government 2013) sets the framework for Sydney's growth and prosperity to 2031 and beyond. To drive the sustainable growth of Sydney, the strategy has identified 'Balanced Growth' as a key outcome. To achieve this outcome, nine 'City Shapers' to guide and influence future development in the

Sydney Metropolitan Area have been identified because of their scale and the opportunities they present for change and investment in Sydney.

Parramatta and the Parramatta Road corridor (which includes a section of the M4 Motorway) are identified as two of the City Shapers. Parramatta is the economic focal point for Western Sydney and considered Sydney's second largest concentration of employment in the Sydney Region. The Parramatta Road corridor has been identified as an important connection between the Sydney CBD and North Sydney with Parramatta via Sydney Olympic Park. Improved road connections and urban revitalisation have been identified as key priorities along the Parramatta Road corridor.

2.2 Core project objectives

The core objectives of the M4 East project are to:

- Support Sydney's long-term economic growth through improved motorway access and connections linking Sydney's international gateways and Western Sydney and places of business across the city.
- Relieve road congestion so as to improve the speed, reliability and safety of travel in the M4 corridor, including parallel arterial roads.
- Cater for the diverse travel demands along these corridors that are best met by road infrastructure.
- Create opportunities for urban revitalisation, improved liveability, and public and active transport improvements along and around Parramatta Road.
- Enhance the productivity of commercial and freight generating land uses strategically located near transport infrastructure.
- Fit within the financial capacity of the State and Federal Governments, in partnership with the private sector.
- Optimise user pays contributions to support funding in a way that is affordable and equitable.

These core objectives are consistent with the core objectives of the WestConnex scheme. An additional specific objective of the M4 East project is to enable integration with the preceding and next stages of WestConnex while not significantly impacting on the surrounding environment in the interim period.

Additionally, the M4 East project, consistent with the WestConnex scheme includes an objective to protect natural and cultural resources and enhance the environment through the following key approaches:

- Manage in tunnel air quality so as to meet community visibility expectations.
- Manage tunnel ventilation emissions to ensure local air quality meets EPA standards.
- Maintain regional air quality.
- Minimise adverse impacts at a local level on air/noise quality.
- Minimise construction and operational energy use.
- Manage noise in accordance with the *NSW Road Noise Policy* and realise opportunities to reduce or mitigate noise impacts.

- Provide for improvement of social and visual amenity.
- Minimise impacts on natural systems including biodiversity.
- Minimise impact on Aboriginal and non-Aboriginal cultural heritage.
- Protect surface and groundwater sources and water quality including management of contaminated areas.
- Reduce susceptibility and minimise impact on flooding.
- Integrate sustainability considerations throughout the design, construction and operation of the M4 East project including consideration of the Infrastructure Sustainability Council of Australia (ISCA) Sustainability Rating tool scorecard.

2.3 Consultation

The purpose of consultation for the M4 East project has been to raise community awareness through a broad range of communication tools as well as engaging with Councils, state government agencies and elected representatives. Objectives of the consultation include:

- Identifying strategic issues by undertaking a market 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 Motorway corridor.
- Raising community awareness and providing information.
- Holding targeted stakeholder and community discussions to seek ideas and opinions.

The consultation feedback has been used to inform the M4 East project development, environmental assessment activities and ongoing communications. A range of consultation methods have been used to seek input and identify issues, including:

- A website www.westconnex.com.au with background information, maps, videos, customer surveys and details for how to provide feedback.
- A centralised feedback telephone line 1300 660 248.
- A project email address info@westconnex.com.au to notify registered stakeholders, solicit comment and respond to community feedback.
- A postal address Sydney Motorways Project Office Locked Bag 928 North Sydney 2059 to contact key stakeholders and receive input.
- Broad advertising in major metropolitan publications such as the *Sydney Morning Herald*, the *Daily Telegraph*, local suburban publications and non-English speaking community papers as well as advertising targeting public transport users in *mX* magazine and online advertising targeting road users.
- Media announcements that have been widely covered in metropolitan television, radio, print and digital news outlets along with trade and advocacy publications such as NRMA's Open Road magazine.
- Concept design displays to local communities within the M4 East corridor.
- A brochure to explain the M4 East project which has been distributed widely along the corridor.

- Market research groups involving residents, professional road users and business operators.
- Targeted stakeholder discussions with advocacy groups, local councils, elected representatives and peak bodies.
- Roundtable discussions with stakeholders such as councils, the freight industry and business groups.
- Meetings with government agencies.
- Individual meetings with representatives and community members.

Issues identified during community consultation associated with the M4 East Homebush Bay Drive to Parramatta Road and City West Link project include:

- Air quality issues associated with ventilation stacks and tunnel portals.
- Access and traffic impacts on local areas.
- Safe accessibility to homes, schools and services.
- Construction impacts (noise, dust, vibration, visual, traffic (heavy vehicles) etc).
- Environmental impacts (flora and fauna, surface water, groundwater, sedimentation, heritage etc.).
- Impacts on properties and perceived impacts on property values.
- Need to consider alternative modes of transport, particularly public transport and cyclists.

Stakeholder consultation undertaken to date has included a number of industry briefings, an online engagement survey conducted from 24 August to 1 October 2012 and from 6 November 2012 to 28 February 2013, discussions with a series of market research groups held during March 2013 and discussions with local Councils.

The purpose of the stakeholder consultation has been to raise awareness of the M4 East project through the website, a project information phone line and emails to registered stakeholders

2.3.1 Animation and website

A website has been set up at: www.westconnex.com.au

Animations explaining the key concepts of the WestConnex scheme are included on the website and have been translated into eight community languages. The Strategic Environmental Review which provides an overview of environmental impacts of the whole WestConnex scheme is also included on the website.

2.3.2 Stakeholder letter, community information sessions and staffed displays

A letter introducing the scheme's concepts and encouraging stakeholders to view the animation and participate in the forum was sent to approximately 100 stakeholders (local government, councils, transport associations, emergency services) on Monday 27 August 2012.

Staffed displays of the overall WestConnex scheme have been held at a number of locations including shopping centres and community events including the Spring Cycle event. Community information sessions are scheduled at a number of suitable community venues and would be ongoing during the consultation on the concept design. An issues report will be developed from feedback at these sessions and issues raised will be addressed in the concept design where appropriate.

2.3.3 Media releases

A comprehensive media campaign is also ongoing for the scheme. Advertisements in various media such as *mX* magazine, as well as *Sydney Morning Herald*, *Daily Telegraph* and local papers will be further enhanced by media coverage in newspapers, TV and radio in the Sydney metro area and suburban areas that are within the scheme area. The media releases are listed on the WestConnex website at the link to 'News':

2.3.4 Community Consultation and Stakeholder Engagement Strategy

A comprehensive community consultation and stakeholder engagement strategy has been prepared to guide consultation on the M4 East concept design and will be implemented during development of the M4 East project and whilst undertaking further environmental assessment. The purpose of the communication strategy is to detail how the project team will engage with affected communities and stakeholders concerning the concept design.

Continuing and specific stakeholder engagement for the M4 East Homebush Bay Drive to Parramatta Road and City West Link project will be undertaken in accordance with the strategy.

2.4 Preferred route option

The preferred route option has evolved through a concept development process and evaluation of options which have been ongoing since 2003. Risk and value management workshops have been undertaken to develop the appropriate options for the tunnel and associated interchanges. Traffic modelling has been undertaken to determine demand levels for proposed ramps and vehicle forecasts for the tunnel. Stakeholder consultation on the preferred option will be ongoing throughout the M4 East project with minor refinements and adjustments to be made as required.

Various route options were considered during the development of the M4 East Homebush Bay Drive to Parramatta Road and City West Link project. Two industry partners were appointed to provide independent development of design options for the M4 Motorway and Parramatta Road corridor. The focus was to identify the most cost effective alignment while achieving engineering solutions. Route options considered by the industry partners included tunnel portals and alignments, opportunities for slots and elevated roads, access locations and development of new roads or upgrades of existing surface roads. Various tunnel and tunnel portal locations were considered at the eastern end of the M4 East project as part of the independent review of design options, particularly with regard to the link to Parramatta Road and City West Link (Wattle Street).

The preferred route option comprises the widening of the M4 Motorway between Homebush Bay Drive, Homebush and Powells Creek, North Strathfield and construction of two three-lane tunnels (east-bound and west-bound) between Powells Creek and Parramatta Road, Haberfield/ Ashfield with links to City West Link (Wattle Street) at Haberfield. Interchanges at Concord Road, North Strathfield, Wattle Street at Haberfield and Parramatta Road at Ashfield would facilitate entry and exit to the tunnels.

Design development is ongoing and is aimed at optimising the function and cost of the M4 East project and also preventing or mitigating potential environmental impacts. Ongoing design options include:

- Optimising the alignment of the tunnel to avoid specific geotechnical constraints such as palaeovalleys and to provide appropriate grades for heavy vehicles.
- Optimising the reconfiguration of the Concord Road, Parramatta Road and City West Link (Wattle Street) interchanges to minimise impacts on property and nearby heritage conservation areas.
- Selecting appropriate sites for tunnel portals and ventilation stacks based on achieving optimal dispersion of emissions and minimising air quality impacts.

3 Project description

RMS is proposing to upgrade and extend the M4 Motorway from Homebush Bay Drive, Homebush, to Parramatta Road and City West Link (Wattle Street), Haberfield. Key features of the M4 East project are shown in Figure 1-2. Construction staging has yet to be developed for the M4 East project but will be outlined in detail during further assessment.

3.1 Surface road works

The M4 East project would require widening of the M4 Motorway carriageway and provision of infrastructure and services to support the future implementation of the managed motorway scheme. Generally surface works would include:

- Extension of the widening of the existing carriageway to three lanes each for the east-bound and west-bound carriageways from east of Homebush Bay Drive to the western tunnel portals.
- Construction of new ramps or realignment of existing ramps to maintain access between the M4 Motorway, the surface road network and the new tunnel.
- Installation of managed motorway and tolling Intelligent Transport Systems (ITS) infrastructure for the Concord Road east-bound off-ramp and west-bound on-ramp.

3.2 Tunnel construction

Tunnels would be constructed underground in the vicinity of the northern side of the existing M4 Motorway continuing east under Parramatta Road. Portals for the tunnels would commence just west of the Powells Creek crossing. Generally, tunnel construction would include the following key features:

- Construction of two three-lane tunnels between Powells Creek to Parramatta Road/ City West Link, Haberfield including tunnel portals west of Powells Creek. The tunnels would comprise about a total length of five kilometres, in each direction.
- Installation of tunnel ventilation systems including ventilation stacks and possible air intake located along the alignment of the tunnel.
- Upgrading of the Concord Road interchange and realignment of surface roads at City West Link and Parramatta Road (at Wattle Street) to facilitate the connection of the proposed tunnel to the surface road network.
- Cycling and pedestrian provisions along the surface M4 Motorway/ Parramatta Road corridor would be maintained or upgraded if required.

3.3 Interchange upgrades

The M4 East Homebush Bay Drive to Parramatta Road and City West Link project would require the upgrade of major interchanges and realignment of major roads to connect the tunnel to the surface road network. All current connections to arterial roads along the M4 Motorway would be maintained. Upgrades to interchanges would include:

- Upgrade of the existing grade-separated interchange at Concord Road.
- Connection between the M4 Motorway, Parramatta Road and Concord Road would be retained.
- New east-bound entry and west-bound exit ramps connecting the new tunnels to Concord Road.
- New west-bound exit to Parramatta Road via the existing M4 Motorway at Concord Road.
- New east-bound exit and west-bound entry ramps connecting the new tunnels to City West Link (Wattle Street), north of Ramsay Street.
- New east-bound exit and west-bound entry ramps connecting the new tunnels to Parramatta Road, east of Wattle Street.
- Installation of managed motorways and tolling ITS infrastructure.

3.4 Associated works

The M4 East project may also require associated works located outside the project corridor, including road widening, traffic signalling and line marking. The associated works would aim to alleviate environmental impacts as a result of changed traffic, noise and vibration and air quality conditions following the construction of the M4 East Homebush Bay Drive to Parramatta Road and City West Link project. The associated works would be considered in the environmental assessment with final locations determined during design.

The M4 East project would not include surveys, test drilling, test excavations, geotechnical investigations, utility adjustments or other tests, surveys, sampling or investigation for the purposes of the design or assessment of the project.

Work associated with the WestConnex scheme may involve reconfiguration and optimisation of Parramatta Road between Concord Road and Wattle Street including potential provision for dedicated bus lane, parking provisions, pedestrian/cyclist facilities and/or turning bays. Optimisation of Parramatta Road including traffic signalling, line marking and pavement works would be carried out as a separate project and would be the subject of separate environmental assessment and design development.

3.5 Ancillary facilities

The M4 East project would require ancillary facilities to be developed during construction including but not limited to construction compounds, sedimentation basins, batch plants, and stockpile sites. It is anticipated that there would be a number of construction compound sites, including one likely to be located in the vicinity of Concord Oval, Concord. The final locations of the construction compounds and other ancillary facilities would be assessed during the EIS and determined during detailed design based on project need and specific environmental criteria.

4 Key environmental issues

4.1 Overview

Key environmental issues are those that may have high or moderate impacts (actual or perceived) and assessment is necessary to determine the level of potential impact and to develop appropriate measures to mitigate and manage the impacts.

The preliminary environmental assessment carried out for the M4 East project indicates the following key environmental issues would require detailed assessment and are likely to require project specific impact management and safeguard measures:

- Traffic and transport.
- Noise and vibration.
- Air quality.
- Urban revitalisation, land use and property.
- Socio-economic impacts.
- Urban design and visual impact.
- Non-Aboriginal heritage.
- Energy efficiency.
- Resource use and waste management.

Each of the issues deals with both construction and operation impacts. Additionally, due to the scale of the M4 East Homebush Bay Drive to Parramatta Road and City West Link project, construction activities have the potential to cause a number of construction related impacts for the community including amenity issues such as noise and vibration, dust, visual impact, traffic impacts and construction fatigue due to ongoing works. These issues have been dealt with under the respective issue section.

Other environmental issues have also been identified. These issues are outlined in Chapter 5 and are considered to be of lesser consequence taking into consideration the project scope, the existing environment and the implementation of standard management and safeguard measures. It is expected that these other environmental issues would not likely be key issues; however the potential impacts would be assessed during preparation of the environmental impact statement.

Preliminary consideration has been given to the provisions of the *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act). A search of the EPBC Act Online Protected Matters Search Tool has been conducted and at this stage it is considered unlikely that the M4 East project would have a significant impact on Matters of National Environmental Significance. The search has identified the presence of two Commonwealth Land parcels within a 500 metre wide study area (ie 250 metres either side of the project corridor). The location or nature of these parcels has not yet been identified and further studies such as title searches, would be required during preparation of the environmental assessment.

4.2 Traffic and transport

4.2.1 Overview

The M4 Motorway currently connects the Blue Mountains in the west, with Parramatta Road near Concord Road, in the east. From Concord Road at Strathfield, motorists can access Sydney's CBD, inner west and eastern suburbs via Parramatta Road.

The M4 Motorway carries about an average of 100,000 vehicles per day at the Concord Road interchange, of which 10 per cent are heavy vehicles. Currently, substantial traffic delays are experienced during the AM peak period.

Between Concord Road and City West Link (Wattle Street), Parramatta Road extends for 3.5 kilometres.

There are 14 signalised intersections along this section, from west to east being:

- M4 Motorway off-ramp.
- Mosely Street.
- Wentworth Road.
- Broughton Street.
- Burwood Road.
- Shaftesbury Road.
- Luke Avenue.
- Walker Street / Cheltenham Road.
- Harris Road.
- Arlington Street / Croydon Road.
- Great North Road.
- Frederick/ Wattle streets.
- Bland Street
- Ramsay Street (on Wattle Street)

The M4 Motorway and Parramatta Road cater for private vehicles and freight vehicles, commuter trips, and other commercial traffic. Private vehicles are the main form of transport for residents from the surrounding LGAs, with about 50 per cent of residents travelling to work by private vehicle, as either driver or passenger (ABS, 2011).

On the M4 Motorway, two lanes are provided in each direction between Homebush Bay Drive and Concord Road. At Concord Road the motorway widens to three lanes to the intersection with Parramatta Road, Concord.

On Parramatta Road, three lanes are provided in both directions and the posted speed limit is 60 kilometres per hour (km/h). A clearway is in operation in both directions between 6:00am and 10:00am and between 3:00pm and 7:00pm. Parramatta Road near Franklyn Street at Concord carries on average about 101,000 vehicles per day based on RMS permanent count data from 2012.

Five bus routes operate along Parramatta Road, between Concord Road and City West Link (Wattle Street) including:

- 415 – Chiswick to Campsie.
- 461 – Burwood to The Domain.
- N70 – Penrith to Town Hall (NightRide service).
- N71 – Richmond to Town Hall (NightRide service).
- N80 – Hornsby to Town Hall (NightRide service).

A number of north south bus routes traverse the M4 Motorway and Parramatta Road including:

- 459 – Strathfield to Macquarie Uni
- 462 – Ashfield to Mortlake
- 463 – Burwood to Bayview Park
- 464 – Mortlake to Ashfield
- 466 – Cabarita to Ashfield
- 490 – Drummoyne to Hurstville
- 491 – Five Dock to Hurstville
- 492 – Drummoyne to Rockdale
- M41 – Metrobus Hurstville to Macquarie Centre

Cyclists are permitted to utilise the shoulders of the M4 Motorway, but pedestrians are not permitted access to use the carriageway. Pedestrian facilities are provided along Parramatta Road. In addition, an on-road bicycle path is located between Concord Road and Great North Road, Haberfield.

4.2.2 Summary of issues

Currently traffic volumes on the M4 Motorway and Parramatta Road both within and outside peak periods are causing congestion which has led to inefficiencies in transport through this corridor. East of Concord Road, Parramatta Road serves both longer distance through trips and local trips. Construction of the M4 East project would ensure greater efficiencies and reliability leading to better transport choices for private motorists, as well as freight and commercial vehicles using the corridor and the wider Sydney area.

The M4 East project forms one part of the WestConnex scheme and traffic impacts due to staging of the project will need to be assessed.

Construction of the M4 East project has the potential for the following key traffic and transport related impacts:

- Potential safety risks for road users, including buses, pedestrians and cyclists, during construction due to temporary road arrangements or the close proximity of construction activities to normal traffic.
- Temporary disruptions and delays to traffic and public transport services due to the narrowing of lanes, speed restrictions and temporary road closures.

- Construction staging which would impact different traffic, and access roads, varying with construction material and spoil routes, and impacting different communities.
- The potential for a temporary shift of traffic from Parramatta Road to alternative routes, such as Victoria Road, Liverpool Road and the Patterson/Gipps/Queens street parallel route, particularly during peak periods as motorists try to avoid road works. Currently, these road corridors are congested during peak periods, with minimal spare capacity available.
- Temporary impacts on pedestrian and cyclist access on adjacent roads where modifications to accommodate tunnel access are required.
- Delays to buses along and across Parramatta Road.
- The potential for temporary impacts on sections of the cycleway located near Concord Road.
- Increased truck movements to remove spoil from the tunnel.
- Parking impacts of workers during construction.

Operation of the M4 East project has the potential for the following traffic and transport related impacts:

- Changes to traffic using the M4 Motorway and Parramatta Road, including an increase in the overall corridor capacity which would generate improved reliability in travel time for longer distance motorists using the new tunnel and local motorists using the relieved surface network.
- Impacts on intersecting and parallel road network, including:
    - Increased demand during peak periods at the Concord Road, Parramatta Road and Wattle Street connections.
    - A change in traffic flows on the M4 Motorway and Parramatta Road. Where traffic is reduced, this would create an opportunity to enhance public amenity on Parramatta Road.
    - Congestion on Wattle Street, Dobroyd Parade and the City West Link due to peak capacity constraints.
- Cumulative traffic and transport impacts as a result of the staging and development of WestConnex. Cumulative impacts include construction and operation interactions with other transport related projects as well as other WestConnex stages. Cumulative impacts are discussed in detail in Section 5.10 Cumulative Impacts.

4.2.3 Proposed further assessments

A traffic and transport impact assessment would be undertaken as part of the EIS. This assessment would identify potential impacts and nominate mitigation measures to avoid or manage these impacts. It would include:

- 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, including:
    - An assessment of traffic impacts on the surrounding network over the staged construction period.
    - Recommendations for appropriate traffic and transport management and mitigation measures.
- An assessment of traffic impacts including an assessment of forecast volumes and potential changes to traffic patterns associated with the project including:
    - Forecast traffic volumes for the M4 Motorway / tunnels and the local road network, based on detailed traffic modelling for the project and the local and regional road networks.
    - Traffic congestion and movements on the surrounding road network.
    - Travel time analysis.
    - Tolling sensitivity.
    - An assessment of the performance of key interchanges and intersections.
    - An assessment of the impact on key connecting roads such as Parramatta Road, Concord Road, Wattle Street, Frederick Street, Dobroyd Parade and City West Link.
    - 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.
    - Consideration of opportunities to improve public transport.
    - Road safety analysis.

