ITEM-4	**NORTHCONNEX - ENVIRONMENTAL IMPACT STATEMENT**
THEME:	Balanced Urban Growth
OUTCOME:	6 Safe, convenient and accessible transport options that enable movement through and within our Shire.
STRATEGY:	6.1 Facilitate the provision of integrated transport alternatives that link residents to their home, places of work and services and facilities.
GROUP:	**STRATEGIC PLANNING**
AUTHOR:	**MANAGER – COMMUNITY PLANNING & SPECIAL INFRASTRUCTURE PROJECTS** MICHAEL LATHLEAN
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EXECUTIVE SUMMARY

The Environmental Impact Statement (EIS) for the NorthConnex tolled motorway tunnel linking the Hills M2 Motorway at West Pennant Hills to the M1 Pacific Motorway (formerly F3 Freeway) at Wahroonga, has been placed on public exhibition. Submissions on the EIS can be received up until 12th September 2014.

The EIS has been assessed by a number of Council officers during the exhibition period and this report provides a history and description of the project, outlines the issues as they relate to The Hills Shire, provides some assessment of those issues and gives recommendations for Council to consider that will assist to mitigate and manage the impacts of the project. Critically, issues surrounding the impacts of air quality, noise and vibration, water management, construction traffic, ecology and built form have been identified in this report.

It is essential that the project delivery incorporates engagement activities that allow the community and other key stakeholders such as the affected Councils to be involved in the project's actual delivery. This will help manage the impacts on residents by providing an opportunity for them to influence and feel part of the project. Community liaison or reference groups similar to other recent major infrastructure projects such as the Westlink M7 Motorway, Hills M2 Motorway widening and North West Rail Link all provide successful models.

HISTORY

1980s DMR/RTA undertakes a study to investigate route options for a road network bounded by the Pacific Highway, Pennant Hills Road, Beecroft Road and Epping Road. Proposed surface route options developed by the study, known as the B2/B3 routes, were abandoned by the NSW Government in 1996 because of environmental impacts on Lane Cove Valley bushland.

1993	Commonwealth Government announces its intention to extend National Highway links across major cities.
January 1994	Commonwealth Government declares the Cumberland Highway – Pennant Hills Road to be considered as the Interim National Highway route through Sydney until an alternative route is available for traffic.
1990s	RTA investigates route options for the Western Sydney Orbital (WSO), now known as the Westlink M7 Motorway. As part of the investigation, a 1993/94 study identified a route that would by-pass Pennant Hills Road and connect the proposed WSO from Dean Park to Mount Colah on the then F3 Freeway. The NSW Government did not adopt the proposal because of high environmental impacts and low traffic demand. However the NSW Government received representations from the community at that time, seeking provision for a link to be made between the then F3 Freeway and the WSO and for relief of traffic pressures on Pennant Hills Road. The WSO replaced most of the Cumberland Highway section of the Interim National Highway south of the Hills M2 Motorway.
December 2000	WSO Environmental Impact Statement recognises a need for a National Standard Highway link between the WSO or the Hills M2 Motorway and the then F3 Freeway, suggesting the need to *'initiate a study into the options for the long term development of a high standard road link between the M2 Motorway and the F3 Freeway.'*
4.01.2001	Commonwealth Government and the NSW Government agree (through a Memorandum of Understanding) to undertake a study to identify a route for the interim National Highway from the then F3 Freeway to the WSO or the Hills M2 Motorway.
8.02.2002	Sinclair Knight Merz (SKM) is contracted by the RTA to identify a preferred option to link the WSO with the then F3 Freeway.
21.05.2002	Briefing by SKM received at Council's Corporate Development & Planning Services Review Committee.
19.08.2003	Further briefing by SKM received at Council's Corporate Development & Planning Services Review Committee. SKM indicates that three broad corridor types are being examined: • Type A corridor included more easterly options that generally formed an extension of the Hills M2 Motorway to the then F3 Freeway • Type B corridors that connected the Sydney orbital between Pennant Hills Road and Dean Park to the then F3 Freeway between Wahroonga and the Hawkesbury River • Type C corridors that included more westerly options which connected the Sydney orbital between Windsor Road and Dean Park with the then F3 Freeway north of the Hawkesbury River.

The Type A corridor included four more detailed options as follows:

- 'Red' corridor alignment which extended from the Hills M2 Motorway at Macquarie Park to the then F3 Freeway at Wahroonga
- 'Yellow' corridor alignment which extended from the Hills M2 Motorway near North Epping to the then F3 Freeway at Wahroonga
- 'Blue' corridor alignment which extended from the Hills M2 Motorway at the Pennant Hills Road interchange to the then F3 Freeway at Wahroonga
- 'Purple' corridor alignment extended from the Hills M2 Motorway at the Pennant Hills Road interchange to the then F3 Freeway at Wahroonga and generally followed the alignment of Pennant Hills Road.

The Committee resolved:

'1. The briefing on the Options for the F3 to Sydney Orbital Link from Sinclair Knight Merz be noted

2. The Director Services Delivery provide a further report after additional investigation and research of all options, to the briefing on options for the F3 to Sydney Orbital Link at the next Council Meeting recommending a preferred option for Councils consideration

3. Council write to all relevant State and Federal Departments, all Local State and Federal Members of Parliament and the Minister for Transport and Regional Services advising them of Councils dissatisfaction regarding the limited exhibition period and request them to support an extension of time to at least mid-October 2003.

4. Once Council has determined it's preferred option all adjoining Councils and WSROC be advised.'

26.08.2003 Report considered by Council following briefing. Council resolved:

'1. Council indicate its preference for the Purple Option (Type A Corridor) for the F3 Sydney Orbital connection with three lanes in either direction and based on the untolled option.

2. The Government be encouraged to further investigate providing a reservation along the Type C Broad Corridor so that the longer term planning of vehicle movements between Western Sydney and the Central/Northern Coast can be adequately planned.

3. Items 1 and 2 be now conveyed to the relevant organisations as set out in the resolution of the 19 August 2003.'

6.05.2004 Commonwealth Government announces its endorsement of the Type A corridor 'Purple' option based on social, environmental and economic grounds as recommended in the SKM Study.

October 2004	Hills Motorway, the then owners of the Hills M2 Motorway, presents a case to DOTARS and the RTA for the Type A corridor 'Yellow' option and requests that the route selection decision between the 'Purple' and the 'Yellow' options be re-opened.
June 2005	Transurban acquires the M2 from Hills Motorway and carries out its own assessment of the 'Purple' and 'Yellow' options.
September 2005	Transurban confirms the assertion made by Hills Motorway that it prefers the Type A corridor 'Yellow' option.
December 2005	Commonwealth Government appoints Masson Wilson Twiney (MWT) to undertake a desktop review of assumptions, models and data used by SKM and Transurban in relation to the Type A corridor 'Purple' and 'Yellow' options.
14.03.2006	Motion moved at Council meeting that: *'A report be prepared and brought back to Council within three (3) months, on recent developments and possibly revised options for the M7-F3-M2 link.'* The Motion was lost.
23.03.2006	MWT submits the Draft Interim Report to the Commonwealth and NSW Governments. It is "interim" on the basis that MWT is awaiting further data from Transurban.
19.02.2007	Commonwealth Government announces that it is establishing an independent review of the corridor selection to be undertaken by the Honourable Mahla Pearlman AO, former Chief Justice of the NSW Land and Environment Court.
12.06.2007	Motion moved at Council meeting that : *'This Council review its current policy on the F3 to M7 link.'* The Motion was carried.
17.07.2007	Council considers a report on options for the F3 to Sydney orbital link and resolved: *'1. Council receive the report.* *2. Council strongly indicate to the Federal and State Governments that it supports the "C" Option being built as National Highway No. 1 - the Sydney Orbital Freeway and be Toll Free, as soon as possible.* *3. Council co-operate with all agencies to facilitate the construction as a matter of urgency.'*
August 2007	Pearlman Review released recommending that the Type A 'Purple' option should be the preferred route and should progress to the next stage of design and development.
March 2012	NSW Government receives an unsolicited proposal from Transurban to design, build, operate, maintain and finance a tolled motorway linking the Hills M2 Motorway at West Pennant Hills to the M1 Pacific Motorway at Wahroonga, based on the Type A 'Purple' corridor option.

14.05.2013	Commonwealth Government announces it would contribute $405 million to help deliver the project in partnership with the NSW Government in the 2013-14 Budget.
30.05.2013	NSW Government announces the proposal had progressed to Stage 3 of the unsolicited process, which would include a competitive tender to select a design and construction contractor.
8.08.2013	NSW Minister for Roads and Ports announces that three consortia have been invited to tender for the project. The consortia were Thiess John Holland Joint Venture, Lend Lease Bouygues Joint Venture and GlobalLink Joint Venture consisting of Ghella Pty Ltd and Acciona Infrastructure Australia Pty Ltd. The tendering period closed at the end of November 2013.
25.10.2013	NSW Minister for Planning and Infrastructure declares the project to be 'Critical State Significant Infrastructure' under the *Environmental Planning and Assessment Act 1979* providing environmental, economic and social benefits for NSW.
29.10.2013	Director General of the former Department of Planning & Infrastructure releases the Director General's Environmental Assessment Requirements (DGRs) for the project. These requirements must be addressed in the EIS.
15.10.2013	Initial briefing on NorthConnex at Councillor Workshop by project team.
16.03.2014	Lend Lease Bouygues joint venture announced as the preferred contractor. The tenderers were assessed in terms of innovation, cost effectiveness and environmentally responsible design.
11.04.2014	Amended DGRs released.
2.05.2014	Further briefing on NorthConnex at Councillor Workshop by project team
15.07.2014	EIS placed on public exhibition.
5.08.2014	Further briefing on NorthConnex EIS at Councillor Workshop by project team.

REPORT

1. PROJECT BACKGROUND

Roads and Maritime Services (RMS) is proposing to construct a tolled motorway tunnel, known as NorthConnex, linking the Hills M2 Motorway at West Pennant Hills to the M1 Pacific Motorway at Wahroonga. The route of the motorway is based on the Type A 'Purple' corridor option which largely follows the existing Pennant Hills Road alignment.

A plan of the proposed route is shown in Figure 1.

NorthConnex is a key recommendation of the NSW Government's 2012 '*NSW Long Term Transport Masterplan'* and is consistent with other strategic planning and policy documents at both a Commonwealth and State level including, but not limited to:

- *'The Nation Building Program'*
- *'The White Paper, Auslink: Building our National Transport Future'*
- *'National road Safety Strategy 2011-2020'*
- *'NSW 2021 – A Plan to Make NSW Number One'*
- *'NSW State Infrastructure Strategy'*
- *'Draft Metropolitan Strategy for Sydney to 2031'*
- *'NSW Freight and Ports Strategy'*

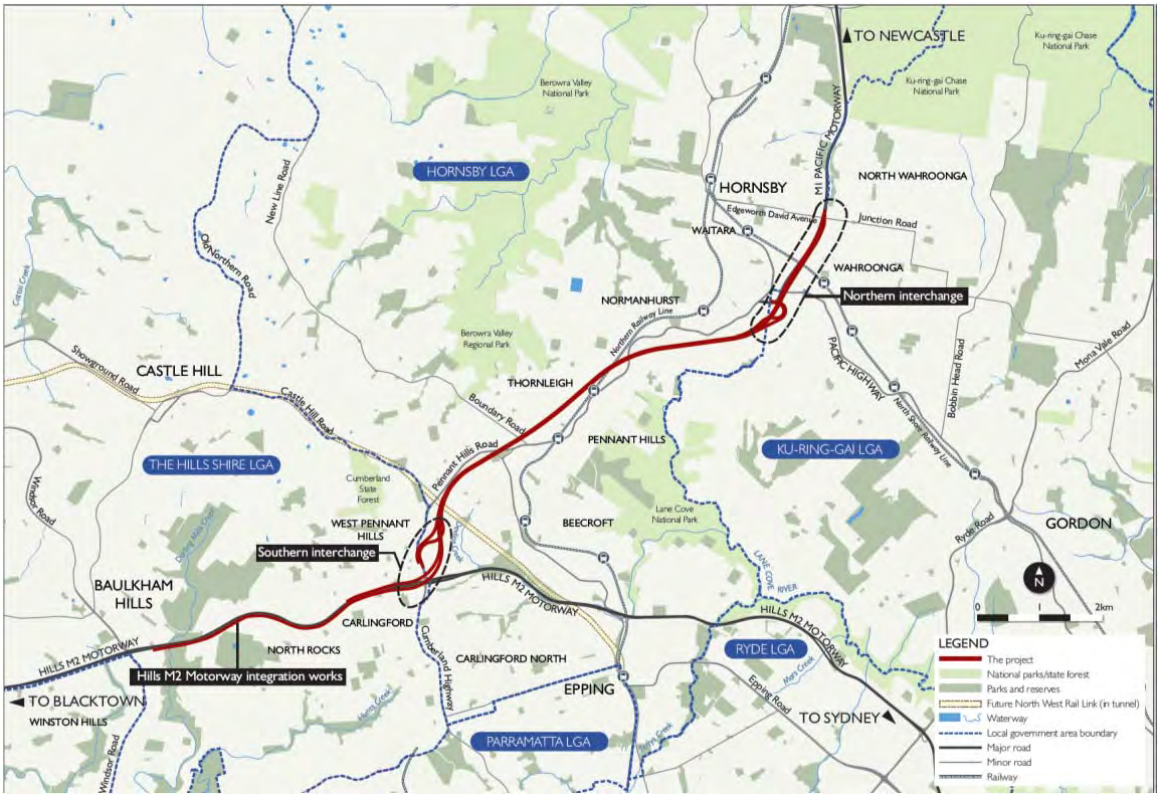


Figure 1: Local context of the project (source: EIS)

The project is based on an unsolicited proposal from Transurban and the Westlink M7 shareholders to construct, operate and maintain the project. The Commonwealth and NSW Government have each committed up to $405 million to the project. The remainder of the cost of the project would be funded by Transurban and the Westlink M7 shareholders and would be recouped from tolls on the project and changes to tolling for heavy vehicles on some Sydney motorways. The proposed toll on the project would be generally consistent with the tolling structure on the Hills M2 Motorway.

On 16th March 2014 Transurban announced that subject to planning approval and finalisation of a contract, the Lend Lease Bouygues consortium had been selected as the preferred contractor for the project. Construction is anticipated to commence in early 2015 and is expected to take around four years to complete with an additional nine months of commissioning works.

An indicative construction program for the entire project is shown in Figure 2.

The project will result in a high standard motorway that integrates with the regional transport network providing the following benefits:

- provision of an efficient and effective National Land Transport Network connection through Sydney delivering improved efficiency for national freight carriers and long distance transport operators;
- improvements to travel connections and reliability of Pennant Hills Road for motorists, road based public transport and cyclists;
- improvements to local amenity and connectivity for people living, working and travelling along Pennant Hills Road due to decreases in traffic volumes and the associated reductions in air and noise emissions;
- improvements to road safety along Pennant Hills Road;
- serving the current and future growth needs of long distance travel, particularly freight.

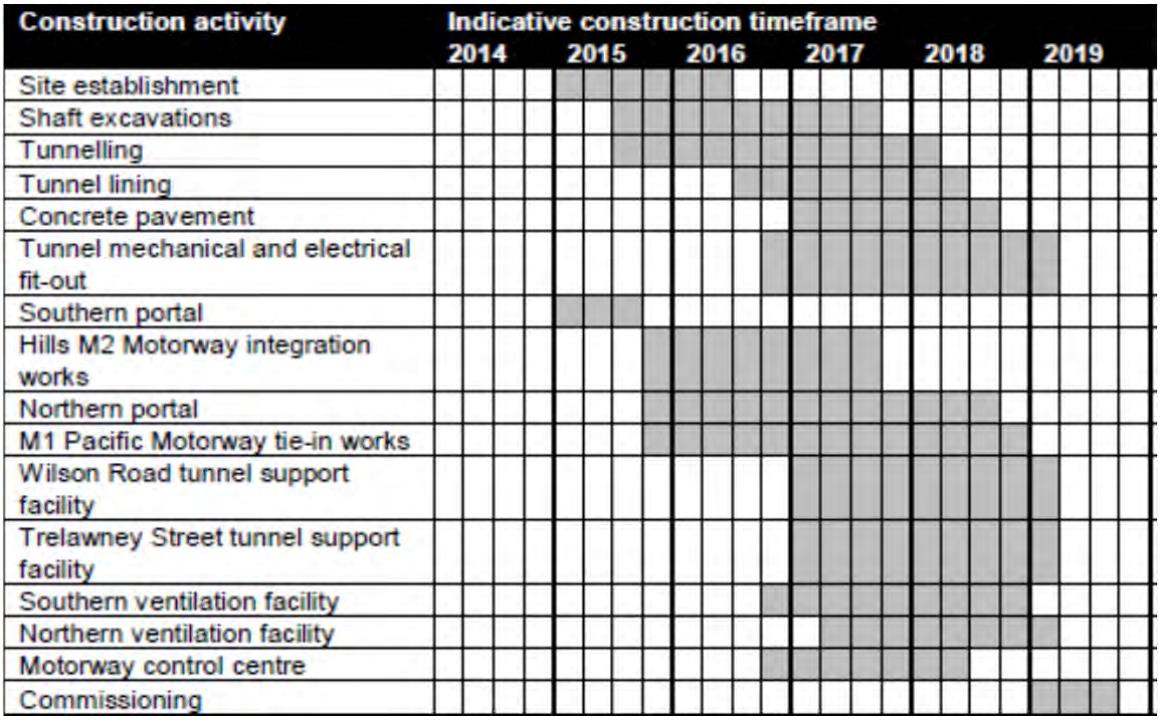


Figure 2: Indicative construction program (source: EIS)

Following the submission of an application by RMS, on 25th October 2013 the project was declared as 'Critical State Infrastructure' under Part 5.1 of the *Environmental Planning & Assessment Act 1979* through *Environmental Planning Policy (State and Regional Development) 2011* (SRD SEPP). The Director General's environmental assessment

requirements (DGRs) for the project were issued on 29th October 2013 and then re-issued on 11th April 2014 to include the Hills M2 Motorway integration works.

Before major work can commence on the project, a detailed environmental impact assessment must be undertaken and approved by the Minister for Planning and Environment in conjunction with the final project approval.
The project will be delivered through a design and construct contract aimed at achieving an innovative, cost effective and environmentally responsive design. The design has evolved through the environmental assessment process to determine the preferred design which is presented in the Environmental Impact Statement (EIS). The EIS has considered the presence of a toll on the project.

The EIS examines the following key issues and includes strategies to avoid, mitigate and manage potential impacts during both construction and operation of the project:

- traffic
- noise and vibration
- air quality
- urban design, Landscape character and visual amenity
- biodiversity
- social and economic
- hydrogeology and soils
- surface water
- heritage
- other matters.

The key issues of relevance to The Hills Shire are discussed later in the report along with recommendations to mitigate and manage the impacts.

Public exhibition of the EIS commenced on 15th July 2014 and concludes on 12th September 2014. Full copies of the EIS have been made available for viewing on both the Department of Planning and Environment and NorthConnex websites, with hardcopies also available for viewing at a number of locations including Council's Administration Centre and at the Baulkham Hills Library. In addition, the project team established a Community Information Centre at Pennant Hills and have conducted regular community information sessions at various locations prior to and during the EIS exhibition process.

2. EXISTING STRATEGIC CONTEXT

Council's Integrated Transport Direction was adopted by on 11th May 2010 and provides the strategic context for planning and management of the Shire's transport system and its development to 2031. It identifies a package of transport improvements considered vital to the development of the Hills and the North West region and provides a framework for responding to federal, state and other local government transport policy and projects. The Direction has an emphasis on improving public transport connectivity within the Shire and to the wider metropolitan network and to address and alleviate existing traffic congestion.

A key infrastructure requirement identified within the Direction is a connection between the M7 and F3 (now M1). The Direction sets out that the preferred option of Council be a westerly connection between M7 at Dean Park and F3 at Kariong. This is the former Type C Option as identified in the 2004 F3 to Sydney Orbital Link Study (Figure 3).

Despite being previously supported in government studies for long term investigation this corridor has not been identified in government transport policy such as the *NSW Long Term Transport Master Plan* (2012). Rather, the *NSW Long Term Transport Master Plan* and more recently the *NSW Freight and Transport Strategy* (2013) identify an 'Outer Sydney Orbital' a broad north-south motorway link which would link the M1 to the Hume Highway without a direct link to the M7.

Council will need to continue to lobby government to commence corridor protection and planning of the Type C Option as a long term strategic transport need. Planning for the Type C Corridor is consistent with the outcomes of the 2007 Pearlman Review of the F3 to M7 Corridor Selection process. The review recommended that whilst a Type A tunnel would provide relief from congestion on Pennant Hills Road in the medium term, planning for a Type C Corridor should commence to cater for long term strategic transport demand.

In this regard it is important to note the EIS identifies the Outer Sydney Orbital as being informed by the Type C Corridor and the outcomes of the Pearlman Review. The potential orbital route as suggested is however substantially different given it would connect with the Hume Highway rather than directly to the M7 therefore reducing opportunity to address demand from future housing and employment growth within the Shire and wider North West region.