4.3 Noise and vibration

4.3.1 Overview

The M4 Motorway and Parramatta Road pass through areas of residential and non-residential land uses. The M4 Motorway and Parramatta Road carry a large percentage of heavy vehicles that access adjacent commercial districts and on a regional basis Port Botany, Sydney Airport and Parramatta. Land uses surrounding the M4 Motorway and Parramatta Road currently experience high noise levels associated with the existing vehicular traffic.

During construction, the project is likely to result in localised construction noise and vibration impacts particularly at ancillary sites, including tunnel portals and ancillary facilities. During operation of the project, vehicle noise is likely to impact sensitive receivers adjacent to the existing road network as well as proposed tunnel portal locations at Powells Creek, Concord Road, Parramatta Road and City West Link.

Conversely, the noise environment on Parramatta Road between Concord Road and City West Link is expected to improve due to the anticipated shift in traffic, particularly heavy vehicles that would use the tunnels.

Sensitive receivers identified within a 600 metre study area (ie 300 metres either side of the project corridor) consist of:

- Residential properties.
- Educational facilities.
- Aged care facilities and health clinics.
- Industrial and commercial premises.
- Mixed use residential/commercial properties.
- Sporting, recreation and open space areas.

Heritage structures of local and state significance that may be impacted by vibration are also located along Parramatta Road.

4.3.2 Summary of issues

Construction of the project has the potential for the following noise and vibration related impacts:

- Areas of construction activity along the project may affect residential and non-residential sensitive receivers to varying degrees. The level of impact from construction works experienced by receivers would depend on the proximity to the works, the types of activities, the duration of activities, the existing noise level and the time of day the work is being carried out.
- Increased noise levels during out-of-standard construction hours may affect residential and non-residential sensitive receivers. Construction activities typically occur during daytime hours however, due to a need to maintain network capacity and safety considerations, work may need to be undertaken outside normal working hours due to construction methods. Tunnelling activities are also expected to be undertaken on a 24 hour basis and need to consider impacts associated with day, evening and night time project criteria.
- Increases in road traffic noise levels for receiver locations are expected around the areas of major construction such as the tie-in works, intersection upgrade locations at Concord Road, Parramatta Road and Wattle Street, and tunnel portal locations, which would provide a new source of traffic noise for sensitive receivers.
- Potential vibration impacts need to be assessed for nearby buildings and other structures during tunnel works due to small offset distances between the works and sensitive receiver locations. Heritage structures may be particularly vulnerable.

Operation of the project has the potential for the following noise and vibration related impacts:

- Operational noise impacts will be considered at the tunnel portals and surface road connections at Powells Creek, Concord Road, Parramatta Road and City West Link (Wattle Street). Whilst these areas are already impacted by road traffic noise from the M4 Motorway and Parramatta Road, additional traffic movements may further increase noise levels at the tunnel portal locations.

4.3.3 Proposed further assessment

A detailed noise and vibration impact assessment identifying all sensitive receivers within the study area would be required. The assessment of noise and vibration impacts from both construction and operation of the alignment would report the following information as a minimum:

- Identification of all residential and non-residential sensitive receivers within the study area.
- Identification of existing background noise levels at representative locations within the corridor using attended and unattended noise monitoring equipment.
- A traffic count survey taken at the time of the noise monitoring survey to correlate measured noise levels with vehicle numbers.
- Identification of project specific noise and vibration criteria for sensitive receivers within the assessment corridor.
- Predicted levels of traffic noise at all receiver locations at year of opening and 10 years after opening for the "build" and "no build" scenarios.
- Predicted levels of construction noise and vibration at all receiver locations.
- Analysis of options and recommendations for reasonable traffic noise mitigation and construction noise and vibration mitigation where exceedances of the project noise and vibration goals are predicted.
- Identification of out of hours work required during construction works and future works.

The assessment of noise and vibration impacts for construction and operational scenarios would be undertaken in accordance with the following guidelines as relevant:

Construction

- Department of Environment and Climate Change (DECC) 2006, *Assessing Vibration – a technical guideline*.
- *Department of Environment and Climate Change (DECC), 2009, Interim Construction Noise Guidelines.*
- Standards Australia, 1997, Australian Standard AS2670.2 '*Evaluation of human exposure to whole-body vibration'.*
- Standards Australia, 2006, Australian Standard AS2187.2-2006 '*Explosives – storage, transport and use'.*
- British Standards Institution, 1993, BS7385: *Part 2 Evaluation and measurement of vibration in buildings*, 0 580 22188 1.
- British Standards Institution, 1992, BS 6472: - 1992 Evaluation of Human Exposure to Vibration in Buildings.
- British Standards Institution, 2009, BS5228:2009 *Part 2 Code of Practice for noise and vibration control on construction and open sites-Vibration*.
- Deutsches Institut für Normung, 1999, DIN 4150: Part 3 – 1999 *Effects of Vibration on Structures.*

- Australian and New Zealand Environment Council 1990, *Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration.*

Operation

- Department of Environment, Climate Change and Water (DECCW) 2011, *NSW Road Noise Policy*.
- Roads and Maritime Services, 2011, *Interim approaches to apply the Road Noise Policy.*
- Roads and Maritime Services, 2001, *Environmental Noise Management Manual*, Sydney.

4.4 Air quality

4.4.1 Overview

The NSW Environment Protection Authority (EPA) has set air quality criteria for a range of air pollutants that are known to cause health and/or environmental effects; most of the criteria refer to National Environment Protection Council standards for air quality. The air pollutants most relevant to the project, and specifically with respect to motor vehicles, are carbon monoxide (CO), nitrogen dioxide (NO_2), and particulate matter (fine particles with equivalent aerodynamic diameters of 10 microns or less, that is, PM_{10}). Whilst there are currently no EPA air quality criteria for $PM_{2.5}$, the national standards (NEPM) were amended in 2003 to include advisory reporting standards.

In addition, the EPA also specifies air quality criteria for many other substances including air toxics such as benzene, toluene, xylenes, formaldehyde and polycyclic aromatic hydrocarbons.

To measure compliance with air quality criteria, the Office of Environment and Heritage (OEH) has established a network of monitoring stations across the state and up-to-date records are published on the OEH website.

The closest OEH air quality monitoring stations to the project are at Chullora and Rozelle. A review of data collected from these stations in 2012 showed that there were no exceedances of CO or NO_2. In 2012 there was one day when the PM_{10} criteria were exceeded (23 August 2012 at Chullora). The majority of OEH monitoring stations record few exceedances of the PM_{10} criteria each year. These exceedances are typically driven by extreme events, such as dust storms, bushfires and hazard reduction.

In general air quality in the Sydney region has improved since the 1980s largely due to initiatives to reduce air pollution from industry, motor vehicles, business and homes. The State of the Environment Report (EPA, 2012) notes that concentrations of four of the six main indicators of air quality (carbon monoxide, nitrogen dioxide, sulfur dioxide and lead) have complied with national air quality standards in recent years. However, national standards of ozone and particulate matter (PM_{10}) continue to be exceeded in some regions of the state, including Sydney.

Notwithstanding there are many locations in the vicinity of the project that are expected to be sensitive to changes in air quality. Such locations would include residences, health care/hospitals and schools.

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 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.

Local air quality – ventilation stacks

The project would require ventilation stacks for the tunnel. Ventilation stacks 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.

Air discharged from tunnel ventilation stacks would be subject to detailed investigations as part of an air quality assessment. The assessment would be based on the location and design characteristics of the stacks, 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 receiver locations.

With good design, ventilation stacks can achieve compliance with local air quality outcome criteria. Ventilation stacks located close to the tunnel portals would be the most cost effective and energy efficient location given the reduced requirement for pushing air in the opposite direction to traffic flow.

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 stacks. There are some circumstances when portal emissions are permitted, such as emergency situations, accidents and breakdowns, and during major maintenance periods.

Notwithstanding, it is recognised that desired air quality outcomes can still be achieved with portal emissions and 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.

The potential air quality impacts of portal emissions would be quantified in the project assessment phase using computer-based air dispersion modelling.

Treatment of emissions

The effectiveness of the treatment of tunnel emissions has been evaluated as part of the environmental assessment phase of a number of existing Sydney road tunnels, including the M5 East, 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 independent review of the operational performance of the M5 East Tunnel Air Filtration Project was carried out in February 2012 (AMOG Consulting 2012). With relevance to the M4 East project, this review recommends measures in the 2012 M5 East Air Quality Improvement Program (formerly the Air Quality Improvement Plan, 2006) should be considered for the M5 East tunnel and future tunnel designs.

It has also been established that it is more beneficial to focus on cleaner vehicles, which will result in greater benefits to air quality, both in-tunnel and in the ambient air, at the local and regional scales. One example of the effectiveness of targeting the source is the enhanced enforcement of smoky vehicles under the M5 East Air Quality Improvement Program, with early indications suggesting a 20 per cent improvement in tunnel haze and visibility.

In-tunnel air quality

Generally, in-tunnel air quality is managed on the basis of a CO limit, used as an alternative for all traffic related pollutants. In NSW, a 15-minute average CO in-tunnel limit is used which, since the 1990s has been based on the World Health Organization (WHO) limit of 87 parts per million (ppm). CO guidelines are well established worldwide however, there is increasing attention on the effects of NO_2 and the adoption of various guideline values. Some countries use threshold values for NO_x and/or NO_2 for in-tunnel air quality, mainly to ensure that air quality criteria outside the tunnel(s) are also met.

Appropriate in-tunnel air quality criteria will be developed in consultation with NSW Environmental Protection Authority (EPA), NSW Health, and Department of Planning and Infrastructure (DP&I) based on a review of current international practice and experience from NSW motorway tunnels.

To further address air quality, the NSW Government has appointed an expert Air Quality Advisory Committee to review current international best practice and experience from Australian motorway tunnels. The committee will:

- Review and set performance standards for road tunnel emissions.
- Recommend appropriate monitoring, compliance and reporting mechanisms to support public confidence in the operation of road tunnels.
- Provide ongoing advice to the NSW Government on air quality issues.

4.4.2 Summary of issues

The project has the potential to improve local air quality on Parramatta Road between Powells Creek, North Strathfield and City West Link, Haberfield. A shift in traffic from Parramatta Road to the tunnels, particularly of heavy vehicles would improve local air quality by reducing pollutants from vehicle emissions.

Construction of the project has the potential for the following air quality related impacts:

- Temporary increases in dust (particulate matter) during clearing earthworks and construction activities. The nature of any increase in dust (and impacts) would depend on the scale of activities, quantities of material handled and proximity of activities to sensitive receivers.
- Temporary increases in air quality impacts from emissions, such as exhaust fumes, generated by the operation of machinery and other construction vehicles as well as temporary ventilation systems during construction of the tunnel. The impact of these emissions would be limited to the construction phase.

Operation of the project has the potential for the following air quality related impacts:

- Potential increases in near roadside air pollutant concentrations due to changes in traffic volumes. The nature of any changes in concentrations would depend on the projected traffic volumes, mode of travel, road grade and mix of vehicles.
- Potential increases in air pollutant concentrations around tunnel portals.
- Potential increases in exposure to air pollutants for motorists using long tunnels.

4.4.3 Proposed further assessments

A detailed air quality assessment would be prepared to provide (as a minimum):

- Identification of potentially affected 'air quality' sensitive receivers.
- An assessment of air quality impacts from proposed construction activities.
- An assessment of air quality impacts during the operational phase, covering existing and future operational scenarios.
- Emission management and safeguard measures during construction and operation.

The assessment would utilise dispersion models to predict air quality impacts. Modelling would be undertaken in accordance with the procedures outlined by the EPA in the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC 2005).

4.5 Urban revitalisation, land use and property

4.5.1 Overview

The area immediately adjacent to the project includes the suburbs of Homebush, Sydney Olympic Park, North Strathfield, Strathfield, Burwood, Concord, Canada Bay, Ashfield, Five Dock and Haberfield.

The surface road works section of the project (M4 Motorway between Homebush Bay Drive and Powells Creek) is largely contained within the existing road corridor. Land uses immediately adjacent to the surface section comprise a mix of industrial, commercial, and retail development. Further east from Powells Creek, areas adjacent to the M4 and Parramatta Road comprise a mix of land uses including medium to high density residential development, commercial development including car yards and other retail, and light industrial uses.

Land uses adjacent to the project are generally characterised by suburb, as follows:

- Homebush and Flemington
    - Large-scale homeware stores, such as DFO Homebush.
    - Business parks such as Lidcombe Business Park.
    - Flemington Markets.
    - Medium to high density residential development.
    - Motor vehicle sales yards and associated automotive industries.
- Burwood
    - Major centre identified under the Metro strategy.
    - Large commercial and retail development within town centre.
    - Large parks and recreation areas.
    - Low, medium and high density residential development with higher density around Burwood town centre.
- Strathfield, North Strathfield, Ashfield and Five Dock
    - Low, medium and high density residential development with low density generally located away from Parramatta Road.
    - Local commercial and retail development in centres as well as along Parramatta Road.
    - Motor vehicle sales yards and associated automotive industries.
    - Local parks.
- Concord, Canada Bay, Ashfield, Five Dock and Haberfield
    - Low and medium density residential development.
    - Commercial and retail development within the Concord town centre as well as along Parramatta Road and Concord Road.
    - Motor vehicle sales yards and associated automotive industries.
    - Community services and local parks (including Concord Oval).

The *Draft Metropolitan Strategy for Sydney to 2031* (Draft Metropolitan Strategy) establishes the strategic planning framework for Sydney to 2031. The Draft Metropolitan Strategy supports the targets and actions identified within NSW 2021, the

NSW Long Term Transport Master Plan and the State Infrastructure Strategy by providing integrated land use and infrastructure outcomes within NSW.

The Draft Metropolitan Strategy identifies WestConnex as a catalyst for major urban revitalisation and regeneration along the Parramatta Road Corridor, serving adjacent local centres as well as Parramatta and the Western Sydney Employment Area. Of relevance to land use and property, priorities for the Parramatta Road Corridor include:

- A focus on Sydney Olympic Park as a Specialised Precinct with capacity for major employment, recreation and housing growth. One of the priorities for the Parramatta Road Corridor is to facilitate delivery of Urban Activation Precincts at Carter Street and Wentworth Point as part of the wider regeneration of Sydney Olympic Park as well as development of a major centre at Burwood (SOPA 2011). This approach is consistent with the *Sydney Olympic Park Masterplan 2030* (SOPA 2010).
- Facilitating the delivery of Urban Activation Precincts around existing and planned public transport and infrastructure with the aim of transforming highly accessible suburbs to improve housing choices and local prosperity.
- Planning for well-designed housing along the Parramatta Road Corridor, including smaller dwellings and apartments to encourage higher population density, which will stimulate business and retail investment.
- Creating high quality places and spaces at key points along and adjacent to Parramatta Road.

4.5.2 Summary of issues

The tunnel component of the project would facilitate opportunity for urban revitalisation and regeneration along and adjacent to Parramatta Road, consistent with the priorities identified for the Parramatta Road Corridor in the Draft Metropolitan Strategy. It is anticipated that reduced traffic volumes, particularly of freight vehicles and the corresponding improved noise, visual and traffic amenity would stimulate changes in land use along Parramatta Road. Reduced traffic volumes and the composition of that traffic, along Parramatta Road, also have implications for north-south movements across the road. In particular, it is anticipated by the Draft Metropolitan Strategy that different housing types, business and retail investment would be developed along Parramatta Road following the construction of the tunnel.

Construction of the project has the potential for the following land use and property related impacts:

- Property acquisitions would be required, including partial or full acquisition of commercial and industrial properties, residential properties and areas of open space. In particular, property acquisition would be required at the proposed Concord Road and Wattle Street interchanges. The eastern side of the Concord Road interchange would have potentially substantial property impacts due to the construction of ramps to access the tunnel portal.
- Property may be temporarily required for the stockpile of spoil and construction compounds. Location of the construction compounds would be determined at the detailed design phase of the project.
- Changes to property access to private and commercial/retail properties.

- Sections of roads surrounding the project area may need to be closed temporarily or permanently to motorists during construction, particularly those accessing residential property.
- Temporary changes to local access arrangements, particularly to Concord Oval which may be used as a construction compound.
- Public transport (bus) networks may be temporarily disrupted and services re-routed to accommodate construction needs.

Operation of the project has the potential for the following land use and property related impacts:

- Urban revitalisation opportunities along the Parramatta Road Corridor in the future.
- There would be changes to existing land uses adjacent to the M4 Motorway and Parramatta Road, resulting from full or partial acquisition of some properties for the road corridor and changed access arrangements. This could impact on the following land uses:
    - Residences in surrounding suburbs.
    - Businesses, including industrial and commercial, particularly along Parramatta Road.
    - Open space and recreational areas.
    - Flemington Markets.
    - The southern end of Sydney Olympic Park.
- Property access within residential suburbs immediately surrounding the M4 Motorway, as well as properties along Parramatta Road may change.
- Existing access arrangements to surrounding residential suburbs, commercial precincts and onto the motorway may be altered.
- Existing bus stop locations along Parramatta Road may be altered.
- Public transport provision across Parramatta Road (north-south services) may be improved.

4.5.3 Proposed further assessment

A detailed land use and property assessment would be prepared. This would include:

- Identification of local land uses, existing access arrangements and potential property acquisition for both public and private land adjacent to the project.
- Assessment of the potential impacts of the project on the property, land use and access arrangements during construction and operation of the project.
- Identification of appropriate management and safeguards to minimise these impacts.

It is noted that planning for the urban revitalisation opportunities would not form part of the environmental assessment of the project as this would be carried out concurrently under a separate process. This work is being led by UrbanGrowth NSW and involves input from other government agencies, local councils and communities. However it will be important to ensure that the assessment, approval processes, and urban revitalisation initiatives inform each other.

4.6 Socio-economic

4.6.1 Overview

The project is located within the local government areas (LGAs) of Strathfield, Canada Bay, Burwood and Ashfield.

In 2011, the Strathfield, Canada Bay, Burwood and Ashfield LGAs had a combined population of 184,588 people (ABS 2011). Compared to NSW as a whole, the LGAs generally comprise a younger population, with a median age of about 36 years. The main occupations include professionals, clerical and administrative workers, and technicians and trades workers. About 61 per cent of the population is employed in full time work.

The LGAs are ethnically diverse with large proportions of Chinese, Indian and Korean born populations in the western section of the corridor and European born populations in the eastern section of the corridor.

The M4 Motorway and Parramatta Road are important connections between Sydney's Central Business District (CBD), Sydney Olympic Park and the growth area of Western Sydney, which is Australia's fastest growing regional economy (Department of Premier and Cabinet 2013). The Draft Metropolitan Strategy (DPI 2013) identifies Sydney Olympic Park as a major future location for employment, high density housing, and sports and entertainment uses.

The existing Homebush Bay Drive, Concord Road and Wattle Street interchanges provide important access to other commercial and industrial areas. In particular:

- Homebush Bay Drive provides access to commercial and retail precincts at Sydney Olympic Park to the north, and Campus Homebush Business Park and Lidcombe Business Park to the south.
- Concord Road provides access to the Strathfield town centre to the south and North Strathfield to the north.
- Wattle Street provides access to the City West Link to the north, which provides efficient access to the Sydney CBD. Frederick Street provides access to Croydon and Ashfield town centres to the south and west.

Homebush, Strathfield and North Strathfield town centres are located adjacent to the existing motorway and generally provide services and retail shopping for local residents. North Strathfield town centre has recently been revitalised with improved streetscapes, featuring the heritage listed Arnott's Biscuit Factory and is a popular destination for local residents. Burwood, Croydon and Ashfield town centres are located adjacent to Parramatta Road. Burwood in particular as a major centre, provides a large shopping centre and a wide variety of shops and services located on the main street for use by local residents and those in surrounding areas.

Town centres located further away from the project corridor provide services and retail shopping to a wider catchment, including communities at Parramatta, Granville, Auburn and Lidcombe to the west and Croydon, Five Dock, Haberfield and Ashfield to the east.