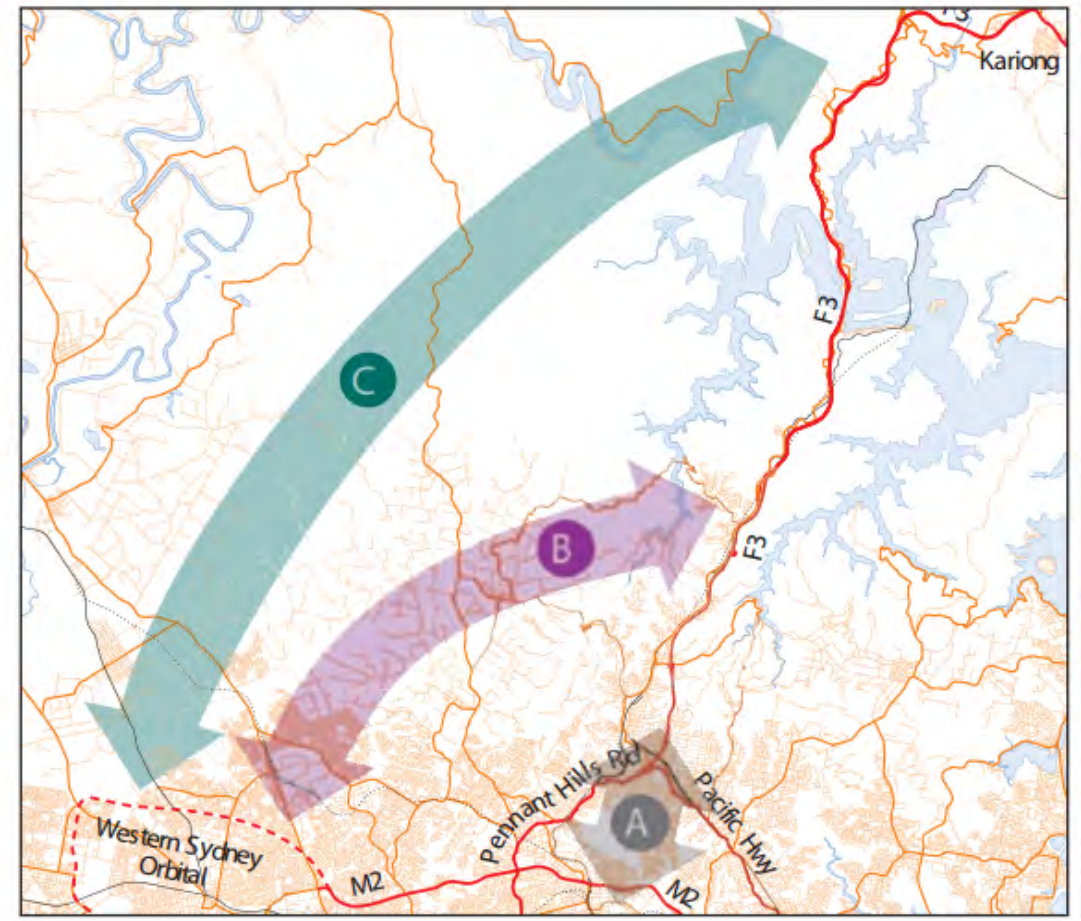


Figure 3: M7 to F3 (now M1) corridor (source: SKM Study 2004)

3. PROJECT NEED

3.1 Existing Road Network Conditions

According to the EIS, Sydney's strategic motorway and arterial road network supports economic growth across the entire metropolitan area by connecting people to jobs, and facilitating trade between businesses. It also supports freight movements to, from and through Sydney. The majority of commercial transport demand in NSW and south-eastern Australia is serviced by road freight, with Sydney being identified in the 2004 SKM Study as being the most common point of either origin or destination. As Sydney's population and economy continue to grow, efficient transport systems will become increasingly important in servicing future growth.

The Draft Metropolitan Strategy recognises the importance of strengthening these connections within Sydney and beyond, including the need to improve these connections to the north for freight and passengers.

Following the completion of the Westlink M7 Motorway, the connection between the Hills M2 Motorway and the M1 Pacific Motorway represents an important 'missing link' in Sydney's motorway network. This has required traffic travelling to, from or through Sydney to share the section of Pennant Hills Road between the M2 Hills Motorway and the M1 Pacific Motorway. This includes traffic travelling to or from major cities and centres intrastate and interstate, such as the Central Coast and Newcastle, Brisbane and Melbourne.

Pennant Hills Road between the Hills M2 Motorway and the M1 Pacific Motorway is part of the AusLink National Network (National Land Transport Network). This is a network of roads that provides connections between all mainland states and territories of Australia.

The primary objectives of the National Land Transport Network are to facilitate overseas and interstate trade, support regional development and allow safe and reliable access to major population centres. Projects to improve road safety and freight efficiency have been completed or are being implemented along the network between Brisbane, Sydney, Canberra and Melbourne. This section of Pennant Hills Road is one of the two remaining sections of the National Land Transport Network within Sydney that is not of a motorway standard. The other is King Georges Road, located in southern Sydney.

Apart from its strategic role in the road network, Pennant Hills Road provides local access for residents and businesses along the route, and services bus connections for commuters accessing local destinations or train stations at Pennant Hills, Thornleigh and Hornsby. Cyclists and pedestrians also travel along Pennant Hills Road.

As a result, Pennant Hills Road not only services a mix of trip purposes and functions, but also carries high volumes of traffic. Due to the combination of the topography, land use constraints, traffic volume and mix, and frequent traffic lights along Pennant Hills Road between the Hills M2 Motorway and the M1 Pacific Motorway, the current Pennant Hills Road alignment is geometrically undesirable, compromising both safety and efficiency.

Although Sydney currently has a comprehensive heavy rail network, it needs to be enhanced to cater for some of the additional transport demand generated by its growing population. Significant investment in rail-based freight and passenger

transport is required with the Epping to Thornleigh Third Track (ETTT), South West Rail Link (SWRL) and the North West Rail Link (NWRL) projects currently underway.

Although the ETTT and NWRL projects in particular will play an important role in servicing the corridor, the 2004 SKM Study found that public transport alone and in particular rail transport, were unlikely to satisfy future growth in transport demand. As traffic volumes grow, there will be greater pressure to improve the efficiency of the National Land Transport Network to service expanding commercial centres and cater for local and district freight transport demands and in doing so, support the State's economy.

3.2 Existing Traffic Conditions

Between the Hills M2 Motorway at West Pennant Hills and the M1 Pacific Motorway at Wahroonga, Pennant Hills Road operates as an arterial road and currently has 21 signalised intersections, many of which are capacity constrained. It also has a posted speed limit of 70 kph.

Pennant Hills Road carries large volumes of traffic with two way average annual daily traffic (AADT) in 2011 of about 80,000 vehicles per day (Infrastructure NSW, 2012). Given the road's importance as a national freight corridor, a large proportion of these vehicles are heavy vehicles.

According to the RMS's 2013 Road Performance Report, travel speeds along Pennant Hills Road are:

- between 23 kph and 43 kph with an average of 31 kph during the morning peak. This compares to an average for Sydney arterial roads of 41 kph;
- between 30 kph and 40 kph with an average of 35 kph during the evening peak. This compares to an average for Sydney arterial roads of 42 kph.

This data indicates that congestion on Pennant Hills Road is leading to relatively low travel speeds when compared to other arterial roads.

Heavy traffic flows and congestion along Pennant Hills Road during commuter peak periods and business hours results in low average peak travel speeds, unreliable travel times and disruptions to inter-regional traffic movements. The resultant detrimental social and environmental effects, including community severance, traffic noise and exhaust emissions, are becoming increasingly unacceptable. Pennant Hills Road, which is already operating at or beyond capacity during peak periods, is expected to experience continued traffic growth in the future.

One of the desired outcomes of the project is to improve travelling conditions on Pennant Hills Road and the surrounding network. The project would provide an alternative route for travel between the Hills M2 Motorway and the M1 Pacific Motorway, especially for inter-regional freight traffic. As such, a number of traffic related benefits are anticipated along Pennant Hills Road between the Hills M2 Motorway and the M1 Pacific Motorway including:

- a daily reduction of approximately 5,000 heavy vehicle movements on Pennant Hills Road;
- improved traffic flow and intersection performance;
- reduced crash rates;
- improved road safety for pedestrians, cyclists and motorists;
- improved travel times for bus services and motorists.

3.3 Road Safety

As stated in the EIS, traffic congestion is often associated with poor road safety performance.

Between 1st July 2008 and 30th June 2013, the section of Pennant Hills Road between the Hills M2 Motorway and the Pacific Highway had a total of 980 crashes, with one fatal and 342 injury crashes. The rate of crashes per km of road was significantly higher on this stretch of road when compared to Sydney's motorways.

Impacts associated with road accidents include economic costs such as medical costs, property damage and vehicle costs, as well as social costs such as decreased quality of life and family pain and suffering.

One of the desired outcomes of the project is to improve travelling conditions on Pennant Hills Road and the surrounding road network. Improvements in road safety would be delivered through the provision of a safe, reliable motorway that acts to reduce interaction between heavy vehicles and other road users.

3.4 Existing Public Transport, Pedestrian and Cyclist Facilities

A number of bus services currently operate along Pennant Hills Road between the Hills M2 Motorway and the M1 Pacific Motorway, with bus stops at regular intervals in both directions. Efficiency of these services is currently limited by high levels of congestion along this section of Pennant Hills Road, particularly during peak commuter periods. In alleviating congestion along Pennant Hills Road, the project would result in improvements to the reliability and accessibility of public transport.

Pedestrian footpaths are provided along the length of Pennant Hills Road, with regular crossings via signalised intersections as well as four pedestrian overpasses. With the exception of a short section around the Pennant Hills Road / Castle Hill Road intersection and the Pennant Hills Road / Hills M2 Motorway interchange, there are no dedicated cyclist facilities along this section of Pennant Hills Road. Peak congestion, heavy traffic flows and the presence of large numbers of heavy vehicles reduces amenity and in turn reduces use of Pennant Hills Road by cyclists and pedestrians. The project would contribute towards a reduction in the number of heavy vehicles using Pennant Hills Road, resulting in improvements in local amenity. It is anticipated that these improvements in amenity would encourage greater use of existing infrastructure by pedestrians and cyclists.

4. PROJECT DESCRIPTION

4.1 Project Scope

The key features of the project include:

- twin motorway tunnels up to around nine kilometres in length with two trafficable lanes and one breakdown lane in each direction, with the width of each tunnel being sufficient for it to be converted to three lanes if required in the future;
- a southern interchange with the Hills M2 Motorway and Pennant Hills Road, including sections of tunnel for on-ramps and off-ramps;
- integration works with the Hills M2 Motorway including alterations to the eastbound carriageway to accommodate traffic leaving the Hills M2 Motorway to connect to the project travelling northbound, and the provision of a new

westbound lane on the Hills M2 Motorway extending through to the Windsor Road off-ramp;
- a northern interchange with the M1 Pacific Motorway and Pennant Hills Road, including sections of tunnel for on-ramps and off-ramps, which also facilitate access to and from the Pacific Highway;
- tie-in works with the M1 Pacific Motorway extending to the north of Edgeworth David Avenue;
- a motorway control centre located within The Hills Shire near the southern interchange on the corner of Eaton Road and Pennant Hills Road, that includes operation and maintenance facilities;
- two tunnel support facilities including air intake systems that draw fresh air into the tunnel if required as part of the tunnel ventilation system, emergency smoke extraction outlets and substations at Wilson Road, Pennant Hills and Trelawney Street, Thornleigh;
- ventilation outlets at the southern and northern interchanges where fresh air is drawn in from outside the tunnel entry portal and combined with tunnel air before it is emitted into the atmosphere via the outlet where it is further diluted and dispersed. No filtered ventilation systems are proposed as part of the project.
- other ancillary facilities for motorway operation including electronic tolling facilities, signage and fire and life safety systems including emergency evacuation infrastructure;
- temporary site compounds and associated works to facilitate construction of the project.

Construction activities would generally include:
- commencement of enabling and temporary works, including construction power, water supply, site establishment, demolition works, property and utility adjustments and public transport modifications (if required);
- construction of the road tunnels, interchanges, intersections and roadside infrastructure;
- haulage of spoil generated during tunnelling and excavation activities;
- fit-out of the road tunnels and support infrastructure, including ventilation and emergency response systems;
- construction and fit-out of the motorway control centre and ancillary operations buildings;
- realignment, modification or replacement of surface roads, bridges and/or underpasses;
- implementation of environmental management and pollution control facilities for the project.

4.2 The Completed Project

The completed project overlaid on aerial photographs along the alignment, is attached (Attachment 1).

4.2.1 Tunnel Alignment

The main alignment tunnels would consist of twin motorway tunnels around 9km in length with separate northbound and southbound carriageway tunnels.

The main alignment tunnels would vary in size and shape to accommodate local geology. However, these tunnels would generally have an excavated cross-sectional area of around 110m^2, with a height of 8m and a width of around 14m. After tunnel lining and fit-out, the cross-section area would be around 75m^2. Figure 4 provides an indicative cross-section of the main alignment tunnels.

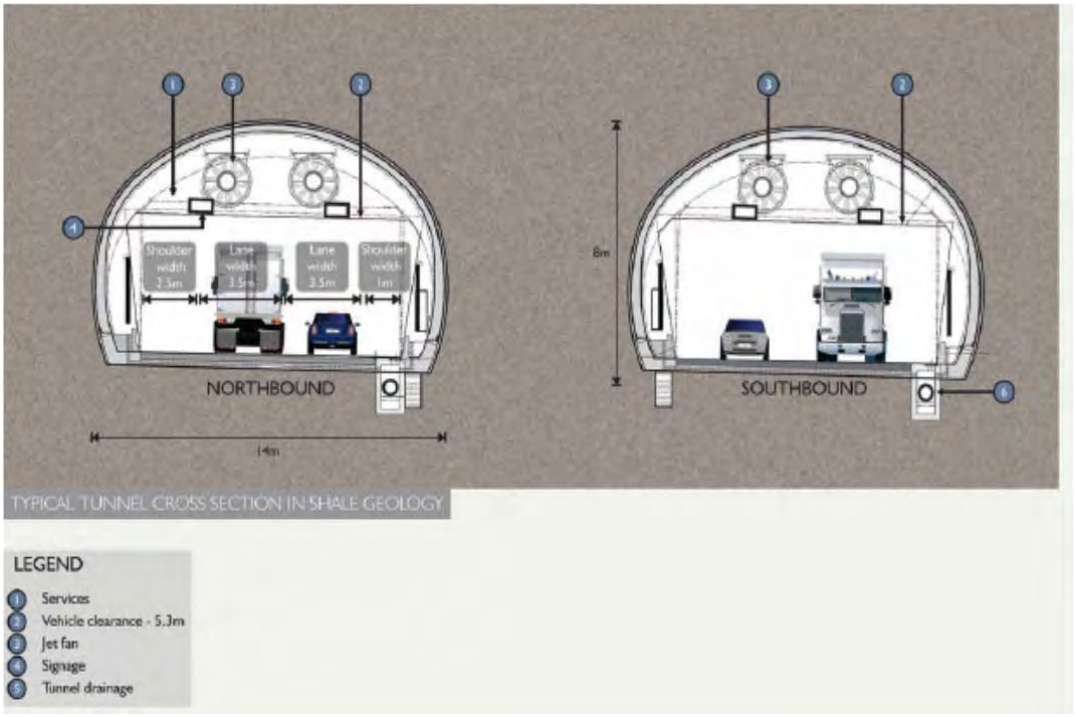


Figure 4: Indicative cross-section of the main alignment tunnels (source: EIS)

The main alignment tunnels would extend from the southern connection with the Hills M2 Motorway around the existing Pennant Hills Road / Hills M2 Motorway interchange (the southern interchange) to the northern connection with the M1 Pacific Motorway at Wahroonga (the northern interchange).

From the Hills M2 Motorway the main alignment tunnels would dive from the motorway shoulders beneath Pennant Hills Golf Course. The tunnels would continue on the southern side of Pennant Hills Road before crossing beneath Pennant Hills Road near Observatory Park. From here the tunnels would continue on the northern side of Pennant Hills Road before crossing back near the Trelawney Street intersection. The tunnels would then remain on the southern side of Pennant Hills Road before crossing under the Pacific Highway and following the M1 Pacific Motorway alignment northwards to emerge onto the shoulders of the M1 Pacific Motorway north of the North Shore railway line and Alexandria Parade, Wahroonga.
On-ramps and off-ramps for the northern and southern interchanges would include sections of tunnel to provide connections from the main alignment tunnels to existing surface roads. On and off-ramp tunnels would also vary in size and shape in response to local conditions. However, these tunnels would generally have a cross sectional area of around 80m^2, with a height of around 8m and a width of around 10m.

4.2.2 Road Grade and Lane Widths

The main alignment tunnels would generally have a maximum grade of 3.5 percent to cater for consistent travel speeds. The absolute maximum grade of the main alignment tunnels would be four per cent, and the absolute minimum grade

would be 0.5 percent. Surface road grades would be compliant with standard Austroads and RMS design parameters.

Each main alignment carriageway would consist of two lanes with a posted speed limit of 80kph. Each lane would be 3.5m wide with the shoulder on the left hand side being 2.5m wide and the shoulder on the right hand side being 1.0m wide.

Although each carriageway would be line marked for two lanes, the motorway tunnels would be constructed to enable retrofitting to three lanes if required in the future. The minimum vertical clearance of each tunnel would be 5.3m which is considerably greater than other motorway tunnels in the Sydney metropolitan area.

On-ramps and off-ramps would have a lane width of 3.5m, a left side shoulder of 2.0m, and a right side shoulder of 1.0m. Surface ramps would have a lane width of 3.5m. Lane widths of surface roads proposed to be altered by the project would be as existing, or as per Austroads and RMS design parameters.

4.2.3 Intersections and Interchanges

A northern and a southern interchange would be constructed at either end of the main alignment tunnels to enable connections to and from the Hills M2 Motorway and Pennant Hills Road in the south and to the M1 Pacific Motorway, Pennant Hills Road and the Pacific Highway in the north.

Southern Interchange

The southern interchange would be located near the existing intersection of the Hills M2 Motorway / Pennant Hills Road at West Pennant Hills. The interchange would provide connections to and from the project with the Hills M2 Motorway and Pennant Hills Road. Existing movements catered for at the Hills M2 Motorway intersection with Pennant Hills Road would be maintained. To enable these new connections, surface road works along Pennant Hills Road immediately north of the Hills M2 Motorway would be required. Works along the Hills M2 Motorway for connection to the project tunnel portals would also be required.

Portals to the northbound on-ramp and southbound off-ramp along Pennant Hills Road would be located south of Eaton Road. Motorists exiting the main alignment tunnels at this location would be able to continue travelling south along Pennant Hills Road or turn left onto the eastbound carriageway of the Hills M2 Motorway.

Motorists travelling north along Pennant Hills Road or exiting the westbound carriageway of the Hills M2 Motorway would be able to utilise the on-ramp to travel north on the project. The main alignment tunnel portals would emerge adjacent to the shoulders of the Hills M2 Motorway to the west of Pennant Hills Road providing an uninterrupted connection between the Hills M2 Motorway.

Northern Interchange

The northern interchange would be located near the intersection of the M1 Pacific Motorway and Pennant Hills Road at Wahroonga. The northern interchange would connect the project with the M1 Pacific Motorway and Pennant Hills Road to enable traffic to travel north, south or east. In addition to this, the northern interchange would provide connections for traffic on or from Pennant Hills Road and the Pacific Highway to continue travel via these existing roads.

Portals to the southbound on-ramp and northbound off-ramp for Pennant Hills Road would be located to the east of Pennant Hills Road within the median of the Pennant Hills Road / M1 Pacific Motorway connector. This would require a widened section of road between these portals and Pennant Hills Road. This design approach has been adopted to minimise the need for permanent alterations to existing roadways and traffic arrangements.

Motorists exiting the main alignment at this location would be able to turn right at the M1 Pacific Motorway / Pennant Hills Road signalised intersection and access the
Pacific Highway northbound or eastbound at Pearce's Corner.

Motorists travelling along Pennant Hills Road northbound or southbound would be able to access the main alignment southbound or the M1 Pacific Motorway northbound by turning at the M1 Pacific Motorway / Pennant Hills Road intersection.

Access to the main alignment from the Pacific Highway southbound and westbound would be facilitated by joining Pennant Hills Road at Pearce's Corner, then turning left at the M1 Pacific Motorway / Pennant Hills Road intersection where the portal and ramp would merge with the southbound tunnel.

The portals of the main alignment tunnels would emerge in the shoulders of the M1
Pacific Motorway to the north of Alexandria Parade in the vicinity of Bareena Avenue, Wahroonga.

4.2.4 Ventilation System and Facilities

The ventilation system for both north-bound and south-bound tunnels would maintain appropriate air quality that is protective of the health and amenity of motorists within the tunnels during normal operation and emergency conditions. The tunnel ventilation systems would comprise jet fans, two emergency smoke extraction outlets and two ventilation facilities. No filtration system is proposed on either of the ventilation facilities.

During operation the ventilation system would draw fresh air into the tunnels and emit air from within the tunnels via two ventilation facilities. One of the ventilation facilities would be located near the northern tunnel portal and one would be located
near the southern tunnel portal within the southern interchange facility. The project does not currently propose portal emissions from the main alignment tunnels. However according to the EIS this approach may be considered in future and would be subject to appropriate assessment and approval.

A plan showing the location of the ventilation and tunnel support facilities at the southern interchange is shown in Figure 4. Key components of the project's ventilation system are described in Table 1.

During emergency conditions, depending on the location of the incident, the ventilation system would extract smoke from the tunnel which would be emitted from one or more of the following locations:

- the southern ventilation facility
- Wilson Road tunnel support facility

- Trelawney Street tunnel support facility
- the northern ventilation facility
- the tunnel portals

Ventilation system component	Description
Jet fans	• Jet fans would be mounted in pairs, with each pair separated by a distance of around 90 metres. • A total of around 65 jet fans would be installed in the northbound tunnel and ramps and around 60 jet fans in the southbound tunnel and ramps. • Jet fans would be located throughout the tunnel and would operate on an as required basis to maintain in tunnel air quality requirements.
Emergency smoke extraction outlets	• Two emergency smoke extraction outlets would be required, one located on the corner of Wilson Road and Pennant Hills Road (at the Wilson Road tunnel support facility), and one on the corner of Trelawney Street and Pennant Hills Road (at the Trelawney Street tunnel support facility) (refer to **Figure 5-13**). • Each tunnel support facility would have a maximum exhaust capacity of around 400 cubic metres per second to generate a net flow of around five metres per second along the tunnel. • Each tunnel support facility would consist of four horizontally mounted bidirectional axial fans, each with an exhaust capacity of around 135 cubic metres per second. • Emergency smoke extraction requirements could be achieved with three fans, with the fourth fan on standby. • During low traffic conditions, the tunnel support facilities would be used to supply additional fresh air to the tunnels.
Ventilation facilities	• Two ventilation facilities would be required – one near the northern and the other near the southern main alignment tunnel portals (refer to **Figure 5-13**). • Each ventilation facility would have a maximum exhaust capacity of around 700 cubic metres per second. • Ventilation facilities would consist of five horizontally mounted axial fans, each with an exhaust capacity of around 175 cubic metres per second. • Total ventilation requirements could be achieved with four fans, with the fifth fan on standby. However, during normal operation it is possible that all five fans could be operated at reduced capacity. • Both the southern ventilation outlet and the northern ventilation outlet would each be around 15 metres in height.

Table 1: Key components of the project's ventilation system (source: EIS)
The tunnel ventilation system would be operated in three principal modes:

- normal traffic conditions
- low speed traffic conditions
- emergency conditions

Operation of the ventilation system under each of these conditions is detailed in Figure 5.

Normal Traffic Conditions

During normal operation the tunnel would be 'longitudinally ventilated' which involves fresh air being drawn in from the tunnel entry portals and through the tunnels by a vehicle generated piston effect (the suction created behind a moving vehicle which pulls air through the tunnel) and pushed toward the tunnel exit

portals. Near the exit portals, tunnel air would be drawn upwards into ventilation facilities with ventilation fans prior to discharge to the environment via a 15m high discharge point.

For the tunnel off-ramps, air would be drawn back down the ramp for extraction via the ventilation facility. This would require jet fans (used to accelerate the movement of air through the tunnel) to maintain the air flow against the direction of traffic flow. A similar approach would be applied to parts of the main alignment tunnels close to the exit portals.

In-tunnel air, containing vehicle emissions, would be extracted from the tunnels prior to reaching the exit portals. Air would be exhausted via a ventilation take off (intake) and transferred to the ventilation facility via a vertical shaft (ventilation outlet). The air would then be discharged at high velocity from the ventilation facility to the atmosphere to achieve effective dispersion of the tunnel air.

In the case of the south-bound tunnel, emissions would be collected at a location directly beneath the south-western corner of Pennant hills golf course and conveyed through a separate ventilation tunnel to the ventilation outlet at the southern end of the motorway control centre.

Low Speed Traffic Conditions

During low speed traffic conditions the vehicle generated piston effect would be lessened. In these situations the airflow may need to be assisted by the tunnel jet fans located throughout the tunnels. Under these conditions, additional fresh air may need to be supplied to the main alignment tunnels via the reverse flow operation of the axial fans in the two tunnel support facilities.

The operation of axial fans in the ventilation facilities would be increased to ensure that acceptable air quality is maintained in the tunnels and to achieve effective dispersion of tunnel air following discharge to the atmosphere.

Based on forecast traffic volumes, low speed conditions are only likely to occur in the event of an incident within the tunnels.

Emergency Conditions

The two emergency smoke extraction outlets at the tunnel support facilities would principally function to maintain air quality in the tunnels in the unlikely event of an emergency. As a secondary feature, these facilities would also supply fresh air to the tunnels during low speed traffic conditions (discussed above).

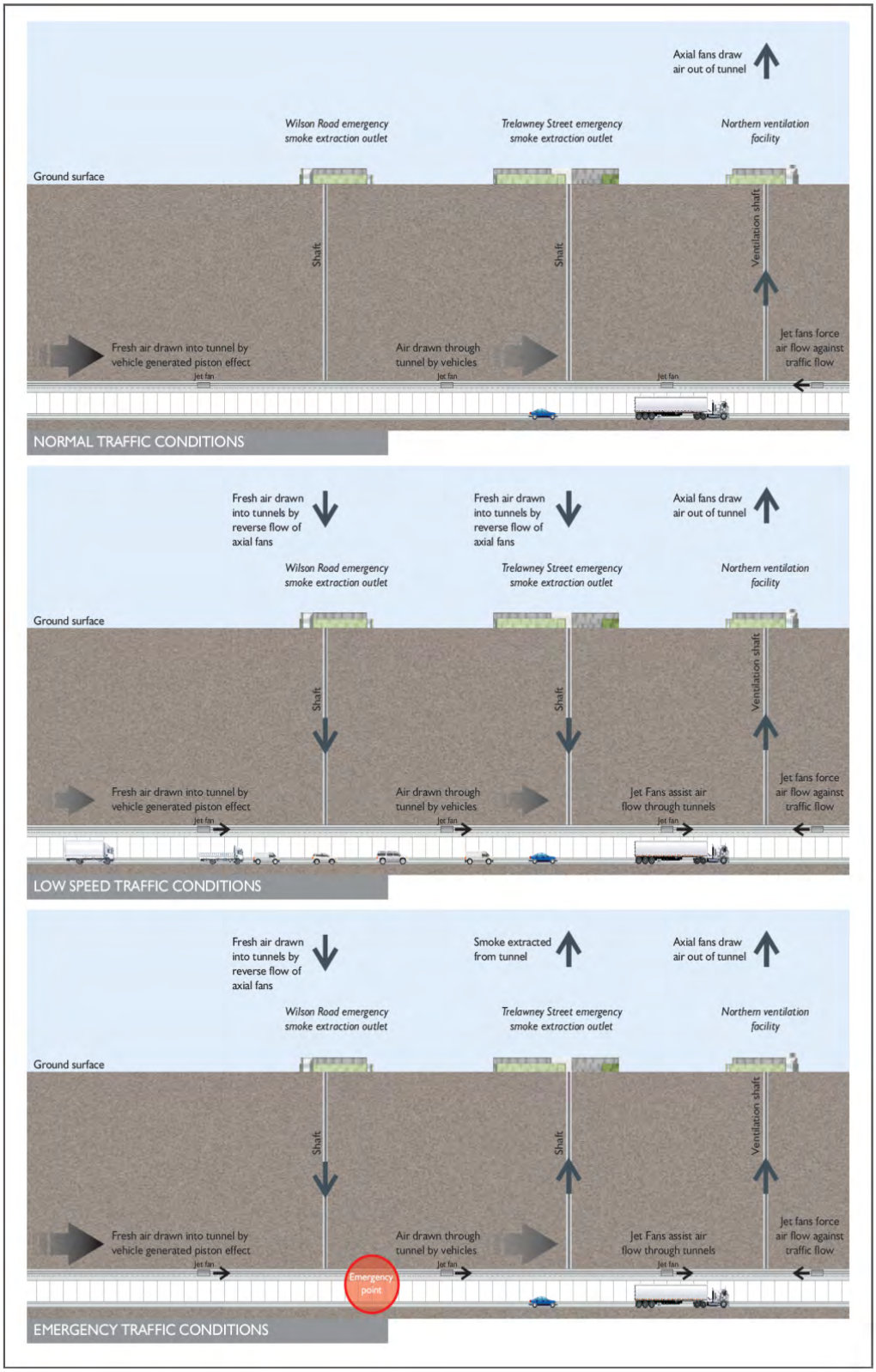


Figure 5: Indicative tunnel ventilation system (northbound tunnel arrangement) (source: EIS)

During smoke control, air would be extracted from the tunnel and transferred to the emergency smoke extraction outlet via a vertical shaft. The smoke would then be discharged from the outlet to the atmosphere.

The emergency smoke extraction outlets are expected to operate infrequently for the extraction of smoke during an emergency and for a short duration while emergency services and tunnel fire and life safety systems bring the situation under control.

4.2.5 Motorway Control Centre

The project would involve construction and operation of a 24 hour staffed motorway control centre, located near the southern interchange on the corner of Pennant Hills Road and Eaton Road (Figure 6). Around 30 full-time equivalent staff would work at the site, of which about 26 would be located at the motorway control centre on a full-time basis. The motorway control centre would include facilities necessary for the monitoring, maintenance and control of tunnel services including tunnel safety, ventilation, power, lighting and other road systems required for the safe and efficient operation of the main alignment tunnels.

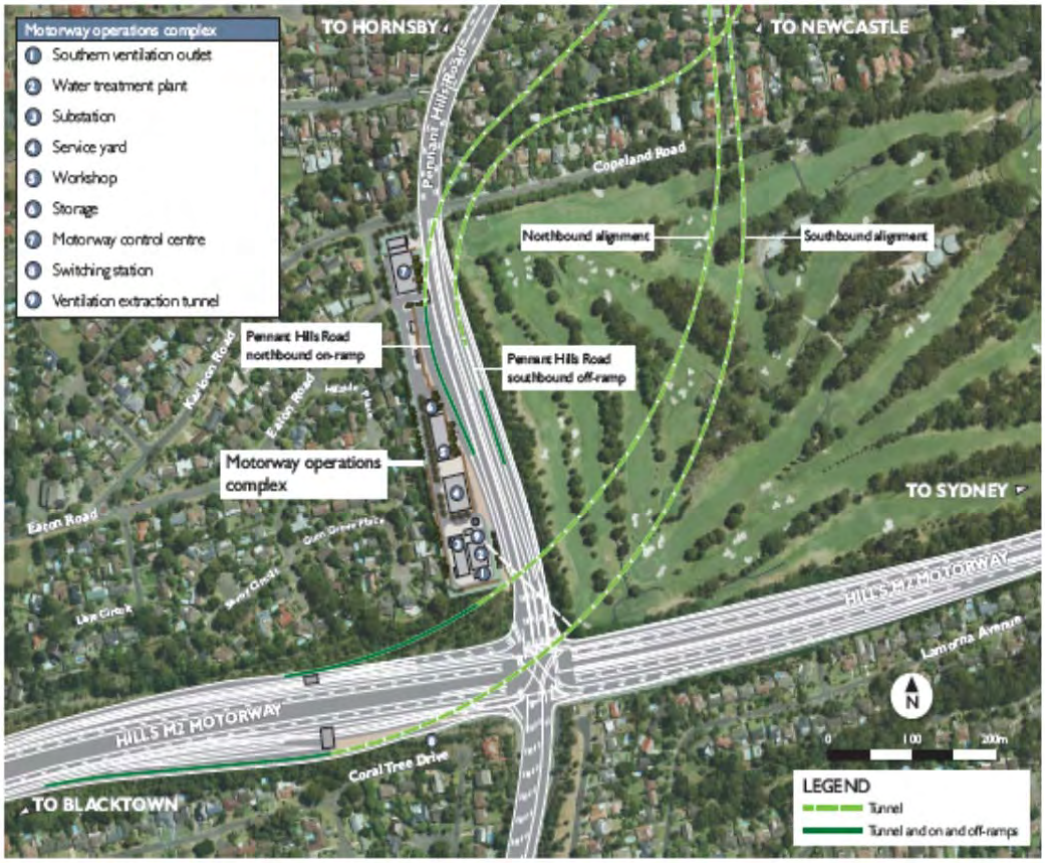


Figure 6: Motorway control centre, ventilation and tunnel support facilities (source: Southern Interchange Fact Sheet NorthConnex website)

Facilities would include a tunnel control room, training and incident response room, workshop space, emergency vehicle depot, garage and parking facilities (around 30 spaces for staff and visitors).

Urban design principles and landscaping would be employed to integrate the motorway control centre into the surrounding streetscape and minimise its visual impact.

4.2.6 Drainage

The proposed drainage system has been designed to prevent additional adverse effects on private properties in the 100 year ARI storm event.

Tunnel Drainage

As the main alignment tunnels are proposed to be drained tunnels, there would be an ongoing inflow of groundwater into the tunnel. This would require the project to accommodate the capture, removal, treatment and discharge of groundwater during the operational phase. The tunnel drainage system and treatment plant would also manage deluge system water (as part of the fire and life safety system) in the unlikely event of an emergency in the tunnels.

The tunnel drainage system would flow to a sump with a capacity of $420m^3$, located at the southern interchange. Water would then be pumped from the sump to a treatment plant for treatment and discharge to the local stormwater system. The sump would contain capacity for accidental spillage up to 50,000 litres.

The final arrangement would be determined as part of the detailed design.

Surface Drainage

Surface works at the portals, the Hills M2 Motorway integration and the M1 Pacific Motorway tie-in are located in areas managed by existing drainage infrastructure.

The project would increase the amount of impervious surface and the catchment area of this drainage infrastructure. This would necessitate the following alterations and / or augmentations to the existing drainage infrastructure:

- demolition and reconstruction of pits and pipes;
- alterations to four existing operational detention basins adjacent to the Hills M2 Motorway;
- alterations to the Pennant Hills Road drainage system to provide capacity for a 20 year ARI storm event, including increasing the size of the existing Pennant Hills Road detention basin and collection of the first flush for the one year ARI storm event;
- extension of five transverse drainage culverts on the Hills M2 Motorway;
- provision for water quality treatment of a one year ARI storm event around the northern interchange using gross pollutant traps and oil / water separators;
- provision of spillage containment tanks around the northern interchange, with a capacity of 50,000 litres;
- a new transverse drainage culvert under the M1 Pacific Motorway / Pennant Hills Road connector to act as a relief culvert for a probable maximum flood event.

Additionally, surface ancillary facilities would require connections to third party stormwater systems.

4.2.7 Bridges and Viaducts

Modifications would be required to the following three existing bridges to accommodate the Hills M2 Motorway integration:

- Yale Close overbridge would be widened by around 3.5m. The existing bridge is a single span bridge around 32m wide.
- Barclay Road overbridge would be lengthened by around four metres. The existing bridge is a two span bridge around 48 metres long.
- Darling Mill Creek viaduct would be widened by around 3.5m. The existing bridge is a five span bridge around 32m wide.

Three cycleway bridges would be constructed as part of the project. The new cycleway bridges would provide a grade separated connection across the on and off ramps of the main alignment connection to the Hills M2 Motorway and the on-ramp of the main alignment connection to the M1 Pacific Motorway. The cycleway bridges would be around 2.5m wide and would vary in number of spans depending on the location and local topographical conditions. The cycleway bridges would be located at:

- the southern interchange from the Hills M2 Motorway across the westbound off-ramp of the project;
- the southern interchange from the Hills M2 Motorway across the eastbound on-ramp of the project;
- the northern interchange from the M1 Pacific Motorway across the southbound on-ramp of the project.

A grade separated connection across the off-ramp of the main alignment connection to the M1 Pacific Motorway would also be provided at the northern ventilation facility.

4.2.8 Connections to Existing Roads

The Hills M2 Motorway

As part of the project, modifications to the Hills M2 Motorway would be undertaken west of Pennant Hills Road to enable southbound traffic from the project to merge safely with existing westbound traffic on the motorway (Attachment 2). These works, which would extend for a distance of around 3.5 kilometres west of the Pennant Hills Road interchange to the existing Windsor Road off-ramp, would include:

- an additional westbound lane on the Hills M2 Motorway;
- widening of Yale Close bridge and Darling Mill Creek viaduct;
- lengthening of Barclay Road overbridge.

Minor alterations would also be required to allow eastbound traffic from the Hills M2 Motorway to leave the motorway and join the northbound carriageway of the project.

M1 Pacific Motorway

To provide connection to the project, modifications to the M1 Pacific Motorway beyond the northern interchange would be required. The works would extend around 200 metres north of Edgeworth David Avenue in Wahroonga.

Surface works along the M1 Pacific Motorway would generally involve widening of the road surface for the merge and diverge to and from the main alignment tunnels.

4.2.9 Changes to the Local Road Network

A number of changes would be required to local roads to facilitate the surface works associated with the project. Changes to the local road network would be required at both the southern and northern interchanges. Surface road works at the southern and northern interchange are outlined below.

Southern Interchange

Local road changes around the southern interchange would include:

- widening of Pennant Hills Road to accommodate the southbound tunnel off-ramp and the northbound tunnel on-ramp;
- temporary provision of an additional right-turn lane at Eaton Road for the purpose of construction heavy vehicle traffic access to Pennant Hills Road. This would also involve adjustments to traffic signals at this intersection.

Details are shown in Figure 7.

Northern Interchange

Local road changes around the northern interchange would include:

- widening of Pennant Hills Road northbound (at Pearce's Corner) to create a
  permanent additional right-turn lane onto the Pacific Highway;
- widening of the M1 Pacific Motorway / Pennant Hills Road connector to accommodate tunnel on and off-ramps;
- repositioning of the Hewitt Avenue cul-de-sac to accommodate the widened
  M1 Pacific Motorway / Pennant Hills Road connector.

4.2.10 Public Transport Opportunities

A number of public transport services currently operate along the Pennant Hills Road corridor. Numerous bus services operate along Pennant Hills Road in between the M1 Pacific Motorway and Hills M2 Motorway, with frequent services operating during peak hours. The corridor is serviced by the high-frequency, high-capacity Metrobus service M60, as well as numerous services connecting the corridor to the central business district, Castle Hill and Dural.

The Northern Railway Line stations at Pennant Hills, Thornleigh and Normanhurst are also located along the corridor. North West Rail Link, although close in

proximity to the Pennant Hills Road corridor, is expected to service a separate catchment area. As a result, strong demand for integrated bus and rail services along Pennant Hills Road will continue beyond the delivery of the North West Rail Link in 2019.

The NorthConnex project is expected to attract through-traffic away from Pennant Hills Road and into the tunnels, including a large number of heavy vehicles. This is expected to reduce congestion and free up road space, providing opportunities to implement improvements to the operation of bus services and local traffic movements.

RMS and Transport for NSW have carried out a preliminary assessment of the public transport improvements that could be delivered due to a reduction in traffic congestion on Pennant Hills Road.

Sydney's Bus Future

Sydney's Bus Future (Transport for NSW, 2013) is a 20 year bus plan that sets out to deliver a simpler, faster and better bus network for customers. Specific to Pennant Hills Road, Sydney's Bus Future targets the corridor as part of a bus rapid route between Hornsby and Baulkham Hills (via Castle Hill).

Pennant Hills Road has been targeted for bus priority treatment to address bus pinch points along the road, including around Boundary Road. In conjunction with this, Sydney's Bus Future includes an action to investigate opportunities for improved bus public transport along Pennant Hills Road, consistent with the project objective.

Sydney's Bus Future proposes that rapid bus routes would form a backbone to the new bus network in Sydney, offering fast and reliable bus travel for customers between major centres. The rapid bus routes would include 'turn up and go' services that would operate at least every ten minutes between 6 am and 7 pm on weekdays and every 15 minutes on weekends. Bus stops would be placed around every 800 metres to one kilometre.

As part of a rapid bus rapid, Pennant Hills Road would provide high quality public transport services which would support growth areas, be integrated with the North West Rail Link, and give the road greater integration in the cross-metropolitan network.

Public Transport Opportunities on Pennant Hills Road

Specific actions to improve bus services along Pennant Hills Road may include:

- signal re-phasing, or changing the pattern of traffic signals at key intersections, to ease traffic flows across Pennant Hill Road by focusing on longer stopping time for through traffic and increased entry time for side traffic;
- bus stop relocations along the corridor to be closer to intersections, taking advantage of the additional stopping time created by signal re-phasing to reduce overall journey time;
- bus priority measures at key intersections to provide better bus reliability;
- more frequent bus services on Pennant Hills Road in the event that congestion levels are lowered following the delivery of the project.

Preliminary work has identified a number of traffic control improvements that could be made at specific intersections along Pennant Hills Road. These intersections tend to contribute to slow peak speeds, and hence would benefit from treatments to deliver bus priority measures and improve cross traffic flows across Pennant Hills Road. Cross traffic is not expected to change greatly with the delivery of the project. Targeted intersection improvements could help improve public transport services along the corridor as well as local traffic movements. These improvement opportunities have been identified in Table 2.

A number of other transport improvements along Pennant Hills Road could be delivered in the medium-term to long-term. Such opportunities could include:

- reconfiguring the bus route network to take advantage of easier crossing of the corridor at junctions, in alignment with Sydney's Bus Future strategy;
- linking the wide transport network better with railway stations in the area;
- improving walking and cycling infrastructure along and across the corridor.

4.2.11 Heavy Vehicle Regulation

As stated previously, Pennant Hills Road between the Hills M2 Motorway and the M1 Pacific Motorway forms part of the National Land Transport Network, and is one of the two remaining sections of the Network within Sydney that is not of a motorway standard.

The project would be an alternative and more efficient route for travel between the Hills M2 Motorway and the M1 Pacific Motorway, improving access, connectivity and reliability of inter-regional freight across the greater Sydney area. It is expected that this would be an incentive for heavy vehicle operators to use the project rather than Pennant Hills Road to travel between the Hills M2 Motorway and the M1 Pacific Motorway.

Measures may also be implemented to achieve the objectives of the project. These may take the form of regulatory measures on the surrounding road network, including introducing, or changing the operation of existing, traffic control facilities, advisory and / or regulatory signage, route designations, notices, application of permits, or other traffic measures. Any regulatory measures that have the effect of regulating heavy vehicles would need to be consistent with the objectives of the National Heavy Vehicle Law, where applicable.

Some of these options may attract a penalty for non-compliance, for certain classes of heavy vehicles using the surrounding road network. Where these options are under consideration, this would need to include consideration of the appropriate method of enforcement. Enforcement measures might include structures upon which equipment such as cameras might be mounted.

Location	Opportunities identified
Along Pennant Hills Road	• Signal re-phasing. • Additional bus services. • Relocation of bus stops.
Boundary Road	• Longer right-turn phase for buses turning right from Pennant Hills Road onto Boundary Road. • Bus queue jump' for buses turning left onto Pennant Hills Road.
Beecroft Road	• 'Bus queue jump' for buses travelling south on Pennant Hills Road.
Cardinal Avenue	• Longer right-turn phase for buses turning right onto Pennant Hills Road. • Longer right-turn phase for buses turning right onto Cardinal Avenue.
Castle Hill Road	• 'Bus queue jump' for through buses travelling south on Pennant Hills Road. • Longer right-turn phase for southbound buses turning right onto Castle Hill Road. • 'Bus queue jump' for through buses travelling north on Pennant Hills Road.
Railway Street	• Longer right-turn phase for buses turning right onto Pennant Hills Road.
Aiken Road	• Longer right-turn phase for buses turning right onto Pennant Hills Road.
Phyllis Avenue	• 'Bus queue jump' for buses travelling north on Pennant Hills Road.
Comenarra Parkway	• 'Bus queue jump' for buses travelling south on Pennant Hills Road.

Table 2: Summary of public transport improvement opportunities (source EIS)

The project may include provision of gantries, for measurement of vehicular traffic.
Where feasible, consideration would be given to integrating the equipment in the motorway operations complex. Possible locations for these gantries are likely to be at the southern end (near Hannah Street around 850m north of the Hills M2 Motorway) and the northern end of Pennant Hills Road to the east of Dartford Road, adjacent to Kenley Park, Thornleigh. These locations minimise light impacts from vehicle detection systems on adjacent properties. The final locations of gantries or other regulatory measures would be determined during detailed design based on the outcomes of detailed site investigations.

4.2.12 Provision for Pedestrians and Cyclists

The introduction of new infrastructure would necessitate the permanent alteration of pedestrian footpaths, cycle lanes and bus stops. However, all existing functionality and available movements would be retained during the operational phase of the project.

4.2.13 Utility Services

A number of utilities are located within or near the project including electricity, telecommunications (including optic fibre cables), sewer and water mains. Utilities would need to be relocated, adjusted or protected where they may be affected by

the construction of the project. Further work would be carried out during detailed design to confirm the exact impacts on utilities, and permanent relocations that may be required.

The project would require connection to mains power and water supply for the safe and efficient operation of the tunnel.

Electricity

Electricity supply infrastructure would be installed to supply power to the main alignment tunnels and associated mechanical and electrical equipment. It is essential that electrical power to tunnels be uninterrupted for ventilation and other safety reasons. As such, two sources of supply would be required; each rated to supply the full load of the tunnel electrical system.

The power supply would be two 66kV feeders supplied via a new switching station that would be located on the south-west side of the Pennant Hills Road / Hills M2 Motorway interchange. The feeders would connect to a project supply substation on the other side of the motorway where the power supply would be stepped down to 22kV. From the project supply substation, power would be reticulated to another six substations along the project.

Of the total of seven project substations, three would be located underground and four would be located aboveground (incorporated into other operational ancillary facilities). In the event that both services of supply are not available, a power system comprising batteries or backup diesel generators would provide power for essential loads for at least 30 minutes. Essential loads would include:

- communications and monitoring equipment;
- computer facilities;
- tunnel signage;
- emergency power outlets;
- closed circuit television;
- emergency lighting evenly distributed along the tunnel.