The motorway also provides access to a range of regional tourist and recreational facilities located within or adjacent to the project. These include:

- 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. Sydney Olympic Park also provides various conference facilities.
- Flemington Markets.
- Five Dock Leisure Centre.
- Local parks, including:
    - Wentworth Reserve, Homebush
    - Bill Boyce Reserve, Homebush
    - Goddard Park, Concord
    - Concord Oval, Concord
    - Cintra Park, Concord
    - Burwood Park, Burwood
    - Wangal Park, Croydon
    - Blair Park, Croydon
    - Charles Heath Reserve, Five Dock
    - Hammond Park, Ashfield
    - Jegorow Reserve, Haberfield
    - Reg Coady Reserve, Haberfield
    - Ashfield Park, Ashfield.

The M4 Motorway and Parramatta Road form part of a primary freight route connecting to Port Botany and Sydney Kingsford Smith Airport. Intermodal terminals are located at Cooks River and Clyde, as well as a proposed intermodal at Enfield.

Community facilities, including churches and community halls, are located in suburbs adjacent to the M4 Motorway and Parramatta Road. In particular, community facilities and childcare facilities are located within the North Strathfield, Burwood, Homebush, Strathfield, Burwood, Croydon and Ashfield town centres. Lucas Special School, Rosebank College and Haberfield Public School are located to the north of Parramatta Road. Concord Repatriation General Hospital is located to the north of the project, and is accessed from Concord Road. A number of smaller hospitals such as Canada Bay Private Hospital and Strathfield Private Hospital are also located along Parramatta Road. Emergency services, including Canada Bay State Emergency Service (SES) and Burwood SES are located at the eastern end of the project.

Bus services currently operate on Parramatta Road and train stations are located near to the project at Flemington, Homebush, Strathfield, Burwood, Croydon, Ashfield, Olympic Park, Concord West and North Strathfield. Sydney Buses depots are located on Parramatta Road (corner of Shaftesbury Road) at Burwood and on Balmain Road in Leichardt. A bicycle path is located between Concord Road and Great North Road, Haberfield. The bicycle path runs adjacent to Concord Road, Patterson Street, Gipps Street and Queens Road and includes sections of dedicated and shared bicycle path. About 35 kilometres of dedicated public cycle paths is provided at Sydney Olympic Park.

The existing amenity of suburbs adjacent to the M4 Motorway and Parramatta Road is characterised by transport infrastructure and an industrial/ urbanised landscape. As such, the amenity of nearby suburbs, particularly those located adjacent to Parramatta Road is currently affected by high levels of traffic noise.

4.6.2 Summary of issues

The project would provide a range of socio-economic benefits for local and regional communities. It would provide improved access, connectivity and reliability for local and regional business, freight vehicles and communities, including to the Sydney CBD, the growth area of Western Sydney, and major community facilities in the region such as the Sydney Olympic Park.

The project would also reduce traffic congestion on Parramatta Road and provide increased capacity to support increased travel demand, due to population growth in western Sydney and increased freight movements between Sydney Airport, Port Botany and Parramatta. Locally, a decrease in traffic congestion would also support improved connections between the north and south of Parramatta Road.

The project would provide improved amenity along Parramatta Road, supporting the future development and investment, and revitalisation of Parramatta Road and adjacent local centres. In particular, the project would facilitate the revitalisation of existing commercial premises on Parramatta Road. This is a priority for the city shaper 'Parramatta Road Corridor' as defined in the Draft Metropolitan Strategy.

The design, construction and operation of the project would also have a number of socio-economic impacts for local and regional communities.

Design of the project has the potential to result in the following socio-economic related impacts:

- Impacts associated with property acquisition near interchanges and tunnel portals at Concord, Haberfield and Ashfield, including uncertainty for residents and business owners about the property acquisition process and possible impacts on future development, and potential need to relocate.

Construction of the project has the potential for the following socio-economic related benefits and impacts:

- Direct and indirect employment opportunities, and opportunities for businesses to supply goods, services and materials to the project's construction.
- Direct property impacts, including surface impacts for properties near the Concord Road and Parramatta Road/Wattle Street interchange locations, tunnel portals, ventilation stacks and intake locations, and at construction compound sites, as well as property impacts for properties above the tunnel alignment.
- Impacts on amenity for local residents, businesses and users of community facilities (including schools) located close to the construction compounds and proposed construction works, due to increased dust, noise and traffic from construction activities, including the haulage of spoil material and parking for construction workers.
- Temporary changes to access and potential for traffic delays and disruptions near to construction works, including for motorists, public transport users, pedestrians and cyclists, commercial and freight transport operators, and emergency services.

- Potential impacts on road safety for motorists, cyclists and pedestrians near to construction works and construction compounds, particularly at Concord Road and Wattle Street interchange upgrade locations.
- Temporary disruption to pedestrian and cycle access near construction works, including potential changes to the cycleway at Concord Road.
- Impact on local businesses, particularly those located directly adjacent to the M4 Motorway (between Homebush Bay Drive and Powells Creek), through changed access and potential property acquisition.
- Temporary disruption for formal and informal sport and recreation users at parks and reserves, including Concord Oval and Reg Coady Reserve. Additionally there would be potential loss of a strip off the front of Ashfield Park to allow for the portals on Parramatta Road. Other community services and facilities located close to the project may also be temporarily impacted during construction.

Operation of the project has the potential for the following socio-economic related benefits and impacts:

- Improved access and connectivity for local and regional transport users, including to major regional community facilities and key economic growth and employment areas within the greater Sydney region.
- Changes to traffic flows with increased possibility for movement of traffic onto adjacent local streets to access upgraded interchanges at Concord Road and Wattle Street.
- Increased severance, either actual or perceived, of communities located north and south of the M4 Motorway and Parramatta Road, particularly near the Concord Road and Wattle Street interchanges as well as between Homebush Bay Drive and Concord Road, due to the widening of the motorway. In particular the eastern side of the Concord Road interchange potentially has substantial property and severance impacts.
- Changes to local access and connectivity near to surface roads, including for motorists, pedestrians, cyclists and public transport users.
- Community perception about changes to air quality and potential health impacts for communities near to the tunnel ventilation stacks.
- Impacts on property due to the location of project infrastructure, such as surface connections and ventilation stacks.
- Opportunities to improve the amenity of local centres and retail areas and local neighbourhoods that are currently affected by high traffic volumes, due to reductions in surface traffic.
- Amenity impacts at properties nearest to the project, due to changes in traffic noise, visual impacts of surface infrastructure (between Homebush Bay Drive and Concord Road) and potential changes in air quality at tunnel portal locations or near ventilation stacks.

4.6.3 Proposed further assessments

A detailed socio-economic impact assessment would assess the potential impacts of the project, including positive and negative direct and indirect impacts. The assessment would consider local and regional communities, businesses and economies, and would use the RMS *Environmental Impact Assessment Practice Note – Socio-Economic Impact Assessment* (EIA-N05).

The assessment would involve:

- An analysis of the existing socio-economic values and conditions of communities near the project including:
    - Population and demography, family and household characteristics; travel behaviour; levels of advantage and disadvantage; and need for assistance.
    - Existing business and industry, employment and income.
    - Existing social infrastructure, including community services, facilities and networks located near the project.
    - Community values that may be affected by the project, such as those relating to local access and connectivity, character and amenity, liveability, community health and safety, natural and built environment, and the local economy.
- Assessment of the potential impacts (both positive and negative) of the project's design, construction and operation on the socio-economic values of the study area.
- Identification of appropriate management and safeguard measures, including measures to enhance the project's benefits or to avoid, manage or mitigate potential impacts.
- Consultation with local communities, local councils, government agencies, property and business owners and key stakeholders, which would include managers of community facilities. This would inform existing socio-economic conditions and values, impacts and management and safeguard measures.

4.7 Urban design and visual impact

4.7.1 Overview

The M4 Motorway and Parramatta Road traverse a varied urban environment, comprising several distinct landscape character zones and visual catchments, each defined by factors such as built form, cultural precincts and adjacent land use types.

Landscape character zones within the project area are based on similar characteristics and defined spatial qualities. The landscape character zones can be defined as follows:

Homebush Bay Drive, Homebush to Concord Road, North Strathfield.

This area comprises the M4 Motorway, which generally follows a gently undulating landform. The motorway is screened through a combination of topography, vegetation and visual screening, particularly to the adjacent residential development near the Concord Road interchange. Land uses adjacent to the motorway include residential, business parks and some open space.

Parramatta Road, between Concord Road, North Strathfield and City West Link (Wattle Street), Haberfield.

This area is characterised by road infrastructure and a diverse mix of adjacent land uses, comprising car yards, large retail and commercial as well as some medium-high residential development, most of which abuts Parramatta Road. The built form of Parramatta Road comprises a mixture of one to two storey buildings and large commercial and retail properties, high rise apartments, road lanes and narrow footpaths. Many properties along Parramatta Road comprise bright colours and large signage, which is highly visible to passing motorists, pedestrians and cyclists. Some mature trees are present, as well as open space such as Concord Oval which is highly visible from Parramatta Road. Overhead power lines are located across and along Parramatta Road. These land uses combined with the built form make for a highly urbanised and cluttered environment along Parramatta Road.

Concord Road and City West Link (Wattle Street) interchanges form an important part of the project. Currently, the landscape character of the Concord Road interchange is dominated by road infrastructure, mature trees, visual barriers, the Concord Road overpass, residential properties and a large motorcycle commercial property. The landscape character of the Wattle Street interchange is dominated by road infrastructure, some mature trees and large retail land uses, including a large hardware store and liquor store.

Visual catchments refer to areas which the project is visible from, currently and in the future. The study area is generally visible to motorists, pedestrians and cyclists who use the M4 Motorway and Parramatta Road, comprising long views over the top of the most adjacent streetscapes to the nearest adjacent ridgelines. Some views of the surrounding residential, open space and road network can be achieved from higher areas in Sydney Olympic Park as well as surrounding high rise buildings on Parramatta Road.

Opportunities for urban revitalisation have been identified by the Draft Metropolitan Strategy within and adjacent to the study area, namely Parramatta Road as well as Five Dock, Homebush Bay and Silverwater/Auburn.

4.7.2 Summary of issues

The project is likely to change the landscape character of the study area, particularly along Parramatta Road and at the Concord Road and Wattle Street interchanges. However as the study area is highly urbanised and comprises existing road infrastructure, sensitivity to change is likely to be low in most landscape character zones.

The tunnel component of the project would facilitate urban revitalisation and land use change on Parramatta Road. This would likely change the landscape character of Parramatta Road, but it is likely that this would occur over time. The experience of motorists within the tunnel may be impacted, as the tunnel would be part of a wider network of tunnels once the WestConnex scheme is complete.

Construction of the project has the potential for the following urban design and visual assessment related impacts, particularly to the adjoining visual catchments:

- Visual impacts associated with construction activities, sites/compounds including machinery, temporary structures and physical impacts on existing public open space and use of land.
- The visual amenity for road users would be impacted during construction.
- Removal of visual screens and vegetation planting along the M4 Motorway to facilitate construction may cause visual impacts to motorists and adjoining residents and businesses.

Operation of the project has the potential for the following urban design and visual assessment related impacts:

- Visual impact of new infrastructure on existing views from residences and surrounding development, including visibility of new motorway infrastructure, bridges, retaining walls, ramps, gantries, and signs.
- Landscape character and visual impact associated with the possible creation of residual land areas adjacent to the M4 Motorway.
- The existing vegetated embankments on steep slopes and visual screens are of important value within the visual catchment around the project area and would be retained wherever possible. It would be expected that some impact would occur in locations where the proposed widening extends into existing vegetated embankments.
- Impact on the existing landscape characteristics of existing open spaces adjacent to the motorway and views of important local landmarks and features.
- Impact on the motorist experience of the corridor due to changes to the existing landscape and visual characteristics of the corridor, the visual quality of new motorway infrastructure, structures and elements, and possible impact to views from the motorway to key local or regional landmarks or features.
- Impact to existing pedestrian and cycle pathways adjacent to, along and across the corridor.

4.7.3 Proposed further assessment

Key areas where urban design and landscape issues would need to be addressed include:

- The design of the proposed infrastructure including tunnel portals, ventilation stacks, retaining walls, ramps, gantries, signs, cuttings and embankments.
- Residential suburbs and local open space interfacing with the M4 Motorway and Parramatta Road to ensure new infrastructure is well designed and integrated within existing areas.
- Immediately adjoining stakeholders including the light industrial areas and commercial precincts forming enterprise corridors, particularly between Homebush Bay Drive and Concord Road, and at Wattle Street interchange.
- Noise or visual mitigation barriers or screens.
- Construction activities and storage of equipment would impact on the visual amenity looking towards the road infrastructure.
- The road user experience within the tunnel.

The following urban design tasks would be carried out:

- Undertake a contextual analysis to identify the community, natural and built values, landscape types and character zones, and opportunities and constraints.
- Refinement of urban design objectives for the project that would be incorporated into the design of the project to ensure the least possible impact on landscape character and visual amenity.
- Production of landscape character and visual impact assessment to improve the design outcome and report on landscape character and visual impacts and their management.
- Development of an urban design strategy to mitigate landscape character and visual impacts to be integrated with the overall design of the project, including structures and landscape design outcomes.
- Identification of opportunities for additional landscaping and high quality redevelopment of potential residual land areas adjacent to the project.
- Identification of appropriate management, mitigation and safeguard measures.

4.8 Non-Aboriginal heritage

4.8.1 Overview

The suburbs of Strathfield, Canada Bay, Burwood and Ashfield grew around the rough bush track which linked the Sydney Cove settlement with the farming settlement at Parramatta. The three metre wide track, later called Parramatta Road, was constructed between 1789 and 1791 using convict labour. By 1810 much of the land in Ashfield had been granted and by the 1820s most of the small land grants had been amalgamated into four large estates (Pratten *undated*). Early settlement in Strathfield was centred around the Cooks River area, however, in the 1820s grants between Parramatta Road and the newly constructed Liverpool Road were established. The area known as Liberty Plains, which included the modern suburbs of Homebush, Concord and Strathfield was farmed by free settlers, although the land proved to be unprofitable (Strathfield Heritage 2010).

In 1814, a stagecoach began running to Parramatta and many inns and staging posts were constructed along Parramatta Road in the 1820s, such as the Bath Arms, and Horse and Jockey hotels (Municipality of Burwood *undated*). Development in these suburbs intensified after the opening of the railway between Sydney and Parramatta in 1855, which made the suburbs easily accessible and attracted wealthy merchants and industrialists to build large villa estates in the area, such as Ashfield Park House (now demolished) and Gorton House in the 1860s (later Ashfield Infant's Home).

Brick-making was an important industry within Ashfield and adjoining suburbs, south of Parramatta Road from the mid-19th century.

Industry gradually diversified in the area, particularly the iconic Arnott's Biscuit Factory, which was in operation at Homebush from 1908 to 1997 and the Peek Freans Factory in Ashfield which opened in 1936. All these suburbs, however, have always been considered residential, rather than industrial areas (Pratten *undated*).

The later subdivision of these industrial properties and the large villa estates from the early 1900s resulted in small pockets of distinctive housing that reflected the most modern thinking in urban design. In 1901 Richard Stanton began the creation of a 'model suburb' in Haberfield, which was marketed as being 'slumless, laneless and publess' (Ashfield Council 2013).

By the 1930s the character of the suburb of Haberfield was well established, with no two houses being alike, although Queen Ann, Arts and Crafts, and Federation styles are common. Significant residential expansion took place in Strathfield, Burwood and Ashfield during the inter-war and post-war years, with many architectural styles represented.

4.8.2 Potential impacts

A preliminary non-Aboriginal heritage assessment has been undertaken for the project. The assessment included:

- A search of all relevant statutory and non-statutory heritage registers.
- Review of relevant heritage studies.
- Review of the heritage schedules of relevant LEPs along the project study area (250 metres either side of the proposed alignment).

The study area contains 135 non-Aboriginal heritage items. All non-Aboriginal heritage items identified within the study area are presented in Attachment B1.

Two nearby items are listed on the State Heritage Register (SHR) as being of State significance and 124 items are listed on Local Environmental Plans (LEP). Ten items have only S170 listings and two items listed on LEPs are also identified as having archaeological potential.

Listed as State significant on the SHR is the Homebush Railway Station Group, which is not within the study area but has been included as it is adjacent to the area.

Also listed as State significant is Yasmar, which is the only surviving relatively intact estate still fronting Parramatta Road As stated on the SHR, the site of Yasmar survives as a rare example of a suburban villa in its garden setting that remains in a relatively intact condition.

The gardens surrounding the villa also have heritage value together with other components such as the gates, gateposts and curving carriageway. The garden has historic, aesthetic, social and scientific significance for its purposeful layout in relation to the house and outbuildings, range of remnant vegetation and formal entrance gates on Parramatta Road.

Numerous items of local heritage significance have been identified within the study area. All local heritage items can be found in the Local Environmental Plans (LEP) of Burwood 2012, Strathfield 2012, Canada Bay LEP 2013, Ashfield LEP 1985 and Draft Ashfield LEP 2013. Most of these items are located above the proposed tunnel and some are located within the possible portal areas. Attachment B1 provides detail on all non-Aboriginal heritage items located within the study area.

Ten conservation areas are also located within the study area, as defined by council LEPs. All conservation areas are assessed as having Local significance on council LEPs, excepting the Haberfield Conservation Area (C42) which has been nominated for State significance.

The Haberfield Conservation Area includes the whole suburb of Haberfield. In addition to being listed on the Ashfield Draft LEP (2013), the Haberfield Conservation Area is listed on the Register of the National Estate, which is a non-statutory archive, and nominated for State significance on the National Heritage List (current status is 'place not included in NHL'). In addition, Powell's Estate in North Strathfield is adjacent to Concord Road. Further detail on the Haberfield Conservation Area and Powell's Estate is provided at Attachment B2.

Two items are listed as having local significance on the council LEPs also have potential for archaeological remains, including:

- Concord Oval, within St Luke's Park. Potential for archaeology associated with the 1838-1843 Longbottom Convict Stockade (City of Canada Bay Heritage Society, *undated*).
- Ashfield Infant's Home, "Gorton House". Potential for archaeology associated with occupation of Gorton House (1860-1876) and Infants' Home (1876-1930s) (Casey and Lowe 2010).

In addition to these two sites, a preliminary search of the NSW Archaeology Online archive of published reports and the NSW Heritage Branch Library indicates that other sites with archaeological potential are likely to be present within the study area.

As Parramatta Road is an early road, where there has been minimal shift of the alignment, there is also potential for inn sites and earlier road remains such as culverts as well as early houses and convict road-building and accommodation sites to survive.

There are eight residential properties and two items of infrastructure which are listed on a S170 register and do not appear on any council LEPs.

- Sewer Vent at Grantham Street (40 metres from Parramatta Road): Sydney Water S170
- Houses at 19, 21, 23-25, 35, 37-39, 41-43, 51, 53 Wattle Street, Haberfield: RTA S170
- Electricity Substation No. 265, 197 Parramatta Road: Energy Australia S170

Construction and operation of the project has the potential for the following non-Aboriginal related impacts:

- Depending on the design, some of these heritage items could be impacted by the project. It is considered that the impacts from the tunnel design would be limited to the entrance and exit portals and ventilation stacks and inlet structures. Several important heritage buildings, such as the former Arnott's Factory in North Strathfield, the Bath Arms Hotel, Rosebank College and Yasmar are located directly on Parramatta Road.
- Depending on the exact location of construction compound sites, potential impacts on the archaeology associated with the 1838-1843 Longbottom Convict Stockade.
- Some of the heritage-listed residential housing in Haberfield is likely to be affected from the City West Link interchange, where the whole suburb is listed on the

Ashfield LEP and has been nominated for listing on the SHR, meaning the landscaping, setting, views and visual coherency all contribute to its heritage significance. There are also heritage items on the northwest corner of Parramatta Road and Frederick Street and the Bunnings (former Peek Frean's factory) on the southeast corner. Therefore the location of a portal and interchange in this general area may be impacted by heritage issues.