Water

Mains water supply would be required during operations for the deluge system and for the maintenance of landscaping associated with the surface facilities. The primary water source for fire suppression would include two water tanks, each with a capacity of 1,220m^3 located at the northern end (within the northern ventilation facility) and a third water tank of 450m^3 at the southern end of the project (within the motorway control centre).

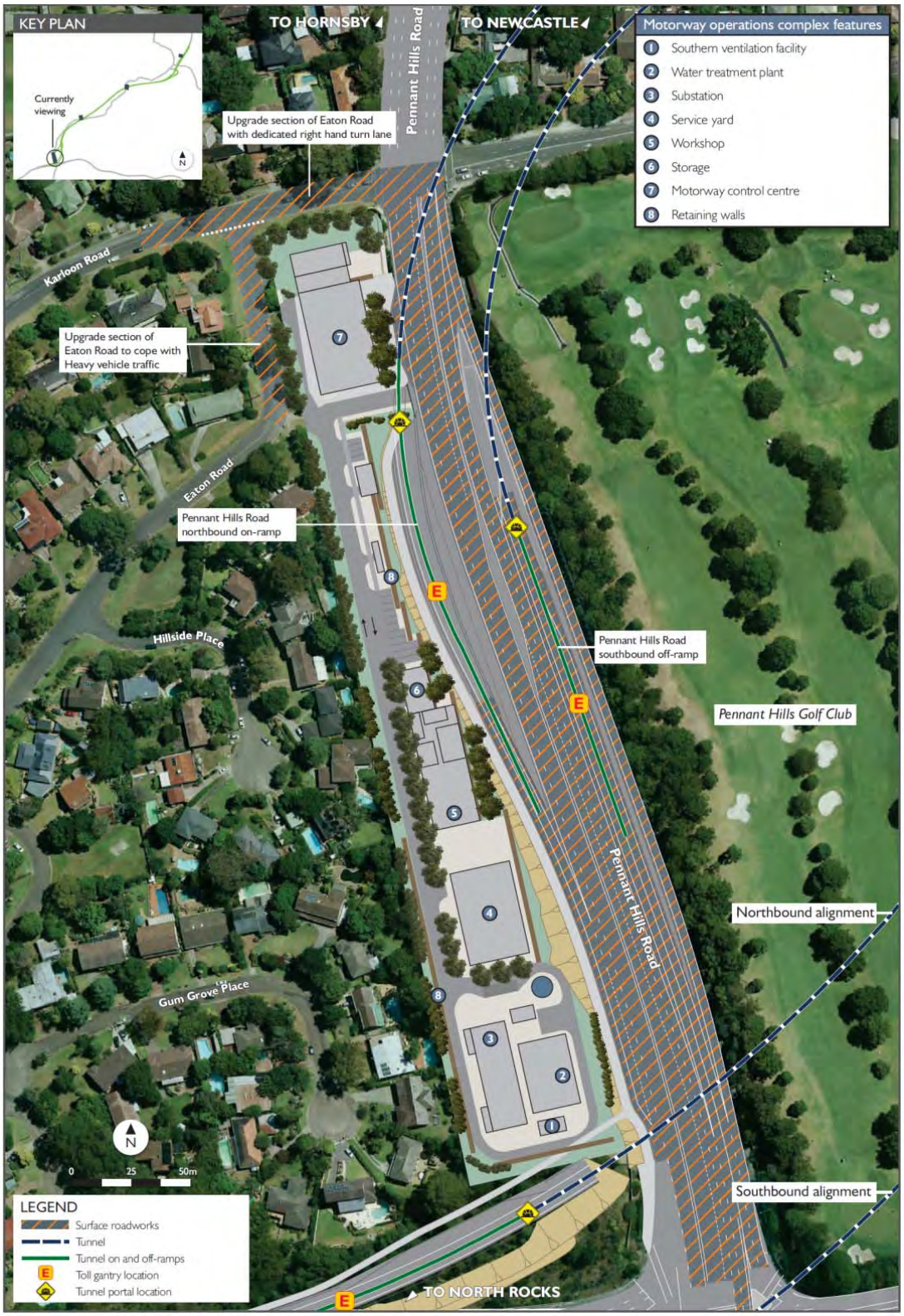


Figure 7: Southern interchange surface roadworks (source: EIS)

4.2.14 Roadside Furniture and Lighting

Lighting

Lighting would be provided along the length of the main alignment tunnels, in accordance with relevant Austroads and RMS standards. Lighting at portals would consider differing light conditions external to the tunnel, and would be zoned to allow sufficient time for the eye to adjust.

Emergency lighting would be installed to provide adequate illumination for evacuation in the event that the primary source is made inoperable. Lighting on surface roads would be as existing or as per relevant Austroads and RMS standards.

Signage

The project would incorporate traffic, locational, directional, warning and variable message signs within the tunnel and at the surface connections approaching the tunnel. The directional signage would be in accordance with Austroads and RMS standards with the focus on providing clear and unambiguous direction to motorists travelling through complex interchanges. Some of the key design principles would include:

- advanced and multiple warnings of the tunnel and toll road;
- directional signs to provide direction on appropriate lane use at complex locations;
- use of diagrammatic advanced warning signs;
- focal point signage around the interchanges consistent with existing Roads and Maritime signage in the Sydney region.

A signage strategy would be developed during the detailed design stage of the project. Consultation with the surrounding community would occur during the development of this signage strategy in relation to the location of signage and associated impacts.

The project would also include tunnel way finding signage such as:

- place names on the tunnel walls to provide motorists with a sense of place during the journey through the tunnel;
- emergency signage providing direction towards emergency exits.

More specific details would be further refined during the detailed design stage.

4.2.15 Property Access and Acquisition

The project has been designed to restrict land acquisition and limit the severance of private properties. The project would require the permanent acquisition of around 56 properties (comprising private properties, and properties owned by Hornsby Council or the Hills Shire Council) over and above 23 properties already acquired by RMS. A further four private properties would be required temporarily to facilitate construction of the project.

RMS has commenced the process to compulsorily acquire Lisle Court Reserve (Reserve No. 5), a 3,427 m^2 public reserve located between the southern rear boundaries of several properties in Lisle Court, West Pennant Hills and the

northern boundary of the Hills M2 Motorway corridor. The reserve is largely undeveloped however there is a local volunteer bushcare group that assists Council in managing the bushland within the reserve. The purpose of the acquisition is to enable the construction of a stormwater drainage detention basin. The outcome of the compulsory acquisition process will be the subject of a separate report to Council at a later date.

Where partial acquisitions are required, private property fencing would be realigned as part of preliminary construction work.

The total area and number of properties that would be acquired for the project may change as the project is refined during the detailed design stage of the project, or in response to changes resulting from the exhibition of this environmental impact statement and conditions of approval that may be applied by the Minister for Planning and Environment.

All partial and full property acquisition would be undertaken in accordance with the Roads and Maritime Land Acquisition Information Guide and the Land Acquisition (Just Terms Compensation) Act 1991. Consultation with affected property owners has commenced and would continue to occur during detailed design.

4.2.16 Emergency or Incident Facilities

Operational emergency systems would be included in the design of the project, such as emergency shoulders, breakdown bays, fire suppression and fire-fighting systems, egress for pedestrians and access for emergency services. Emergency incident facilities would include:

- deluge systems;
- fire and life safety systems;
- CCTV throughout the tunnel and approaches;
- height detection system prior to the tunnel portals;
- tunnel barrier gates to prevent access in the event of tunnel closure;
- vehicle cross passages between the two main alignment tunnels around the Wilson Road tunnel support facility and the Trelawney Street tunnel support facility;
- pedestrian cross passages between the two main alignment tunnels at 120m intervals;
- vehicle breakdown bays on the Hills M2 Motorway and the M1 Pacific Motorway prior to and after the main alignment tunnel portals.

5. CONSTRUCTION WORKS

5.1 Construction Footprint

The majority of the construction footprint is located underground within the main alignment tunnels. However surface areas would be required to support tunnelling activities, and to construct the interchanges, tunnel portals, the Hills M2 Motorway integration, the M1 Pacific Motorway tie-in, the motorway control centre, north and south ventilation buildings, tunnel support facilities and ancillary operations buildings and facilities.

The surface construction footprint generally aligns with the operational footprint, with the location of future operational ancillary facilities being utilised to support construction activities. Despite this, additional construction support sites would be required around the northern interchange. Additionally, in order to facilitate construction access and construction traffic management, additional areas adjacent to the operational footprint would be required around the portals, on and off-ramps the Hills M2 Motorway integration and the M1 Pacific Motorway tie-in. The total area required to facilitate the construction of the project is referred to as the construction footprint. This is anticipated to require the clearing of around 21 hectares of vegetation (both native and exotic).

An overview of the construction footprint from Windsor Road to the southern interchange is attached (Attachment 3).

It should be noted that in the EIS the Torrs Street carpark site is identified as the Windsor Road construction compound. Representatives of the NorthConnex project team have acknowledged that the site has recently been leased to Council for construction of a commuter carpark and are therefore looking at potential alternate locations for a construction compound. One such site that has been mentioned by the project team is Conie Avenue Reserve and it is expected that a formal approach from RMS to use the reserve for this purpose is expected to be received in the near future.

5.2 Overview of Construction Works

Details of the proposed early works and construction activities are as follows:

5.2.1 Early Works

Early works are works that would generally take place early in the construction program in order to facilitate main construction activities. Early works would include:

- property acquisitions;
- demolition of properties;
- adjustment, relocation and / or protection of utilities;
- surveys and existing condition surveys of buildings and infrastructure;
- investigative drilling;
- traffic management changes to allow access to and egress from the construction sites;
- installation of environmental control measures;
- establishment of construction site fencing;
- construction site establishment;
- provision of power and other services to the construction sites;
- heritage salvage or conservation works;
- establishment of ancillary facility sites;
- minor clearing works to facilitate other early work.

5.2.2 Tunnelling

Tunnel Excavation

The project would involve the excavation of two tunnels around 9km in length for the main alignment as well as additional tunnels for on and off-ramps at both the northern and southern interchanges. Tunnel depth would vary depending on geological constraints however the tunnel crown (top of the tunnel) would vary up

to a maximum depth of around 90m below ground level with shallower sections approaching the northern and southern portals.

Two standard cross sections for excavation would be used to accommodate the varying geology along the length of the project area. A fully arched profile would be used for excavations in Ashfield Shale and an arched roof profile with straight walls would be used for excavations in Hawkesbury Sandstone. Prior to tunnel fit-out, the main alignment tunnels would generally have an excavated width of around 14m, an excavated height of around 8m and an excavated cross sectional area of around 110m^2. To accommodate 'line of sight' requirements and enlargements of egress tunnels and emergency bays, a number of sections would be widened beyond these standard widths.

The tunnels would not only provide space required for the traffic envelope, but would also provide space for required tunnel services including deluge systems, drainage infrastructure, communications cables, mechanical and electrical equipment, incident response infrastructure and ventilation infrastructure.

It is anticipated that tunnel excavation would be undertaken using a number of road headers and surface miners, supported from multiple sites. A road header is an excavation machine consisting of a boom-mounted rotating cutter head mounted on bulldozer-style tracks, a loader device usually on a conveyor, and a crawler travelling track to move the machine forward into the rock face. A surface miner is a mechanically driven excavation machine capable of cutting, crushing and loading in one continuous process. Localised blasting works may be carried out underground depending on the geological conditions encountered.

Ground support, involving tunnel lining, would be installed progressively following tunnel excavation. Two types of lining would be used for the project depending on the local geology. For the tunnels in Ashfield Shale or Class VI Hawkesbury Sandstone this would involve a full cast in-situ concrete lining, with a sprayed shotcrete lining used for the sections of tunnel in Class I to V Hawkesbury Sandstone.

The southern and northern interchanges, as well as the Wilson Road and Trelawney Street compounds, have all been identified as tunnelling launch and support sites. Each of these sites would require support services for the tunnelling activity including power supply, ventilation, water supply, construction water treatment plants, workforce facilities and spoil handling and removal.

In addition to the main alignment tunnels and on and off-ramp tunnels, pedestrian cross passages would be excavated between the main alignment tunnels at 120 metre intervals and vehicle cross passages would be excavated around the Wilson Road and Trelawney Street tunnel support facilities. These cross passages would be excavated using small road headers, excavators with rock hammer, drilling and blasting.

Tunnel Finishing Works

On completion of the tunnelling works, a variety of civil finishing works would occur including:

- roadway drainage;
- road pavement;
- installation of road furniture;

- electrical substations;
- low point sumps;
- cross passages including electrical rooms;
- emergency smoke extraction outlets.

Tunnel Fit-out

Following tunnel excavation and civil finishing works, the tunnels would be fitted out with required operational infrastructure. This would include power, ventilation, fire safety systems, communications, traffic control, tunnel lighting and the operations management and control systems and would be followed by a comprehensive commissioning process undertaken to validate the correct operation and integration of tunnel systems prior to road opening.

5.2.3 Earthworks

Earthworks would be required for the following above ground sections:

- the tunnel portals at the two interchanges;
- the Hills M2 Motorway integration works;
- the M1 Pacific Motorway tie-in works.

Earthworks would be completed using conventional methods of road construction which would include:

- vegetation clearance and topsoil stripping, with mulched vegetation and topsoil stockpiled for later re-use in site rehabilitation and landscaping works;
- areas of new cut and fill to design levels, and widening of existing cuts and embankments, including the construction of retaining walls and reinforced soil walls;
- installation of road drainage infrastructure.

5.2.4 Bridge Works

Bridge works would generally include:

- construction of the substructure, likely to be from cast in-situ concrete in the following sequence:
  - piling works, such as bored piles;
  - pile cap construction including localised excavation around the piles;
  - pier or column construction;
- headstock construction;
- construction of the superstructure, likely to be through the placement of pre-cast concrete segments.

5.2.5 Drainage

The project would require construction of new drainage infrastructure and alterations to existing drainage infrastructure. This would include:

- construction of new pits and pipes for both surface and tunnel sections of the road;
- construction of a sump near the southern interchange;
- construction of an operational water treatment plant near the southern

interchange;
- adjustment of existing pits to suit new road alignments;
- modification to four existing detention basins along the Hills M2 Motorway;
- extension of five transverse drainage culverts under the Hills M2 Motorway by retrofitting of pre-cast concrete pipes or box segments;
- alterations to the existing Pennant Hills Road drainage infrastructure;
- construction of a new transverse drainage structure under the M1 Pacific Motorway / Pennant Hills Road connector;
- construction of two spillage containment tanks around the northern interchange.

5.2.6 Pavement

Following tunnelling works, earthworks and bridge works, pavement works would be required. This would involve the construction of:

- base and select layers of materials (in areas of earthworks only);
- pavement layers;
- pavement drainage, including kerb and gutter (where required);
- concrete barriers, wire rope fencing and guardrails (where required).

5.2.7 Finishing Works

Finishing works would be undertaken towards the completion of construction and would include:

- line marking of new road pavement;
- erection of directional signage and other roadside furniture such as street lighting;
- erection of toll gantries at the southern interchange, including four new toll gantries for the project and the relocation of two existing Hills M2 Motorway toll gantries;
- erection of truck regulatory gantries at the northern and southern ends of Pennant Hills Road;
- landscaping works;
- site demobilisation and rehabilitation of temporary ancillary facilities.

5.2.8 Construction of Operational Ancillary Facilities

The project would involve the construction of a number of operational facilities including:

- the motorway control centre;
- tunnel support facilities;
- ventilation buildings and facilities near the southern and northern interchanges;
- electrical switching station located on Coral Tree Drive (Figure 8).

Figure 8: Coral Tree Drive Electrical Switching Station (source: EIS)

Motorway Control Centre

The motorway control centre (refer to Figures 6 and 7) would be fitted out with communications, security and electrical equipment to monitor and control all aspects of the tunnel, along with office space and worker amenities. Construction works would include:

- excavation, footing and base slab installation;
- erection of in-situ concrete columns and deck to the first floor;
- erection of a precast concrete column to support the roof;
- enclosure of the building with precast panels and curtain walls;
- internal fit out of control rooms, computer rooms, offices and workshop and associated staff amenities;
- on-site maintenance and special vehicle sheds would be mainly constructed of light steel framing and roofs;
- security fencing;
- construction of an open storage and hardstand area for miscellaneous items.

Tunnel Support Facilities

Two tunnel support facilities would be constructed as part of the project, each comprising an emergency smoke extraction outlet and a substation. The emergency smoke extraction outlet would be operated in the unlikely event of an emergency within the tunnels.

The construction methodology for the tunnel support facilities would involve:

- bulk excavation and installation of retention piles to form a space for the fan chamber, intake and discharge plenum;
- construction of footings and base slab for the structures;
- installation of precast concrete panels and steel roof to expedite enclosure of the building (water tight);
- internal fit out of plant areas, equipment installation and commissioning of the smoke plant rooms;
- excavation of shafts to the main alignment tunnels;
- construction of substations.

Ventilation Facilities

Two ventilation facilities would be constructed as part of the project, with one facility situated at either end of the main alignment tunnels near the portals. The southern ventilation facility would be located to the north-west of the Hills M2 Motorway / Pennant Hills Road interchange, with the northern ventilation facility located on the western side of the M1 Pacific Motorway on the corner of Bareena Avenue and Woonona Avenue, Wahroonga.

The construction methodology for the ventilation facilities would typically involve:

- excavation to the main alignment tunnels;
- backfilling or erecting a secondary floor to raise the plant as required to suit maintenance access requirements;
- erecting precast concrete panels, block walls, steel roof to enclose the building;
- erecting a facade supporting steel and cladding panels as per architectural design;
- installing roof panels;
- internal fit-out of plant areas, equipment installation and commissioning.

Electrical Switching Station

An electrical switching station would be constructed on Coral Tree Drive adjacent to the Hills M2 Motorway (Figure 8). The construction methodology for the switching station would typically involve:

- excavation, footing and base slab installation;
- erection of a precast concrete column to support the roof;
- enclosure of the building with precast panels;
- internal fit-out of electrical infrastructure.

5.2.9 Construction Ancillary Facilities

Eleven construction ancillary facilities would be required as part of the project. This would include locations for road header and surface miner launch and support, earthworks support and workforce amenities.

Table 3 provides details of those facilities.

5.2.10 Demolition

The project has been designed with the aim of minimising the need for land acquisition and property demolition as far as practical. However, the project would require the demolition of a number of properties located within the construction footprint with the majority of these being residential properties. Indicatively, the project would involve the demolition of:

- forty-seven residential properties;
- three commercial properties;
- various industrial buildings and structures at the Pioneer Avenue compound including a storage shed, steel silos, a kiln structure and a residential house.

The Hills M2 Motorway integration works and the M1 Pacific Motorway tie-in would also require the demolition of some existing road infrastructure including bridge elements, road pavement and retaining walls.

Generally, demolition works would be undertaken early in the construction program
To ensure that sites are ready for the commencement of main construction activities.

5.2.11 Traffic Management and Access

The construction of the project would be subject to careful traffic management to ensure the ongoing functionality of surrounding roads, and the safety of members of the public, motorists and construction personnel.

Generally, temporary road pavements would be constructed early in the construction program to remove live traffic from the construction work zones. However, a number of phases of traffic management and traffic switches would be required around the two interchanges to facilitate construction of the on and off-ramps as well as the Hills M2 Motorway integration works and the M1 Pacific Motorway tie-in.

The project would also necessitate the temporary alteration of cyclist and pedestrian facilities, although alternative access arrangements would be implemented around construction sites, compounds and access points. As the project would occupy the breakdown lanes of both the Hills M2 Motorway and the M1 Pacific Motorway during the construction period, it would be necessary to exclude cyclists from these stretches of road for safety reasons. Appropriate detour routes would be established, utilising existing cycle routes and paths wherever possible.

No.	Site	Temporary facilities							Permanent facilities				
		Site offices	Staff amenities	Stores and laydown	Workshop and maintenance	Tunnelling launch and support	Spoil management	Water treatment plant	Ventilation outlet	Emergency smoke outlet	Substation	Motorway control centre	Water treatment plant
C1	Windsor Road compound	✓	✓	✓									
C2	Darling Mills Creek compound		✓										
C3	Barclay Road compound		✓	✓									
C4	Yale Close compound		✓										
C5	Southern interchange compound	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
C6	Wilson Road compound	✓	✓	✓	✓	✓	✓	✓		✓	✓		
C7	Trelawney Street compound	✓	✓	✓	✓	✓	✓	✓		✓	✓		
C8	Pioneer Avenue compound	✓	✓										
C9	Northern interchange compound	✓	✓	✓	✓	✓	✓	✓					
C10	Bareena Avenue compound	✓	✓	✓					✓		✓		
C11	Junction Road compound	✓	✓										

Table 3: Proposed construction ancillary facilities and activities (source: EIS)

Daily worst case light vehicle and heavy vehicle numbers associated with spoil and waste removal, material deliveries and arrival and departure of construction workers are summarised in Table 4. Wherever possible, access and egress routes are proposed to be from major arterial roads.

Significant concerns have been raised by the Mayor, Councillors, local MPs, Council officers and residents concerning one of the proposed construction vehicle access routes to the southern interchange construction site. For vehicles travelling to the site from the north, the EIS proposes to use Aiken Road, Oakes Road, Eaton Road/ Karloon Road to access the site. For vehicles leaving the site the EIS proposes that construction traffic would turn left or right out of Eaton Road onto Pennant Hills Road with an additional right turn lane being constructed on Eaton Road.

For the inbound construction vehicle access there is doubt that large truck trailer combinations would even be able to negotiate the Eaton Road/Karloon Road section of the route due to the horizontal alignment of the road and the presence of a roundabout at the southern intersection of Eaton Road and Karloon Road. Furthermore, the route is heavily used by traffic in the AM peak and would result in heavy vehicles passing a large number of residential properties. This would have an unacceptable impact on the amenity and safety of those residents. It is also likely that such a large number of truck movements would cause significant and ongoing damage to the road pavements.

For these reasons the proposed in-bound route for construction vehicles coming to the southern interchange construction site from the north is considered totally unacceptable.

5.2.12 Construction Workforce and Construction Work Hours

Construction Workforce

Around 1,250 jobs are expected to be directly created during the peak construction period of the project. This would include both the staff and labour workforce. Further jobs in the local area are likely to be indirectly supported by the project.

Construction Work Hours

The proposed construction hours for surface, tunnelling and traffic management at each of the construction sites are summarised in Table 5.

The majority of above ground construction works would be undertaken between the following hours:

- 7 am to 6 pm Monday to Friday;
- 8 am to 1 pm Saturdays;
- No works on Sundays or Public Holidays.