4.8.3 Proposed further assessments

The potential for additional non-Aboriginal heritage items to occur would be further investigated as part of the environmental impact assessment, including:

- Consult with stakeholders such as the Heritage Branch, Office of Environment and Heritage and local councils.
- Systematic pedestrian survey and assessment of all buildings, house-groups and streetscapes in areas of potential impact.
- Undertake an Archaeological Assessment for the study area. This assessment would include detailed historical research to identify additional potential non-Aboriginal archaeological sites. The assessment would include analysis of historic, maps, plans and aerial photos in archives and libraries, such as Mitchell Library, State Archives and council Local Studies Libraries. Particular consideration needs to be given to identifying pre-1855 land uses, prior to the development of residential suburbs.
- Understand/assess the significance of all known State and local heritage items in the study area in accordance with the Burra Charter and the NSW Heritage Office, *Assessing Heritage Significance, NSW Heritage Manual 2* (NSW Heritage Office 2001) and *Assessing Significance for Historical Archaeological Sites and Relics* (Heritage Branch 2009) including cumulative impacts and cultural landscape impacts.
- Where required, undertake archaeological investigations to determine the presence of potential archaeological items and the potential impacts as a result of the project.
- Assess potential impacts to the known State and local heritage items including Yasmar, adjacent to the project and any other potential heritage items of local or greater significance identified in survey or archaeological investigation.
- Review appropriate architectural treatments to apply to potentially impacted heritage buildings. The aim of this would be to develop suitable approaches for consideration from the building owners and local councils.
- Identify appropriate management and mitigation measures to minimise impact on the heritage values of the area.

4.9 Energy efficiency

4.9.1 Overview

The NSW State of Environment 2012 report (EPA 2012) indicates that transport emissions produced from the use of fuels are currently the third fastest growing component of NSW-generated greenhouse gases (after electricity generation and industrial processes).

NSW 2021 (NSW Department of Premier and Cabinet 2011) includes initiatives aimed at using energy more efficiently including a move to sources of electricity with lower emissions. Use of more sustainable energy sources is one priority, with NSW 2021 Goal 22 targeting an increase in renewable energy by 20 per cent by 2020.

4.9.2 Summary of issues

As is the case with all large infrastructure projects, the project will consume energy and generate greenhouse gas emissions during construction from activities such as the transport of materials, operation of plant and equipment and throughout its lifecycle. Emissions formed during energy consumption can be reduced but it will be almost impossible to achieve zero emissions. Additionally there is likely to be indirect generation of greenhouse gas emissions that are produced off-site through the consumption of electricity for lighting and signage and the energy used to produce construction materials such as concrete, bitumen and steel

The major energy consumption for the project will be due to operation of the tunnel ventilation systems. Managing this energy use will be a high priority for the project and will require the need to minimise energy usage where possible and consider the use of renewable energy for any residual energy requirements.

Traffic energy consumption

The net energy consumption with or without the project is expected to be relatively unchanged as the energy consumed by the growth in traffic in the corridor is expected to be offset by improvements in travel times and improvements in vehicle and fuel efficiency.

Operational energy efficiency

The main energy consumption for operation of the project would be through operation of the tunnel ventilation systems and lighting/signalling requirements.

With respect to tunnel ventilation, megawatt hours per tunnel kilometres (MWh/km) has been used as an indicator to review potential operational energy consumption for the project. Indicative energy consumption of four road tunnel projects has been considered, as shown in Table 4-1, comparing energy consumption in megawatt hours (MWh) per year to tunnel length. The data obtained provides a range of potential tunnel ventilation energy consumption scenarios.

Extrapolation from the existing tunnels shown in Table 4-1 indicates that potential electricity consumption ranging from 1,400 MWh per year to 6,750 MWh per year per kilometre of tunnel could be expected depending on tunnel ventilation design and operation.

Table 4-1 Tunnel electricity consumption (indicative only)

Project	Electricity consumption (MWh/annum)	Total (2 way) tunnel length (km)	MWh/km per annum
Eastern Distributor[1,5]	4,400	3.2	1,375
M5 East[2,3]	54,000	8	6,750
CityLink[4] (Melbourne)	21,500	5	4,300
Lane Cove Tunnel[5]	15,400	7.2	2,139

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 re-circulation type ventilation system and a 1 kilometre exhaust tunnel to Turrella
4. CityLink comprises two tunnels including Burnley Tunnel which is 3.4 kilometres and Domain Tunnel which is 1.6 kilometres.
5. Calculation assumes energy consumption equivalent in both tunnels

Applying this to the project total tunnel length of ten kilometres (ie five kilometres of separate tunnel tubes in each direction) indicates a potential range of energy consumption of between 11,200 and 54,000 MW/hrs per year for the project depending on tunnel ventilation system efficiencies. This would equate to the energy consumption of about 1,800 to 8,500 households.

With respect to road lighting and signalling, low energy state of the art lighting and signalling systems (such as LED technology) will be considered in order to reduce energy consumption associated with those activities.

4.9.3 Proposed further assessment

An iterative design process would inform the EIS and would investigate means to reduce energy consumption to the greatest extent possible. Key design aspects that will be investigated will include:

- Road design – particularly minimising tunnel grades.
- Quantifying construction greenhouse gas emissions.
- Quantifying operational greenhouse gas emissions, including embodied emissions and comparing against existing scenarios.
- Ventilation design – both at a macro design level and also at an operational level to reduce energy requirements while achieving air quality outcomes.

In addition, project specific energy targets would be established consistent with the NSW Government's 20 per cent renewable energy target by 2020 (identified as Goal 22 in NSW 2021) and the Infrastructure Sustainability Council of Australia's (ISCA) Infrastructure Sustainability Rating Tool Scorecard. This would include:

- Implementation of identified energy reduction activities across all emission scopes including:
    - Energy and carbon reduction activities with a payback of less than four years.
    - At least one energy and carbon reduction activity with a payback of more than four years.

- Assessment of feasibility of reductions in energy consumption during 'peak demand' periods.

- Investigating further opportunities for renewable energy use such as providing 20-40 per cent of energy from renewable sources for the infrastructure lifecycle.

4.10 Resource use and waste management

4.10.1 Overview

Raw and processed materials would be required for construction of the project. These materials would include concrete, steel, quarried aggregates, imported fill, fuel to power construction equipment and water. The quantity and types of materials required for construction would be further defined during detailed design.

The project requires 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 construction. About 1 million cubic metres of spoil is likely to be generated, the majority of which would be generated through tunnelling operations and is likely to comprise rock and virgin excavated natural material (VENM).

Specific reuse options are yet to be identified for the project, but would generally depend on specific construction timing, generation rates, demand induced by other developments in the area and specific construction industry needs. Construction and operation of the project would see varying amounts of waste produced. Construction wastes generated would include fill material, general construction and demolition waste, contaminated soil, vegetation waste, packaging materials and liquid wastes, and potential acid sulfate soils. Operational wastes (which would be much smaller in quantity) may include spills and leakages from vehicles, litter generated by road users and sediment from water quality control basins.

4.10.2 Potential impacts

Impacts on resource use and waste management would mainly occur during construction. Construction of the project has the potential for the following resource use and waste management related impacts:

- Areas for disposal or beneficial reuse of excavation and tunnel spoil and associated environmental impacts.
- Depletion of natural resources such as virgin quarried materials and sand required as construction materials.
- Demolition wastes (building materials, vegetation, kerbs and pavements).
- Excavation wastes.
- Vegetation waste from the removal of trees, shrubs and groundcovers.
- Packaging materials such as crates, pallets, cartons, plastics and wrapping materials.
- General waste from construction sites (including office wastes, scrap materials and biodegradable wastes).

- Transport of resources and wastes and the impact on traffic and the community.
- Disposal of hazardous materials.
- Generation of sediment, hydrocarbons (oils and greases) and gross pollutants.
- Spill and leaks from construction vehicles.

Operation of the project has the potential for the following resource use and waste management related impacts:

- Generation of sediment, hydrocarbons (oils and greases) and gross pollutants.
- Spill and leaks from construction vehicles.
- Litter generated by road users.
- Wastes generated from operational maintenance activities.

4.10.3 Proposed further assessment

A detailed resource use and waste management assessment would be prepared to provide (as a minimum):

- Assess environmental impacts associated with spoil disposal including traffic, land use, noise, air quality and socio-economic.
- Undertake an earthworks cut and fill analysis to establish the volume of spoil likely to require disposal/reuse during construction.
- Identify potential receiving sites/projects for the excess spoil.
- Assess environmental impacts associated with spoil disposal including traffic, land use, noise, air quality and socio-economic.
- Identify the indicative resource requirements for the project and an assessment of the resource use impacts of the project.
- Identify specific waste impacts of the project and the waste management approach, to be outlined within a construction environmental management plan (CEMP).
- Strategies for reducing waste would be discussed in the EIS such as the use of recycled materials, bulk delivery of good to minimise packaging and arrangements with suppliers to return any unused construction materials.
- Identify opportunities to use recycled materials within pavements provided they are fit for purpose and meet engineering requirements.
- Strategies for minimising the export of excavated materials off-site, maximising re-use opportunities and minimising the volume of excavated material disposal to landfill.

5 Other environmental issues

5.1 Overview

Other environmental issues listed below are considered to be of lesser consequence taking into account the scope of the project, the existing environment and the implementation of standard and best practice management and mitigation measures. It is considered unlikely that these would be key issues for the project; however, further assessment would be undertaken as part of any future environmental impact assessment for the project. Environmental management and safeguard measures required to minimise and mitigate impacts would be documented as part of the environmental impact statement.

5.2 Climate change risk and adaptation

5.2.1 Overview

Climate change refers to the warming temperatures and altered climatic conditions associated with the concentration of gases in the atmosphere, known as greenhouse gases. There is a need to understand how these potential changes can impact future climatic conditions and the effect they could have on the project.

Greenhouse gases generated through construction and operation of the project have the potential to contribute to altered climatic conditions.

In 2010 the NSW Government published refined climate change projections for each region in NSW including the Sydney metropolitan area. In summary, climate change predictions identified by the NSW Government for the Sydney region are:

- More intense extreme rainfall events.
- Increased spring and summer precipitation and a decrease in winter precipitation.
- Increased evaporation in spring and summer.
- Higher average temperatures.
- More frequent occurrence of extreme temperatures.

5.2.2 Potential impacts

Construction of the project has the potential for the following climate change related impacts:

- Generation of greenhouse gas emissions due to the operation of the road.
- Increased damage to road surfaces through more frequent inundation or extreme rainfall.
- More frequent subsidence/geotechnical issues including erosion impacts, resulting in sediment loss from the site.

5.2.3 Proposed further assessment

Further assessment of greenhouse gas and climate change impacts for the project would include:

- Identifying measures to avoid and reduce emissions from both operation and construction of the project.

5.2.4 Management and safeguard measures

Climate change issues are commonly encountered on all road projects and are generally adequately managed through the development of construction management plans and appropriate consideration to climate change issues during the design process. Best practice management measures and safeguards would be implemented during construction of the project such as:

- Identify ways to improve efficiency and provide resilience against the impacts of climate change through design of the project.
- Assess energy efficiency when selecting construction equipment.
- Undertake periodic maintenance of equipment to retain fuel efficiency.
- Substitute for low greenhouse intensity material where appropriate and where it meets engineering requirements.
- Establish recycling practices, including partial replacement of cement with fly ash and using recycled aggregate and recycled content in steel.
- Establish "green" supply procurement guidelines in consultation with design engineers to ensure quality is not compromised.

Management of risks posed by climate change for road infrastructure involves the completion of a climate change risk assessment and detailed discussions with project design engineers to adequately design and plan for predicted changes in climatic conditions.

5.3 Aboriginal heritage

5.3.1 Overview

Aboriginal occupation of the Sydney area 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.

The project traverses the boundaries of the Metropolitan Local Aboriginal Land Council. A search of land comprising Native Title or Crown land with undetermined Aboriginal land claims has not been carried out as part of this assessment, but would be carried out as part of the EIS. Consultation has not been undertaken with any Aboriginal stakeholders at this stage, but would be a necessary and important component of the project going forward.

Aboriginal people using the southern margins of the Parramatta River relied on the bountiful supply of food from swamps, estuaries and the open water. It is likely that parts of the future Parramatta road alignment followed Aboriginal travel routes, therefore having the potential for cultural significance.

The long Aboriginal occupation and use of this area and also throughout the greater Sydney area is amply supported by archaeological evidence. This is known to have extended beyond the last glacial maximum [18,000 years ago] when the environment was drier and significantly cooler and the permanent water sources even more critical to survival. At that time the shore was 30 kilometres further east, and the Parramatta River a much steeper, fast running river. As the planet thawed, Aboriginal people would have responded to the changing ecology with patterns of land use that may have been completely different to those observed at European contact. Modelling can predict the most likely places for such evidence to have survived the past two centuries of intense development.

5.3.2 Potential impacts

The project area has been subject to ground disturbing activities over a long period during the original road construction, associated ancillary activities and the development of the densely populated city of Sydney. Given the presence of Aboriginal heritage within an urban context it should be assumed that unrecorded Aboriginal heritage may exist within the study area. Despite this, there are still areas of known Aboriginal cultural heritage significance, as well as areas of potential Aboriginal archaeological significance, within the urban landscape which must be considered in design and construction plans.

This preliminary Aboriginal archaeological assessment has included a search of the Aboriginal Heritage Information Management System (AHIMS March 2013) which revealed there is one recorded Aboriginal site (HP-1, site ID 45-6-2627) which could potentially be impacted by the project.

The *Parramatta Historical Archaeology Landscape Management Study* (NSW Heritage Office 2000) identified A'Beckett Creek, running west to east into Duck Creek near the M4 Motorway as a 'Zone of Aboriginal Camp Sites recorded by Europeans'.

Construction of the project has the potential for the following Aboriginal heritage related impacts:

- Permanent loss of cultural heritage values from direct impact to potential Aboriginal archaeological deposits due to construction works for the project.
- Direct impact to known Aboriginal archaeological sites (isolated finds) due to construction works for the project.
- Potential direct impacts to unknown/unidentified archaeological items that may be uncovered, disturbed, damaged or destroyed during construction works.

5.3.3 Proposed further assessment

An Aboriginal cultural heritage assessment report (CHAR), including completion of at least stage 1 of PACHCI in liaison with RMS Aboriginal officer, for the project would be prepared in accordance with the following policy documents and heritage guidelines:

- RMS *Procedure for Aboriginal Cultural Heritage Consultation and Investigation* (PACHCI) (RTA 2011).
- *Aboriginal Cultural Heritage Consultation Requirements for Proponents* (DECCW 2010a).
- *Code of Practice for Archaeological investigation of Aboriginal Objects in NSW* (DECCW, 2010b).

Given the known historical observations of Aboriginal people living on Parramatta Road's fringes particular attention should be given to better understanding potential post-contact sites in the development of the CHAR by systematically researching early records, newspaper accounts and other archival sources. A search of land comprising Native Title or Crown land with undetermined Aboriginal land claims should also be carried out.

The preparation of a CHAR would also fulfil the requirements of the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales* (DECCW 2010c). This assessment would also include:

- Ongoing consultation with OEH and the local Aboriginal community throughout the environmental impact assessment process.
- The development of management measures to identify opportunities to minimise impacts on Aboriginal heritage.

5.3.4 Management and safeguard measures

Appropriate management and safeguard measures would be identified in consultation with the registered Aboriginal stakeholders and in accordance with DP&I approved methodologies outlined within the CHAR. For unexpected finds, application of the RMS *Unexpected Finds Procedure* (RMS 2012), would identify relevant reporting and assessment actions to be initiated.

5.4 Biodiversity

5.4.1 Overview

The project is located within the Sydney Basin Bioregion, which is within the Sydney Metro Sub-region. Prior to European settlement, the natural vegetation of this area was dominated by wet sclerophyll eucalypt forests and grassy woodlands (LPI NSW 2013a). 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 (LPI NSW 2013b).

Native vegetation in the Sydney metropolitan area, including the study area, has been reduced to 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 (DEWHA 2010). Mammal and bird species have been particularly badly affected with many species in these groups considered likely to be extinct within the Sydney metropolitan area (DEWHA 2010).

The biodiversity study area (250 metres either side of the alignment) is largely cleared and developed for residential purposes, transport infrastructure with remnant native vegetation restricted to small isolated patches within parks, council reserves, golf courses, road reserves and rail corridors. Plantings of a mixture of locally indigenous native plants, non-indigenous native plants and exotic species are found along the edges of the existing main road areas such as the M4 Motorway and Parramatta Road. Areas dominated by entirely by exotic plants also occur.

Despite the limited habitat in the study area, some Threatened species of plants and animals 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.

5.4.2 Potential impacts

Vegetation communities

All vegetation previously mapped within the study area is designated as Urban Exotic/Native. Some patches of this vegetation could be commensurate with poor condition threatened ecological communities as listed under the listed under the TSC Act and/or the EPBC Act. The possible presence of Threatened Ecological Communities is discussed in Table 5-1. Areas of vegetation further north surrounding Canada Bay and the bay north of the City West Link are commensurate with threatened estuarine ecological communities such as Coastal Saltmarsh. The tunnel proposal is unlikely to affect this endangered ecological community due to the distance from the proposed construction work areas.

Table 5-1 Status of vegetation communities within the study area possibly impacted upon by the project

Vegetation communities likely to be affected1	Possible corresponding Threatened Ecological Community	Comment
Urban Exotic/Native	Some areas of planted native vegetation may correspond to poor condition Threatened Ecological Communities.	Requires field survey to determine whether any Threatened Ecological Communities present

Notes: 1: Vegetation communities based on the *Native Vegetation of the Sydney Metro Catchment Management Authority Area mapping* (DECCW 2009).

Threatened and migratory species

Seven Threatened species of animal, one Threatened species of plant and one threatened population of plant are considered to be likely to potentially occur in the habitats within the study area. Attachment C1 outlines threatened and migratory fauna that have been identified as having potential to occur within the study area. Attachment C2 outlines a list of the threatened flora species that have been identified from database searches as having potential to occur within the study area. No Threatened aquatic species are likely to occur in the study area.

Table 5-2 Threatened species potentially occurring within the study area

Common name	Scientific name	TSC Act status[1]	EPBC Act Status[2]	Likelihood of occurrence & risk
Animals				
Green and Golden Bell Frog	*Litorea aurea*	E	V	**Moderate** possibility of occurring north of the motorway and limited possibility of occurring within the creek lines within the study area such as Powells and Iron Cove Creeks.
Little Bent-Wing Bat	*Miniopterus australis*	V	-	**Moderate** probability of foraging by this species throughout the study area. Roosting habitat in the form of hollow trees may occur within the urban exotic native vegetation or within trees located in local parks.
Eastern Bent-wing Bat	*Miniopterus schreibersii oceanensis*	V	-	**Moderate** probability of foraging by this species throughout the study area. Moderate probability that existing bridges may be roost sites.
Eastern Free-tail bat	*Mormopterus norfolkensis*	V	-	**Moderate** probability of foraging by this species throughout the study area. Roosting habitat in the form of hollow trees may occur within the urban exotic native vegetation or within trees located in local parks.
Southern Myotis	*Myotis macropus*	V	-	**Moderate** possibility of occurring around creek lines in the study area. Existing bridges over water bodies may be roost sites.

Common name	Scientific name	TSC Act status[1]	EPBC Act Status[2]	Likelihood of occurrence & risk
Greater Broad-nosed Bat	*Scoteanax rueppellii*	V	-	**Moderate** probability of foraging by this species throughout the study area. Roosting habitat in the form of hollow trees may occur within the urban exotic native vegetation or within trees located in local parks.
Long-nosed Bandicoot	*Perameles nasuta*	E2	-	**Moderate** probability of occurring in Urban Exotic/Native and Weeds and Exotics vegetation
Grey-headed Flying-fox	*Pteropus poliocephalus*	V	V	**High** probability of foraging by this species in trees of the study area. A flying-fox camp is located approximately 1km south-west of the study area near the rail crossing of Duck River.
Plants				
Downy Wattle	*Acacia pubescens*	*V*	*V*	**Moderate** likelihood of occurrence in the Urban Exotic/Native vegetation community. Sometimes found in disturbed environments.
Tadgells Bluebell population areas of Auburn, Bankstown, Canterbury, Hornsby, Parramatta and Strathfield	Wahlenbergia multicaulis Endangered Population	*E2*	-	**Moderate** probability of presence in Urban Exotic/Native vegetation community. Sometimes found in disturbed environments.

Notes: 1: E = Endangered, E2 = Endangered Population, V = Vulnerable.

Five Migratory species of bird listed under the EPBC Act may also use the area (refer Appendix A). The site would not be classed as an 'important habitat' for any Migratory species as defined under the *EPBC Act Policy Statement 1.1 Significant Impact Guidelines - matters of national environmental significance* (DEWHA 2009) in that the site is unlikely to contain:

- Habitat utilised by a Migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species.
- Habitat utilised by a Migratory species which is at the limit of the species range.
- Habitat within an area where the species is declining.

As such, it is unlikely that the project within the study area would significantly impact any Migratory species.

5.4.3 Summary of potential impacts

Construction and operation of the project has the potential for the following biodiversity related impacts:

- Clearing of urban/exotic vegetation.
- Potential clearing of Threatened Ecological Communities if present; ground truthing of vegetation is required to determine if any threatened ecological communities may occur (eg Sydney Turpentine Ironbark Forest).
- Clearing of mixed native and exotic vegetation and associated habitat for native fauna eg the Threatened Grey-headed Flying-fox and threatened micro-bats.
- Loss of threatened plants eg *Acacia pubescens* and *Wahlenbergia multicaulis*.
- Possible introduction or spread of environmental weeds.
- Mortality of animals during clearing and operation, possibly including the threatened Green and Golden Bell Frog.

5.4.4 Proposed further assessment

Further assessment of the project on biodiversity impacts would include:

- Vegetation survey to determine the extent to which Threatened Ecological Communities and Threatened species of plant would be impacted.
- Assessment of the likelihood of vegetation within the subject site to provide habitat for Threatened species of animals based on field surveys.
- Inspection of existing bridges and culverts for the presence or evidence of bats and potential roost sites.
- Inspection of land near Powells Creek and Iron Cove Creek for potential Green and Golden Bell Frog breeding and overwintering habitat.
- Additional field surveys may be required to target any Threatened species of animal considered likely to occur based on field habitat assessment.
- Detailed impact assessment would be required for any Threatened species, populations and ecological communities considered likely to be present in the study area based on the findings of field surveys.

5.4.5 Management and safeguard measures

Management and safeguard measures for the project would include:

- Minimising removal of existing native vegetation.
- Revegetation with indigenous species suitable as habitat for Threatened species (eg Grey-headed Flying-fox) and consistent with the native vegetation of the locality.
- Implementation of weed management and hygiene measures to minimise possible weed proliferation.
- Preparation and implementation of detailed management plans for Threatened species which are detected during surveys and likely to be at risk of significant impact (eg roosting bats, Green and Golden Bell Frog).

Additional measures may be identified based on the findings of field investigations as part of the environmental assessment.

5.5 Geology, soils and water quality

5.5.1 Overview

The project is contained within the Parramatta River catchment and is located in low relief landscape with elevations generally below 20 metres Australian height datum (AHD) and slopes less than five per cent. Elevated sections of the existing motorway (between Homebush Bay Drive, Homebush and Concord Road, North Strathfield) raise the road surface over creeks, roads and other infrastructure.

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 alluvium deposits associated with streams are relatively limited in extent and unlikely to be a significant groundwater resource. The Hawkesbury Sandstone is a significant aquifer and groundwater flow is mainly via fracture networks and faults, with minor flow via primary porosity.

Three soil landscapes (Birrong, Blacktown and Disturbed) are encountered across the study area. There is the potential for some of the study area to be reclaimed land or landfill and consequently classified as a disturbed soil (McLoughlin 2000). Soil landscape classes are generally classified for the study area as Erosional or Residual.

The project is located on the southern side of the Parramatta River within the Haslams Creek and Powells Creek sub-catchments, both of which drain to Parramatta River (Bewsher Consulting 2003). Parramatta Road traverses Cintra Park Canal at Concord Oval, Concord and the lower reaches of Iron Cove Creek (Dobroyd Canal) at Henley Marine Drive, Five Dock. These catchments are highly urbanised with large sections comprising concrete lined channels. The remaining natural channels are impacted by erosion and sedimentation. 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. High pollutant loads including cadmium, copper and zinc have been recorded in Powells Creek. Stormwater loadings of lead are predominantly associated with suspended particulates; loadings of copper and zinc are equally partitioned between dissolved and particulate phases.

Sewer overflows, particularly during high rainfall events, also influence water quality in these catchments, providing additional sources of nitrogen, phosphorus, suspended solids and faecal coliforms (SKM, 1999).

There is a potential for acid sulfate soils to occur along the project due to its proximity to the Parramatta River estuary. Mapping has also identified a high probability of the occurrence for acid sulfate soils around Haslams and Powells Creeks (Cardno Lawson Treloar 2008) as well as Iron Cove Creek. Salinity is part of the natural landscape of the Parramatta River sub-catchments with salt being found in the rocks, soils and the estuarine sections of the sub-catchments. These salts can potentially be mobilised during construction.

5.5.2 Potential impacts

Construction of the project has the potential for the following soil and water quality related impacts:

- Direct erosion impacts during construction due to excavation, vegetation removal or heavy vehicle use resulting in soil exposure and mobilisation. An increase in erosion and sedimentation would impact stream water quality.
- Direct impacts to bank stability of waterways traversed by the project, particularly at canal crossings.
- Direct impacts to water quality from accidental spillages of chemicals or materials during construction or improper management of surface runoff, sediment control and spillages from the construction site.
- Potential for contamination of groundwater through direct interception (possibly during tunnelling) or through seepage via porous soils and rock.
- Potential to disturb acid sulfate soils during excavation activities in the vicinity of Powells Creek. This could result in sulfuric acid affecting structures and contaminating local waterways, groundwater and soil. The risk of heavy metals being mobilised increases.
- Potential impact on salinity if changes in the landscape affect the way salt and water move through the environment and where they concentrate.
- Groundwater seepage into the tunnel would need to be collected and disposed. This has the potential to contaminate receiving environments, particularly if the seepage water originated from the contaminated Botany Sands aquifer. Groundwater in the Hawkesbury Sandstone contains ferrous iron and manganese, which would form a thick sludge when exposed to oxygen in the tunnel. Disposal of this sludge has the potential to contaminate receiving environments.
- If the tunnel alignment intersects geological structures, including igneous dykes and fault zones, that are connected to water bearing stratum, high inflows of groundwater to the tunnel, and water table drawdown, may result.

Operation of the project has the potential for the following soil and water quality related impacts:

- Contamination of local waterways may result from runoff from the road (at tunnel entrance and exit). Road runoff would typically contain oils and greases, petrochemicals and heavy metals as a result of vehicle leaks, operational wear and road wear. Atmospheric deposition and construction and maintenance activities during operation may result in herbicides, fertilisers and eroded material to be transferred to surface waters.
- Potential impact to stream water quality due to groundwater seepage, fire fighting water, tunnel cleaning water and accidental spills including chemicals in transit or vehicle oils and fuels through leakage or the product of a crash.
- Potential impact to water quality of local waterways from discharge of tunnel drainage water.
- Potential to scour surface soil, banks or bed material due to the changes in drainage off new impervious surfaces.
- Altering the movement of groundwater is possible, particularly in the vicinity of the tunnels.

5.5.3 Proposed further assessment

Further investigations and assessments are required to detail the potential soil and water quality issues that this project presents, including:

- Identify all land areas, waterways and groundwater systems that could be impacted by the construction and operation of the project, ascertain their current state, their environmental values and assess the changes that could occur due to project construction.
- Obtain water quality data and establish a water sampling study to allow baseline analysis of impacts on receiving waters.
- Undertake a detailed assessment of potential impacts to soil and water, including field investigations.
- Assessment of the risk of erosion and sedimentation in accordance with the RMS *Erosion and Sedimentation Management Procedure* (RMS 2008).
- Assess the degree of direct and indirect impacts from construction site and road runoff (tunnel entry and exit) and surface disturbance.
- Investigate options for treatment and disposal of groundwater seepage into new tunnels.
- Determine location and capacity of existing sedimentation and treatment basins along the existing M4 Motorway and stormwater drainage along Parramatta Road. Assess the current state and performance of basins and where appropriate, resize or construct new basins and stormwater infrastructure accordingly.
- Calculate settlements along tunnel alignment and ascertain any inputs to structures and infrastructure.
- Investigate the occurrence and extent of any actual or potential acid sulfate soils and identify an appropriate management approach, in accordance with relevant guidelines and RMS's *Acid Sulfate Materials Guideline* (RMS 2005).

5.5.4 Management and safeguard measures

Appropriate management strategies would be incorporated into the design and the risks to soil, water quality and groundwater would be investigated further during the EIS. Some initial considerations include:

- Soil and water issues are commonly encountered on all road projects and are generally adequately managed through standard RMS management measures and safeguards, which include consideration during the design process and the development of construction soil and water management plans.
- Prior to commencement of construction, silt and sediment controls would be established for the construction site, including the temporary compound site. Controls would be in accordance with *Managing Urban Stormwater, Soils and Construction* (NSW Government 2004) (The Blue Book).
- Identification of potential management measures to reduce the impact on soil and water quality during operation. These would be prioritised in order to select the most appropriate course of action.
- Establish a management plan for actual and potential acid sulfate soils including the testing, identification and control of such areas to minimise the impact on soil and water quality.

- Identify options for containment of spills during operation such as the use of baffles at drainage basins.
- Investigate scour protection at high risk sites with the option to retain existing vegetation where appropriate/feasible.
- The majority of the tunnelled components would be constructed as drained structures and would potentially cause drawdown of the water table. In areas with high flow potential and within fault zones, ground treatment would be used to limit seepage and minimise drawdown of groundwater (Birch & Rochford 2010).
- Seepage water would be collected and treated to the relevant standard prior to disposal, release or reuse (Birch & Rochford 2010). The tunnel drainage system would also collect iron sludge deposition, which would be appropriately contained and disposed.

5.6 Hydrology and flooding

5.6.1 Overview

The M4 Motorway and Parramatta Road are located within the lower Parramatta River catchment and crosses Powells Creek, Hen and Chicken Bay, and Dobroyd Canal sub-catchments. These highly urbanised catchments comprise an area of about 27 square kilometres and are characterised by gently sloping and undulating plains.

Drainage occurs in the sub-catchment through a closed pipe system in the upstream urban areas of Strathfield, Homebush Concord, Five Dock, Croydon and Ashfield. As the creeks that comprise the subcatchments cross Parramatta Road, they are generally characterised as open concrete lined channels. Three open concrete lined channels empty into Hen and Chicken Bay while the Dobroyd Canal, a concrete lined channel, empties into Iron Cove. The Powells Creek channel becomes unlined and fringed by mangroves at the downstream end close to Homebush Bay. The proposed M4 East tunnel portal at Powells Creek would be located within 500 metres of the open concrete lined section of Powells Creek. Flooding has occurred upstream of the lined channels when the stormwater runoff has exceeded the capacity of the closed pipe drainage system (Westra & Ball 2008).

Flood level information is very limited for the catchments (SKM 2005). Flood rise and fall is rapid due to swift response of runoff from the catchment and conveyance of floodwaters along the pipe network and the concrete lining of channels. A flood study is currently being prepared for Dobroyd Canal by Ashfield Council and should be available for reference by the end of 2013.

Climate variability could cause more intense and extreme rainfall into the future over the various sub-catchments. Further discussion on climate change is provided in Section 5.2 Climate Change and Greenhouse Gas.

5.6.2 Potential impacts

Construction of the project has the potential for the following hydrology and flooding related impacts:

- Potential changes to flood behaviour and changes to flood flow distribution from earthworks and construction activities.
- Potential direct impacts to the project 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 obstruction to flood flows as a result of construction of new bridges, culverts, onramps, and tunnel portals.
- Potential change to channel alignment as a result of the construction of tunnel portals.
- Potential impacts to peak flood levels in the various sub-catchments that may impact existing development.
- Increased roadway and removal of vegetated median strips could increase runoff resulting in larger stormwater flows.
- Downstream flooding behaviour could be modified as a result of new bridges, batters and culverts.
- New motorway on-ramps requiring fill may change the local flow behaviour and re-route flood flows.

5.6.3 Proposed further assessment

A hydrology and flood impact assessment would determine the impacts of the proposed works. The assessment would input into the design of the project and would detail management and safeguard measures for hydrology and flooding across all the sub-catchments. This further assessment would consider the impacts of projected climate variability.

5.6.4 Management and safeguard measures

RMS standard safeguards and management measures for hydrology and flooding would 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.
- Adopting and appropriate flood protection standard for the tunnels.
- Provision of an emergency plan during construction, particularly in the event of flooding in the proposed tunnel.
- 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 would be considered and, where appropriate to the project, also be applied.

5.7 Contaminated land

5.7.1 Overview

The project is surrounded by a number of areas of potential contaminated land (EPA 2013a and EPA 2013b). Historical aerial photographs (1943 to 2005) (LPMA 2007) show that past land use activities on and/or adjacent to the project, as well as numerous contaminated sites notified to the NSW EPA, pose a potential risk to the project with respect to contamination.

The areas of potential contamination within or near to the project would be primarily associated with past land uses and urban expansion, and include:

- Landfills (nutrients, hydrocarbons, metals, organic acids, asbestos in waste materials, groundwater and gas).
- Railway facilities (hydrocarbons, solvents, phenolics, metals, asbestos in soils, groundwater and vapour).
- Industrial sites (hydrocarbons, solvents, phenolics, pesticides, nutrients, metals, asbestos in soil, groundwater and vapour).
- Substations (polychlorinated biphenyls, asbestos, polyaromatic hydrocarbons, heavy metals in soil).
- Former quarries (heavy end hydrocarbons, heavy metals, general water quality parameters in soil and groundwater).
- Sediments within waterways (ie estuaries of Parramatta River and Canada Bay) (hydrocarbons, pesticides, metals in sediments).
- Reclaimed land (metals, nutrients, hydrocarbon, asbestos in fill material and sediments).
- Point sources of contamination (eg service stations and associated underground storage tanks, workshops, garages, Sydney Buses bus depot) (hydrocarbons, solvents, metals in soil, groundwater and vapour).
- Contamination associated with road usage (eg fuel and chemical spillage, emissions/deposition from vehicles, road degradation) (hydrocarbons, heavy metals, asbestos, polycyclic aromatic hydrocarbons in soil and groundwater).

5.7.2 Potential impacts

Contaminated land on and/or adjacent to the project, if not managed appropriately could potentially impact upon sensitive receivers during construction.

Additionally, if contamination is identified and the design of the construction elements incorporates management of contamination, there is likely to be an ongoing liability to manage and/or monitor construction materials and risk to sensitive receivers. This could affect the location of proposed construction elements and/or the methods of construction.

Exposure or disturbance of contaminated land during construction of the project may have the following impacts:

- Mobilisation of surface and subsurface contaminants during construction (impacting groundwater, surface water and soils).
- Migration of potential contaminants into surrounding areas (impacting groundwater, surface water and soils) via leaching, overland flow and/or subsurface flow.
- Mobilising potential groundwater and/or surface water contamination.
- Risk of exposure to site workers, site users, and the public.
- Risk of exposure to the surrounding environment (ie flora, fauna, surrounding ecosystems).

Based on the information reviewed, the potential areas of contamination identified within this section of the project present a low to moderate risk of impacting upon sensitive receivers and/or the environment. This is due to the nature of the contamination, the possible migration pathways, and the distance and location of these sites relative to the project. The risk of contamination impacting upon construction activities is increased if excavation works (eg tunnelling) take place within or adjacent to these areas. The risk of exposure to site users, site workers and surrounding environments, and the migration of contamination (if present), is also increased.

5.7.3 Proposed further assessment

Further assessment of the areas of potential contamination that could impact upon sensitive receivers during construction of the project would be required. Where applicable, the further assessments will be undertaken in accordance with the NSW EPA endorsed guidelines and RMS's *Contaminated Land Management Guideline* (RTA 2006).

Additional assessments for the project would involve:

- A site walkover, which is designed to visually assess potential contamination issues on and/or adjacent to the project that may have arisen from past and/or present activities undertaken on and/or adjacent to the project which may represent a risk to human health or the environment during construction of the project elements.
- Recommendations for further investigations (if required) and/or identification of appropriate management and mitigation measures.

5.7.4 Management and safeguard measures

Once the additional assessments have been undertaken and if no further contamination is identified, the existing contamination (if present) can be managed by a project Construction Environmental Management Plan (CEMP). The CEMP would detail contingency measures to manage potentially contaminated materials if suspected and/or encountered during the construction phase.

5.8 Hazard and risk

5.8.1 Overview

Hazards and risks arising from construction and operation of the project have the potential to impact the environment and human health.

The key potential hazard to arise during construction would be impacts to environmental and human health resulting from operation of vehicles and construction equipment in the tunnel. In particular, the risk of fire and leakage or spillage of dangerous goods, including explosives within the tunnel.

Pedestrian and cyclist access to the tunnels would be prohibited. Dangerous goods within the tunnel would also be prohibited, including vehicles which fall into the Austroads Vehicle Classification 10 to 12 (including B-Double or heavy truck trailer, double road trains, and triple road trains).

5.8.2 Potential impacts

During construction, the following hazards and risks may be associated with the project:

- Environmental and human health impacts from accidental release of hazardous substances as a result improper handling and storage within the project area.
- Environmental and human health impacts from accidental release of hazardous substances as a result of vehicle accident during transport to the construction area.
- Human health impacts from fire within the tunnel.
- Tunnel collapse or subsidence.
- Flooding and inundation during construction.

During operation, the following hazards and risks may be associated with the project:

- Potential release of hazardous substances during operation from vehicles transporting these substances through the tunnel.
- Spills and leaks from minor vehicle accidents.
- Large fires or explosions from major vehicle accidents.
- Tunnel collapse or subsidence.
- Flooding and inundation during operation.

5.8.3 Management and safeguard measures

Specific hazards and risks from construction and operation of the project would be considered in the environmental impact statement along with a project specific environmental risk analysis.

Management and safeguard measures would be implemented to avoid, minimise or manage hazard and risk. These management measures would include:

- Prepare site specific Hazard and Risk Management Plans as part of the CEMP.
- Occupational health and safety risks associated with construction would be managed through the implementation of an occupational health and safety plan.
- The risks associated with the use and storage of hazardous substances during construction would be mitigated through appropriate design, and establishment of bunded areas in accordance with relevant Acts and codes of practice.
- Locate any potential chemical storage areas outside areas subject to the 1 in 100 flood event.
- Transport all hazardous substances in accordance with relevant legislation and codes.
- Consult with relevant utility owners to identify necessary protection measures in the vicinity of utilities.
- Blast Management Plan would be developed that would contain information relating to blast design configuration.
- Provide an emergency plan during construction, particularly in the event of flooding in the proposed tunnel.

Hazards and risks associated with the project during operation are considered low and would be managed with the implementation of standard management and safeguard measures including:

- The carriage of dangerous goods through the tunnel would be prohibited.
- Appropriate in-tunnel monitoring systems would be installed to allow tunnel operators to respond to the traffic conditions within the tunnel.
- Appropriate fire protection systems would be provided within the tunnel.
- Implement an Incident Response Plan in the event of an accident or spill.
- Identifying appropriate design criteria for portal flood immunity and drainage infrastructure capacities.

5.9 Utilities

5.9.1 Overview

Avoiding or relocating utilities is a common issue encountered on many road projects. There are a number of public utilities that cross, or are located adjacent to the existing M4 Motorway and Parramatta Road.

The project may require the relocation, adjustment or protection of existing public utilities such as electricity transmission and distribution lines, sewer trunks, stormwater infrastructure, communications cables and gas mains.

Any utility adjustments would likely be restricted to surface works as the tunnelled component of the project (between Powells Creek, Homebush to Parramatta Road and City West Link, Haberfield) would generally be too deep to interfere with existing utilities.

5.9.2 Potential impacts

Construction of the project has the potential for the following resource use and waste management related impacts:

- Disruption to electricity services from protection or relocation of power lines near Homebush Bay Drive and George Street.
- Relocation of optic fibre cables along the current M4 Motorway alignment.
- Protection of sewer trunk utilities at or near Bedford Road, Powell Street, Queen Street, Concord Road interchange, Parramatta Road (between Lloyd George Avenue and Elsie Street), Bennett Street, and Fairlight Street.
- Protection of the primary and secondary gas main located adjacent to the M4 Motorway between Homebush Bay Drive and Cartwright Avenue, George Street, and William Street.
- Protection of the pipeline at City West Link.
- Indirect damage to utilities from vibration or other construction related activities.

5.9.3 Management and safeguard measures

Management and safeguard measures would be implemented to avoid, minimise or manage disruptions to utilities. These management measures would include:

- Consultation with local councils, service providers, asset owners and any affected landowners would be undertaken throughout the design process.
- Identifying the location of utilities through survey.
- Residents would be notified for any disruptions to services, should these be required. Protection measures would be incorporated into design of the project with an aim to minimising disruption to customers using those services.
- Adjustment or relocation of utilities.
- Physical protection of utilities where necessary.
- Alternate construction methods may be considered where utilities are likely to be impacted.

Management and safeguard measures would be detailed in the assessment for the project.

5.10 Cumulative impact

5.10.1 Overview

Cumulative impacts result when the effects of an action are added to or interact with other effects in a particular place and within a particular time. It is the combination of these effects, and any resulting environmental degradation, that is generally the focus of cumulative impact assessment.

The prediction and evaluation of cumulative impacts is not straightforward since it is not always possible to directly combine different types of environmental impacts on an objective basis.