As tunnelling works operate continuously, below ground tunnelling and the associated surface support activities would be undertaken up to 24 hours per day and seven days per week. This would include heavy vehicle movements to and from the tunnelling support compounds, and on these sites outside the acoustic sheds, up to 24 hours per day and seven days per week.

Heavy vehicle movements outside of standard construction hours associated with tunnel support works (spoil removal, concrete delivery and other truck movements) would only occur via access and egress directly to and from Pennant Hills Road or the M1 Pacific Motorway and would only occur at the following compounds:

- southern interchange compound;
- Wilson Road compound;
- Trelawney Street compound;
- southern interchange compound.
- road tie-in works;
- traffic management, set-up and traffic switches;
- utility relocations (where the relocation is in proximity to traffic);
- erection of traffic signs (where erection is in proximity to traffic);

- pavement and temporary median works;
- asphalt works and line-marking;
- use of construction compounds to support out of hours works.

Other works which would be undertaken outside of standard daytime construction hours without any further approval would include any of the following circumstances:

- works which are determined to comply with the relevant Noise Management Level at the nearest sensitive receiver;
- the delivery of materials as required by the Police or other authorities for safety reasons;
- where it is required to avoid the loss of lives, property and / or to prevent environmental harm in an emergency;
- where agreement is reached with affected receivers

Site	Proposed access route	Daily heavy vehicle	Daily light vehicle
Windsor Road compound (C1)	Torr Street	20	85
Darling Mills compound (C2)	Hills M2 Motorway eastbound carriageway and Ventura Street.	50	20
Barclay Road compound (C3)	Perry Street	50	52
Yale Close compound (C4)	Hills M2 Motorway westbound carriageway.	50	20
Southern interchange (C5)	Eaton Road (left in, right out)	740	165
Wilson Road compound (C6)	Pennant Hills Road (left in, left out; heavy vehicles only) Wilson Road (light vehicles only)	600	100
Trelawney Street compound (C7)	Loch Maree Avenue (left in; heavy vehicles only) Pennant Hills Road (left out; heavy vehicles only) Loch Maree Avenue (separate light vehicle only access)	570	100
Pioneer Avenue compound (C8)	Lymoore Avenue Pioneer Avenue (secondary)	12	650
Northern interchange (C9)	M1 Pacific Motorway / Pennant Hills Road connector (left in, left out; heavy vehicles only) Eastbourne Avenue (light vehicles only)	720	100
Bareena Avenue compound (C10)	M1 Pacific Motorway (left in, left out) Woonona Avenue North	20	25
Junction Road compound (C11)	Coonanbarra Road	1	100

Table 4: Construction traffic management and access (source: EIS)

Spoil would be moved during the day where practical, and feasible and reasonable management strategies investigated in consultation with the NSW Environment Protection Authority (EPA) to minimise the volume of heavy vehicle movements at night. Substantial works would need to be undertaken outside of these hours to reduce inconvenience to road users and ensure the safety of construction workers and the public. This would include activities such as the widening and lengthening of existing bridges;

Out of hours work may also be undertaken where explicitly approved through an environment protection licence.

Activity	Construction hours	Comments or exceptions
Underground construction activities		
Tunnelling works	24 hours per day, seven days per week.	• Activities that support tunnelling works would occur 24 hours per day, seven days per week. • Rock hammering and blasting in the tunnel would be avoided between 10 pm and 7 am where it may impact nearby receivers.
Surface construction activities		
Construction sites	Daytime construction hours: • 7 am to 6 pm on weekdays. • 8 am to 1 pm on Saturdays. • No works on Sundays or public holidays.	Where noise management measures have been established, the following activities would be undertaken 24 hours per day, up to seven days per week: • Surface works supporting underground construction. • Construction traffic movements for tunnel support. • Excavation and spoil removal from construction shafts at the surface, conducted over two shifts per day. • Temporary possession of roads may need to be undertaken outside standard construction hours to avoid elevated safety impacts and inconvenience to commuters.
Construction traffic	24 hours per day, up to seven days per week.	• Construction traffic would be limited and managed during peak hours and special events. • Construction vehicle movements would be limited and managed during evening and night-time in residential areas or close to identified sensitive receivers. • Heavy vehicle movements outside of standard construction hours associated with tunnel support works (spoil removal, concrete delivery and other heavy vehicle movements) would only occur via access and egress directly to and from Pennant Hills Road or the M1 Pacific Motorway and would only occur at the following compounds: – Southern interchange compound (C5). – Wilson Road compound (C6). – Trelawney Street compound (C7). – Northern interchange compound (C9). Spoil would be moved during the day where practical, and feasible and reasonable management strategies investigated in consultation with the NSW Environment Protection Authority to minimise the volume of heavy vehicle movements at night.

Table 5: Proposed construction hours (source: EIS)

5.2.13 Plant and Equipment

The items of plant and equipment listed in Attachment 4 are likely to be used during the construction of the project.

5.2.14 Construction Materials

Construction would require various materials and pre-cast elements. The major construction materials required would include:

- general fill and select fill for earthworks. This would be sourced from within the project cutting and from tunnel spoil where the material is of suitable quality;
- pavement materials, including road base and sub-base;
- materials for lining drainage channels;
- aggregate used for concrete and asphalt;
- cement and concrete;
- steel for reinforcement;
- wood for use in formwork and other temporary structures;
- water;
- pre-cast concrete including pipes, culvert segments, and roadside barriers;
- mechanical and electrical equipment for tunnel fit out.

Construction material would generally be sourced from off-site suppliers. This would include the balance of fill material to address shortfalls in required volumes in the event that material sourced from on-site is unsuitable. Wherever possible, local sources of construction materials would be preferred in order to minimise haulage distances.

5.2.15 Spoil and Waste Disposal

Based on the concept design, the project would generate around 2.6 million m^3 of spoil. The anticipated volume from each site is shown in Table 6.

Site	Spoil volume (cubic metres)
Southern interchange compound (C5)	613,900
Wilson Road compound (C6)	441,950
Trelawney Street compound (C7)	492,200
Northern interchange compound (C9)	743,150
Northern portals	281,200
Hills M2 Motorway integration works	39,800
Total	2,612,200

Table 6: Anticipated spoil generation (source: EIS)

Other waste streams which would be generated during construction of the project include:

- demolition waste from existing structures and properties;
- contaminated soil which may be encountered during construction;
- general construction waste such as concrete, steel and timber formwork off-cuts;
- vegetation waste from clearing and grubbing;
- plant and vehicle maintenance waste such as oils and lubricants;

- general office waste such as paper, cardboard, plastics and food waste;
- sewage waste.

A number of potential sites have been identified with the necessary capacity to receive the spoil generated by the project. These include:

- the ADI site, St Marys with a capacity for between two and 2.5 million m^3;
- Gosford quarry with a capacity of around 2.5 million m^3;
- Hornsby quarry with a capacity of around 3.3 million m^3;
- the CSR quarry with a capacity of around 1.16 million m^3;
- the Defence Precinct at Schofields (HMAS Nirimba) with a capacity of 500,000m^3;
- the Great Southern Rock Quarry, Sandy Point with an anticipated capacity of around 5.0 million m^3.

Other disposal / re-use sites may be used depending on need at the time spoil is generated.

5.2.16 Resource Consumption

Indicative quantities of the major sources of materials required for construction are
detailed in Table 7.

Construction Power

Power supply would be required during the construction works at the majority of construction ancillary facilities. In particular, high voltage power would be required at the tunnel support sites. Prior to the connection of mains power supply to the tunnel support sites, road headers would be powered by diesel generators.

Further assessment would be required in consultation with the relevant power supply authorities before finalising the power supply routes.

Material	Estimated quantity required
Plain shotcrete	41,000 cubic metres
Steel fibre reinforced shotcrete – concrete	221,000 cubic metres
Steel fibre reinforced shotcrete – steel	8,200 tonne
Polypropylene reinforced shotcrete – polypropylene	136 tonne
No-Fines – concrete	64,000 cubic metres
Base paving – concrete	66,400 cubic metres
New jersey kerbs – concrete	26,000 cubic metres
Piles – concrete	59,000 cubic metres
Retaining walls – concrete	54,000 cubic metres
Bridges – concrete	1,300 cubic metres
Noise walls -	1,400 cubic metres
Rock bolts	5,000 tonne
Reinforcing steel	5,280 tonne
Asphalt	25,000 tonne
Crushed aggregate	21,500 tonne
Conduit – PVC	810,000 metres
Copper cables	1,880 tonne
Concrete drainage pipes	18,000 metres
Power	80 million kilowatt hours
Water	3,000 mega litres

Table 7: Indicative resource requirements (source: EIS)

Construction Water

Tunnelling works would require significant volumes of water for excavation and would generate wastewater requiring treatment and disposal. Construction water supply would also be required for the following construction activities:

- interchange construction and road widening activities, including earthworks, concreting and dust suppression for surface works;
- building construction activities.

Estimated volumes of water required for construction are provided in Table 8.

Source		Southern interchange compound (C5)	Wilson Road compound (C6)	Trelawney Street compound (C7)	Northern interchange compound (C9)	Road works	Total
Total potable water supply (mega litres)	Sydney Water mains	635	485	450	600	80	2,250
Total non-potable water supply (mega litres)	Collected rainwater	35	10	10	15	-	70
	Treated groundwater	190	160	150	235	-	735
Total		860	655	610	850	80	3,055

Table 8: Indicative construction water supply (source: EIS)

6 KEY ISSUES

6.1 Traffic

6.1.1 Future Strategic Alignment Considerations

The current NorthConnex project is based on an alignment of the Type A 'Purple' corridor being a tunnel under Pennant Hills Road as recommended by the 2004 F3 to Sydney Orbital Link Study. As part of that study it was recommended that should the route be progressed to concept proposal stage, consideration should be given to intermediate openings and access points such as the possibility of local access from major roads such as Boundary Road or Beecroft Road.

An intermediate interchange would provide access opportunities for motorists that would otherwise need to travel to either the northern or southern interchange to access the main alignment tunnels.

The EIS states intermediate connections for north facing ramps surfacing near Pennant Hills Railway Station and south facing ramps surfacing near Railway Parade at Thornleigh were considered as part of the preliminary design. This however was reviewed during the Stage 2 unsolicited proposal process which identified that an intermediate interchange would be unsuitable due to:

- additional costs related to the difference in grade between the surface and main alignment tunnels and extent of extra tunnelling that would be required;
- additional property acquisition that would be required and;
- proximity of works to the Northern Railway Line which would cause engineering and construction challenges.

In addition the EIS considered that there would be limited traffic benefits associated with an intermediate interchange based on forecast patronage.

The EIS outlines that whilst an intermediate interchange was considered as part of the earlier planning for the project it was not pursued. The EIS does not provide the background data relating to future patronage forecasts at these locations or details on the feasibility of any other locations such as those suggested in the 2004 report.

It is noted that intermediate access to the tunnel would allow better ease of access for motorists travelling from the north without having to first travel south along Pennant Hills Road. Given the strategic importance of the project, the design should be capable of facilitating the provision of intermediate access locations between the Hills M2 Motorway and the M1 Pacific Motorway.

This would future proof the project and enable it to cater for long term demand and support future growth and development of the North West region, particularly having regard to anticipated population growth in the Box Hill and Box Hill North Precincts as well as West Pennant Hills, Cherrybrook and Castle Hill locality as a result of the North West Rail Link.

Recommendation 1

The NorthConnex project should consider longer term options for intermediate access between the Hills M2 Motorway and the M1 Pacific Motorway.

6.1.2 Construction Traffic

As indicated previously in the report, significant concerns have been raised with regard to the proposed heavy construction vehicle access route for vehicles travelling to the southern interchange construction site from the north. The EIS proposes that such vehicles would use Aiken Road, Oakes Road, Eaton Road/ Karloon Road, West Pennant Hills.

Although these roads are identified in Council's adopted road hierarchy as a major collector (Aiken Road), a sub-arterial (Oakes Road) and a minor collector (Eaton Road/ Karloon Road/Eaton Road), they are considered to be totally unsuitable for use by a large number of heavy construction vehicles.

These roads are already heavily congested during the morning and evening peak with significant on-street commuter parking. There is also doubt that the width and alignment of the Eaton Road/Karloon Road section of the proposed route would even allow access by heavy construction vehicles without significant changes to the design of the road including alterations to existing traffic facilities. There are also concerns about the damage to the road pavements that will inevitably occur due to the use of these roads by such a large number of heavy construction vehicles.

Perhaps of greatest concern would be the impact on the amenity and safety of residents living along this proposed route who could be subject to such heavy vehicle movements over several years of construction.

Representatives of the NorthConnex project team have acknowledged these concerns in several forums attended by Councillors and Council staff and have indicated that they are pursuing options with RMS and the Transport Management Centre (TMC) for an alternate inbound access route from the north into the southern interchange construction site directly off Pennant Hills Road.

Recommendation 2

The use of Aiken Road, Oakes Road and Eaton Road/Karloon Road as a proposed inbound heavy vehicle access route from the north into the southern interchange construction site is totally unacceptable. Alternate routes need to be identified that restrict inbound access to the site off Pennant Hills Road or the Hills M2 Motorway.

Recommendation 3

A copy of the Construction Traffic Management Plan (CTMP) be provided to all affected Councils for review prior to approval.

6.2 Noise

An acoustic report has been prepared for the project, covering both the construction and operation stages of the development. The report has used several guidelines, including the *Interim Construction Noise Guideline* (EPA) (ICNG), *NSW Industrial Noise Policy* (EPA) (INP), *NSW Road Noise Policy*, *Assessing vibration: a technical guideline* (DEC, 2006) and *Environmental Noise Management Manual*.

A number of representative locations have been used to establish rating background levels for noise catchment areas. The noise catchment areas that fall within The Hills Shire LGA are NCA08 (7 Eaton Road, West Pennant Hills), NCA10 (35 Coral Tree Drive, Carlingford), NCA11 (33-37 Carmen Drive, Carlingford), NCA12 (28 Carlton Road, North Rocks), NCA13 (59 Mills Road, North Rocks), NCA14 (23 Williams Road, North Rocks) and NCA15/16 (46 Dremeday Street, Northmead).

The Rating Background Level (RBL) (used for assessment of under the ICNG and the INP) for the noise catchment areas are detailed in Table 8.

Catchment	Indicative Location	RBL			Sleep Screening	Awakening criteria
		Day	Evening	Night	$L_{A1(1\ min)}$	$L_{A1(1\ min)}$
		$L_{Aeq,\ 15\ min}$				
		dB(A)				
NCA08	7 Eaton Road	44	44	39	54	65
NCA10	35 Coral Tree Drive	44	40	36	51	65
NCA11	33-37Carmen Drive	51	46	37	52	65
NCA12	28 Carlton Road	39	39	39	48	65
NCA13	59 Mills Road	49	44	33	48	65
NCA14	23 Williams Road	53	37	35	50	65
NCA15	46 Dremeday Street	53	48	38	53	65

Table 8: Catchment rating background levels (source: EIS)

5.2.1 Construction Stage

The ICNG provides a framework for assessing and managing noise impacts from construction work and establishes recommended hours and noise levels. The recommended noise levels are dependent upon the proposed hours of construction.

During standard hours (Monday – Friday, 7am to 6pm and Saturday, 8am to 1pm), the Noise Management Level (NML) is $L_{Aeq(15\ min)}$ RBL plus 10 dB, with a maximum level of 75dB(A).

Outside of the standard hours, the NML is $L_{Aeq(15\ min)}$ RBL plus 5 dB.

Tunnelling works, including support activities such as removal of spoil and concrete delivery, will be occurring 24 hours a day, seven days a week. If required, blasting will be restricted to Monday to Friday, 9am to 5pm and Saturday, 9am to 1pm, whilst surface construction activities will be limited to the standard hours unless noise management measures have been established.

The report has modelled the noise levels for the activities to be carried out and predicted the levels at the receivers in each of the Noise Catchment Areas. For each reported activity, there are significant numbers of receivers where the NMLs are exceeded, with several highly noise affected receivers. The location of these receivers needs to be interpreted from the Construction Airborne Noise L_{Aeq} Maps in Appendix F of the EIS.

The assessment of sleep disturbance has identified 264 receivers where the screening criteria (where $L_{A1(1\ min)}$ outside a bedroom window exceed the $L_{A90(15\ min)}$ background noise level by more than 15dB) is exceeded, and four receivers where the awakening reaction criteria (where $L_{A1(1\ min)}$ outside a bedroom window exceeds 65dB(A)) is exceeded.

As stated in the EIS, the proposed northern inbound route to the southern interchange construction site will generate a potential 805 daily vehicle movements (740 heavy, 165 light) on local roads (Aiken Road, Oakes Road, Eaton Road and Karloon Road), there will be potential traffic flow issues as well as acoustic impacts. It is noted that it is proposed that vehicle movements outside the standard hours are proposed to enter and exit directly onto Pennant Hills Road, however site plans do not indicate an alternative site entrance other than Eaton Road.

It is proposed to prepare a Construction Noise and Vibration Management Plan (CNVMP) which would include:

- identification of nearby residences and other sensitive land uses;
- description of approved hours of work;
- description and identification of all construction activities, including work areas, equipment and duration;
- description of what work practices would be applied to minimise noise and vibration;
- complaints handling process;
- noise and vibration monitoring procedures;
- overview of community consultation required for identified high impact works;
- consideration for cumulative construction noise impacts and construction noise fatigue.

It is not possible to assess the potential effectiveness of noise control and mitigation measures until the CNVMP has been prepared.

5.3.3 Operation Stage

Within The Hills Shire LGA, Noise Catchment Areas NCA08, NCA09 and NCA10 are potentially affected by operational noise. The potential sources of noise from the operation of the tunnel are:

- road traffic noise;
- ventilation fans;
- in-tunnel jet fans;
- switches within the switching station;
- transformers within substations; and
- noise associated with car parking facilities.

Road traffic noise is assessed against the *NSW Road Traffic Noise Policy* (DECC, 2011) (RNP) and the *Environmental Noise Management Manual* (RTA, 2001) (ENMM), whilst the other noise sources are assessed against the *NSW Industrial Noise Policy* (EPA, 2000) (INP).

The RNP & ENMM establish the following criteria for residential land use affected by the proposal and are detailed in Table 9.

Project/Land use	Assessment Criteria dB(A) (external)			
	RNP		ENMM (acute)	
	Day (7am – 10pm)	Night (10pm – 7am)	Day (7am – 10pm)	Night (10pm – 7am)
Existing residences affected by noise from new freeways/ arterial/sub-arterial road corridors	$L_{Aeq, (15\ hour)}$ 55	$L_{Aeq, (9\ hour)}$ 50	$L_{Aeq, (15\ hour)}$ 65	$L_{Aeq, (9\ hour)}$ 60
Existing residences affected by noise from redevelopment of existing freeways/arterial/sub-arterial roads	$L_{Aeq, (15\ hour)}$ 60	$L_{Aeq, (9\ hour)}$ 55		
New road corridor with potential to generate additional traffic on existing road	Existing traffic $L_{Aeq, (15\ hour)}$ + 12 dB	Existing traffic $L_{Aeq, (9\ hour)}$ + 12 dB		

Table 9: Noise level assessment criteria (source: EIS)

Other criteria apply to non-residential land uses and have been assessed within the report and have been considered as a part of this assessment.

The modelling of the noise impacts from the southern interchange and Hills M2 Motorway integration works in 2029 will exceed the RNP night criteria at 217 receivers, with 46 of those receivers exceeding the ENMN acute level.

Along the Hills M2 Motorway, some existing noise barriers will be relocated to allow for modified alignment. An additional barrier of 5 metres height is proposed and relocated barriers are proposed to be the same as the existing heights.

Where the predicted noise level exceeds the criteria by more than 2 dB, the receiver is considered to be a sensitive receiver and eligible for consideration of noise mitigation measures. Forty-seven residential receivers and one childcare centre have been identified as sensitive receivers. Mitigation measures may include fresh air ventilation, sealing of wall vents and upgrades to window and door seals.

It is noted that an increase up to 2dB is generally accepted as being indiscernible and therefore mitigation measures are not proposed for receivers where the levels are less than 2dB.

The residential criteria established under the INP are based upon the lesser of the intrusive or amenity criteria. The intrusive criteria is RBL + 5 dB, whilst the amenity criteria is based upon an acceptable level of noise for different receiver types at different times.

The project specific noise criteria under the INP are detailed in Table 10.

Catchment	Day	Evening	Night	Sleep Screening	Awakening criteria
				$L_{A1(1\ min)}$	$L_{A1(1\ min)}$
	dB(A)				
NCA08	49	49	44	54	65
NCA09	53	50	49	59	65
NCA10	49	45	41	51	65

Table 10: Project specific noise criteria (source: EIS)

Environmental noise from ventilation facilities, jet fans, substations and transformers and the motorway control centre will be addressed in the detailed design stage and controlled through standard engineering solutions, such as material selection, orientation and location, noise attenuation and enclosures.

Where geological conditions warrant, blasting is proposed as part of the construction process. Blasting will be limited to once daily and only occur between 9am-3pm, Monday to Friday and 9am-12pm on Saturday. As there is minimal tunnelling work within The Hills Shire LGA, there will be minimal impacts, if any, from blasting.

Recommendation 4

A copy of the Construction Noise and Vibration Management Plan (CNVP) be provided to all affected Councils for review prior to approval.

Recommendation 5

The detailed design stage of ventilation facilities, jet fans, substations and motorway control centre be certified by an acoustic consultant as meeting the project specific noise criteria.

Recommendation 6

A post commencement acoustic assessment be carried out to verify the findings of modelling and/or identify any further acoustic treatment required to protect the acoustic amenity of the neighbourhood around the southern interchange facility.

5.4 Vibration

Minimal tunnelling will occur within The Hills Shire LGA, explicitly the southbound integration with the M2 Motorway and the commencement of the northbound tunnel from both the M2 Motorway and Pennant Hills Road. Works on the southbound integration are expected to exceed the $0.14 m/s^{1.75}$ night-time criteria established by the *Assessing Vibration: A Technical Guideline* (DEC, 2006), relating to human comfort.

The areas identified as potentially impacted are not residential land. They are either part of the M2 Motorway or adjacent bushland, or within the footprint of the southern interchange construction compound.

Safe working distances have been identified for vibration intensive plant, which may be encroached upon for properties to the west of the southern interchange construction compound.

It is proposed that prior to the commencement of tunnelling or other vibration intensive work, that all properties within 50m be surveyed so as to ascertain at a later date what damage has occurred if any, as a result of these construction activities.