The EIS will need to consider construction impacts from a cumulative perspective and may require adjustments to mitigation and management measures.

5.10.2 Potential impacts

Specific to the M4 East Homebush Bay Drive to Parramatta Road and City West Link project, the objective of the project level cumulative impact assessment will be to ensure that construction and operational cumulative impacts are considered, balanced and mitigated. Key developments in the Sydney region that are expected to interact with the project include:

- Service improvements on the Western Line as identified in the NSW Government's "Sydney's Rail Future". This may result in increased patronage on the M4 Motorway corridor. The effect of this would be reflected in traffic modelling undertaken for the M4 East.
- Development of the North West Rail Line - given the high usage of the M4 Motorway by users from north-west Sydney (cited above), development of the North West Rail Line has the prospect of altering current car-based travel from the sector. This effect would be reflected in traffic forecasts.
- Upgrade of the M4 and M5 corridors - as part of WestConnex, the upgraded M4 and M5 corridors would feed into a new motorway standard north-south link between Camperdown and Mascot. The M4 East Homebush Bay Drive to Parramatta Road and City West Link project would reduce traffic volumes on the existing Parramatta Road, diverting them to the underground connection. This would further improve travel times on the M4 Motorway, as the congestion currently experienced at its western end would be reduced.

The project has the potential for cumulative impacts during both construction and operational phases should other large scale developments within the Sydney region be planned and delivered during the same timeframe as the project. Potential issues include:

- Construction noise and vibration (particularly night time works).
- Construction traffic.
- Air quality impacts from construction activities.
- Visual impact and amenity effects of construction compounds and associated sites and activities.
- Non-Aboriginal and Aboriginal heritage impacts.

- Ecological impacts such as impacts to biodiversity, hydrology and resource usage.
- Economic and social impacts including construction fatigue due to large and ongoing construction works for surrounding residents and businesses.

Construction impacts on communities adjacent to the project would be addressed in detail as described in Section 5.10.3.

5.10.3 Proposed further assessment

Project specific investigations and assessments would be undertaken to detail the potential cumulative impacts that this project would present as well as proposed mitigation and management measures. These would be included in the assessment of the relevant environmental issue chapter in the EIS. This would include:

- Potential impacts on air quality, due to the net effect of emissions to air from the project and existing sources, and assessed in accordance with the *EPA's Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC, 2005). Assessment of potential impacts, including cumulative impacts on threatened ecological communities and flora and fauna species listed under the TSC Act, FM Act and/or the EPBC Act and their habitats.
- Assess the potential social and economic cumulative impacts during construction and operation of the project.
- Assessment of the potential cumulative impacts on Aboriginal archaeological and cultural heritage values, including intangible cultural values.
- Assess the cumulative visual impacts, particularly as a result of the introduction of proposed infrastructure including ventilation stacks and tunnel portals.
- Assess the potential noise and vibration impacts associated with the construction and operation of the project, particularly the increase in road traffic noise at tunnel portal locations.
- Assess the significance of heritage items that would be potentially impacted in accordance with the Burra Charter and the NSW Heritage Office, *Assessing Heritage Significance NSW Heritage Manual 2, 2001* and *Statements of Heritage Impact, 1991* including cumulative impacts and cultural landscape impacts.

5.10.4 Management and safeguard measures

As indicated above, and subject to the time and location of impact overlaps with other projects associated with the WestConnex scheme, the mitigation and management measures identified may need to be enhanced and strengthened beyond that typically provided for a project to take into account the potential for significant construction fatigue. These adjustments (if necessary) would be identified as part of the detailed assessments.

6 Conclusion

The NSW Government is proposing to upgrade and extend the M4 Motorway from Homebush Bay Drive, Homebush, to Parramatta Road and City West Link (Wattle Street), Haberfield (the project). The project would involve widening of the M4 Motorway between Homebush Bay Drive and Concord Road; two three-lane tunnels in an east-bound and west-bound direction from about Powells Creek, North Strathfield to Parramatta Road/ City West Link, Haberfield; with interchanges at Concord Road and Wattle Street.

RMS has formed the opinion that the impacts of the project on the issues listed below would be likely to significantly affect the environment and require the preparation of an environmental impact statement under the EP&A Act 1979. Accordingly, the project is State significant infrastructure under Part 5.1 of the EP&A Act. Approval from the Minister for Planning and Infrastructure is required for the project.

The key environmental issues identified for the project include:

- Traffic and transport.
- Noise and vibration.
- Air quality.
- Urban revitalisation, land use and property.
- Socio-economic impacts.
- Urban design and visual impact.
- Non-Aboriginal heritage.
- Energy efficiency.
- Resource use and waste management.

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Attachment A

Requirements of the Environmental Planning and Assessment Regulation 2000

Clause 192 of the *Environmental Planning and Assessment Regulation 2000* requires that an application for approval of the Minister to carry out State significant infrastructure must include:

(a) details of any approval that would, but for section 115ZG of the Act, be required for the carrying out of the State significant infrastructure, and

(b) details of any authorisations that must be given under section 115ZH of the Act if the application is approved, and

(c) a statement as to the basis on which the proposed infrastructure is State significant infrastructure, including, if relevant, the capital investment value of the proposed infrastructure.

Approvals that would otherwise apply

Approvals that may be required to carry out the SSI, if not for section 115ZG of the EP&A Act, include:

- An approval under Part 4, or an excavation permit under section 139, of the *Heritage Act 1977*.
- An Aboriginal heritage impact permit under section 90 of the *National Parks and Wildlife Act 1974*.
- A water use approval under section 89, a water management work approval under section 90 or an activity approval under section 91 of the *Water Management Act 2000*.

Authorisations if the application is approved

Authorisations that may be required for the project under section 115ZH of the EP&A Act include:

- An environment protection licence under Chapter 3 of the *Protection of the Environment Operations Act 1997* (for any of the purposes referred to in section 43 of that Act).
- A consent under section 138 of the Roads *Act 1993*.

State significant infrastructure statement

Clause 14(1) of State Environmental Planning Policy (State and Regional Development) 2011 provides that development is declared to be State significant infrastructure pursuant to section 115U(2) of the Act if it is permissible without development consent under Part 4 of the Act under a State environmental planning policy; and is specified in the categories of development in Schedule 3.

State Environmental Planning Policy (Infrastructure) (ISEPP) permits development for the purpose of a road or road infrastructure facilities to be carried out by or on behalf of

a public authority without consent. As the M4 East project is for a road and road infrastructure facilities, and is to be carried out by RMS, the project is permissible without development consent under Part 4 of the EP&A Act.

Schedule 3 clause 1 of State Environmental Planning Policy (State and Regional Development) 2011 includes infrastructure or other development that (but for Part 5.1 of the EP&A Act and within the meaning of Part 5 of the Act) would be an activity for which the proponent is also the determining authority, and would, in the opinion of the proponent, require an environmental impact statement to be obtained under Part 5 of the EP&A Act.

RMS has formed the opinion that the impacts of the project on the issues listed in Chapter 4 would be likely to significantly affect the environment and require the preparation of an environmental impact statement under Part 5 of the EP&A Act. Accordingly, the project is State significant infrastructure under Part 5.1 of the EP&A Act. Approval from the Minister for Planning and Infrastructure is required for the project.

Attachment B1

Items of non-Aboriginal heritage located within the study area

Map/ LEP No	Item Name	Address	Locality	Council	Significance	Date	LEP	SHR	S170 register	NT	RNE[1]
102	Public Reserve	Corner Frederick & Henry Streets	Ashfield	Ashfield	Local		Ashfield Draft LEP (2013)	-	-	-	-
115	Ashfield Infants Home: “Gorton House”, original building, Emily Trollope Nursing Ward, Louise Taplin Ward, Laundry, Grounds & lesser buildings.	17 Henry Street	Ashfield	Ashfield	Local	1860s-1930	Ashfield Draft LEP (2013)	-	-	(S8574)	-
273	Vita-Weet Building, formerly Peek Freans Biscuit Factory	476 Parramatta Road	Ashfield	Ashfield	Local	1936	Ashfield Draft LEP (2013)	-	-	-	-
369	Site (part) of “Ashfield Park House”	3-7 Byron Street	Croydon	Ashfield	Local		Draft Ashfield LEP (2013)	-	-	-	-
382	House	40 Dalmar Street	Croydon	Ashfield	Local		Draft Ashfield LEP (2013)	-	-	-	-
383	House	52 Dalmar Street	Croydon	Ashfield	Local		Draft Ashfield LEP (2013)	-	-	-	-
427	House	30 Page Avenue	Croydon	Ashfield	Local		Draft Ashfield LEP (2013)	-	-	-	-
428	Site (part of “Ashfield Park House”)	6-10 Scott Street	Croydon	Ashfield	Local		Draft Ashfield LEP (2013)	-	-	-	-
451	Houses "Cashman's Corner" 147, 149, 151 Ramsay Street	146-148 Ramsay Street	Haberfield	Ashfield	Local	1912	Ashfield Draft LEP (2013)	-	-	(S6577)	-

Map/ LEP No	Item Name	Address	Locality	Council	Significance	Date	LEP	SHR	S170 register	NT	RNE[1]
452	Houses "Cashman's Corner" 147, 149, 151 Ramsay Street	150-152 Ramsay Street	Haberfield	Ashfield	Local	1912	Ashfield Draft LEP (2013)	-	-	(S6576)	-
462	House	9 Wattle Street	Haberfield	Ashfield	Local		Ashfield Draft LEP (2013)	-	-	-	-
-	House	19 Wattle Street	Haberfield	Ashfield	Local	1910-	-	-	RMS	-	-
-	House	21 Wattle Street	Haberfield	Ashfield	Local	1910-	-	-	RMS	-	-
-	Houses	23-25 Wattle Street	Haberfield	Ashfield	Local	1912	-	-	RMS	-	-
-	House	35 Wattle Street	Haberfield	Ashfield	Local	1916-	-	-	RMS	-	-
-	House	37-39 Wattle Street	Haberfield	Ashfield	Local	1912	-	-	RMS	-	-
-	House "Airley"	41-43 Wattle Street	Haberfield	Ashfield	Local	1912	-	-	RMS	-	-
-	House	51 Wattle Street	Haberfield	Ashfield	Local	1913	-	-	RMS	-	-
-	House "Bunnia"	53 Wattle Street	Haberfield	Ashfield	Local	1909	-	-	RMS	-	-
-	House	164 Ramsay Street	Haberfield	Ashfield	Local	1916-	Ashfield Draft LEP (2013)	-	RMS	-	-
C30	Hammond Park Estate Conservation Area	Frederick Street	Ashfield	Ashfield	Local		Ashfield Draft LEP (2013)	-	-	-	-
C37	The Ranch Conservation Area		Haberfield	Ashfield	Local		Ashfield Draft LEP (2013)	-	-	-	-
C42	Haberfield Conservation Area		Haberfield	Ashfield	Local (nominated for State significance)		Ashfield Draft LEP (2013)	-	-	(S7848)	R

Map/ LEP No	Item Name	Address	Locality	Council	Significance	Date	LEP	SHR	S170 register	NT	RNE[1]
01379	Yasmar	185 Parramatta Road,	Haberfield	Ashfield	Local	1985	Ashfield Draft LEP (2013)	Yes			R
I201	Arts and Crafts House	29 Roberts Street	Strathfield	Burwood	Local	1919	Burwood LEP (2012)	-	-	-	-
C16	Philip Street Heritage Conservation Area		Burwood	Burwood	Local		Burwood LEP (2012)	-	-	-	-
C17	Rosetherne Avenue Heritage Conservation Area			Burwood	Local		Burwood LEP (2012)	-	-	-	-
C21	Wychbury and Alexandra Avenues Heritage Conservation Area			Burwood	Local		Burwood LEP (2012)	-	-	-	-
I105	House “Fernleigh”	32 Shaftesbury Road	Burwood	Burwood	Local	1918	Burwood LEP (2012)	-	-	-	-
I150	“Lurleah” cottage and garden	13 Lang Street	Croydon	Burwood	Local	1920	Burwood LEP (2012)	-	-	-	-
I16	Semi-detached House	12 & 14 Burwood Road	Burwood	Burwood	Local	1918	Burwood LEP (2012)	-	-	-	-
I95	Federation House	20 Mosely Street	Strathfield	Burwood	Local	1874-1918	Burwood LEP (2012)	-	-	-	-
I196	Arts and Crafts House	22 Mosely Street	Strathfield	Burwood	Local	1919	Burwood LEP (2012)	-	-	-	-
I197	1930s Housing Group	24-32 Mosely Street	Strathfield	Burwood	Local	1919-1930	Burwood LEP (2012)	-	-	-	-
I199	Victorian Cottages	28 & 30 Philip Street	Burwood	Burwood	Local	1880	Burwood LEP (2012)	-	-	-	-
I2	Attached House	9-11 Archer Street	Burwood	Burwood	Local	1874-1918	Burwood LEP (2012)	-	-	-	-
I200	Victorian Houses	15 & 17 Roberts Street	Strathfield	Burwood	Local		Burwood LEP (2012)	-	-	-	-

Map/ LEP No	Item Name	Address	Locality	Council	Significance	Date	LEP	SHR	S170 register	NT	RNE[1]
I202	House “Wilgunyah”	30 Roberts Street	Strathfield	Burwood	Local	1919	Burwood LEP (2012)	-	-	-	-
I203	House “Helikon”	33 Roberts Street	Strathfield	Burwood	Local	1893	Burwood LEP (2012)	-	-	(S7889)	R
C16	Mosely and Roberts Streets Conservation Area	31, 35a, 37 Roberts Street	Strathfield	Burwood	Local	-	Burwood LEP (2012	-	-	(S8015-S8017)	-
I3	Worker’s Cottage	13 Archer Street	Burwood	Burwood	Local	1874-1918	Burwood LEP (2012)	-	-	-	-
I66	House “Grantham”	21 Grantham Street	Burwood	Burwood	Local	1880	Burwood LEP (2012)	-	-	(S7809)	R
-	Sewer Vent	Grantham Street (40m from Parramatta Road)	Burwood	Burwood	-		-	-	Sydney Water		
I83	Federation House	7 Neich Parade/47 Park Road	Burwood	Burwood	Local	1918	Burwood LEP (2012)	-	-	-	-
I89	Methodist Ladies’ College	45 Park Road	Burwood	Burwood	Local		Burwood LEP (2012)	-	-	-	-
I94	Bath Arms Hotel	352-354 Parramatta Road	Burwood	Burwood	Local	1834	Burwood LEP (2012)	-	-	-	-
CQ	Park Avenue Conservation Area			Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I108	House	64 Concord Road	North Strathfield	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I165	House	8 Daly Avenue	Concord	Canada Bay	Local	1920-1930	Draft Canada Bay LEP (2013)	-	-	-	-
I180	House “Kelvin”	1A Edward Street	Concord	Canada Bay	Local	1920-1930	Draft Canada Bay LEP (2013)	-	-	-	-

Map/ LEP No	Item Name	Address	Locality	Council	Significance	Date	LEP	SHR	S170 register	NT	RNE[1]
I181	House	16 Edward Street	Concord	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I182	Street trees	Edward Street	Concord	Canada Bay	Local	1940-1950	Draft Canada Bay LEP (2013)	-	-	-	-
I182	Street trees	Edward Street	Concord	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I2	House “Marathon”	3 Ada Street	Concord	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I206	House “Wangi”	21 Franklyn Street	Concord	Canada Bay	Local	1920-1930	Draft Canada Bay LEP (2013)	-	-	-	-
I207	Street trees	Franklyn Street	Concord	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I212	Shops	16-18 George Street, North Strathfield	North Strathfield	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I214	Goddard Park	52P Gipps Street	Concord	Canada Bay	Local	1891	Draft Canada Bay LEP (2013)	-	-	-	-
I282	Street trees	Lansdowne Street	Concord	Canada Bay	Local	c.1940	Draft Canada Bay LEP (2013)	-	-	-	-
I283	Corner Shop and Residence	30 Lavender Street	Five Dock	Canada Bay	Local	c.1925	Draft Canada Bay LEP (2013)	-	-	-	-
I284	House	5 Leicester Avenue	Strathfield	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I285	House	7 Leicester Avenue	Strathfield	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I3	Federation House	4 Ada Street	Concord	Canada Bay	Local	1906	Draft Canada Bay LEP (2013)	-	-	-	-
I307	House	24 Lloyd George Avenue	Concord	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I308	St Luke’s Park entrance,	Loftus Street	Concord	Canada Bay	Local	1913	Draft Canada	-	-	-	-

Map/ LEP No	Item Name	Address	Locality	Council	Significance	Date	LEP	SHR	S170 register	NT	RNE[1]
	gates and trees only						Bay LEP (2013)				
I335	House	10 Manson Road	Strathfield	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I336	House	14 Manson Road	Strathfield	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I337	House	16 Manson Road	Strathfield	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I338	House and Garden	18 Manson Road	Strathfield	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I339	House	20 Manson Road	Strathfield	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I340	House	22-24 Manson Road	Strathfield	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I341	House	30 Manson Road	Strathfield	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I342	Street trees	Manson Road	Strathfield	Canada Bay	Local	c.1940	Draft Canada Bay LEP (2013)	-	-	-	-
I357	Street Trees	Napier Street, North Strathfield	North Strathfield	Canada Bay	Local	c.1940	Draft Canada Bay LEP (2013)	-	-	-	
I368	House “Netherby” and Garden	2 Park Avenue	Concord	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I369	House	15 Queen Street	North Strathfield	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	
I369	House	8 Park Avenue	Concord	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I370	House	14 Park Avenue	Concord	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I371	Rosebank College	121 Parramatta Road	Five Dock	Canada Bay	Local	1870-	Draft Canada Bay LEP (2013)	-	-	-	-

Map/ LEP No	Item Name	Address	Locality	Council	Significance	Date	LEP	SHR	S170 register	NT	RNE[1]
I387	House "Sunnyside"	14 Princess Avenue	North Strathfield	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I388	House	26 Princess Avenue	North Strathfield	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I4	House and Garden, (Norfolk Pine and two Frangipani trees)	6 Ada Street	Concord	Canada Bay	Local	1906-	Draft Canada Bay LEP (2013)	-	-	-	-
I40	St Luke's Anglican Church and Grounds	19 Burton Street	Concord	Canada Bay	Local	1859-1861	Draft Canada Bay LEP (2013)	-	-	(S9879)	-
I400	House "Riverview	44 Queens Road	Five Dock	Canada Bay	Local	1855-1859	Draft Canada Bay LEP (2013)	-	-	-	-
I401	One of a pair of Terrace Houses	140 Queens Road	Canada Bay	Canada Bay	Local	1885	Draft Canada Bay LEP (2013)	-	-	-	-
I402	One of a pair of Terrace Houses	142 Queens Road	Canada Bay	Canada Bay	Local	1885	Draft Canada Bay LEP (2013)	-	-	-	-
I41	House "Lansdowne"	25 Burton Street	Concord	Canada Bay	Local	1853	Draft Canada Bay LEP (2013)	-	-	-	R
I42	Houses "Melaleuca" and "Clewer", pair of terrace houses, fences and garden	31-33 Burton Street	Concord	Canada Bay	Local	1879	Draft Canada Bay LEP (2013)	-	-	-	-
I425	St Andrew's Church	37 Swan Avenue	Strathfield	Canada Bay	Local	1914	Draft Canada Bay LEP (2013)	-	-	-	-
I426	House	19 Swan Avenue	Strathfield	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I427	House	20 Swan Avenue	Strathfield	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I428	Milling Place, mature deodar, cedar trees (known as Swan Avenue Reserve)	42P Swan Avenue	Strathfield	Canada Bay	Local	c1950	Draft Canada Bay LEP (2013)	-	-	-	-
I43	House "Loretto"	46 Burton Street	Concord	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-

Map/ LEP No	Item Name	Address	Locality	Council	Significance	Date	LEP	SHR	S170 register	NT	RNE[1]
I431	Street trees	Sydney Street	Concord	Canada Bay	Local	1950s	Draft Canada Bay LEP (2013)	-	-	-	-
I433	House	11 Sydney Street	North Strathfield	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I434	House	23 Sydney Street	North Strathfield	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I435	House	33 Sydney Street	North Strathfield	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I44	St Mary's Church, church and school	56-60 Burton Street	Concord	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I45	Former Post Office building	22 Burwood Road	Concord	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I46	Former Anglican Rectory building	34 Burwood Road	Concord	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I461	House & Garden	10 Thornleigh Road	Concord	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I462	House "Glenora"	11 Thornleigh Avenue	Concord	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I47	House	33 Burwood Road	Concord	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I48	House	35 Burwood Road	Concord	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I5	House	7 Ada Street	Concord	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I522	Pair of semi-detached Houses	1A-5 York Avenue	Five Dock	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I539	House	35 Sydney Street	North Strathfield	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I541	Bakehouse Quarter (former Arnott's complex)	11, 20-22 George Street	North Strathfield	Canada Bay	Local	1907-	Draft Canada Bay LEP (2013)	-	-	-	-

Map/ LEP No	Item Name	Address	Locality	Council	Significance	Date	LEP	SHR	S170 register	NT	RNE[1]
I55	Sandstone kerbing (west side, adjacent)	22-26 Burwood Road	Concord	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I64	House	2 Carrington Street	North Strathfield	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I65	Concord Baptist Church	3 Carrington Street	North Strathfield	Canada Bay	Local	1910-1928	Draft Canada Bay LEP (2013)	-	-	-	-
I66	House	4 Carrington Street	North Strathfield	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I67	House	7 Carrington Street	North Strathfield	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I68	House	13 Carrington Street	North Strathfield	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I69	House	14 Carrington Street	North Strathfield	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I7	Street tree	Corner Ada and Coles Streets	Concord	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I70	House	17 Carrington Street	North Strathfield	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I71	House	19 Carrington Street	North Strathfield	Canada Bay	Local		Draft Canada Bay LEP (2013)	-	-	-	-
I99	Wesley Uniting Church - and hall	81 Concord Road	North Strathfield	Canada Bay	Local	1927	Draft Canada Bay LEP (2013)	-	-	-	-
CT	Powell's Estate Conservation Area	Queen, Carrington & Sydney Street	North Strathfield	Canada Bay	Local	1880s-1940s	Draft Canada Bay LEP (2013)	-	-	-	-
	Electricity Substation No. 265	197 Parramatta Road	Homebush	Canada Bay	-	1928	-	-	Energy Australia	-	-
C6	Houses within Welfare Street Precinct Group	1-11 Flemington	Homebush	Strathfield	Local		Strathfield LEP (2012)	-	-	-	-

Map/ LEP No	Item Name	Address	Locality	Council	Significance	Date	LEP	SHR	S170 register	NT	RNE[1]
		Road									
C6	Houses within Welfare Street Precinct Group	2-14 Welfare Street	Homebush West	Strathfield	Local		Strathfield LEP (2012)	-	-	-	-
I1170	Homebush Railway Station Group	Great Southern and Western Railway	Homebush	Strathfield	State	1891-1993	Strathfield LEP (2012)	yes (01170)	RailCorp	-	R
I28	Spanish Mission House & Garden	80 Park Road (formerly 80 Wentworth Road	Homebush	Strathfield	Local		Strathfield LEP (2012)	-	-	-	-
I29	Railway Bridge with Arnott's sign over road	Parramatta Road	Homebush	Strathfield	Local		Strathfield LEP (2012)	-	RailCorp	-	-
I30	Milestone	Parramatta Road (south side) & Bridge Road (east side)	Homebush	Strathfield	Local		Strathfield LEP (2012)	-	-	(S8999)	-
I31	Former Homebush Theatre/Niterider Theatre & Arnott's sign	55-57 Parramatta Road	Homebush	Strathfield	Local		Strathfield LEP (2012)	-	-	-	-
I32	Horse & Jockey Hotel	70 Parramatta Road & Knight Street	Homebush	Strathfield	Local		Strathfield LEP (2012)	-	-	-	-
I33	Commercial Building	72-76 Parramatta Road	Homebush	Strathfield	Local		Strathfield LEP (2012)	-	-	-	-
I34	Railway Viaduct over Powells Creek	Railway Land	Homebush	Strathfield	Local		Strathfield LEP (2012)	-	-	-	-
I38	Weatherboard Cottage& Garden	1 Short Street East	Homebush	Strathfield	Local		Strathfield LEP (2012)	-	-	-	-
I39	Federation House "Station"	11 Station	Homebush	Strathfield	Local		Strathfield LEP	-	-	-	-

Map/ LEP No	Item Name	Address	Locality	Council	Significance	Date	LEP	SHR	S170 register	NT	RNE[1]
		Street					(2012)				
I51	1950s Garden, carport and fence	74 Underwood Road	Homebush	Strathfield	Local		Strathfield LEP (2012)	-	-	-	-
I62	Wentworth Hotel	195 Parramatta Road	Homebush West	Strathfield	Local		Strathfield LEP (2012)	-	-	-	-
I63	Former Ford Factory Building	350-374 Parramatta Road	Homebush West	Strathfield	Local		Strathfield LEP (2012)	-	-	-	

Note 1: R = registered

Attachment B2

Haberfield and Powell's Estate Conservation Areas

The summary statement of significance for the Haberfield Conservation Area states:

Haberfield was Australia's first comprehensively planned and developed garden suburb, establishing a model for Australia's suburban development in the twentieth century (Criterion B.2). Astutely conceived and promoted by Richard Stanton, a Summer Hill real estate agent and former Mayor of Ashfield, Haberfield comprised individually designed, locally adapted Queen Anne style houses, set along tree lined streets, which were antithesis of the unhealthy crowded inner city suburbs (Criterion D.2). Haberfield's significance derives from its successful adaptation of the garden suburb idea and the architectural quality of its houses related in style and character, but carefully individualised in form and detail (Criterion F.1).

Condition and Integrity: *While a small number of the Stanton houses have been altered irreversibly, the majority are in fair to excellent condition and capable of restoration/reconstruction works which would enhance their cultural significance. Some later housing on individual sites has been intrusive, but more strict planning policies are now being pursued in relation to infill development (Department of Sustainability, Environment, Water, Population and Communities, 2013).*

Figure B-1 shows the southern part of the Haberfield Conservation Area, indicating its extent in relation to the 250 metre corridor relevant to the proposed entrance and exit ramps around City West Link. City West Link is outlined in green and the 250 metres curtilage either side of Parramatta Road is dashed in blue. A new conservation area, C37 – The Ranch Conservation Area, is also located on the northwest corner of Parramatta Road and Frederick Street.

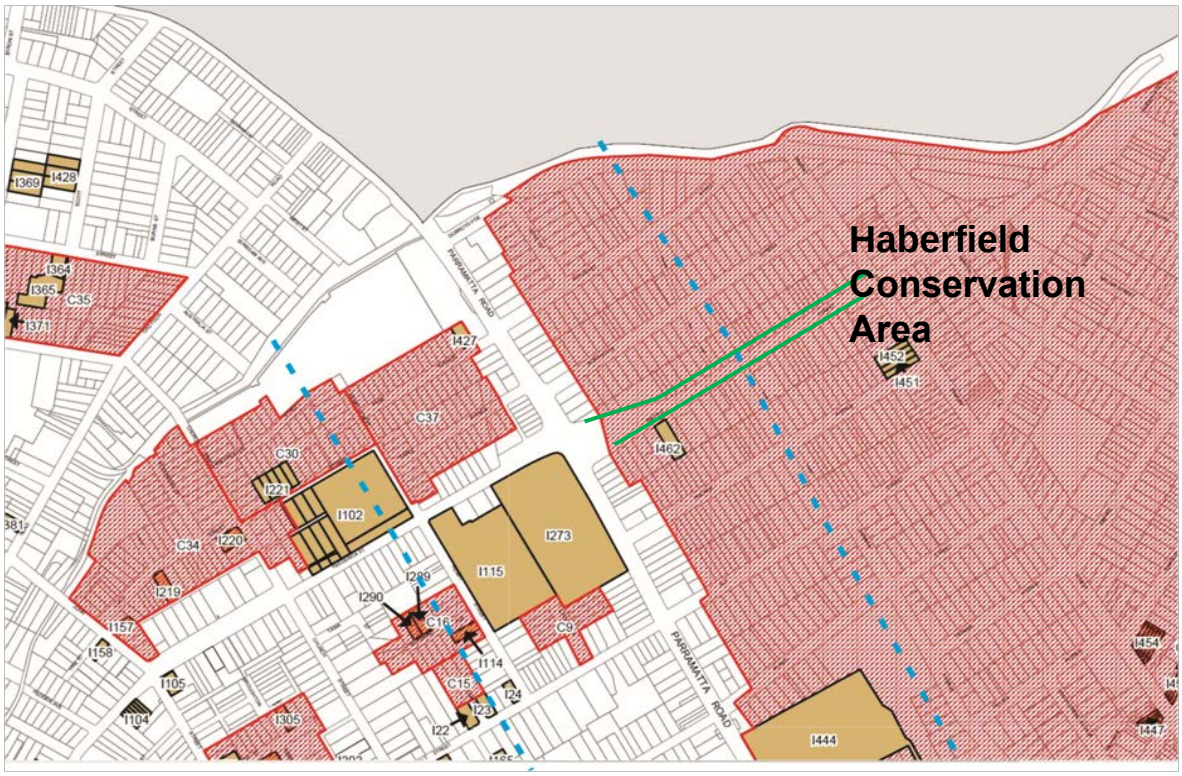

Figure B-1 Haberfield Conservation Area C42 to the north and east of Parramatta Road

Source: Ashfield Draft LEP (2013) (Map 1)

Figure B-2 displays the extent of the Haberfield Conservation Area, which is shaded in blue.

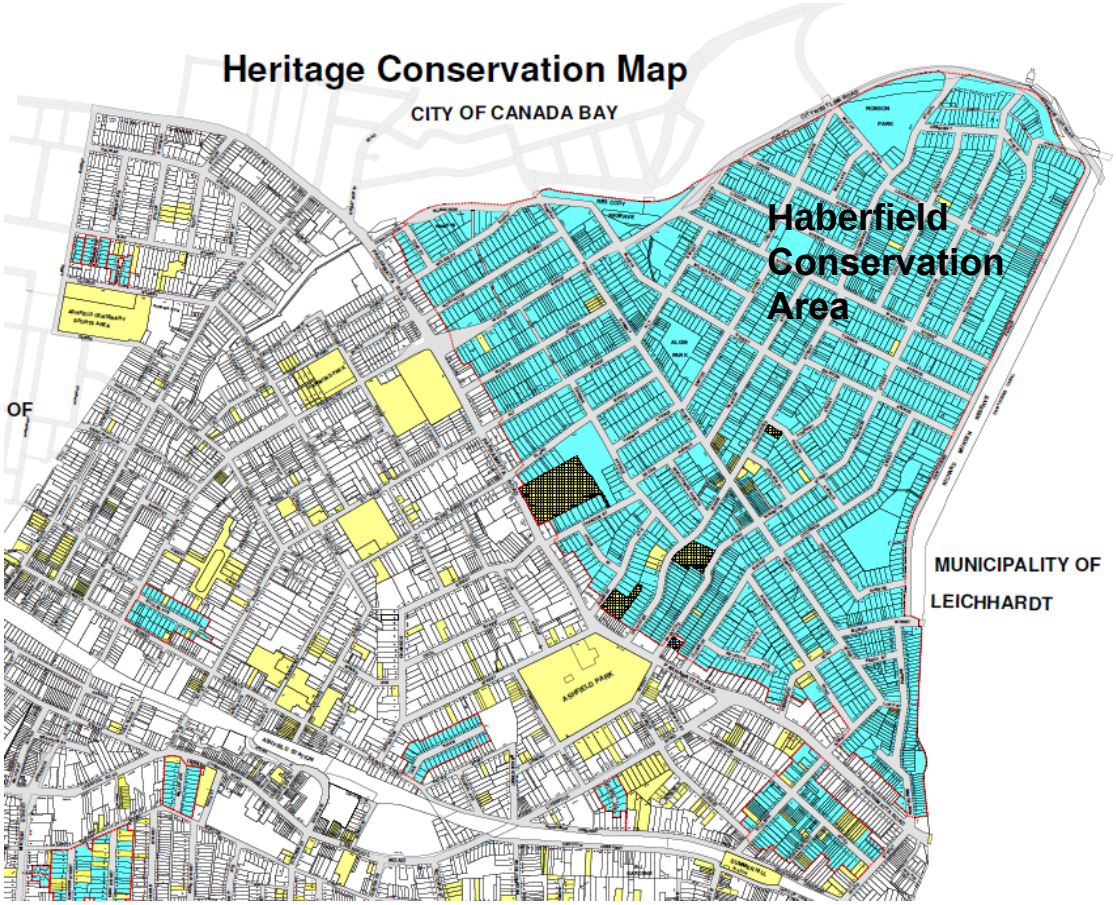

Figure B-2 Ashfield Heritage Conservation Map (2005)

Source: Ashfield Council, 2005

Figure B-3 displays the heritage items, which are shaded in brown and Powell's Estate Conservation Area (labelled T). Concord Road is outlined in green and the 250 metre curtilage either side of Parramatta Road is dashed in blue.

Figure B-3 Detail from Draft Canada Bay LEP (2013)

Source: Canada Bay Council LEP, 2013

Attachment C1

Fauna species identified within the study area

Type of animal	Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Data source	Likelihood of occurrence	Risk of significant impact
Frog	*Crinia tinnula*	Wallum Froglet		V	Atlas of NSW Wildlife	Low	No
Frog	*Heleioporus australiacus*	Giant Burrowing Frog	V	V	Atlas of NSW Wildlife, EPBC	Low	No
Frog	*Litoria aurea*	Green and Golden Bell Frog	V	E	Atlas of NSW Wildlife, EPBC	Moderate	Moderate
Frog	*Litoria brevipalmata*	Green-thighed Frog		V	Atlas of NSW Wildlife	Low	No
Frog	*Litoria littlejohni*	Littlejohn's Tree Frog, Heath Frog	V	V	Atlas of NSW Wildlife, EPBC	Low	No
Frog	*Litoria raniformis*	Southern Bell Frog	V	E	EPBC	Low	No
Frog	*Mixophyes balbus*	Stuttering Frog	V	E	Atlas of NSW Wildlife, EPBC	Low	No
Frog	*Mixophyes iteratus*	Giant Barred Frog	E	E	EPBC	Low	No
Frog	*Pseudophryne australis*	Red-crowned Toadlet		V	Atlas of NSW Wildlife	Low	No
Bird	*Actitis hypoleucos*	Common Sandpiper	M		Atlas of NSW Wildlife	Low	No
Bird	*Anthochaera phrygia (syn. Xanthomyza phrygia)*	Regent Honeyeater	EM	CE	Atlas of NSW Wildlife, EPBC	Low	No
Bird	*Apus pacificus*	Fork-tailed Swift	M		EPBC	Moderate	Low
Bird	*Ardea ibis*	Cattle Egret	M		Atlas of NSW Wildlife, EPBC	Moderate	Low
Bird	*Ardea modesta*	Eastern Great Egret	M		EPBC	Moderate	Low
Bird	*Arenaria interpres*	Ruddy Turnstone	M		Atlas of NSW	Low	No

Type of animal	Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Data source	Likelihood of occurrence	Risk of significant impact
					Wildlife, EPBC		
Bird	*Botaurus poiciloptilus*	Australasian Bittern		E	Atlas of NSW Wildlife, EPBC	Low	No
Bird	*Burhinus grallarius*	Bush Stone-curlew		E	Atlas of NSW Wildlife	Low	No
Bird	*Cacatua leadbeateri*	Major Mitchell's Cockatoo		V	Atlas of NSW Wildlife	Low	No
Bird	*Calidris acuminata*	Sharp-tailed Sandpiper	M		Atlas of NSW Wildlife, EPBC	Low	No
Bird	*Calidris alba*	Sanderling	M	V	Atlas of NSW Wildlife, EPBC	Low	No
Bird	*Calidris bairdii*	Baird's Sandpiper	M		Atlas of NSW Wildlife	Low	No
Bird	*Calidris canutus*	Red Knot	M		Atlas of NSW Wildlife, EPBC	Low	No
Bird	*Calidris ferruginea*	Curlew Sandpiper	M	E	Atlas of NSW Wildlife, EPBC	Low	No
Bird	*Calidris mauri*	Western Sandpiper	M		Atlas of NSW Wildlife	Low	No
Bird	*Calidris melanotos*	Pectoral Sandpiper	M		Atlas of NSW Wildlife	Low	No
Bird	*Calidris ruficollis*	Red-necked Stint	M		Atlas of NSW Wildlife, EPBC	Low	No
Bird	*Calidris tenuirostris*	Great Knot	M	V	Atlas of NSW Wildlife, EPBC	Low	No
Bird	*Callocephalon fimbriatum*	Gang-gang Cockatoo		V	Atlas of NSW Wildlife	Low	No
Bird	*Calyptorhynchus lathami*	Glossy Black-Cockatoo		V	Atlas of NSW Wildlife	Low	No
Bird	*Charadrius bicinctus*	Double-banded Plover	M		EPBC	Low	No

Type of animal	Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Data source	Likelihood of occurrence	Risk of significant impact
Bird	*Charadrius leschenaultii*	Greater Sand Plover	M	V	Atlas of NSW Wildlife, EPBC	Low	No
Bird	*Charadrius mongolus*	Lesser Sand Plover	M	V	Atlas of NSW Wildlife, EPBC	Low	No
Bird	*Charadrius veredus*	Oriental Plover	M		Atlas of NSW Wildlife, EPBC	Low	No
Bird	*Chlidonias leucopterus*	White-winged Black Tern	M		Atlas of NSW Wildlife	Low	No
Bird	*Chthonicola sagittata (syn. Pyrrholaemus sagittatus)*	Speckled Warbler		V	Atlas of NSW Wildlife	Low	No
Bird	*Circus assimilis*	Spotted Harrier		V	Atlas of NSW Wildlife	Low	No
Bird	*Climacteris picumnus victoriae*	Brown Treecreeper (eastern subspecies)		V	Atlas of NSW Wildlife	Low	No
Bird	*Cuculus opatus (syn. Cuculus saturatus)*	Oriental Cuckoo, Himalayan Cuckoo	M		Atlas of NSW Wildlife	Low	No
Bird	*Daphoenositta chrysoptera*	Varied Sittella		V	Atlas of NSW Wildlife	Low	No
Bird	*Dasyornis brachypterus*	Eastern Bristlebird	E	E	Atlas of NSW Wildlife, EPBC	Low	No
Bird	*Egretta sacra*	Eastern Reef Egret	M		Atlas of NSW Wildlife	Low	No
Bird	*Ephippiorhynchus asiaticus*	Black-necked Stork		E	Atlas of NSW Wildlife	Low	No
Bird	*Epthianura albifrons*	White-fronted Chat		E2	Atlas of NSW Wildlife, Atlas of NSW Wildlife	Low	No
Bird	*Erythrotriorchis radiatus*	Red Goshawk	VM	CE	Atlas of NSW Wildlife, EPBC	Low	No
Bird	*Esacus neglectus*	Beach Stone-curlew		CE	Atlas of NSW	Low	No

Type of animal	Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Data source	Likelihood of occurrence	Risk of significant impact
					Wildlife		
Bird	*Gallinago hardwickii*	Latham's Snipe	M		Atlas of NSW Wildlife, EPBC	Low	No
Bird	*Glossopsitta pusilla*	Little Lorikeet		V	Atlas of NSW Wildlife	Low	No
Bird	*Grantiella picta*	Painted Honeyeater		V	Atlas of NSW Wildlife	Low	No
Bird	*Gygis alba*	White Tern		V	Atlas of NSW Wildlife	Low	No
Bird	*Haematopus fuliginosus*	Sooty Oystercatcher		V	Atlas of NSW Wildlife	Low	No
Bird	*Haematopus longirostris*	Australian Pied Oystercatcher		E	Atlas of NSW Wildlife	Low	No
Bird	*Haliaeetus leucogaster*	White-bellied Sea-Eagle	M		Atlas of NSW Wildlife, EPBC	Moderate	Low
Bird	*Hieraaetus morphnoides*	Little Eagle		V	Atlas of NSW Wildlife	Low	No
Bird	*Hirundapus caudacutus*	White-throated Needletail	M		Atlas of NSW Wildlife, EPBC	Moderate	Low
Bird	*Hydroprogne caspia (syn. Sternia caspia)*	Caspian Tern	M		Atlas of NSW Wildlife	Low	No
Bird	*Ixobrychus flavicollis*	Black Bittern		V	Atlas of NSW Wildlife	Low	No
Bird	*Lathamus discolor*	Swift Parrot	E	E	Atlas of NSW Wildlife, EPBC	Low	No
Bird	*Limicola falcinellus*	Broad-billed Sandpiper	M	V	Atlas of NSW Wildlife, EPBC	Low	No
Bird	*Limosa lapponica*	Bar-tailed Godwit	M		Atlas of NSW Wildlife, EPBC	Low	No
Bird	*Limosa limosa*	Black-tailed Godwit	M	V	Atlas of NSW Wildlife, EPBC	Low	No