5.3 Air Quality

An assessment of the air quality impacts of the construction and operational activities of the proposed project have been undertaken and reported in the EIS. The assessment has been carried out in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (published by the Department of Environment & Climate Change, 2005), the *Environmental Health Risk Assessment: Guidelines for assessing human health risks from environmental hazards* (published by enHealth, 2012) and take into account advice provided by the *Independent Advisory Committee on Tunnel Air Quality.*

5.3.1 Construction Stage

During the construction stage of the project, demolition, earth moving, vegetation clearing, excavation and tunnelling activities will be the primary sources of possible emissions. The management and mitigation measures to be used will be contained in Construction Environmental Management Plans (CEMPs), and may include modifying activities during unfavourable wind conditions, the use of water carts, sprays and sprinklers for dust suppression and air filtration systems for underground works. A dust observation program will be put in place to monitor conditions daily.

The use of standard management and mitigation controls are expected to be sufficient to control and manage any emissions.

5.3.2 Operation Stage

The design of the tunnel ventilation is based upon the movement of the vehicles drawing fresh air into and along the tunnel (referred to as 'the piston effect') to the point of ventilation at the exit of the tunnel. In the event of low speed traffic conditions, twin jet fans regularly spaced on the ceiling of the tunnel and reverse flow of the emergency smoke extraction outlets would be used to assist air flow through the tunnels to the ventilation point. Jet fans at the exit of the tunnel will stop the airflow from exiting the tunnel and force it towards the ventilation point.

In the event of an emergency, such as a fire in the tunnel, the jet fans would force air towards the ventilation point and fresh air would be drawn into the tunnel by reverse flow of one of the emergency smoke extraction outlets, whilst the other would extract smoke.

Vehicle emissions will be captured within the tunnels and discharged through the northern and southern ventilation outlets, which would be around 15m in height.

Vehicle emissions would be diluted within the tunnel and through ventilation and discharged higher in the atmosphere where greater dispersion occurs.

Emissions of interest are particulate matter (PM_{10} and $PM_{2.5}$), nitrogen dioxide (NO_2), carbon monoxide (CO), total volatile organic compounds (total VOCs) and polycyclic aromatic hydrocarbons (PAHs).

Modelling was undertaken to predict the emission levels in 2019 (year of opening) and in 2029, with current conditions used as a baseline.

The modelling is reliant upon the assumption that vehicle emissions will continue to improve in line with emission standards to 2020.

Overall, the project is predicted to lessen the impact of motor vehicle emissions along the Pennant Hills Road corridor due to:

- trucks being required to use the tunnel;
- private vehicles preferring to use the tunnel;
- improved travel times and speeds (therefore increasing vehicle efficiency);
- the avoidance of 21 sets of traffic lights.

The study predicted emissions for 2019 and 2029 and found that there is a net reduction in emissions, however there is a predicted increase in $PM_{2.5}$ levels for the 24 hour average and annual average in 2019 and 2029 around the southern ventilation outlet, which will result in higher levels for residents of The Hills Shire LGA.

There are no formally adopted criteria for the assessment and regulation of $PM_{2.5}$ in NSW. The assessment has adopted the advisory reporting standards in the *National Environment Protection (Ambient Air Quality) Measure*.

The standard for the 24 hour average $PM_{2.5}$ is 25µg/m^3. The assessment predicts a 24 hour average of 18.8µg/m^3 in 2019 and 19.4µg/m^3 in 2029, which are increases on current levels, but below the reporting criteria.

The standard for the annual average $PM_{2.5}$ is 8µg/m^3. The assessment predicts an annual average of 10.1µg/m^3 in 2019 and 10.2µg/m^3 in 2029. Both levels exceed the reporting standard, however the predicted levels without the project are higher with 12.6µg/m^3 and 15.3µg/m^3 respectively. The project is therefore expected to have a net benefit to residents over time.

Community concerns have questioned the feasibility of the southern ventilation stack as it is located approximately 250m from the southbound tunnel and there are no specific details in the EIS as to how the stack shall be connected to the tunnel. During the EIS exhibition period the NorthConnex project team has acknowledged these concerns and produced a Fact Sheet that is available on the NorthConnex website (Attachment 5).

Requests have been made by local residents for the southern ventilation stack to be located within the Pennant Hills Golf Course. From the information available in the EIS, it cannot be determined if this would result in an improved air quality outcome. Furthermore, the NorthConnex project team has discounted this option on the basis that it would require the acquisition of additional land within the Golf Course for the construction of the ventilation stack and associated mechanical and electrical services. A means of accessing the site for construction and operational activities would also have to be identified. Despite these responses from the project team, it is considered that this option should be investigated further in order to determine whether or not it would provide an improved air quality outcome.

The tunnel is expected to have a net benefit for air quality along Pennant Hills Road, with a small increase in $PM_{2.5}$ levels around the southern ventilation stack, however the predicted levels are lower than if the project did not proceed.

According to officers from the Department of Planning and Environment, independent air quality experts will be engaged by the Department to review the air quality modelling assessment in the EIS. It is also understood that the Department is seeking input from the EPA and the NSW Department of Health. The results of that review and any recommendations from the other government agencies will be used by the Department in its assessment of the EIS.

Recommendation 7

The proponent evaluate the relocation of the southern ventilation stack to a suitable site within the south-western corner of the Pennant Hills Golf Course, by modelling the air quality impacts from that site to enable comparisons with the proposal in the EIS to locate the ventilation stack within facilities at the southern end of the motorway control centre. Should air quality benefits be identified as a result of the evaluation, the southern ventilation stack be relocated to the Pennant Hills Golf Course.

5.4 Urban Design, Landscape Character and Visual Amenity

5.4.1 Southern Interchange Facility and Motorway Control Centre

The southern interchange facility is identified as the 'Urban Gateway' to the project. It is located at the corner of Pennant Hills and Eaton Roads, at West Pennant Hills and extends towards the existing intersection of the Hills M2 Motorway and Pennant Hills Road. The proposed site area for the facility is approximately 1.55ha.

The existing built form is mainly comprised of single or double storey dwelling houses. Under The Hills Local Environmental 2012, the site area and surrounding locality is zoned R2 Low Density Residential and has a maximum building height of 9m. The EIS provides an indicative design approach towards built form, urban design and landscaping. The final outcomes would however be subject to more detailed design and development prior to construction.

During the operational phase of the project the southern interchange facilitywould be comprised of a series of buildings including the motorway control centre and several service facilities including a water treatment plant, storage area, workshop, ventilation outlet, service yard, substation and associated parking facilities. The total built area across the site would be approximately 6,055m^2. The building heights across the site would vary and the proposed height of the main components is set out below:

Motorway Control Centre	15m
Workshop	11m
Covered Service Yard	10m
Southern Ventilation Facility	20m

As the site is currently zoned for low density housing, a floor space ratio (FSR) does not apply to the land. Should the land be developed with building footprints as indicated in the EIS, the FSR would be approximately 0.25:1.

The taller facilities of the southern ventilation building and the motorway control centre are located at either end of the site. They are described as being markers for the project due to increased visibility in the landscape.

The colour palette as proposed is largely neutral and comprises shades of grey and green to contribute to the contemporary 'urban gateway' function, legibility and branding of the project. The proposed planting scheme includes feature and bush planting areas to each boundary.

Figure 9: View of southern ventilation facility and motorway operations centre looking north west from corner of Pennant Hills Road and the M2 Hills Motorway (source: EIS)

Figure 10: Southern interchange facility aerial view looking south towards Pennant Hills Road from Pennant Hills Golf Course (source: EIS)

Figure 11: View of motorway control centre looking south-west from Pennant Hills Road (source: EIS)

Figure 12: View of motorway control centre looking north-east from Eaton Road (source: EIS)

The EIS outlines that the impacts of the complex are reduced as it faces away from the adjoining residential area. In addition the provision of screening vegetation within a 10m setback along the boundary would assist with reducing visual and amenity impacts to nearby residences.

In terms of built form and urban design, the nature and scale of the proposed development would be generally compatible with the existing roadway character of the M2 Motorway and Pennant Hills Road. The complex would be of a contemporary design and form a consistent street edge to Pennant Hills Road which is a beneficial outcome in urban design terms.

It is however noted that the southern interchange area also lies immediately adjacent to an existing low density residential area. The scale, form and fabric of the proposed buildings would be distinct from the existing low density built character.

The visual impact of the facility would extend approximately 1.0km from the site as identified in Figure 13.

In order to reduce impacts and assist integration with the surrounding locality it is noted a series of measures are proposed. These include a predominantly visually recessive colour palette and a variation across building heights. In addition, a combination of feature, tall tree and screen landscaping is proposed. Substantial landscaping to the rear of the site would be contained within a 10m setback adjacent to an internal roadway along the length of the complex.

When mature, the landscaping would provide separation between the complex and adjoining development, particularly the motorway control building and residential properties in Eaton Road and Karloon Road. Given the fact that the full maturity of species will not occur until sometime after the commencement of the project's operation, it is recommended that where practicable, mature or advanced tree species should be planted prior to the occupation of the site, particularly where they are adjacent or opposite residential properties.

In terms of overshadowing, there would be some minor impact to the rear of properties closest to the western boundary during the morning in the winter months. There would generally be no overshadowing in the summer period. Given the adjoining residential properties are oriented away from the complex, and overshadowing would affect a small portion of the rear backyards of affected properties, any such impacts are considered acceptable.

With regard to building heights, the southern ventilation facility is proposed to be 20m above ground level on one of the highest points of the site and would be visible from the rear of properties adjacent in Gum Grove Place and in the wider locality. It is noted that a separate recommendation to further investigate the relocation of the southern ventilation facility to Pennant Hills Golf Course is outlined as part of this report. If this was to occur, it would mitigate the visual impacts in this location.

Recommendation 8

Where practicable, advanced tree species should be planted prior to the operational occupation of the southern interchange facility and motorway control centre and particularly where there is an interface with residential properties on Eaton and Karloon Roads, and where the site adjoins Hillside Place and Gum Grove Place.

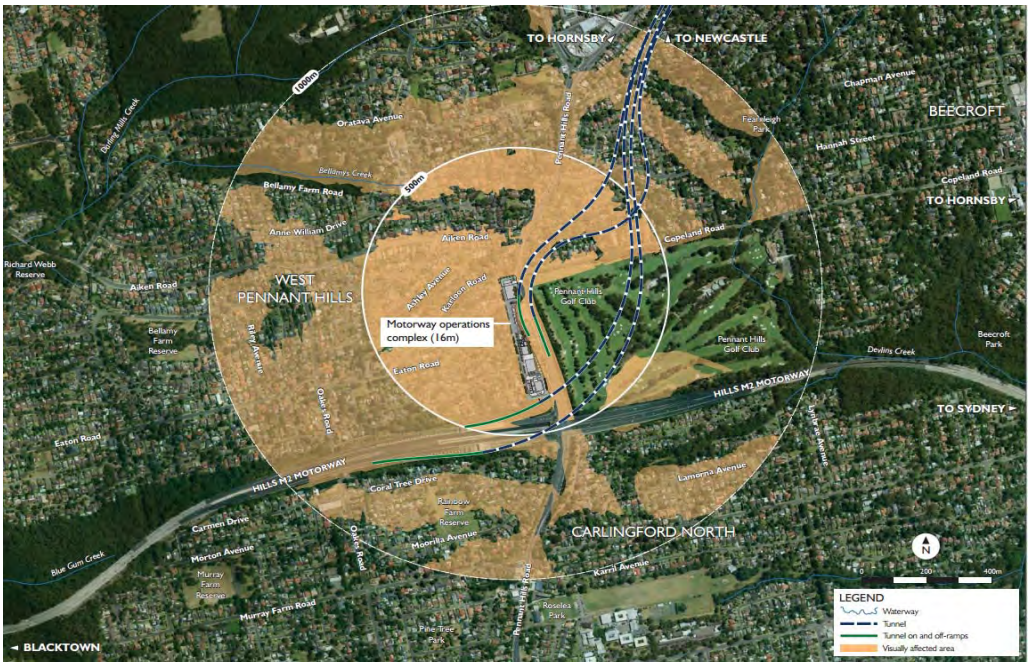


Figure 13: Motorway control centre visual envelope map (source: EIS)

5.5 Biodiversity

The construction work associated with the NorthConnex project will include the clearing of 5.87 hectares of vegetation, including 2.81 hectares of Blue Gum High Forest and 0.10 hectares of Sydney Turpentine-Ironbark Forest (Critically Endangered Ecological Communities); and the removal of an estimated 106 individual *Epacris purpurascens* var. *purpurascens*, also a threatened species.

The majority of the proposal is within the Hornsby Shire Local Government Area, with the northern interchange being in the Ku-Ring-Gai Local Government Area and the southern interchange and Hills M2 Motorway integration works within The Hills Shire LGA.

The proposal will require the removal of 5.87 hectares of vegetation, including 2.81 hectares of Blue Gum High Forest; 0.10 hectares of Sydney Turpentine-Ironbark Forest; and the removal of an estimated 106 individual *Epacris purpurascens* var. *purpurascens* which is deemed to be a significant impact on the local occurrence of this species. The study identified that the project may also have impacts on: *Hibbertia superans;* a maternity colony of Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*); Red-Crowned Toadlet (*Pseudophryne australis);* and hollow-dependent fauna including various bats and birds with the removal of up to 62 hollow bearing trees including four very large hollows suitable for large forest owls or Glossy Black Cockatoos and that have evidence of being used.

In order to address the impacts, the following are some of the mitigation measures proposed:

- route selection was apparently selected based on minimal impact to biodiversity;

- a Flora and Fauna Management Plan is recommended to be prepared with consideration to the Roads and Maritime Biodiversity Guidelines (Roads and Traffic Authority 2011) including standard mitigation measures;
- potential translocation and seed soil bank propagation of *E. purparescens* var. *purpurascens*. This is considered to be a potential substitute for the purchase of species credits (1,767 credits have been calculated to adequately offset the impact to this species).
- native vegetation rehabilitation – areas and actions to be identified in Flora and Fauna Management Plan;
- a Microbat Management Plan is recommended to detail measures required to eliminate the likelihood of any microbats being harmed;
- installation of nest boxes as a means of compensating for the loss of habitat for hollow-dependent fauna.

Recommendation 9

The report relies largely on the purchase and retirement of BioBanking credits, including Blue Gum High Forest (163 ecosystem credits), and *E. purpurascens* var. *purpurascens* (potentially 1,767 species credits). The issue of impact on Blue Gum High Forest will be particularly difficult to offset as there are so few sites with Blue Gum High Forest left. Offset sites or credits should be identified and procured prior to works commencing.

Recommendation 10

Specific priority should be given to securing offset sites as near to the location of the impact/loss as possible, to assist with the preservation of the specific endemic community of the area and assure that the ecological and amenity benefits of retaining endemic vegetation remain within the Local Government Area.

Recommendation 11

The offsets are reviewed against the Office of Environment and Heritage's Principles for the use of Biodiversity Offsets in NSW. It notes 'discounting of offsets due to significant social and economic benefits accruing to NSW would be the subject of discussions with NSW Department of Planning and Environment'. The proponent should be encouraged to avoid pursuing the discounting of offsets, in order to ensure that the real impacts on biodiversity are appropriately and fully compensated for through mitigation or offset measures (where avoidance is not possible).

Recommendation 12

The Flora and Fauna Management Plan, Microbat Management Plan and Offset Strategy are to be provided to all affected Councils for review prior to approval.

Recommendation 13

Should the project require the translocation of *E. purpurascens* var. *purpurascens* individuals, a monitoring program should be developed and implemented over an adequate timeframe in order to monitor and report on the long-term success of this management action. Should translocation fail, then the adequate number of

BioBanking credits should be purchased and surrendered to compensate for their loss given that the impact is deemed to be significant for this species.

Recommendation 14

Maintenance of the native vegetation rehabilitation areas should occur for a period of at least five years following construction, to ensure weeds are controlled and native plants are surviving and thriving in these areas.

Recommendation 15

A significant number and range of nest boxes should be carefully selected and placed in suitable locations as a means of providing habitat for the variety of species that may be using the existing hollows including microbats, Glossy Black Cockatoos and large forest owls. Consideration should be given to the reuse of the hollows cut from trees removed in the construction footprint, and securely attached to trees within adjacent bushland areas. The removal of trees containing hollows should be avoided if at all possible. The use of the nest boxes and reused tree hollows should be monitored over a longer timeframe in order to monitor and report on the success of this management action.

5.6 Greenhouse Gases and Climate Change

The EIS estimates that the construction of the project would generate approximately 535,500 tonnes of CO_2e, with 43% Scope 1 emissions, 13% Scope 2 emissions and 44% Scope 3 emissions. Fuel use for plant and equipment and transport of materials comprise the majority of Scope 1 emissions. The embodied energy of the construction materials accounts for 87% of the Scope 3 emissions.

The operation and maintenance of the project over the anticipated design life of 100 years is expected to generate 7,227 tonnes of CO_2e, primarily being electricity consumption.

Given that the project would result in providing a more direct route at higher average speeds for road users, it is estimated to save 47,100 tonnes of CO_2e from road users in the first year (2019). This saving is estimated to offset the emissions generated from the construction of the project by 2027.

Recommendation 16

The report identified a variety of mitigation measures associated with greenhouse gas emissions and climate change. Many of these are broad sweeping statements, such as *'emissions intensity of construction materials would be considered during procurement'* and *'fuel efficiency of the construction plant and equipment would be considered during selection'*.

There is a concern that this would be overlooked through the decision-making process and therefore it is recommended that mechanisms such as policy, setting minimum standards and targets be established early in the process to ensure that greenhouse gas emissions are a key element of decision-making for procurement, detailed design and operation of the project.

Recommendation 17

Consideration should be given to the development of a Greenhouse Gas Emissions Management Plan in order to document the above mechanisms to ensure that emissions from the construction and operation of the project are reduced as much as possible and that climate change impacts are appropriately incorporated into the project.

5.7 Social and Economic

An assessment of social and economic impacts as well as a business assessment was undertaken as part of the EIS. The assessment considers social and economic impacts to businesses along Pennant Hills Road and the Pacific Highway. A technical working paper on business impacts has also been prepared.

Construction expenditure for the project would be of significant benefit to the local, regional and state economies. Businesses within the study area would principally benefit from purchases made by construction contractors and their associated workers. Economic impacts can be split into direct and indirect impacts. Businesses whose turnover may directly benefit from the project would include local contractors, local suppliers of goods and businesses who service the construction industry such as food and beverage retailers, accommodation providers and other retail outlets that would service the day to day needs of the construction workforce.

Indirect impacts are those to the wider state economy. The project would result in the following indirect and direct economic impacts:

- around $2.9 billion generated in direct construction expenditure with flow-on (indirect) effects of around $1 billion;
- around $500 million of household income with flow-on effects of around $200 million;
- direct employment of around 5,060 full-time equivalent (FTE) positions per year for four years with flow-on employment of about 3,649 FTE positions per year for four years;
- valued added attributable to the construction of the project is estimated to be around $900 million directly, with flow-on effects of $400 million, giving an estimated total value added contribution of $1.3 billion. This is the estimated contribution to Gross State Product (GSP).

During construction there may also be employment opportunities for local residents as part of the construction workforce or in a secondary business supporting construction. Around 1,250 jobs would be directly created at the peak of the construction period. This would include both the staff and labour workforce. Further jobs in the local area are likely to be indirectly supported by the project. Increasing demand for employees may also increase wages within the area. It is predicted that the overall wealth and disposable income in the region could grow as a result of increases in local business turnover and employment of local residents.

Cumulative impacts such as those related to the construction of the North West Rail Link may potentially increase the construction impacts outlined above, particularly impacts relating to local employment and economic stimulus. The demand for labour for major projects such as this project, the North West Rail

Link and the Epping to Thornleigh Third Track project would increase employment opportunities for local residents and potentially increase wages as demand for construction workers increases. The opportunity for local businesses to supply goods or services to the construction phase of these projects and their construction workforces has the potential to increase business turnover due to high demand from multiple projects.

In relation to local impacts the EIS notes that construction impacts relating to noise and air quality would most likely affect outdoor restaurants, cafes and eateries. The neighbourhood centre at Carmen Drive, Carlingford is outlined as potentially being affected due to its proximity to the southern interchange/ Coral Tree Drive switching station. The specific impacts on this centre or proposed mitigation measures are not however addressed in any detail within the report and it is recommended that further information in the form of a detailed economic impact assessment be provided.

Recommendation 18

A detailed economic impact assessment incorporating proposed mitigation measures relating to the Carmen Drive neighbourhood centre during the construction and operational phases of the project, be provided for consideration by Council.

5.8 Surface Water

5.8.1 Flooding

The assessment of flooding (Section 7.9.2, page 857) on the local overland flow and drainage system, specifically in regard to the Hills M2 Motorway widening works, has not been addressed sufficiently within the Environmental Impact Statement (EIS).

Specifically, the following statement in the Flooding section on Page 857 of the report, "*The nearest identified flood prone areas are along the northern boundaries of the Hornsby and Hills Shire local government areas, which are both over 20 kilometres north of the project corridor*" is incorrect.

Within that part of The Hills Shire Council area near the project, flood and overland flowpath information in relation to both local urban and mainstream flooding is available for Blue Gum Creek, Darling Mills Creek, Stevensons Creek and other various local catchment draining into these waterways, north and south of the Hills M2 Motorway.

The then Upper Parramatta River Catchment Trust (now the Greater Sydney Local Land Services) carried out significant flood modelling in the Upper Parramatta River Catchment and Council has also carried out investigations to identify overland flowpaths within local floodplains.

General statements in regard to "*the control of discharge flow rates, as well as other standard construction measures*" have been provided. However the statement "*Due to the location of the project away from flood prone land and the maintenance of existing drainage infrastructure, the construction of the project is not anticipated to result in changes to localised flooding*" has not been qualified within the EIS, specifically in relation to the Hills M2 Motorway upgrade works.

Recommendation 19

The EIS has not adequately considered the impacts on flood prone land and overland flowpaths for the waterways and catchments in the vicinity of the Hills M2 Motorway as it relates to the proposed widening works and any stormwater infrastructure upgrades. Further information is required in order to satisfy Council's concerns about these potential impacts.

5.8.2 Existing Stormwater Drainage Systems

The EIS has proposed an extension of five existing transverse drainage culverts on the Hills M2 Motorway during the project and alteration to the Pennant Hills Road drainage system to provide capacity for a 20 year ARI storm event. Specific details of the location and possible activity/changes to the structures have not been provided within the EIS.

Flood prone land is directly adjacent to the Hills M2 Motorway and the existing drainage structures and culverts that convey flows under the M2 have a direct influence on the local flood regime of these catchments. Additionally, if there are to be direct connections to the Council's existing downstream stormwater system from Pennant Hills Road, it should be noted that Council's stormwater drainage system is unlikely to have the capacity to convey the 20 year ARI flows proposed within the EIS.

Where any surface operational ancillary facilities require connections into Council's stormwater system, a full understanding of the hydraulic capacity and performance of that system is required. Furthermore, where the connection is likely to increase the impacts on Council's stormwater system, it should be upgraded to meet the increased demand from the project.

Recommendation 20

Any design carried out for alterations to the existing drainage structures and culverts associated with the Hills M2 Motorway widening works and any connection into Council's existing stormwater system needs to be undertaken with a complete understanding of the local flood regime, the receiving stormwater system's capacity and the associated flood hazard and impacts to the local community affected. Flood impacts to the local community as a result of the proposed works should be reduced or at least not exacerbated.

Where there will be a negative impact on the performance and capacity of Council's existing stormwater system arising from the project, it must be upgraded by the project.

5.9 Other Matters

Recommendation 21

Following its lease to Council by the RMS for construction of a commuter carpark, an alternate site be found for the proposed Windsor Road construction compound.

Recommendation 22

All relevant emergency services be consulted on the proposed fire fighting, evacuation and rescue arrangements during the detailed design phase of the project.

Recommendation 23

It is essential that the project delivery incorporates engagement activities that allow the community and other key stakeholders such as the affected Councils to be involved in the project's actual delivery. This will help manage the impacts on residents by providing an opportunity for them to influence and feel part of the project. Community liaison or reference groups similar to other recent major infrastructure projects such as the Westlink M7 Motorway, Hills M2 Motorway widening and North West Rail Link all provide successful models.

Recommendation 24

At the conclusion of the project the RMS should dedicate any existing parcels of land still in its ownership that are located on carriageway and footway areas on Pennant Hills Road around the southern interchange facility, as public road.

CONCLUSION

When completed the NorthConnex project will be one of the largest motorway projects to be undertaken within the Sydney metropolitan area in recent years. The project has been the subject of significant technical investigations over many years as well as an independent enquiry chaired by the late Mahla Pearlman AO, former Chief Justice of the NSW Land and Environment Court.

NorthConnex will result in a high standard motorway that integrates with the regional transport network providing a number of benefits at a regional and local level. While it is disappointing that a direct connection to the motorway will not be available for many residents of the Shire travelling to and from the M1 Pacific Motorway, it will significantly improve traffic conditions on Pennant Hills Road by removing approximately 5,000 heavy vehicles per day.

Overall it is considered that the impacts of the project as described in the EIS are generally satisfactory. Furthermore it is considered that the project's proponents have largely addressed the Director General's environmental assessment requirements. However Council officers have identified in the report a number of concerns and comments which should be submitted to the Department of Planning and Environment.

Perhaps the most significant of those concerns is the proposal for heavy vehicles travelling to the southern interchange construction site from the north to use Aiken Road, Oakes Road, Eaton Road and Karloon Road.

As described in the report such a proposal is totally unacceptable because of its potential impact on existing traffic movements through the West Pennant Hills Valley, damage to Councils road pavement assets and perhaps most importantly, the impact on the amenity of local residents. It is also highly unlikely that the width and alignment of Eaton and Karloon Roads would even allow heavy vehicles to use these roads without significant changes to their design.

IMPACTS

Financial

This matter has no direct financial impact upon Council's adopted budget or forward estimates.

The Hills Future - Community Strategic Plan

The NorthConnex project is consistent with The Hills Future Community Strategic Plan as it will provide a strategic north-south road transport link for traffic, including road freight, travelling through the Sydney metropolitan area. It will also provide a range of other benefits for many residents of The Hills and Hornsby Shires in particular, through the removal of large numbers of heavy vehicles from Pennant Hills Road.

RECOMMENDATION

The report and following recommendations form the basis of Council's submission to the NorthConnex Project's Environmental Impact Statement.

Traffic

1. The NorthConnex project should consider longer term options for intermediate access between the Hills M2 Motorway and the M1 Pacific Motorway.

2. The use of Aiken Road, Oakes Road and Eaton Road/Karloon Road as a proposed inbound heavy vehicle access route from the north into the southern interchange construction site is totally unacceptable. Alternate routes need to be identified that restrict inbound access to the site off Pennant Hills Road or the Hills M2 Motorway.

3. A copy of the Construction Traffic Management Plan (CTMP) be provided to all affected Councils for review prior to approval.

Noise

4. A copy of the Construction Noise and Vibration Management Plan (CNVP) be provided to all affected Councils for review prior to approval.

5. The detailed design stage of ventilation facilities, jet fans, substations and motorway control centre be certified by an acoustic consultant as meeting the project specific noise criteria.

6. A post commencement acoustic assessment be carried out to verify the findings of modelling and/or identify any further acoustic treatment required to protect the acoustic amenity of the neighbourhood around the southern interchange facility.

Air Quality

7. The proponent evaluate the relocation of the southern ventilation stack to a suitable site within the south-western corner of the Pennant Hills Golf Course, by modelling the air quality impacts from that site to enable comparisons with the proposal in the EIS to locate the ventilation stack within facilities at the southern end of the

motorway control centre. Should air quality benefits be identified as a result of the evaluation, the southern ventilation stack be relocated to the Pennant Hills Golf Course.

Urban Design, Landscape Character and Visual Amenity

8. Where practicable, advanced tree species should be planted prior to the operational occupation of the southern interchange facility and motorway control centre and particularly where there is an interface with residential properties on Eaton and Karloon Roads and where the site adjoins Hillside Place and Gum Grove Place.

Biodiversity

9. The report relies largely on the purchase and retirement of BioBanking credits, including Blue Gum High Forest (163 ecosystem credits), and *E. purpurascens* var. *purpurascens* (potentially 1,767 species credits). The issue of impact on Blue Gum High Forest will be particularly difficult to offset as there are so few sites with Blue Gum High Forest left. Offset sites or credits should be identified and procured prior to works commencing.

10. Specific priority should be given to securing offset sites as near to the location of the impact/loss as possible, to assist with the preservation of the specific endemic community of the area and assure that the ecological and amenity benefits of retaining endemic vegetation remain within the Local Government Area.

11. The Offsets are reviewed against the Office of Environment and Heritage's Principles for the use of Biodiversity Offsets in NSW. It notes 'discounting of offsets due to significant social and economic benefits accruing to NSW would be the subject of discussions with NSW Department of Planning and Environment'. The proponent is encouraged to avoid pursuing the discounting of offsets, in order to ensure that the real impacts on biodiversity are appropriately and fully compensated for through mitigation or offset measures (where avoidance is not possible).

12. The Flora and Fauna Management Plan, Microbat Management Plan and Offset Strategy are to be provided to all affected Councils for review prior to approval.

13. Should the project require the translocation of *E. purpurascens* var. *purpurascens* individuals, a monitoring program should be developed and implemented over an adequate timeframe in order to monitor and report on the long-term success of this management action. Should translocation fail, then the adequate number of BioBanking credits should be purchased and surrendered to compensate for their loss given that the impact is deemed to be significant for this species.

14. Maintenance of the native vegetation rehabilitation areas should occur for a period of at least five years following construction, to ensure weeds are controlled and native plants are surviving and thriving in these areas.

15. A significant number and range of nest boxes should be carefully selected and placed in suitable locations as a means of providing habitat for the variety of species that may be using the existing hollows including microbats, Glossy Black Cockatoos and large forest owls. Consideration should be given to the reuse of the hollows cut from trees removed in the construction footprint, and securely attached to trees within adjacent bushland areas. The removal of trees containing hollows should be avoided if at all possible. The use of the nest boxes and reused tree hollows should be

monitored over a longer timeframe in order to monitor and report on the success of this management action.

Greenhouse Gases and Climate Change

16. The report identified a variety of mitigation measures associated with greenhouse gas emissions and climate change. Many of these are broad sweeping statements, such as *'emissions intensity of construction materials would be considered during procurement'* and *'fuel efficiency of the construction plant and equipment would be considered during selection'*.

    There is a concern that this would be overlooked through the decision-making process and therefore it is recommended that mechanisms such as policy, setting minimum standards and targets be established early in the process to ensure that greenhouse gas emissions are a key element of decision-making for procurement, detailed design and operation of the project.

17. Consideration should be given to the development of a Greenhouse Gas Emissions Management Plan in order to document the above mechanisms to ensure that emissions from the construction and operation of the project are reduced as much as possible and that climate change impacts are appropriately incorporated into the project.

18. A detailed economic impact assessment incorporating proposed mitigation measures relating to the Carmen Drive neighbourhood centre during the construction and operational phases of the project be provided for consideration by Council.

Surface Water

19. The EIS has not adequately considered the impacts on flood prone land and overland flowpaths for the waterways and catchments in the vicinity of the Hills M2 Motorway as it relates to the proposed widening works and any stormwater infrastructure upgrades. Further information is required in order to satisfy Council's concerns about these potential impacts.

20. Any design carried out for alterations to the existing drainage structures and culverts associated with the Hills M2 Motorway widening works and any connection into Council's existing stormwater system needs to be undertaken with a complete understanding of the local flood regime, the receiving stormwater system's capacity and the associated flood hazard and impacts to the local community affected. Flood impacts to the local community as a result of the proposed works should be reduced or at least not exacerbated.

    Where there will be a negative impact on the performance and capacity of Council's existing stormwater system arising from the project, it must be upgraded by the project.

Other Matters

21. Following its lease to Council by the RMS for construction of a commuter carpark, an alternate site be found for the proposed Windsor Road construction compound.

22. All relevant emergency services be consulted on the proposed fire fighting, evacuation and rescue arrangements during the detailed design phase of the project.

23. It is essential that the project delivery incorporates engagement activities that allow the community and other key stakeholders such as the affected Councils to be involved in the project's actual delivery. This will help manage the impacts on residents by providing an opportunity for them to influence and feel part of the project. Community liaison or reference groups similar to other recent major infrastructure projects such as the Westlink M7 Motorway, Hills M2 Motorway widening and North West Rail Link all provide successful models.

24. At the conclusion of the project the RMS should dedicate any existing parcels of land still in its ownership that are located on carriageway and footway areas on Pennant Hills Road around the southern interchange facility, as public road.

ATTACHMENTS

1. Project Operational Footprint (Maps 1-8) (8 pages)
2. Hills M2 Motorway Integration Works Maps 1 and 2 (2 pages)
3. Project Construction Footprint Map 1 and 2 (2 pages)
4. Plant & Equipment (2 pages)
5. Permanent Features - Southern Interchange (1 page)