Type of animal	Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Data source	Likelihood of occurrence	Risk of significant impact
Bird	*Lophoictinia isura*	Square-tailed Kite		V	Atlas of NSW Wildlife	Low	No
Bird	*Melanodryas cucullata cucullata*	Hooded Robin (South-Eastern)		V	Atlas of NSW Wildlife	Low	No
Bird	*Melithreptus gularis gularis*	Black-chinned Honeyeater (eastern subspecies)		V	Atlas of NSW Wildlife	Low	No
Bird	*Merops ornatus*	Rainbow Bee-eater	M		Atlas of NSW Wildlife, EPBC	Low	No
Bird	*Monarcha melanopsis*	Black-faced Monarch	M		EPBC	Low	No
Bird	*Monarcha trivirgatus*	Spectacled Monarch	M		EPBC	Low	No
Bird	*Myiagra cyanoleuca*	Satin Flycatcher	M		EPBC	Low	No
Bird	*Neophema chrysogaster*	Orange-bellied Parrot	CEM	E	Atlas of NSW Wildlife, EPBC	Low	No
Bird	*Neophema pulchella*	Turquoise Parrot		V	Atlas of NSW Wildlife	Low	No
Bird	*Nettapus coromandelianus*	Cotton Pygmy-Goose		E	Atlas of NSW Wildlife	Low	No
Bird	*Ninox connivens*	Barking Owl		V	Atlas of NSW Wildlife	Low	No
Bird	*Ninox strenua*	Powerful Owl		V	Atlas of NSW Wildlife	Low	No
Bird	*Numenius madagascariensis*	Eastern Curlew	M		Atlas of NSW Wildlife, EPBC	Low	No
Bird	*Numenius minutus*	Little Curlew	M		Atlas of NSW Wildlife, EPBC	Low	No
Bird	*Numenius phaeopus*	Whimbrel	M		Atlas of NSW Wildlife, EPBC	Low	No
Bird	*Pandion cristatus (syn. P. haliaetus)*	Eastern Osprey	M	V	Atlas of NSW Wildlife	Low	No
Bird	*Petroica boodang*	Scarlet Robin		V	Atlas of NSW	Low	No

Type of animal	Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Data source	Likelihood of occurrence	Risk of significant impact
					Wildlife		
Bird	*Petroica phoenicea*	Flame Robin		V	Atlas of NSW Wildlife	Low	No
Bird	*Petroica rodinogaster*	Pink Robin		V	Atlas of NSW Wildlife	Low	No
Bird	*Pezoporus wallicus*	Ground Parrot		V	Atlas of NSW Wildlife	Low	No
Bird	*Phaethon lepturus*	White-tailed Tropicbird	M		Atlas of NSW Wildlife	Low	No
Bird	*Philomachus pugnax*	Ruff	M		Atlas of NSW Wildlife	Low	No
Bird	*Plegadis falcinellus*	Glossy Ibis	M		Atlas of NSW Wildlife	Low	No
Bird	*Pluvialis fulva*	Pacific Golden Plover			Atlas of NSW Wildlife, EPBC	Low	No
Bird	*Pluvialis squatarola*	Grey Plover	M		Atlas of NSW Wildlife, EPBC	Low	No
Bird	*Polytelis swainsonii*	Superb Parrot	V	V	EPBC	Low	Low
Bird	*Ptilinopus superbus*	Superb Fruit-Dove		V	Atlas of NSW Wildlife	Low	No
Bird	*Rhipidura rufifrons*	Rufous Fantail	M		EPBC	Low	No
Bird	*Rostratula australis (syn. R. benghalensis)*	Australian Painted Snipe (Painted Snipe)	VM	E	Atlas of NSW Wildlife, EPBC	Low	No
Bird	*Stagonopleura guttata*	Diamond Firetail			Atlas of NSW Wildlife	Low	No
Bird	*Stictonetta naevosa*	Freckled Duck		V	Atlas of NSW Wildlife	Low	No
Bird	*Tringa brevipes (syn. Heteroscelus brevipes)*	Grey-tailed Tattler	M		Atlas of NSW Wildlife, EPBC	Low	No
Bird	*Tringa glareola*	Wood Sandpiper	M		Atlas of NSW Wildlife	Low	No
Bird	*Tringa incanus (syn. Heteroscelus*	Wandering Tattler	M		Atlas of NSW	Low	No

Type of animal	Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Data source	Likelihood of occurrence	Risk of significant impact
	brevipes)				Wildlife		
Bird	*Tringa nebularia*	Common Greenshank	M		Atlas of NSW Wildlife	Low	No
Bird	*Tringa stagnatilis*	Marsh Sandpiper	E		Atlas of NSW Wildlife, EPBC	Low	No
Bird	*Tryngites subruficollis*	Buff-breasted Sandpiper	M		Atlas of NSW Wildlife	Low	No
Bird	*Tyto longimembris longimembris*	Eastern Grass Owl		V	Atlas of NSW Wildlife	Low	No
Bird	*Tyto novaehollandiae novaehollandiae*	Masked Owl (southern mainland)		V	Atlas of NSW Wildlife	Low	No
Bird	*Tyto tenebricosa*	Sooty Owl		V	Atlas of NSW Wildlife	Low	No
Bird	*Xenus cinereus*	Terek Sandpiper	M	V	Atlas of NSW Wildlife, EPBC	Low	No
Fish	*Epinephelus daemelii*	Black Cod		V	EPBC, DPI	Low	No
Invertebrate	*Meridolum corneovirens*	Cumberland Plain Land Snail		E	Atlas of NSW Wildlife	Low	No
Mammal	*Cercartetus nanus*	Eastern Pygmy-possum		V	Atlas of NSW Wildlife	Low	No
Mammal	*Chalinolobus dwyeri*	Large-eared Pied Bat	V	V	Atlas of NSW Wildlife, EPBC	Low	No
Mammal	*Dasyurus maculatus maculatus*	Spotted-Tailed Quoll (Southern Subspecies)	E	V	Atlas of NSW Wildlife, EPBC	Low	No
Mammal	*Dasyurus viverrinus*	Eastern Quoll		E	Atlas of NSW Wildlife	Low	No
Mammal	*Falsistrellus tasmaniensis*	Eastern False Pipistrelle		V	Atlas of NSW Wildlife	Low	No
Mammal	*Isoodon obesulus*	Southern Brown Bandicoot	E	E	Atlas of NSW Wildlife, EPBC	Low	No
Mammal	*Kerivoula papuensis*	Golden-tipped Bat		V	Atlas of NSW Wildlife	Low	No

Type of animal	Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Data source	Likelihood of occurrence	Risk of significant impact
Mammal	*Miniopterus australis*	Little Bent-wing Bat		V	Atlas of NSW Wildlife	Moderate	Low
Mammal	*Miniopterus schreibersii oceanensis*	Eastern Bent-wing Bat		V	Atlas of NSW Wildlife	Moderate	Low
Mammal	*Mormopterus norfolkensis*	Eastern Free-tail bat		V	Atlas of NSW Wildlife	Moderate	Low
Mammal	*Myotis macropus*	Southern Myotis		V	Atlas of NSW Wildlife	Moderate	Low
Mammal	*Perameles nasuta*	Long-nosed Bandicoot		E2	Atlas of NSW Wildlife	Low	No
Mammal	*Petaurus australis*	Yellow-bellied Glider		V	Atlas of NSW Wildlife	Low	No
Mammal	*Petaurus norfolcensis*	Squirrel Glider		V	Atlas of NSW Wildlife	Low	No
Mammal	*Petrogale penicillata*	Brush-tailed Rock-wallaby	V	E	EPBC	Low	No
Mammal	*Phascolarctos cinereus*	Koala (NSW, ACT & QLD - excluding SE QLD)	V	V	Atlas of NSW Wildlife, EPBC	Low	No
Mammal	*Potorous tridactylus tridactylus*	Long-nosed Potoroo (SE mainland)	V	V	EPBC	Low	No
Mammal	*Pseudomys novaehollandiae*	New Holland Mouse	V		Atlas of NSW Wildlife, EPBC	Low	No
Mammal	*Pteropus poliocephalus*	Grey-headed Flying-fox	V	V	Atlas of NSW Wildlife, EPBC	High	Low
Mammal	*Saccolaimus flaviventris*	Yellow-bellied Sheathtail-bat		V	Atlas of NSW Wildlife	Low	No
Mammal	*Scoteanax rueppellii*	Greater Broad-nosed Bat		V	Atlas of NSW Wildlife	Moderate	Low
Reptile	*Caretta caretta*	Loggerhead Turtle	E	E	EPBC	Low	No
Reptile	*Chelonia mydas*	Green Turtle	VM	V	Atlas of NSW Wildlife, EPBC	Low	No
Reptile	*Dermochelys coriacea*	Leatherback Turtle	EM	E	EPBC	Low	No

Type of animal	Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Data source	Likelihood of occurrence	Risk of significant impact
Reptile	*Eretmochelys imbricate*	Hawksbill Turtle	VM	V	EPBC	Low	No
Reptile	*Hoplocephalus bungaroides*	Broad-headed Snake	V	E	Atlas of NSW Wildlife, EPBC	Low	No
Reptile	*Natator depressus*	Flatback Turtle	VM	V	EPBC	Low	No
Reptile	*Varanus rosenbergi*	Heath Monitor (Rosenberg's Goana)	-	V	Atlas of NSW Wildlife	Low	No

Attachment C2

Flora species identified within the study area

Species name	Family name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Data source[3]	Likelihood of occurrence	Risk of significant impact
Acacia baueri subsp. aspera	Fabaceae (Mimosoideae)			V	Atlas of NSW Wildlife	Low	No
Acacia bynoeana	Fabaceae (Mimosoideae)	Bynoes Wattle	V	E	Atlas of NSW Wildlife, plantnet	Low	No
Acacia gordonii	Fabaceae (Mimosoideae)		E	E	Atlas of NSW Wildlife	Low	No
Acacia prominens	Fabaceae (Mimosoideae)	Gosford Wattle		E2	Atlas of NSW Wildlife	Low	No
Acacia pubescens	Fabaceae (Mimosoideae)	Downy Wattle	V	V	Atlas of NSW Wildlife	Moderate	Low
Acacia terminalis subsp. terminalis	Fabaceae (Mimosoideae)	Sunshine Wattle	E	E	Atlas of NSW Wildlife	Low	No
Allocasuarina glareicola	Casuarinaceae		E	E	Atlas of NSW Wildlife	Low	No
Allocasuarina portuensis	Casuarinaceae		E	E	Atlas of NSW Wildlife	Low	No
Astrotricha crassifolia	Araliaceae	Thick-leaf Star-hair	V	V	Atlas of NSW Wildlife	Low	No
Bothriochloa biloba	Poaceae		V	V	Atlas of NSW Wildlife	Low	No
Caesia parviflora var. minor	Anthericaceae	Small Pale Grass-lily		E	Atlas of NSW Wildlife	Low	No
Caladenia tessellata	Orchidaceae	Thick Lip Spider Orchid	V	E	Atlas of NSW Wildlife	Low	No
Callistemon linearifolius	Myrtaceae	Netted Bottle Brush		V	Atlas of NSW Wildlife, PlantNet	Low	No
Camarophyllopsis kearneyi	Hygrophoraceae			E	Atlas of NSW Wildlife	Low	No

Species name	Family name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Data source[3]	Likelihood of occurrence	Risk of significant impact
Chamaesyce psammogeton	Euphorbiaceae	Sand Spurge		E	Atlas of NSW Wildlife	Low	No
Cryptostylis hunteriana	Orchidaceae		V	V	EPBC Act	Low	No
Cynanchum elegans	Asclepiadaceae	White-flowered Wax Plant	E	E	Atlas of NSW Wildlife	Low	No
Darwinia biflora	Myrtaceae		V	V	Atlas of NSW Wildlife, PlantNet	Low	No
Deyeuxia appressa	Poaceae		E	E	Atlas of NSW Wildlife, EPBC, PlantNet	Low	No
Dichanthium setosum	Poaceae	Bluegrass	V	V	Atlas of NSW Wildlife	Low	No
Dillwynia tenuifolia	Fabaceae (Faboideae)		V	V	Atlas of NSW Wildlife	Low	No
Epacris purpurascens var. purpurascens	Epacridaceae	-		V	Atlas of NSW Wildlife	Low	No
Eucalyptus camfieldii	Myrtaceae	Heart-leaved Stringybark	V	V	Atlas of NSW Wildlife, EPBC	Low	No
Eucalyptus fracta	Myrtaceae			V	Atlas of NSW Wildlife	Low	No
Eucalyptus nicholii	Myrtaceae	Narrow-leaved Black Peppermint	V	V	Atlas of NSW Wildlife	Moderate (planted)	No
Eucalyptus pulverulenta	Myrtaceae	Silver-leaved Gum	V	V	Atlas of NSW Wildlife	Low	No
Eucalyptus scoparia	Myrtaceae		V	E	Atlas of NSW Wildlife	Moderate (planted)	No
Genoplesium baueri	Orchidaceae	Bauers Midge Orchid		V	Atlas of NSW Wildlife, PlantNet	Low	No
Genoplesium plumosum	Orchidaceae		E	CE	Atlas of NSW Wildlife	Low	No
Grammitis stenophylla	Grammitaceae	Narrow-leaf Finger Fern		E	Atlas of NSW	Low	No

Species name	Family name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Data source[3]	Likelihood of occurrence	Risk of significant impact
					Wildlife		
Grevillea caleyi	Proteaceae	Caleys Grevillea	E	E	Atlas of NSW Wildlife, PlantNet	Low	No
Grevillea parviflora subsp. parviflora	Proteaceae	Small-flower Grevillea	V	V	Atlas of NSW Wildlife, EPBC	Low	No
Gyrostemon thesioides	Gyrostemonaceae			E	Atlas of NSW Wildlife	Low	No
Haloragodendron lucasii	Haloragaceae		E	E	Atlas of NSW Wildlife	Low	No
Hibbertia puberula	Dilleniaceae			E	Atlas of NSW Wildlife	Low	No
Hibbertia sp. Bankstown	Dilleniaceae		CE	CE	Atlas of NSW Wildlife, EPBC, PlantNet	Low	No
Hibbertia sp. nov. Menai	Dilleniaceae			E	Atlas of NSW Wildlife	Low	No
Hibbertia superans	Dilleniaceae			E	Atlas of NSW Wildlife	Low	No
Hygrocybe anomala var. ianthinomarginata	Hygrophoraceae			V	Atlas of NSW Wildlife	Low	No
Hygrocybe aurantipes	Hygrophoraceae			V	Atlas of NSW Wildlife	Low	No
Hygrocybe austropratensis	Hygrophoraceae			E	Atlas of NSW Wildlife	Low	No
Hygrocybe collucera	Hygrophoraceae			E	Atlas of NSW Wildlife	Low	No
Hygrocybe griseoramosa	Hygrophoraceae			E	Atlas of NSW Wildlife	Low	No
Hygrocybe lanecovensis	Hygrophoraceae			E	Atlas of NSW Wildlife	Low	No
Hygrocybe reesiae	Hygrophoraceae			V	Atlas of NSW Wildlife	Low	No
Hygrocybe	Hygrophoraceae			V	Atlas of	Low	No

Species name	Family name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Data source[3]	Likelihood of occurrence	Risk of significant impact
rubronivea					NSW Wildlife		
Isotoma sessiliflora (Syn Hypsela sessiliflora)	Lobeliaceae		X	E	PlantNet	Low	No
Lasiopetalum joyceae	Sterculiaceae		V	V	Atlas of NSW Wildlife	Low	No
Leptospermum deanei	Myrtaceae		V	V	Atlas of NSW Wildlife, EPBC	Low	No
Leucopogon exolasius	Epacridaceae	Woronora Beard-heath	V	V	Atlas of NSW Wildlife	Low	No
Maundia triglochinoides	Juncaginaceae	-		V	Atlas of NSW Wildlife	Low	No
Melaleuca deanei	Myrtaceae	Deanes Paperbark	V	V	Atlas of NSW Wildlife, EPBC	Low	No
Microtis angusii	Orchidaceae		E	E	Atlas of NSW Wildlife	Low	No
Pelargonium sp. Striatellum (G. W. Carr 10345), syn. Pelargonium sp., Pelargonium sp. 1	Geraniaceae	Omeo Stork's-bill	E	E	EPBC	Low	No
Persoonia bargoensis	Proteaceae		V	E	Atlas of NSW Wildlife	Low	No
Persoonia hirsuta	Proteaceae	Hairy Geebung	E	E	Atlas of NSW Wildlife	Low	No
Persoonia nutans	Proteaceae	Nodding Geebung	E	E	Atlas of NSW Wildlife, EPBC, PlantNet	Low	No
Pimelea curviflora var. curviflora	Thymelaeaceae		V	V	Atlas of NSW Wildlife, EPBC	Low	No
Pimelea spicata	Thymelaeaceae	Spiked Rice-flower	E	E	Atlas of NSW Wildlife, EPBC, PlantNet	Low	No

Species name	Family name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Data source[3]	Likelihood of occurrence	Risk of significant impact
Pomaderris prunifolia var. prunifolia	Rhamnaceae	Plum-leaf Pomaderris		E2	Atlas of NSW Wildlife	Low	No
Prasophyllum fuscum	Orchidaceae	Slaty Leek Orchid	V	V	Atlas of NSW Wildlife	Low	No
Prostanthera densa	Lamiaceae	Villous Mint-bush	V	V	Atlas of NSW Wildlife, EPBC	Low	No
Prostanthera marifolia	Lamiaceae		CE	CE	Atlas of NSW Wildlife, EPBC	Low	No
Pterostylis saxicola	Orchidaceae	Sydney Plains Greenhood	E	E	EPBC, Atlas of NSW Wildlife	Low	No
Pterostylis sp. Botany Bay	Orchidaceae			E	Atlas of NSW Wildlife	Low	No
Pultenaea aristata	Fabaceae (Faboideae)		V	V	Atlas of NSW Wildlife	Low	No
Pultenaea humilis	Fabaceae (Faboideae)	Dwarf Bush Pea		V	PlantNet	Low	No
Pultenaea pedunculata	Fabaceae (Faboideae)	Matted Bush-pea		E	Atlas of NSW Wildlife, PlantNet	Low	No
Sarcochilus hartmannii	Orchidaceae	Hartmans Sarcochilus	V	V	Atlas of NSW Wildlife	Low	No
Senecio spathulatus	Asteraceae	Coast Groundsel		E	Atlas of NSW Wildlife	Low	No
Streblus pendulinus	Moraceae	Whalebone Tree	E		EPBC	Low	No
Syzygium paniculatum	Myrtaceae	Magenta Lilly Pilly	V	E	Atlas of NSW Wildlife, EPBC	Moderate (planted)	No
Tetratheca glandulosa	Tremandraceae	Glandular Pink-bell	V	V	Atlas of NSW Wildlife, EPBC	Low	No
Tetratheca juncea	Tremandraceae	Black-eyed Susan	V	V	Atlas of NSW Wildlife	Low	No
Thelymitra atronitida	Orchidaceae	Black-hooded Sun Orchid		E	Atlas of NSW Wildlife	Low	No

Species name	Family name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Data source[3]	Likelihood of occurrence	Risk of significant impact
Thelymitra sp. Kangaloon	Orchidaceae	Kangaloon Sun Orchid	CE	CE	EPBC	Low	No
Thesium australe	Santalaceae	Austral Toadflax	V	V	EPBC	Low	No
Triplarina imbricata	Myrtaceae	Creek Triplarina	E	E	Atlas of NSW Wildlife, PlantNet	Low	No
Wahlenbergia multicaulis	**Campanulaceae**	**Tadgells Bluebell**		**E2**	**Atlas of NSW Wildlife**	**Moderate**	**Moderate**
Wilsonia backhousei	Convolvulaceae	Narrow-leafed Wilsonia		V	Atlas of NSW Wildlife, Plantnet	Low	No
Wilsonia rotundifolia	Convolvulaceae	Round-leafed Wilsonia		E	Atlas of NSW Wildlife	Low	No
Zannichellia palustris	Zannichelliaceae	-		E	PlantNet	Low	No

1. Listed as Vulnerable (V), Endangered (E), Critically Endangered (CE) or Extinct (X) under the EPBC Act.
2. Listed as an Endangered Population (E2), Vulnerable (V), Endangered (E) or Critically Endangered (CE) under the TSC Act.
3. EPBC = EPBC Act Protected Matters Search Tool Report

Atlas of NSW Wildlife = Office of Environment and Heritage Bionet Atlas – 10 km buffer of study area
PlantNet = The Royal Botanic Gardens PlantNet database – 10 km buffer of study area