ATTACHMENT 1

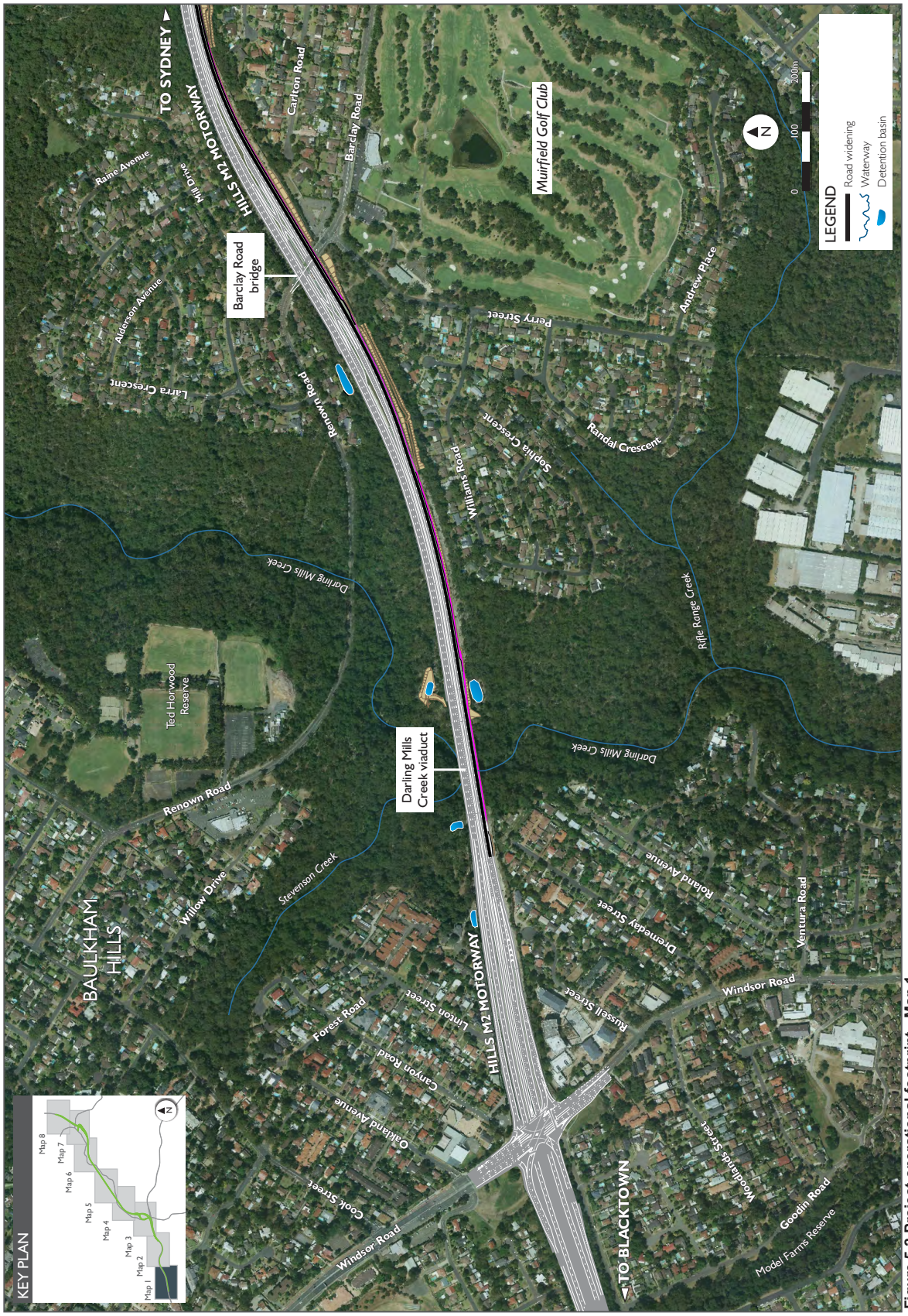


Figure 5-2 Project operational footprint - Map 1

Figure 5-3 Project operational footprint - Map 2

Figure 5-4 Project operational footprint - Map 3

Figure 5-5 Project operational footprint - Map 4

Figure 5-6 Project operational footprint - Map 5

Figure 5-7 Project operational footprint - Map 6

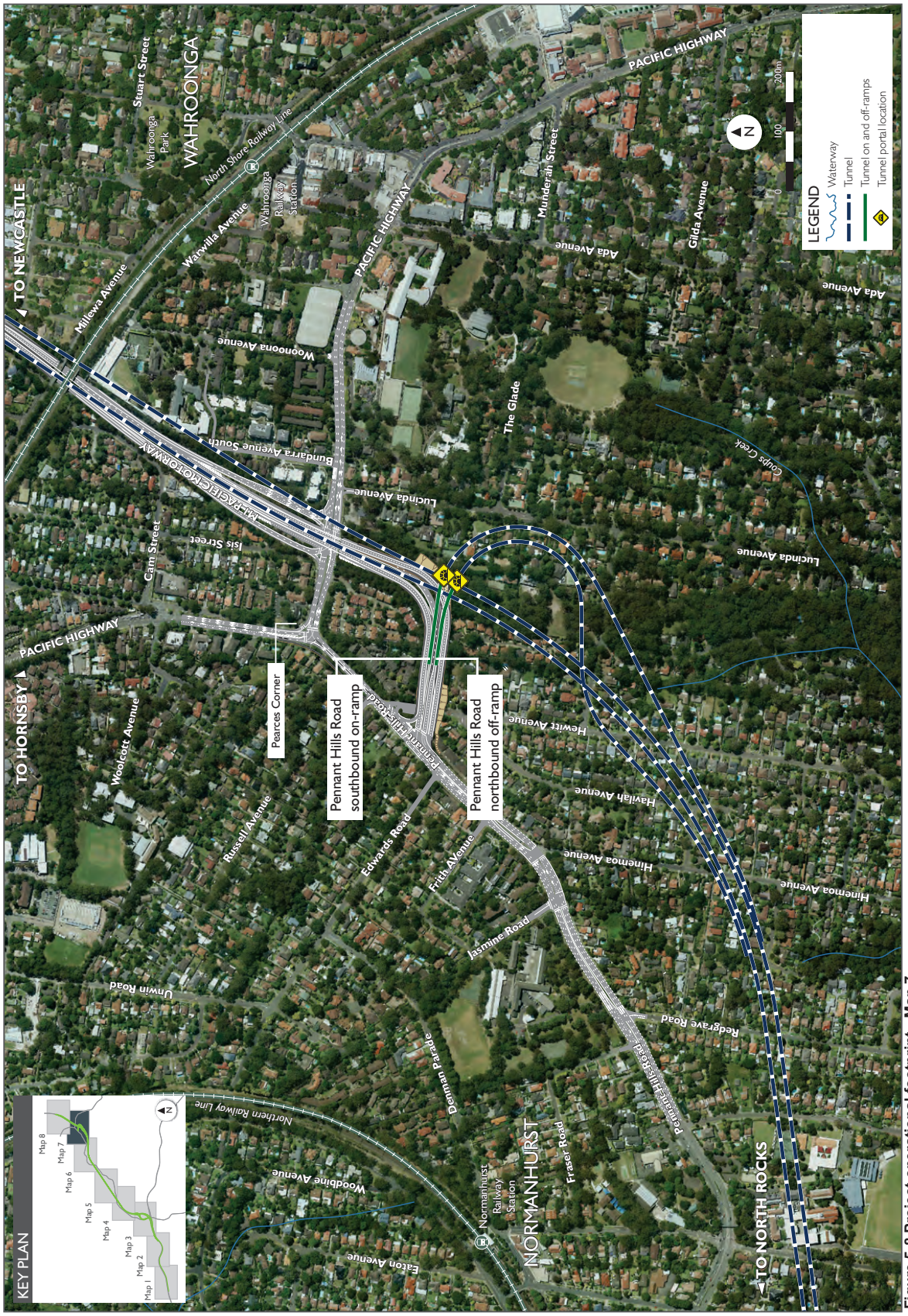


Figure 5-8 Project operational footprint - Map 7

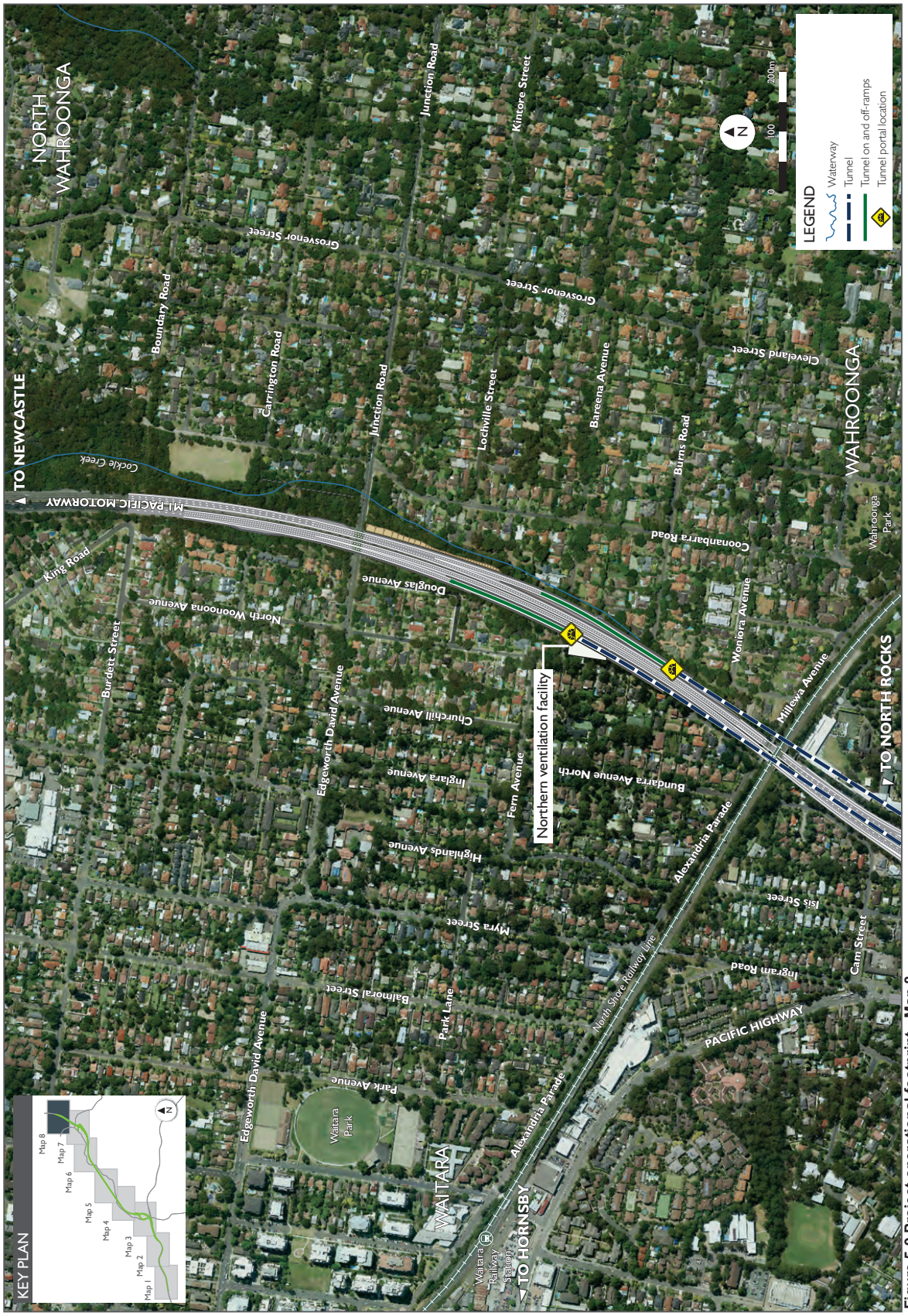


Figure 5-9 Project operational footprint - Map 8

ATTACHMENT 2

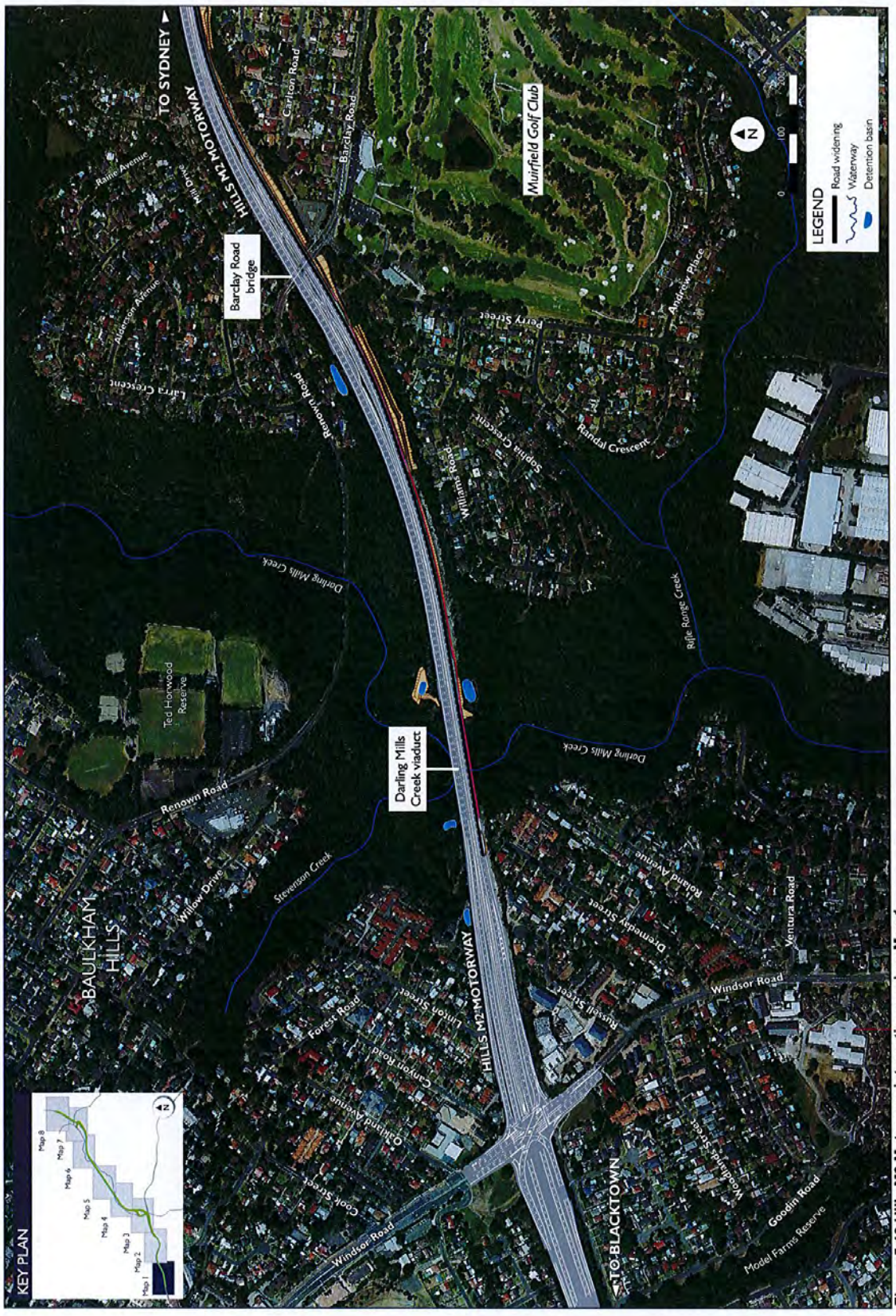


Figure 5-19 Hills M2 Motorway integration works - Map 1

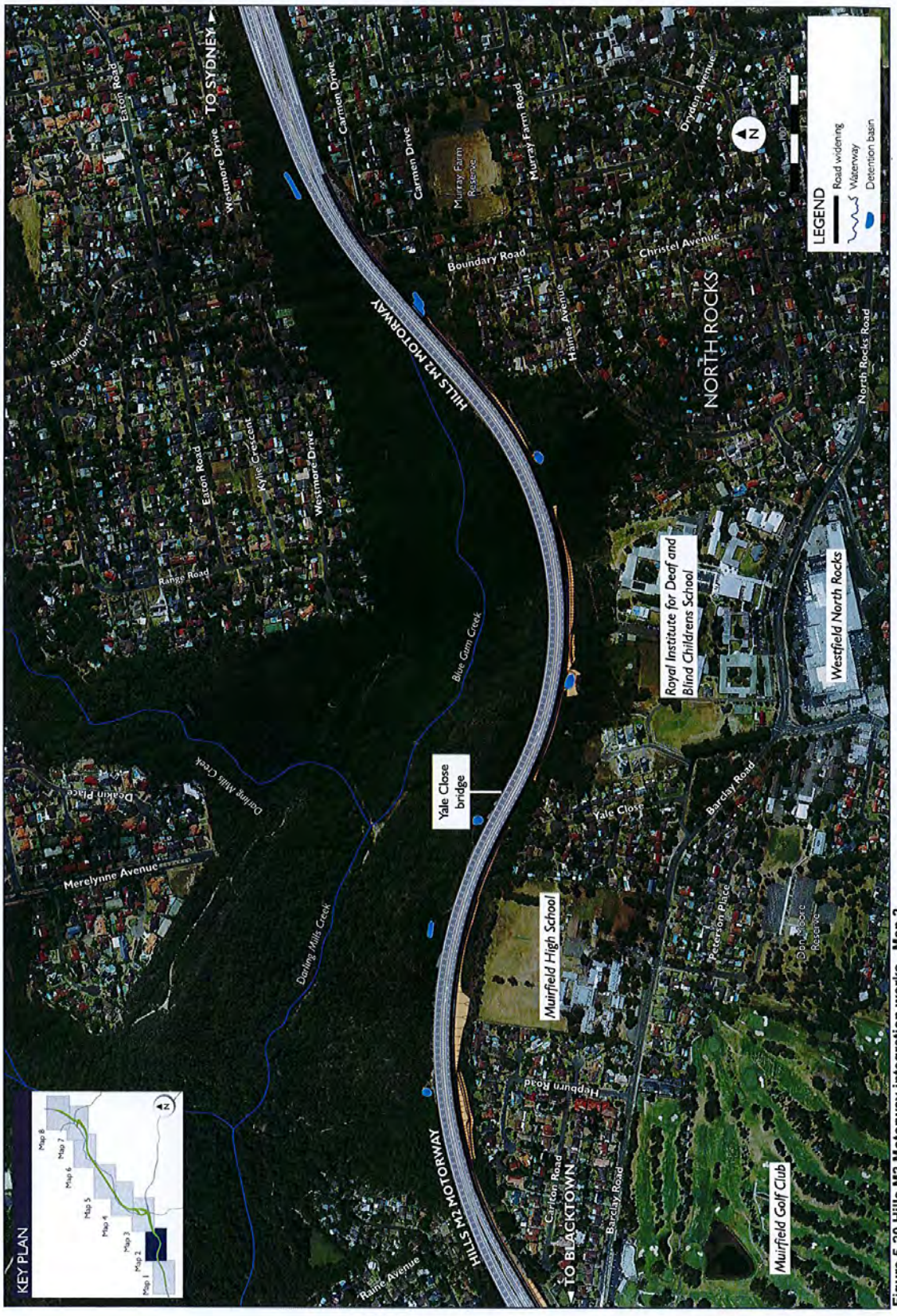


Figure 5-20 Hills M2 Motorway integration works - Map 2

ATTACHMENT 3

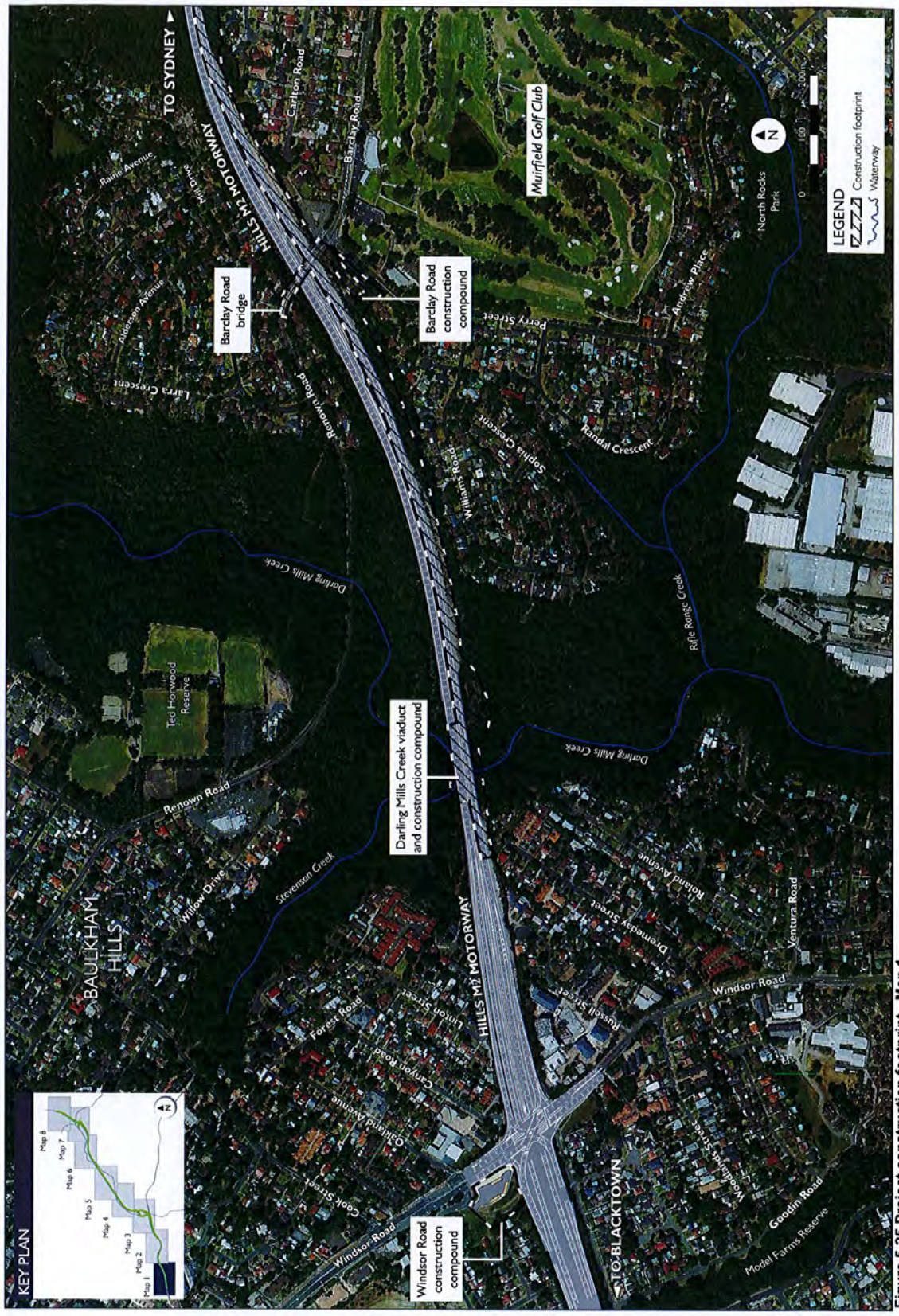


Figure 5-25 Project construction footprint - Map 1

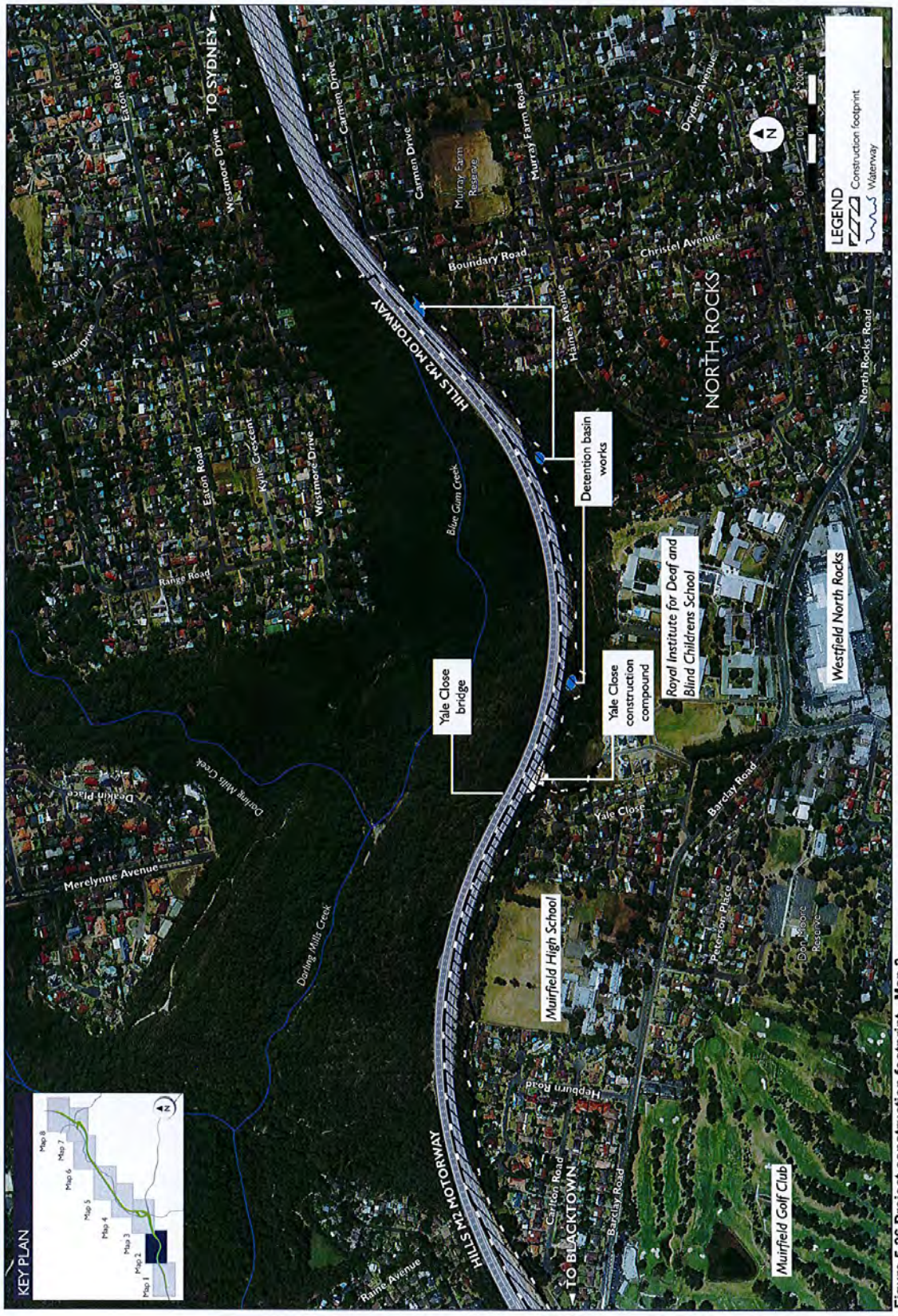


Figure 5-26 Project construction footprint - Map 2

ATTACHMENT 4

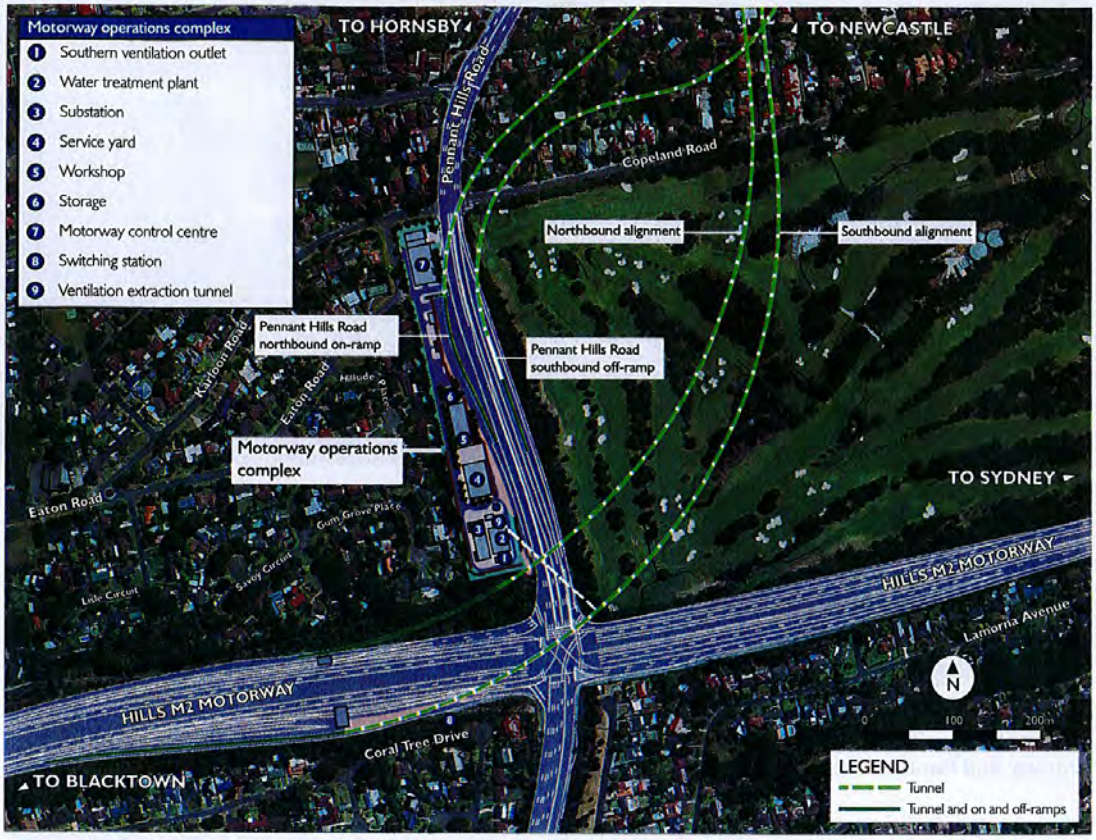
Plant / equipment	Hills M2 Motorway integration	Southern interchange compound (C5)	Wilson Road compound (C6)	Trelawney Street compound (C7)	Northern interchange compound (C9)	Bareena Avenue compound (C10)
Surface						
100 tonne / 10 tonne gantry crane			✓	✓	✓	
160 kilowatt fan		✓(4)	✓(4)	✓(4)	✓(4)	
20 tonne excavator		✓	✓	✓		✓
24 tonne excavator		✓(2)	✓	✓	✓	
30 tonne excavator	✓(6)	✓	✓	✓		✓
Backhoe	✓(6)	✓	✓	✓		
Bobcat		✓	✓	✓		
80 tonne piling rig	✓(3)	✓	✓	✓		✓
Dozer	✓(6)					✓
Dump truck						✓(4)
25 tonne mobile crane		✓	✓	✓		✓
50 tonne mobile crane	✓(6)	✓	✓	✓		✓
100 tonne mobile crane		✓	✓	✓		✓
Hiab truck		✓	✓	✓		✓
10 tonne smooth drum vibrating roller	✓(6)	✓	✓	✓		✓
Compactor						✓
Grader	✓(6)					
Concrete saw / cutter	✓(4)					
Rock saw	✓(4)					
Hydraulic hammer / rock breaker	✓(6)					
Jackhammer	✓(6)					
Rock crusher	✓(6)					

Plant / equipment	Hills M2 Motorway integration	Southern interchange compound (C5)	Wilson Road compound (C6)	Trelawney Street compound (C7)	Northern interchange compound (C9)	Bareena Avenue compound (C10)
Asphalt laying machine	✓(2)					
Truck	✓(10)					
Line marking machine	✓(2)					
Paving machine	✓(2)					
30 tonne gantry crane			✓	✓	✓	
60 kilowatt fan		✓				
Air compressor		✓(2)	✓(2)	✓(2)	✓(2)	
Bucket loader		✓(2)	✓	✓	✓	✓
100 tonne crawler crane		✓(2)	✓	✓	✓	
Grout plant / paddle mixer		✓(2)	✓	✓	✓	
Jumbo drill (shaft)		✓(2)	✓	✓	✓	
Road sweeper truck		✓	✓	✓	✓	✓
Skid steer loader		✓	✓	✓	✓	✓
Submersible pump		✓(8)	✓(6)	✓(6)	✓(6)	✓
Sump pump		✓(3)	✓(2)	✓(2)	✓(2)	✓(3)
Water cart	✓(2)	✓	✓	✓	✓	✓
Water treatment plant		✓	✓	✓	✓	
100 kilovolt ampere generator	✓(4)	✓	✓	✓		✓
Underground						
12 tonne mini excavator with hammer		✓	✓	✓	✓	
24 tonne excavator		✓	✓	✓	✓	
24 tonne excavator with diamond cutting tool		✓(2)	✓	✓	✓	
Booster pumps		✓	✓	✓	✓	
Bucket loader		✓(3)	✓(3)	✓(3)	✓(3)	
Colloidal grout mixer		✓	✓	✓	✓	
Concrete agitator		✓(4)	✓(4)	✓(4)	✓(4)	
Deduster (dry type) and fan		✓(4)	✓(5)	✓(5)	✓(5)	
25 tonne articulated dump truck		✓(7)	✓(6)	✓(6)	✓(6)	
Gate end box		✓(4)	✓(4)	✓(4)	✓(4)	
200 kilowatt roadheader (for cross passages)			✓	✓	✓	
300 kilowatt roadheader		✓(4)	✓(4)	✓(4)	✓(4)	
Rockbolting rig		✓(3)	✓(3)	✓(3)	✓(3)	
Shotcrete robot		✓(3)	✓(3)	✓(3)	✓(3)	
Skid steer loader			✓	✓	✓	
Water cart					✓	

ATTACHMENT 5

Fact Sheet - Southern interchange | July 2014 www.northconnex.com.au

Permanent features - Southern interchange



Motorway control centre

A 24 hour staffed motorway control centre would be located on the corner of Pennant Hills Road and Eaton Road. The centre would include a tunnel control room, training/incident response room, workshop space, emergency vehicle depot, garage and parking facilities. This is necessary to monitor, maintain and control tunnel services including tunnel safety, ventilation, power, lighting and other road systems required for safe and efficient tunnel operation. Centre would be staffed by around 30 personnel.

Tunnel ventilation outlet

The ventilation outlet would be located on the north-western corner of the current Hills M2 Motorway/Pennant Hills Road interchange. The site has been co-located with other operational facilities to reduce the amount of land acquisition required.

The outlet would be over 24 metres in height, relative to the adjacent properties and is around 15 metres from Pennant Hills Road. During operation, the ventilation system would draw fresh air into the tunnel and emit air via the ventilation outlet.

The air quality modelling predicts emissions from the ventilation outlet would have a negligible impact on local air quality. The improvement along Pennant Hills Road when the tunnel opens in 2019 is up to 20 per cent (for annual average of $PM_{2.5}$ concentrations)

Air quality in the vicinity of the project would be monitored before and after the tunnel is operational for a minimum of 12 months once open. There would also be 24-hour air monitoring inside the tunnel. Air quality monitoring results would be made publicly available.

Coral Tree Drive switching station

An electrical switching station would be constructed on Coral Tree Drive, Carlingford, on the south-west side of the Pennant Hills Road/Hills M2 Motorway interchange, to power the tunnels and associated mechanical and electrical equipment. Back up generators and batteries would be used to provide an uninterrupted power supply which is essential for effective tunnel operation and safety.

Project information line: **1800 997 057** (free call) | Email: **enquiries@northconnex.com.au** www.northconnex.com.au